

**EFFICACY OF PRE-EMERGENCE AND POST-EMERGENCE
HERBICIDES ON WEED CONTROL IN WHEAT-GREEN GRAM
CROPPING SYSTEM UNDER TRANS-GANGETIC PLAINS OF
PUNJAB**

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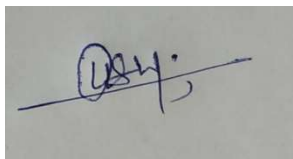


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2023

Declaration

I, hereby declared that the present work in the thesis entitled **EFFICACY OF PRE-EMERGENCE AND POST-EMERGENCE HERBICIDES ON WEED CONTROL IN WHEAT-GREEN GRAM CROPPING SYSTEM UNDER TRANS-GANGETIC PLAINS OF PUNJAB** in fulfilment of degree of **Doctor of Philosophy (Ph.D.)** is outcomes of research work carried out by me under the supervision of Dr. Sandeep Menon, working as Head of Department (Agronomy), School of Agriculture, Lovely Professional University, Punjab, India. In keeping with general practice of reporting scientific observations, due acknowledgement have been made whenever work described here has been based on findings of other investigators. This work has not been submitted in part or full to any other University or Institute for the award of any degree.



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Certificate

This is certify that the work reported in the Ph.D. thesis entitled **EFFICACY OF PRE-EMERGENCE AND POST-EMERGENCE HERBICIDES ON WEED CONTROL IN WHEAT-GREEN GRAM CROPPING SYSTEM UNDER TRANS-GANGETIC PLAINS OF PUNJAB** submitted in fulfilment of the requirement for the reward of **Doctor of Philosophy (Ph.D.)** in the School of Agriculture of Lovely Professional University, Punjab, India, is a research work carried out by Research Scholar, Vyvahare Laxman Somanath (Registration No. 11915272), is bonafide record of his original work carried out under my supervision and that no part of thesis has been submitted for any other degree, diploma or equivalent course.



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ABSTRACT

In order to determine the most efficient weed control treatments in the wheat-green gram cropping system, area investigate at study farm of LPU, Punjab, two consecutive *Rabi* and *Kharif* seasons 2020-21 and 2021-22. Three replications of the experiment were run using the Randomised Block Design method. Eight different treatments were used in the studies on wheat pyroxasulfone 120 g PE combined with pendimethalin 850 g PE, pyroxasulfone 110 g PE combined with pendimethalin 800 g PE, sulfosulfuron combined with metsulfuron 40 g PoE, HW (30 and 60 DAS), sulfosulfuron combined with metsulfuron 35 g PoE, clodinafop propargyl 400 g PoE combined with HW (60 DAS), PoE 2, 4-D Na 0.750 kg combined with HW (60 DAS) and Control. Amongst the herbicide treatments, the use of pyroxasulfone 120 g PE combined with pendimethalin 850 g PE which statistically at par with pyroxasulfone 110 g PE combined with pendimethalin 800 g PE and use of PoE 2, 4-D Na 0.750 kg combined with HW (60 DAS) all weeds' dry weight and density were successfully decreased (*Phalaris minor*, *Cynodon dactylon*, *Cyperus rotundus*, *Cannabis sativa*, *Chenopodium album*, *Medicago denticulate* and *Parthenium hysterophorus*) by maximum WCE (94.34 %) and lower WI (0.00 %). The use of PE pyroxasulfone 120 g combined with PE pendimethalin 850 g which statistically near with PE pyroxasulfone 110 g combined with pendimethalin 800 g PE, 2, 4-D sodium salt 0.750 kg PoE combined with HW (60 DAS) greater height of plants, tillers per meter square, accumulation of dry weight and yield characteristics of wheat were produced. In this approach, maximum net earnings (₹ 64,700 ha⁻¹), B: C ratio (1.92) and wheat grain yields (4.45 t ha⁻¹) was noted.

In green gram experiments were consist of eight treatments *viz.* imazethapyr 60 g PE, PE pendimethalin 1000 g, PE pendimethalin 1000 g combined with imazethapyr 50 g PoE, HW (20 and 40 DAS), quizalofop p ethyl 75 g PoE, imazethapyr combined with imazamax 75 g PoE, sodium aciflourfen combined with clodinafop propargyl 180 g PoE, weedy check. Among herbicidal treatments, use of pendimethalin 1000 g PE combined with imazethapyr 50 g PoE it is comparable to PE pendimethalin 1000 g and imazethapyr 60 g PE all weeds dry weight and density were successfully decreased. (*Commelina*

benghalensis, *Digitaria sanguinalis*, *Cyperus rotundus*, *Cassia tora* and *Celosia argentea*) by highest WCE (94.34 %) and minimum WI (0.00 %). The PE use of PE pendimethalin 1000 g combined with imazethapyr 50 g PoE it is comparable to PE pendimethalin 1000 g and imazethapyr 60 g PE plant height, branches per plant, accumulation of dry weight and the yield characters of green gram (Pods per plant, seeds per pod and weight of 1000 grain weight). In this treatment, greater net earnings (₹ 37,131 ha⁻¹), benefit cost ratio (2.01) and grain yield (7.25 q ha⁻¹) were noted. In year 2020-21 and 2021-22 wheat-green gram cropping system higher benefit cost ratio (1.91) and net earnings (₹ 49,412) were noted by pyroxasulfone 120 g PE combined with pendimethalin 850 g PE in wheat and imazethapyr 60 g PE in green gram. The entirely doses of herbicides are accurate on hectare bases.

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LIST OF ABBREVIATIONS

Abbreviations	Description	Abbreviations	Description
+	Plus	Max.	Maximum
%	Percent	Min.	Maximum
@	At the rate	ml	Millilitre
a.i.	Active ingredient	M t	Million ton
B:C	Benefit cost ratio	No.	Number
°C	Degree Celsius	NS	Non-significant
CD	Critical Difference	PE	Pre-emergence
cm	Centimeter	PoE	Post-emergence
CS	Capsule Suspension	q	Quintal
DAHA	Days after herbicide application	Rs	Rupees
EC	Emulsifiable concentrate	S. No.	Serial number
<i>et al.</i>	And co-worker	SEm±	Standard error of mean
Fig	Figure	t	Tonnes
g	Gram	<i>Viz.</i>	Namely
ha	Hectare	WCE	Weed control efficiency
ha ⁻¹	Per hectare	WP	Wettable powder
HI	Harvest index		
Hrs	Hour		
m	Meter		
m ⁻²	Meter square		

I-INTRODUCTION

India, among the greatest significant cereals is wheat (*Triticum aestivum* L.). It is extensively grown, manufactured and used over the globe. Wheat greatest extensively grown primary food for use by humans among all grain crops. It produces an annual crop of self-pollinated flowers and is someone from intimate Poaceae. It is planted for photoperiodic with irregularly long days. In addition to being grown cold season, grown during the *Rabi* season in temperate areas. It is the preferred grain that many nations view as the foundation of their food security.

The distinction between wheat and other cereals is wheat contains gluten and is rich in protein, allowing bakers to create light pieces of bread. In India, chapatis, paranthas, and poories are typically made using whole-flour wheat (atta). Various types of bread and baby food options include pancakes, crackers, piecrust, cookies noodles, bulgur, ice cream cones, pizza, cakes, and other foods also include it.

The Northern states are where most of the wheat is cultivated, Uttar Pradesh leading the way with Punjab second with 15.78 MT out of a total production of 25.22 MT. The production of wheat crops, however, is highest in Punjab. Wheat is grown from September to December and harvested from February to May in several Indian states. When sowing in the winter, the temperature should be between 10 and 15 °C and when harvesting, it should be between 21 and 26 °C. Due to its high production, wheat is regarded as a staple crop. In India: U P, Punjab, M P, and Haryana are the main growing regions of wheat. In India wheat has grown in an area of 30.47 million hectares with a production of 106.84 million tonnes and about 3507 kg ha⁻¹ of its productivity (Anon., 2021-22). In Punjab wheat is grown in an area of 3.52 million hectares with a production of 14.82 million tonnes and productivity of 4206 kg ha⁻¹ (Anon., 2021-22).

One of the main factors preventing irrigated wheat from producing as much is the presence of weeds, they aggressively fight with the crop for space, moisture, sunshine, and other essential elements, decreasing the amount as well as the quality of wheat output (Chhokar et al. 2012; Chopra et al. 2015). When compared to weed-free, unchecked weed development often results in a 48% drop in wheat grain production (Singh et al. 2012).

In wheat, barley, and oats most observed weeds are canary grass and wild oats in Pakistan during the cold season. (Yasin *et al.*, 2011).

One of the main biotic constraints on wheat yield is weed infestation. Wheat is contaminated by a variety of weed flora since it is grown in a variety of different agro-climatic locations with various cropping patterns, ploughing techniques, and irrigation systems. The amount of produce lost as a result of weeds varies according to the type, density and surrounding conditions. In *Phalaris minor* the most prevalent monocot weed in the northern Indian plains, responsible for considerable production losses. Herbicides are the main tool used to manage weeds in wheat since they are inexpensive and effective. (Chhokar *et al.* 2016).

Weeds can harm crop productivity by 66% if they aren't controlled during key growth stages (Kumar *et al.* 2011). Herbicides are the main method used by wheat growers to control weeds because they are cost and time-effective. Different herbicidal combinations are needed to effectively control wheat diverse weed flora (Singh *et al.* 2015).

HW is laborious and required energy. Herbicide use, both combination with HW, is the better option to control weeds due to the rising expense of labour and their lack of availability.

Additionally approved for use in wheat and cotton, pyroxasulfone may also be used in sunflower, peanut, potato, and other crops (Food Use, 2014). Sulfosulfuron + metsulfuron-methyl herbicide use was quite prevalent in PoE dicot and monocot weeds yearly and it resulted in much-decreased fresh and dry biomass of weeds in addition to maximum seed output at 60 DAS (Sahu *et al.*, 2018). Inorganic chemicals are utilized, but in very small quantities, meaning that the best combination of chemicals and cultural approaches is used to manage weeds. Chemical weed management approaches are being used by farmers in India since they are highly efficient, appropriate and useful.

The unique greatest prominent and commonly grown pulse crop is the mung bean (*Vigna radiata* L.), sometimes referred as green gram. It is sometimes referred to as golden and green gram. It is a self-pollinating annual crop from the Leguminosae family. It has roughly 62.6% carbohydrates, 25% protein, 1.1% fat, and 16.3% dietary fiber make up the

entire meal. Additionally, it contains a variety of essential amino acids, including lysine, which is often absent from cereals and gives vegetarians access to one of the nation highest protein diets (Indian Institute of Pulses Research, 2019, Pulses of Human Health and Nutrition). In India, green gram is grown on about 40.38 lakh hectares with a total production of 31.5 lakh tonnes with a productivity of 783 kg ha⁻¹ (Crop outlook report, 2021-22). Moong grown an area of 2.1 thousand hectares and the total production was 2.0 thousand tonnes during 2021-22 in Punjab and its average yield was 9.38 quintals per hectare (Package of practices for crops of Punjab, 2023).

It has been calculated that weeds are responsible for a total actual economic loss of roughly USD 11 billion in 10 of India primary crops (Gharde et al. 2018). In Punjab irrigated green gram fields, weeds can reduce productivity by 31-58 %. (Singh et al., 2014, Singh et al. 2015 and Kaur et al. 2016). In the remaining area of India, weeds have been linked to similar reductions in grain yields of green gram, under Maharashtra including fifty-eight percent (Khairnar et al. 2014), thirty-four percent and fifty-one percent under Gujarat (Chhodavadia et al. 2014 and Patel et al. 2016), thirty-nine percent and fifty-two percent in UP (Kumar et al. 2016), under Rajasthan (Mirjha et al. 2013), forty eight percent then seventy-five percent (Tamang et al. 2015).

In addition to lowering grain yield, weeds can also have an impact on seed quality. In irrigated upland green gram cultivation, weed attack and its strength on important periods of plant has been found to reduce yield by 50% to 80% in both irrigated dry and rainfed ecosystems (Nagender et al. 2016, Das et al. 2012, Osari et al. 2019 and Yadav et al., 2019). Moongbean yield losses from weeds were also found to vary from 30 to 85% (Mirjha et al. 2013; Algotar et al. 2014). Weeds generate major losses in green gram, which can be between forty and sixty-eight percent, due to their short build (Tamang et al. 2015). (Mehriya and Shukla, 2015) noted at Mandor, weed competition for space, nutrients, water, and light results in a 23.5-45.8% drop in grain yield (Jodhpur). The manual weeding method is not cost-effective due to the labour shortage and higher costs for crops. In this situation, applying an herbicide is practical and gets attention for weed control. In addition to causing crop losses, weeds also lower crop quality, the soil nutritional status, etc.

The most common and traditional methods of weed management in Indian agriculture are manual weeding, which is more effective but not the most economical. Because of the labour-intensive nature of this skill and the high labour demand during the cropping season, it is both physically tough and expensive. Consequently, weed management is of the highest significance. On 20 days intervals, weeds can be manually controlled. However, manual hand weeding requires a lot of labour, is irritating and does not guarantee weed elimination during a crucial stage of the crop-weed competition. Chemical herbicide efficacies are severely diminished during *Kharif* because of unpredictable monsoons (Sasode et al. 2017). On the other side, even herbicide usage reasons ecological damage and increases the risk of weeds developing chemical resistance.

Both manual and mechanical weeding require a lot of effort, time and money. Herbicides prevent weed growth for a long time after treatment. Therefore, switching from expensive physical-motorized weed control to integrated weed control is urgently needed. In such cases, chemical weed control may represent the most practical and economical option for this crop. An efficient herbicide used at the right dosage may prove to be a successful weed-controlling approach and take the place of more traditional weed management techniques. However, there is limited information on the herbicides that are sincerely appropriate for either PE or PoE use in green gram. The goal of the current study was to identify the best herbicides for weed control in mung bean by PE or PoE treatment and to assess the relative efficacy of herbicide in green gram development, output and cost-effectiveness.

One of the main obstacles to growing green gram is weed attack. The potential yield is typically not achieved in green gram because of the heavy infestation of annual and perennial weeds. To effectively control weeds, to identify suitable herbicides used PE and PoE. In summer-irrigated black gram, the use of PoE herbicides imazethapyr combined with quizalofop ethyl 75 g led to greater weed control, seed production, remaining earnings the benefit cost ratio (Ramesh and Rathika, 2016). During the early stages of crop growth, PE use of pendimethalin successfully reduces monocot and dicot weeds. Imazethapyr PoE spraying provides active switch weed in green gram by Singh et al., (2014_a), Singh et al., (2017).

A new imidazolinone herbicide group called imazethapyr has recently been released to eliminate complex weeds in pulse crops including lentils and black gram (Duary et al. 2016 Singh et al. 2014). A broad-spectrum herbicide called imazethapyr has minimal residual effect on soil and foliar activities that give it flexibility in when to be applied (Gupta et al. 2017, Tamang et al. 2015). According to Chhodavadia et al. (2013) using imazethapyr 25 g PoE consumed not any adverse effects of growing characteristics and produced grain yields that were statistically comparable to those obtained by two manual weeding (20 days intervals). PE herbicide is pendimethalin. Utilizing a combination of currently available herbicides is necessary for the efficient management of complex weed flora (Devi et al., 2017_a). These herbicides should have a broad spectrum of weed control without causing crop damage or having a lasting impact on succeeding sensitive crops, and they should also be able to increase crop productivity (Devi *et al.* 2017_b).

For the success of mungbean production in India, the role of weeding needs to be emphasized. The manual and mechanical weeding are laborious, time-consuming and costly. Herbicides inhibit weed growth for a considerable period after their application. Therefore; there is an urgent need to move from costly manual-mechanical weed control to integrated weed control. Under such circumstances, chemical control of weeds may be the viable and cost-effective alternative for this crop. Effective herbicides at an appropriate rate may prove as an effective weed control method and replace conventional methods of weed control. Chemical control methods include the many herbicides with different selectivity and efficiency available for use. For efficient weed control, herbicides should be applied at the recommended rate and time to avoid inhibiting the growth of weeds and increase grain yield in wheat-green gram cropping system. (Singh and Singh, 2020)

Thus, the major goal of this study was to assess the best tillage and weed control practices for increasing wheat–green gram system productivity, and profitability. We hypothesized that the adoption of weed management practices would result in improved crop yields, increased net income, and reduced weed infestation in wheat-green gram cropping system (Roy *et al.*, 2023).

Since overhead evidence on attention effort the findings were accomplished with this study to provide the greatest practical and reasonable way **Efficacy of pre-emergence and post-emergence herbicides on weed Control in Wheat-Green gram Cropping system under Trans-gangetic plains of Punjab** has the objects:

1. To study the weed flora and weed control treatments on weed growth and WCE,
2. to study the response of weed control treatments on wheat and green gram in terms of growth and yield and
3. to screen out the most cost-effective weed management treatment in Wheat-Green gram Cropping System.

II-REVIEW OF LITERATURE

The section takes looks and presents the relevant articles under the following categories on the response herbicide control treatments in wheat-green gram cropping systems, damages produced with weeds control strategies, and their impact on growing and production:

A) Wheat

2.1 Weed flora (wheat)

Amare *et al.* (2014) reported that observed grasses such as *Phalaris spp.*, *Avena spp.*, and dicots such as *Guizotia spp.*, *Chenopodium spp.*, *Oxalis spp.*, *Spergula spp.*, *Cayluseaa spp.*, *C. spp.*, *Corrigoialac spp.*, *Polygonumne spp.*, *Raphanus spp.*, *Taget spp.* weeds in wheat fields.

Punia *et al.* (2017) at Hisar, observed that 21 weed species total of four monocots and seventeen dicot weeds originate to be infested in wheat fields. Grasses weeds such as *Rumex spp.*, *Carthamus spp.*, *Avena spp.*, *Cirsium spp.*, *Polypogon spp.*, and dicot weeds like *Chenopodium spp.*, *Chenopodium spp.*, *Asphodelus spp.*, *Coronopus spp.*, *Vicia spp.*, *Medicago spp.*, *Melilotus spp.*, *Anagallis spp.*, *Convolvulus spp.*, *Phalaris spp.*, *Poa spp.*, *Trigonella spp.*, *Fumaria spp.*, *Malva spp.*, *Pluchea spp.*, and *Rumex spp.*

Joshi *et al.* (2017) stated that difficult weeds in the study area from MP, which included grassy weeds like Canary grass and purple nut sedge and Broad-leafed weeds such as *Convolvulus arvensis*, *Chenopodium album* and *Spergula arvensis* etc.

Singh *et al.* (2017) stated that *Melilotus spp.*, *Medicago spp.*, *Chenopodium spp.*, *Vicia spp.*, and *Lathyrus spp.*, were among the dicot weeds observed in Madhya Pradesh and *Avena sp.* and *Phalaris minor* are monocot weeds.

Sahu *et al.* (2018) observed that *Phalaris spp.*, *Avena spp.*, 2 monocot weeds, and 5 dicot weeds including *Medicago spp.*, *Oxalis spp.*, *Rumex spp.*, *Chenopodium spp.*, and *Anagallis spp.* in wheat field.

Yadav *et al.* (2019) reported that canary grass was the predominant grassy weed in the experimental field, whereas *Lathyrus spp.*, *Medicago spp.*, *Melilotus spp.*, *Coronopus spp.*, *Anagallis spp.*, and *Vicia spp.* the most common broad-leaf weeds.

Mitra *et al.* (2019) reported that in West Bengal the following weeds were Redshank, pink smartweed, knot weed, Orientale pepper, Common lambquarter, Sun berry, Creeping wood sorrel, Common purslane, Cotton weed, Asiatic pennywort and lesser swine- cress a total crop growing period.

2.2 Weed density (%)

Singh *et al.* (2015) stated that major dicot weeds included *Melilotus spp.*, *Cornopus spp.*, *Rumex spp.*, *Chenopodium spp.*, and *Fumeria spp.* and Canary grass, a monocot observed at Uttarakhand.

Rana *et al.* (2016) reported that *Avena spp.*, *Anagallis spp.*, *Phalaris spp.*, *Coronopus spp.*, and *Lolium spp.* were the predominant weeds observed at Himachal Pradesh.

Chaudhari *et al.* (2017) reported that at B.A. College of Agriculture, Anand Agricultural University, Gujarat weed density was recorded *Melilotus spp.*, *Chenopodium spp.*, *Phalaris spp.*, and *Chenopodium spp.* in wheat fields.

Pacanoski *et al.* (2020) reported at the Republic of Kosova recorded weed densities such as *Galium spp.*, *Consolida spp.*, *Convolvulus spp.*, then *Polygonum spp.* etc.

2.3. Crop weed competition

Saxena and Singh (2013) reported that weed permitted 15 day periods were observed to result in considerable progress in all growth and yield parameters and were recorded comparable to free of weeds check from harvest. This shows that agricultural weed competition, which was harmful to wheat growth, was not checked by weed-permitted conditions initial period of 15 days. Stated that weeds need to be eliminated between 0 and 30 DAS to get an economic yield potential (Saha *et al.* 2016).

Hussein *et al.* (2018) reported that grain yield increased by 26% as a result of weed control one month after sowing. The rivalry of weed crops was reduced with weed control treatments since reduced weed population, dry weight, and WCE in wheat fields were noted by (Singh *et al.* 2018).

2.4. Yield loss caused by weeds

Haq and Khan (2002) reported by wheat, weeds can reduce grain yield by 48%. Oad *et al.* (2007) noticed that weed reveals economic produce damages of twenty-four to forty percent. Joshi *et al.* (2017) reported that weeds noted like *Celosia* spp., *Setaria* spp., *Echinochloa* spp., *Phyllanthus* spp., *Leptochloa* spp., *Eragrostis* spp., *Acrachne* spp., *Digera* spp., *Cynodon* spp., *Commelina* spp., and *Cyperus* spp. reduces the yield of wheat. At Punjab, the experimental field predominant weeds observed such as *Commelina* spp., *Eleusine* spp., and *Cyperus* spp. causes yield in wheat reported by (Singh *et al.* 2019).

2.5 Study of different weed control practices (Wheat)

2.5.1 Pre-emergence weed control

2.5.1.1 Pyroxysulfone 85 % WP

2.5.1.1.1 Impact of pyroxasulfone on weeds and crop yield

Preston *et al.* (2014) revealed that before it emerged use of pyroxasulfone 60 g resulted very effective control of ryegrass and higher seed yield on wheat fields (four t ha⁻¹).

Johnson *et al.* (2018) reported that PE use of pyroxasulfone 112 g caused control of *Bromus* spp. and higher seed yield in wheat (five t ha⁻¹) in wheat.

Kaur *et al.* (2019) reported that PE use of pyroxasulfone (127.5 g) results in control of the population of canary grass as well as increased wheat grain yield (5.43 t ha⁻¹) in wheat fields.

Bayat and Zarger (2020) reported that in wheat fields use of PoE pyroxasulfone 120 g was observed to control field bindweed very effectively and increase the grain yield.

2.5.2.1 Sulfosulfuron combined with metsulfuron

2.5.2.1.1 Impact of sulfosulfuron on weeds growth and crop yield

Singh *et al.* (2015) reported that PoE use of sulfosulfuron + metsulfuron 32 g causes a decrease in weed population and biomass for weeds very positively and increases the production of seed yield in wheat (5 t ha^{-1}).

Tiwari *et al.* (2015) reported that PE use of clodinafop propargyl combined with metsulfuron methyl 400 g use after 30 DAS caused equally kinds of narrow leaf and broad leaf weeds were successfully suppressed and increased seed yield (5 t ha^{-1}) in a wheat field.

Katara *et al.* (2015) reported that PoE use of pinoxaden combined with metsulfuron-methyl 50 and 4 g resulted in control of both types of weed population as well as got higher grain yield of wheat (3.81 t ha^{-1}).

Tiwari *et al.* (2015) stated that PE use of clodinafop propargyl combined with metsulfuron methyl 400 g resulted in effective control of both kinds of weeds and increased seed yield in wheat (3.95 t ha^{-1}).

Kalita *et al.* (2016) reported that PoE use of metsulfuron + sulfosulfuron (3 g and 20 g) caused minimum grassy and broad-leaf weed population and dry weight of (1.35 g m^{-2}) were noted and increased wheat grain production (5.22 t ha^{-1}).

Chaudhari *et al.* (2017) reported that grassy and broadleaf weeds were controlled by PoE use of sulfosulfuron mixed with metsulfuron methyl 32 g as well as increased seed yield (4.38 t ha^{-1}) in wheat.

Meena *et al.* (2017) stated that PoE use of metsulfuron combined with sulfosulfuron (3 and 2 g) provided a reduction total dry weight of weeds and increased wheat grain yield (4.98 t ha^{-1}) over weedy check.

Devi *et al.* (2018) noted that PoE use of carfentrazone and metsulfuron-methyl 25 g tank mixed efficiently controlled dicot weeds and increased seed yield (4.5 t ha^{-1}) in wheat.

Singh *et al.* (2018) stated that less weed dry matter and higher WCE were observed in the PoE use of sulfosulfuron combined with metsulfuron-methyl (30 + 2 g) and obtained maximum seed yield in a wheat field (3.90 t ha⁻¹).

Patil *et al.* (2018) reported that the use of metasulfuron methyl 4 g PoE in wheat fields after a month recorded lower weed population, minimum dry matter production, and higher seed yield (3.35 t ha⁻¹).

Sahu *et al.* (2018) reported that PoE use of sulfosulfuron 25 g and metsulfuron methyl 2 g after a month resulted in control of all types of weed populations and higher seed yield in wheat (3.98 t ha⁻¹).

Singh *et al.* (2018) reported that PoE use of sulfosulfuron combined with metsulfuron (32 g) successively decreased broad-leaved and grassy weeds and enhanced seed yield in wheat (3.29 t ha⁻¹).

2.5.2.2. 2, 4-D Na

2.5.2.2.1 Impact of 2, 4-D Na on weed growth and crop yield

Chandra *et al.* (2018) stated that PoE use of isoproturon combined with 2, 4-D (500 g) use after a month showed the highest weed control and increased seed production (3.8 t ha⁻¹) in wheat fields.

Kaur and Kaur (2019) reported that the use of 2, 4-D Na (500 g ha⁻¹) post-emergence had a negative effect on the growth of all weed populations at 21 days after treatments and higher seed and straw yield in wheat (4.52 and 8.63 t ha⁻¹).

2.5.2.3 Codinofop propargyl

2.5.2.3.1 Effect of codinofop propargyl on weed growth and crop yield

Kaur *et al.* (2015) reported that PoE use of clodinafop combined with metsulfuron 75 g in wheat efficiently destroyed dicot and monocot weeds and got maximum seed yield (5 t ha⁻¹).

Tiwari *et al.* (2015) stated that PoE use of 400 g clodinafop propargyl combined with metsulfuron methyl after a month caused weed population in wheat for control successfully grassy and broad leaf weeds and increased yield in wheat (3.95 t ha⁻¹).

Kaur *et al.* (2016) reported that PoE use of clodinafop-propargyl (60 g ha⁻¹) resulted in suppressed *Phalaris minor* in wheat fields and got higher grain yield (3.46 t ha⁻¹).

Pawar *et al.* (2017) stated that PoE use of pinoxaden mixed with clodinafop propargyl (60 g) effectively controls monocot weed in wheat. However, it was ineffective against dicot weed and increased grain yield in wheat (five t ha⁻¹).

Yadav *et al.* (2018) stated that PoE use of pinoxaden combined with clodinafop (60 g) resulted in control of both types of weed population and noted maximum grain yield in wheat (5.7 t ha⁻¹).

Kumar *et al.* (2019) reported that PoE use of markclodina (60 g) resulted in better control of canary grass and wild oat population and a rise in wheat grain yield (4.2 t ha⁻¹).

2.5.2.4 HW

2.11.4.4.1 Impact of HW on weed growth and crop yield

Surin *et al.* (2013) stated that HW at 30 DAS in wheat resulted in better control of weed population in wheat fields as well as more productive tillers metre⁻² (31.3%), longer spikes (5.3%) and more straw yield (8.6%).

Amare *et al.* (2016) reported that integrating HW combined with 2, 4-D (2000 g) in the wheat field recorded a reduction of weed fresh and dry weight and recorded the highest grain yield in wheat (4 t ha⁻¹).

Safina and Absy (2017) stated that twice HW and herbicides reduced broad leaved weed density and weight in wheat very effectively and raised wheat yield (12 t ha⁻¹).

Barla *et al.* (2017) reported that 2 HW at 30 and 60 DAS was recorded reduced weed density and dry matter of broad-leaf, grassy and sedges weeds and increased wheat seed yield (4.0 t ha⁻¹).

Sasode *et al.* (2017) stated that manual HW (30 and 60 DAS) caused in population of monocot and dicot weeds very efficiently and enhanced the wheat yield (4.66 t ha^{-1}).

Rasool *et al.* (2017) reported that physical weeding control all types of weed in population wheat as well as enhances wheat yield (5 t ha^{-1}).

Chandra *et al.* (2018) reported that 2, 4-D at (500 g) after 1 month of sowing or isoproturon at 30 DAS with one HW resulted reduces weeds population as well as produced maximum seed yield in wheat (4 t ha^{-1}).

Hussein *et al.* (2018) reported that physical weeding caused control all types of weed population results reduce competition in crop and weed and improved seed yield in wheat (2.9 t ha^{-1}).

Meena *et al.* (2019) stated that manual HW (15 days intervals) caused as better switch of weed population and increased seed yield of wheat (6.31 t ha^{-1}).

Yadav *et al.* (2020) noted that manual HW as better control of total weeds in wheat field and recorded higher grain yield in wheat (5 t ha^{-1}).

2.6 WCE (%) and WI (%)

Kumar *et al.* (2012) reported that PoE use of clodinafop propargyl combined with metsulfuron methyl ($60 + 4 \text{ g}$) was recorded maximum WCE (85 %) and lower weed index in wheat (5.1 %).

Kumari *et al.* (2013) stated that PoE use of sulfosulfuron combined with metsulfuron (32 g) improved WCE (84 %) in wheat recorded minimum weed index.

Yadav and Dixit (2014) reported that two-HW after one month interval boosted wheat ability to suppress weeds with WCE (92 %) and recorded lower weed index in wheat.

Vyavahare and Bhilare (2014) stated that PoE use of sulfosulfuron 16.5 g combined with 2, 4-D (563 g) caused as increase WCE in wheat (64 %) as well as observed lower weed index in wheat (7.8 %).

Kaur *et al.* (2015) reported that PoE use of metsulfuron (4 g) and clodinafop (60 g) resulted reduces weed density resulted in wheat having the highest WCE (80 %) and minimum weeds index (2.3 %).

Tiwari *et al.* (2015) stated that PoE use of clodinafop 300 g mixed with metsulfuron methyl 60 + 4 g noted higher WCE (85 %) and observed lowest weed index (1.45 %).

Bhoir *et al.* (2016) sated that manual HW in 20 Days in wheat had highest WCE in wheat (97.72 %) and reported as minimum weed index (0.00 %) in wheat.

Sudha and Biradar (2016) stated that application of sulfosulfuron combined with metsulfuron (25 and 4 g) was recorded maximum WCE in wheat (81.62 %) and got lowest weed index.

Kaur *et al.* (2017) reported that pendimethalin PE use after PoE use of sulfosulfuron (1000 g and 18 g) was recorded suppress weed growth results higher WCE in wheat (95.6 %) and noted minimum weed index in wheat.

Shakya *et al.* (2017) reported that PoE use of sulfosulfuron (18 g) was control all types of weed competition finally got better WCE and lowest weed index in wheat (1.25%).

Kumar *et al.* (2018) stated that in wheat PoE use sulfosulfuron mix with metsulfuron (32 g) was noted that higher WCE (83.6 %) and lower weed index in wheat.

Singh *et al.* (2018) stated that PoE use of sulfosulfuron combined with metsulfuron methyl (30 + 2 g) record better performance to kill weeds results maximum WCE and minimum weed index in wheat (2.1%).

Kumar *et al.* (2019) revealed that PoE use of markclodina 60 g noted that highest WCE in wheat (80.5 %) and recorded minimum weed index (5.2 %).

Meena *et al.* (2019) stated that PoE use of sulfosulfuron combined with metsulfuron (30 and 2 g) recorded uppermost WCE (95.36 %) and observed lowest weed index recorded in wheat (2%).

Mitra and Mondal (2019) reported that PoE use of metsulfuron 4 g mixed with carfentrazone 20 g mixed with surfactant observed higher WCE (99 %) as well as noted minimum weed index in wheat (6 %).

2.8 Plant Character

Katara *et al.* (2012) founded that pinoxaden mixed with metsulfuron methyl (50 + 4 g) caused that weed kill at initial period minimum competition of weed with crop results improved plant performance such as active tiller per m², grains per spike (199.85 tillers per m², 47.7 grains per spike) in wheat.

Shehzad *et al.* (2012) reported that PoE use of clodinafop propargyl (240 g) was recorded highest plant height (96.6 cm) and grains per spike (58.5 grains per spike) in wheat.

Kumari *et al.* (2013) stated that PoE use of sulfosulfuron mixed with metsulfuron (32 g) caused higher spike per m² and grains per spike (452 spike per m² and 33.8 grains per spike) in wheat.

Yadav and Dixit (2014) reported that HW (30 and 60 DAS) resulted as kill narrow as well as broad types of weed density noted increased effective tillers per m² and effective spike per m (210.3 tillers per m² and 48 spike per m) in wheat.

Vyavahare and Bhilare (2014) stated that PoE use of sulfosulfuron (16.5 g) combined with 2,4-D (563 g) grown 30 DAS caused better length of spike (cm), no. of spikelets per spike, no. of grains per spike, (8.6 cm, 16.4 spikelet's per spike, 44.9 grains per spike) in wheat.

Tiwari *et al.* (2015) stated that in wheat field PoE use of clodinafop (300 g) mixed with metsulfuron methyl (60 + 4 g) resulted that better development of plant such as panicle length (10.75 cm) and effective tillers (334.95 per m²).

Bhoir *et al.* (2016) revealed that manual three HW 20 days interval observed weed free situation in wheat field leads to positive impact of crop growth as increased plant

height, tiller per meter, panicle length and no. of spikelets panicle⁻¹ (88.76 cm, 194.66 m⁻¹, 7.19 cm and 17.6 spikelets panicle⁻¹) in wheat.

Sudha and Biradar (2016) reported that PoE use of sulfosulfuron mixed with metsulfuron (25 + 4 g) caused plant height, tiller per meter and spikes per m² (89.40 cm, 99.5 tillers per m and 252.8 per m²) in wheat.

Chaudhary *et al.* (2017) founded that PoE use of sulfosulfuron (75%) combined with metsulfuron methyl (32 g) recorded higher plant height and number of tillers per m (88.6 cm and 98.6 tillers m⁻¹) in wheat.

Sasode *et al.* (2017) reported that PoE use of pinoxaden combined with metsulfuron (0.06 + 0.004 kg) recorded higher plant height (cm), number of tillers per plant, ear head length (cm) and number of grains per ear (92.2 cm, 5.18 tillers per plant, 9.7cm, and 53.5 grains per ear) in wheat.

Kumar *et al.* (2018) stated that PoE use of sulfosulfuron combined with metsulfuron (32 g) recorded as weed free environment to got increased plant height (cm), tillers per plant, spike length (cm), no. of grains per spike (95.4 cm, 416 tillers per plant, 11.10 cm, 56.8 grains per spike) in wheat.

Singh *et al.* (2018) stated that PoE use of sulfosulfuron mixed with metsulfuron methyl (30 + 2 g) recorded boosted plant performance like maximum effective tillers (234.8 per m²) in wheat.

Kumar *et al.* (2019) stated that PoE use for markclodina (60 g) was noted increased the tiller per meter square, spikelets per spike, length of spike, grains per spike and weight of the grains per spike in wheat crop (216 tillers per m², 15.7 spikelets per spike¹, 14 cm, 48.9 grains per spike¹ and 2.9 g).

Mitra and Mondal (2019) stated that PoE use of metsulfuron (4 g) mixed carfentrazone (20 g) combined with surfactant caused higher number of spike per m² and grains per spike¹ (336 spike per m² and 44.5 grains per spike¹) in wheat.

Khatri *et al.* (2020) reported that PoE uses of pendimethalin (3.3 L) and sulfosulfuron (33.3 g) results as observing weed control situation in wheat field leads to increased plant height, panicle length and number of tillers per m² (104 cm, 10.9 cm, and 414 tillers per m²).

2.9 Yield attributes and yield

Kumar and Rana (2011) reported that PoE of use metsulfuron methyl mixed with clodinafop and surfactant (4 + 60 g) results as best weed management practice to got higher seed yield (3.7 t ha⁻¹) in wheat.

Katara *et al.* (2012) stated that pinoxaden mixed with metsulfuron methyl (50 + 4 g) was best way to kill weeds results observing maximum test weight and grain yield in wheat (43.8 g and 3.8 t ha⁻¹).

Shehzad *et al.* (2012) noticed that PoE use of clodinafop propargyl (240 g) caused maximum weight of 1000 seeds, straw and grain yield in wheat (60.5 g, 5.7 and 3.7 t ha⁻¹).

Kumari *et al.* (2013) reported that PoE use of sulfosulfuron mixed with metsulfuron (32 g) was recorded higher straw yield and grain yield in wheat (9 and 6.42 t ha⁻¹).

Yadav and Dixit (2014) revealed that two HW a month interval resulted suppress the weed growth, its beneficially impact on crop such as increase weight of 1000 seeds and grain yield (46.1 g and 3.81 t ha⁻¹) in wheat.

Tiwari *et al.* (2015) reported that PoE use of clodinafop (300 g) mixed with metsulfuron methyl (60 + 4 g) was shown negative impact on weeds as well as positively result on crop like got it higher grain yield (3.95 t ha⁻¹) in wheat.

Nanher *et al.* (2015) stated that PoE use of sulfosulfuron combined with metribuzin (25+105 g) caused increase biological yield and grain yield (13 and 5.51 t ha⁻¹) in wheat.

Kien *et al.* (2016) reported that PoE use of metsulfuron combined with sulfosulfuron (3 g + 20 g) after month of sowing was noted higher grain production under *rabi* season in wheat (5.22 t ha⁻¹).

Bhoir *et al.* (2016) stated that manual three HW (20 days intervals) results higher weight of 1000 seeds, straw yield and grain yield (45.03 g, 7.5 and 5 t ha⁻¹) in wheat.

Sudha and Biradar (2016) reported that PoE use of sulfosulfuron combined with metsulfuron (25 + 4 g) recorded highest weight of 1000 seeds and grain yield (42.3 g, and 4.3 t ha⁻¹) in wheat.

Chaudhary *et al.* (2017) stated that PoE use of sulfosulfuron combined with metsulfuron methyl (32 g) caused higher straw and grain yield in wheat (6.7 and 4.2 t ha⁻¹).

Sasode *et al.* (2017) reported that PoE use of pinoxaden mixed with metsulfuron (0.06 + 0.004 kg) were recorded maximum straw and grain yield (5.9 and 4.5 t ha⁻¹) in wheat.

Devi *et al.* (2018) found that PoE use of pinoxaden (50 g) along with a ready mixture of carfentrazone and metsulfuron (25 g) recorded higher grain yield in wheat (5.4 t ha⁻¹).

Kumar *et al.* (2018) reported that PoE use of sulfosulfuron mixed with metsulfuron (32 g) was in achieve higher weight of 1000 seeds, straw yield and grain yield (41.9 g, 4.9 and 3.9 t ha⁻¹) in wheat.

Patil *et al.* (2018) reported that hoeing at 20 DAS combined with metasulfuron methyl (4 g) PoE use after 1 month was topmost weed control practice recorded maximum weight of 1000 seeds, straw yield and grain yield in wheat (44.6 g, 6.4 and 4.9 t ha⁻¹).

Singh *et al.* (2018) stated that PoE emergent use of sulfosulfuron combined with metsulfuron methyl (30 + 2 g) was recorded maximum weight of 1000 seeds, straw yield and grain yield in wheat (35.8 g, 4.4 and 3.2 t ha⁻¹).

Kumar *et al.* (2019) stated that PoE use of markclodina (60 g) in wheat higher weight of 1000 seeds, straw and grain yield in wheat (48.1 g, 5.4 and 4.2 t ha⁻¹).

Meena *et al.* (2019) reported that PoE use of sulfosulfuron combined with metsulfuron (30 +2 g) observed higher straw and grain yield in wheat (6.2 and 4.4 t ha⁻¹).

Mitra and Mondal (2019) reported that PoE use of metsulfuron (4 g) combined with carfentrazone (20 g) and surfactant recorded maximum weight of 1000 seeds and grain yield in wheat (42.4 g and 5 t ha⁻¹).

Kaur and Kaur (2019) stated that PoE use of 2, 4-D Na 500 g was recorded higher weight of 1000 seeds, straw and grain yield in wheat (50.17 g, 8.6 and 4.5 t ha⁻¹).

Khatri *et al.* (2020) reported that PoE use of pendimethalin (3.3 L) and sulfosulfuron (33.3 g) observed minimum growth of weeds results as noted higher weight of 1000 seeds and grain yield in wheat (43.6 g and 4.4 t ha⁻¹).

2.10 Economics

Shehzad *et al.* (2012) noticed that PoE clodinafop propargyl 45 g caused on weeds and beneficial practice in wheat for recorded maximum net benefits in wheat (₹ 13, 997 ha⁻¹).

Kumar *et al.* (2012) reported that PoE use clodinafop propargyl mixed with metsulfuron methyl (60 + 4 g) caused maximum net revenues in wheat (₹ 30,340 per hectare) and benefit cost ratio (2.56) in wheat.

Shyam *et al.* (2014) stated that PoE use sulfosulfuron (33.3 g) after month were noted maximum benefit cost ratio in wheat (1.80).

Nanher *et al.* (2015) noticed that PoE use of sulfosulfuron (25 g) combined with metribuzin mixed with (105 g) caused wheat to provide maximum net revenues (₹ 63,453.59 per hectare) and benefit cost ratio (2.48) in wheat.

Bhoir *et al.* (2016) revealed that PoE use metsulfuron methyl (4 g) was noted higher net earnings (₹ 54,306) and benefit cost ratio (2.48) in wheat.

Sudha and Biradar (2016) stated that PoE use sulfosulfuron and metsulfuron (25 and 4 g) was recorded as maximum benefit cost ratio (2.19) in wheat.

Kaur *et al.* (2017) reported that PoE use of pinoxaden mixed with metsulfuron (0.06 + 0.04 kg) and pendimethalin (PE) (1 kg PoE) were recorded highest benefit cost ratio in wheat (2.38).

Sasode *et al.* (2017) stated that PoE use of pinoxaden combined with metsulfuron (0.06 + 0.004 kg) were recorded higher benefit cost ratio in wheat (3.2).

Kumar *et al.* (2018) noticed that PoE use of sulfosulfuron combined with metsulfuron (32 g) was recorded maximum net earnings (₹ 36790 per hectare) and benefit cost ratio (1.88) in wheat.

Patil *et al.* (2018) stated that one hoeing on after 20 days and PoE use of metasulfuron methyl (4 g) was recorded achiev maximum net revenues (₹ 47,555 per hectare) and B: C ratio (2.23).

Kumar *et al.* (2019) reported that PoE use of markclodina (60 g ha⁻¹) was recorded higher net revenues (₹ 36,163 per hectare) and benefit cost ratio (2.09) in wheat.

Meena *et al.* (2019) stated that PoE use of sulfosulfuron combined through metsulfuron (30 and 2 g) was recorded higher net revenues (₹ 63,830 per hectare) and benefit cost ratio in wheat (2.34).

Khatri *et al.* (2020) reported that PoE use of pendimethalin (3.3 L and sulfosulfuron 33.3 g) recorded higher net revenues (₹ 50,940 per hectare) and benefit cost ratio (1.61) in wheat.

B) Green gram

2.11 Weed flora (green gram)

Joshi *et al.* (2017) stated that major weed flora on study areas observed like *Eragrostis spp.*, *Echinochloa spp.*, *Cyperus spp.*, *Phyllanthus spp.*, *Celosia spp.*, *Leptochloa spp.*, *Setaria spp.*, and *Cynodon spp.*, *Acrachne spp.*, *Digera spp.* and *Commelina spp.*, in green gram.

Singh *et al.* (2018) at Varanasi, was observed monocot weed species such as *Cynodon dactylon* and *Dinebra retroflexa*, dicot weeds included *Ageratum conyzoides*,

Corchorus trilocularis, *Digera arvensis*, and *Parthenium hysterophorus*, as well as *Cyperus rotundus* sedges in green gram field.

Yadav *et al.* (2019) reported that at Haryana observed *Echinochloa colona* and nut sedge two weeds species are most dominant in green gram field.

Osari *et al.* (2019) at Madhya Pradesh observed such as *Cyperus rotundus*, *Echinochloa colona*, and *Setaria glauca* were three most prevalent monocot weeds and *Digera spp.*, *Commelina spp.*, and *Phyllanthus spp.* were three most prevalent dicot weeds observed in wheat field.

Singh *et al.* (2019) reported that study at Punjab Agricultural University in Ludhiana, Punjab observed *Commelina benghalensis*, *Eleusine aegyptiacum* and *Cyperus rotundus* make up the majority of weeds in green gram field.

Verma and Chaudhary (2020) stated that at Rajasthan, College of Agriculture in Udaipur (Rajasthan), some common weed species in green gram field was observed such as *Cyperus rotundus*, *Commelina bengalensis*, *Trianthema portalacastrum*, *Digera arvensis*, and *Echinochloa colona*.

T. Ramesh and S. Rathika (2020) stated that at Anbil Dharmalingam Agricultural, Tiruchirappalli, Tamil Nadu, collective weed observed in green gram were *Trianthema spp.*, dicot weeds, *Echinochloa spp.* in monocot and *Cyperus spp.* in sedges.

2.12 Weed density (Green gram)

Mishra *et al.* (2017) reported that at Anand Agricultural University, Anand, Gujarat *Eleusine indica* and *Digera spp.* are grassy and broad-leaved weeds more dominating weed species in green gram field.

Kumar *et al.* (2017) stated that a relative density 64% of *Cyperus rotundus* were the most prevalent weed, followed by *Digera arvensis* (15%) in green gram.

Vera and Chaudhary (2020) stated that weeds observed in green gram field such as *Cyperus spp.*, *Commelina spp.*, *Digera spp.*, *Trianthema spp.* and *Parthanium spp.* and *Echinochloa spp.*

T. Ramesh and S. Rathika (2020) reported that in green gram field observed weeds such as *Trianthema spp.* (71 percent) under dicot, *Echinochloa spp.* (21 percent) in monocot and *Cyperus spp.* (8 percent) in sedges.

2.13 Crop weed competition

Singh *et al.* (2015) reported that important time for crop-weed rivalry in green gram is during the first 30-40 DAS. Mishra *et al.* (2017) noticed that the crucial time for crop-weed competition in green gram is the first 20-40 DAS. At Andhra Pradesh the important time for weed crop rivalry in black gram is one month after sowing reported by (K. Sasikala *et al.* 2019).

2.14 Weeds reduce crop yields (Green gram)

Bahar *et al.* (2017) reported that at Budgam, Kashmir weeds increases their population in green gram field causes competition of weeds with crop results reduces grain yield in mungbean (32.58 percent).

Mishra *et al.* (2017) noticed that at Gujarat, weeds in green gram reduced seed yield (44%).

Kumar *et al.* (2017) reported at Kanpur weed competition causes yield loss with the *kharif* season green gram (62%).

K. Sasikala *et al.* (2019) reported that weeds emergence in black gram results in yield reductions (45 to 70%).

Patel *et al.* (2020) recorded at Gujarat weeds causes (58.8%) yield losses under unweeded control in green gram field.

2.15 Study of different weed management practices on Green gram

2.15.1 PE treatments

2.15.1.1 Imazethapyr

2.15.1.1.1 Impact of imazethapyr on weeds and crop yield

Singh *et al.* (2015) reported that PoE use of imazethapyr (75 g) control total weeds and caused better grain yield in green gram (1.51 t ha⁻¹) in green gram.

T. Nagender *et al.* (2016) noticed that PE use of imazethaypr (70 g) with combination of HW 20 DAS were with better control all type of weeds as well as crop character recorded higher plant height, production of dry material and seed of yield (35.57 cm, 914.5 g per m and 1 t ha⁻¹).

Yadav *et al.* (2019) stated that PE use of imazethapyr spraying (100 g) caused reduced weeds and dry weight of weeds and caused in maximum seed and stover yield in green gram (0.9 & 2.6 t ha⁻¹).

Joshi *et al.* (2020) stated that PE use of imazethaypr (80 g) combination HW reduced total weed population (2.5 per m²) and noted better seed of yield in green gram (1.03 t ha⁻¹).

R.P.S.Shaktawat (2020) reported that early PE use of imazethapyr (75 g and HW were caused lower total weed and biomass of weed in (3.7 per meter and 1.4 g per meter) and maximum seed and straw yield in green gram (0.9 t and 2.09 t ha⁻¹).

2.15.1.2 Pendimethalin

2.15.1.2.1 Pendimethalin impact on weed growth and crop yield

Punia *et al.* (2015) reported that PE use of pendimethalin mixed with imazethapyr (1000 g) at Hisar provided season long control of weed and noted that higher seed yield in green gram (1.54 t ha⁻¹).

Chaudhari *et al.* (2016) observed that in green-gram PE use of pendimethalin (1000 g) recorded less weed population as well as recorded higher seed yield in green gram (1.20 t ha⁻¹).

T. Muthuram *et al.* (2017) stated that PE uses of pendimethalin (1000 g) use after early PoE use of quizalofop ethyl and imazethapyr (50 g) was efficiently decrease monocot and dicot weeds and resulted higher grain yield in green-gram (1.00 t ha⁻¹).

Mishra *et al.* (2017) noticed that PE use imazethapyr combined with pendimethalin (1000 g) recorded efficiently control amongst monocot and dicot weeds and was recorded higher seed ield in *Kharif* green gram (1.54 t ha⁻¹).

Leva *et al.* (2018) stated that in green gram PE pendimethalin (1000 g) noted efficiently control of all types of weed population its positively impact on crop production and reported that higher seed and straw yield in green-gram (0.9 and 1 t ha⁻¹ t ha⁻¹).

Kumar *et al.* (2019) stated that PE use of pendimethalin mixed with imazethapyr use after manual weeding 30 DAS caused higher WCE (90.45%), lower weed count (5.5 per meter) and dry weight of weed (8.4 g per meter) and resulted maximum seed and stover yield in green gram (0.65 and 1.078 t ha⁻¹) in green gram.

Sahu *et al.* (2019) stated that PoE use of pendimethalin (1000 g) month after HW gave successfully reduced population of weed and total weeds (8.22 per m² and 8.22 g per m²) and resulted higher seed yield in green gram.

Patel *et al.* (2020) observed that PE use of pendimethalin (1000 g) cause reduced population on weed in green gram (5.37 per m²) and enhance seed and stover yield in green gram (1.2 and 2.1 t ha⁻¹).

2.15.2 PoE control (green gram)

2.15.2.1 Pendimethalin PE combined with Imazethapyr PoE.

2.15.2.1.1 Effect of pendimethalin PE combined with Imazethapyr PoE for weed growth and crop yield

Singh and Yadav (2015) reported that PE pendimethalin (750 g) + imazethapyr (40 g) resulted as effectively controlled grassy and BLW and recorded higher seed yield (1.22 t ha⁻¹) in green gram.

Kaur *et al.* (2016) noticed that PoE uses of Imazethapyr mixed with pendimethalin (1000 g ha⁻¹) recorded that control monocot and dicot weeds and noted that higher seed yield in green gram (0.86 t ha⁻¹).

Muthuram *et al.* (2017) observed that PE use of pendimethalin (1000 g) after early PoE use of quizalofop ethyl and imazethapyr (50 g) very effective control of all weeds as well as increased grain yield in green gram (1.00 t ha⁻¹).

Kumar and Hiremath (2018) reported that pre and PoE use of imazethapyr (750 ml) mixed with adjuvant (2.0 ml per L) recorded reduction in weeds and dry weight of weeds (5.12 per m² and 10.47 g per m²) and recorded expressively higher plant height (49.5 cm), LAI (3.51), dry weight (14.7 g per plant), pods per plant (29.51 pods per plant), seeds per pod (10.7), seed and straw yield (1 and 2 t ha⁻¹) in *Kharif* green gram.

Danga *et al.* (2020) stated that PE use of pendimethalin mixed with imazethapyr (900 g) was resulted lower total weeds and dry weight (2.7 per m² and 1.3 g per meter) and reported higher seed yield (1.1 t ha⁻¹).

Ramesh *et al.* (2020) noticed that PE use of pendimethalin (1000 g) in green gram, expressively recorded higher total weed (137 per m²) and dry weight (30.4 g per meter) and WCE (89.6%) and rise mean seed yield in green-gram (0.6 t ha⁻¹).

2.15.2.2 Aciflourfen 16.5 % and Clodinafop-propargyl 8 % EC in Green gram

2.15.2.2.1 Effect of Aciflourfen 16.5 % and clodinafop-propargyl 8 % EC in weed growth and crop yield

Verma and Kushwaha (2018) reported that PoE use of clodinafop propargyl combined with aciflourfen sodium (187.5 g) caused lower density of weed and dry weight of weed (5.7 per m² & 9.8 g per m²) as well as was recorded higher seeds in green gram (0.53 t ha⁻¹).

Verma and Chaoudhary (2020) noticed that PoE use of aciflourfen mixed with clodinafop propargyl (370 g) 3-4 leaf stage, it is greater WCE (88.97%) and caused on higher seed yield (0.9 t ha⁻¹) in green gram.

2.15.2.3 Imazethapyr combined with imazamax in green gram

2.15.2.3.1 Effect of imazethapyr combined with imazamax on weed growth and crop yield

Gupta *et al.* (2019) reported that PoE use of imazethapyr mixed with imazamox (80 g) recorded effective control all weeds and higher seed yield obtained in green gram (1 t ha⁻¹).

Osari *et al.* (2019) noticed that PoE use of imazethapyr mixed with imazamox (80 g) recorded that lower total weeds and total weed dry weight in green gram (2 per m² & 4.91 g per m²) and higher seed and stover yield in green gram (0.8 and 1.7 t ha⁻¹).

2.15.2.4 HW in Green gram

2.15.2.4.1 Influence of HW on weeds and crop yield

Yadav *et al.* (2019) revealed that hand weeding were recorded less dry weight of weeds during crop growing periods and maximum seed and straw yield recorded in green gram (1.1 and 2.7 t ha⁻¹).

Joshi *et al.* (2020) stated that HW with combination of straw mulching was recorded lower weed count (2.12 per m²) and higher WCE (94.1%) and higher seed and stover yield (0.8 t and 1.1 t ha⁻¹) in green gram.

2.16 WCE (%) and WI (%) (Green gram)

Singh *et al.* (2019) reported that PE use of pendimethalin mixed with imazethapyr (750 g) recorded lower weed count finally reduced competition for crop that why recorded highest WCE (86.08%) and lower weed index (9.56%) in green-gram.

Senthivelu *et al.* (2020) stated that PE use pendimethalin mixed with imazethapyr (1000 kg) was recorded higher WCE (82.9%) and were recorded lower weed index (3.1%) in *Kharif* green gram.

2.18 Plant characters

Osari *et al.* (2019) noticed that PoE use of imazethapyr mixed with imazamox (80 g) recorded highest plant height (50.83 cm) and plant root nodules (40.67 g plant⁻¹) in green gram.

Patel *et al.* (2020) observed that PoE use of pendimethalin (1000 g ha⁻¹) was recorded higher plant height (60.5 cm) and branches per plant in green gram (7.82 per plant).

2.19 Yield and yield attribute.

Osari *et al.* (2019) revealed that PoE use of imazethapyr mixed with imazamox (80 g) were recorded higher pods per plant (41.33), seeds per pod (13.17), weight of 1000 seeds (37.13 g) seed and stover yield in green gram (1 and 1.8 t ha⁻¹).

Patel *et al.* (2020) reported that PE use pendimethalin (1000 g) were recorded higher seeds per pod (8.09), pods per plant (20.4), weight of 1000 seeds (46.9 g) and seed and haulm yield (1.2 and 2.1 t ha⁻¹) in green gram.

2.20 Economics of Green-gram

Osari *et al.* (2019) observed that PoE Use of imazethapyr mixed with imazamox 80 g recorded in maximum total profit (₹ 62,000), net profit (₹ 43,490) and benefit cost ratio in green gram (3.18).

Joshi *et al.* (2020) PE use of imazethapyr 80 g were recorded higher net profit (₹ 31,100) and maximum benefit cost ratio (2.52) in green gram.

Research gap identification:

1. Earlier farmers were careless about weed management, because they were not aware about the use of herbicide. Hence it were the main reason of yield reduction. Some of the weeds did not respond well to herbicides therefore weed crop rivalry existed on arenas.
2. Weed crop rivalry times on wheat remains one to one half month then green gram of halt to one month but farmers are not using specific herbicides to weed controlling in this competition periods that's why more yield reduction occurs in and wheat-green gram cropping system.

III-MATERIALS AND METHODS

The area evaluations with the heading **Efficacy of pre-emergence and post-emergence herbicides on weed Control in Wheat-Green gram cropping system under Trans-gangetic plains of Punjab** were carried out at Lovely Professional University research site at Phagwara, Punjab, for two successive *kharif* and *rabi* seasons of 2020-2021 and 2021-2022. This chapter includes a brief explanation of the many tools, techniques, and resources that were used in the research.

3.1 The site and place of the study

The actual field study was held at the Lovely Professional University, School of Agriculture, study field, Phagwara, Punjab, with *Rabi* and *Kharif* seasons in 2020-2021 and 2021-2022 respectively. Geographically, Lovely Professional University is 8 kilometers away from Phagwara. With a height of 245 meters MSL, the represent-cool environment, located at 30° 13'28" North latitude and 75° 46'25 East longitude.

3.2 Climate and weather

Lovely Professional University is located 245 meters above mean sea level. This area often experiences warm summers with little precipitation. This location experiences 816 mm (32.1 inches) of precipitation yearly and the average yearly heat is 23.2 degrees celsius. Late June marks the start of the monsoon season and late September marks its end. Maximum rainfall in that area was recorded in July and August. The first week of November is often the start of winter. January and December are the two coldest months. In Table 3.1, climatic variables are displayed.

Table 3.1: Weekly basis weather data in the cropping period (November 2020 to August 2021)

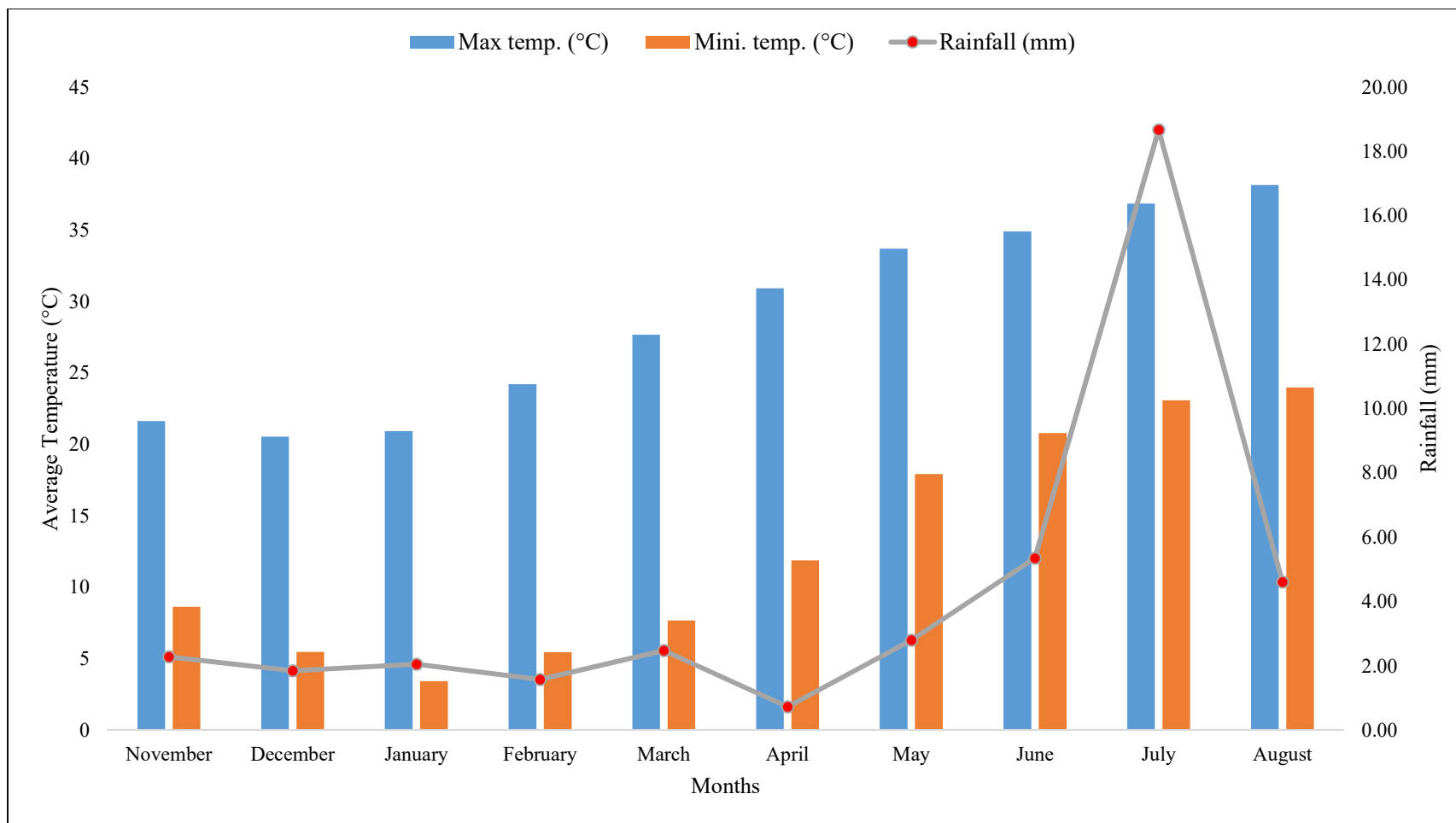
Year and Months	weather-week	Average Temperature (°C)		RH (%)		Precipitation (mm)
		Max.	Min.	Morning	Evening	
(2020)-November	45	23.1	8.2	88.0	36.0	3.0
	46	24.4	5.4	90.0	33.1	1.0
	47	25.1	8.5	91.0	37.3	5.0
	48	24.3	9.2	92.0	37.6	1.3
(2020)-December	49	22.1	4.1	89.0	41.2	0.0
	50	23.1	3.1	93.0	33.2	4.0
	51	21.3	6.4	92.0	34.2	0.6
	52	20.5	7.5	95.0	36.7	3.0
(2021)-January	1	21.1	2.3	97.5	44.3	0.8
	2	21.2	2.8	99.5	47.5	3.5
	3	22.5	3.1	99.5	44.1	0.6
	4	21.8	4.5	99.7	66.5	4.0
(2021)-February	5	24.7	5.6	98.1	39.2	0.2
	6	22.7	4.8	95.4	39.7	3.7
	7	24.4	7.9	95.6	49.4	1.4
	8	26.8	9.8	99.7	47.4	1.0
(2021)-March	9	27.4	9.2	97.1	37.5	0.1
	10	29.9	9.1	91.8	33.7	2.8
	11	30.3	9.5	84.2	41.1	1.2
	12	30.4	11.5	90.2	37.1	5.1
(2021)-April	13	31.97	11.95	89.0	36.5	0.0
	14	32.31	15.37	90.0	43.0	0.5
	15	34.12	17.37	89.4	42.1	0.0
	16	34.21	17.33	88.1	43.5	1.1
(2021)-May	17	34.61	16.55	86.5	43.7	4.7
	18	34.58	17.31	86.4	44.1	2.3
	19	35.11	18.34	87.1	44.1	0.6
	20	35.19	19.55	85.4	45.0	5.1
(2021)-June	21	34.16	18.55	83.8	46.1	1.7
	22	35.44	20.33	86.6	45.2	6.1
	23	36.23	19.61	82.1	43.7	3.8
	24	36.16	20.37	85.4	45.2	10.2
(2021)-July	25	36.42	21.41	84.4	42.1	5.2
	26	36.66	20.55	83.1	40.4	2.0
	27	37.03	21.65	83.3	46.5	8.3
	28	37.13	21.73	84.0	43.1	11.5
(2021)-August	29	37.65	20.44	81.8	40.3	2.2
	30	38.16	21.56	83.2	43.2	6.1
	31	38.46	22.55	85.6	44.1	3.6
	32	39.1	20.41	80.4	42.6	10.5
	Total	1201.8	517.43	3591.5	1679.69	127.8
	Mean	30.0	12.9	89.7	41.9	3.19

***Source:** Punjab agriculture university Ludhiana. (Punjab, 2020-21)

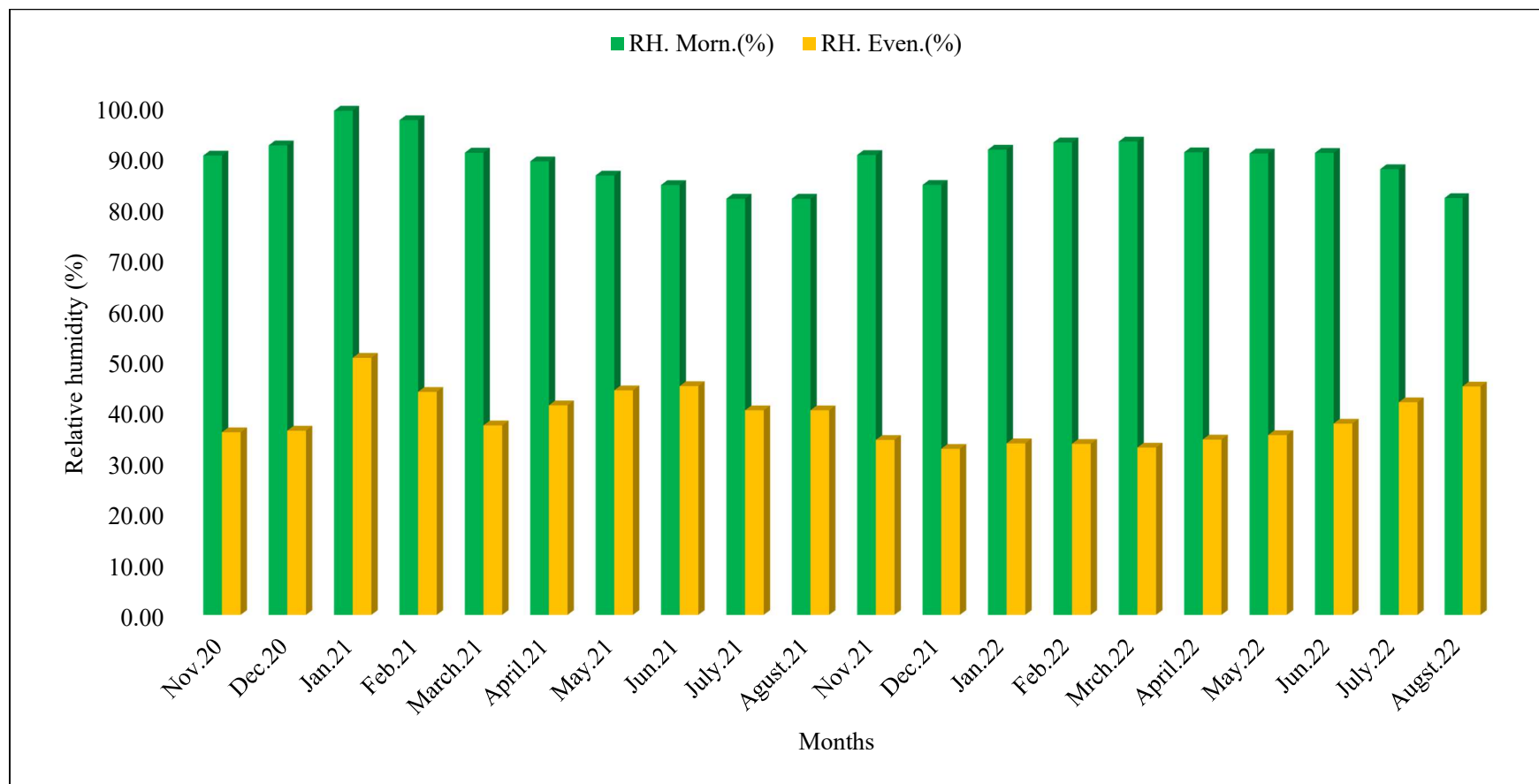
Table 3.2: Weekly basis weather data in the cropping period (November-2021 to August-2022)

Year and Months	weather-week	Average Temperature (°C)		RH (%)		Precipitation (mm)
		Max.	Min.	Morning	Evening	
(2021)-November	45	17.8	9.5	92.3	33	4.0
	46	19.13	9.3	90.3	41	1.0
	47	19.46	9.8	91.6	29	2.0
	48	19.71	9.2	87.3	35	1.0
(2021)-December	49	18.4	6.2	86.2	35	0.0
	50	19.3	5.4	81.3	31	3.0
	51	19.5	6.1	84.7	33	1.6
	52	20.2	5.1	85.8	32	2.6
(2022)-January	1	19.6	4.2	89	34	0.2
	2	20.7	4.7	93.3	35.2	4.2
	3	19.1	3.3	92.8	33.3	3.1
	4	21.4	2.6	90.6	32.8	0.1
(2022)-February	5	22.1	3.9	91.6	33.6	0.0
	6	25.2	3.1	93.1	35.4	2.5
	7	23.1	4.0	94.5	34.0	3.0
	8	24.7	4.6	92.1	31.9	1.1
(2022)-March	9	25.12	4.2	92.5	32.5	0.0
	10	24.9	5.7	91.0	33.0	3.2
	11	26.1	6.3	93.9	34.2	1.1
	12	27.3	6.0	94.6	32.3	6.3
(2022)-April	13	27.0	7.2	90.6	33.7	0.5
	14	29.2	9.0	91.2	34.1	1.7
	15	28.0	7.8	89.3	35.3	0.0
	16	30.6	9.1	92.5	35.2	2.0
(2022)-May	17	31.2	16.55	91.40	34.7	5.0
	18	32.3	17.31	89.1	35.1	1.0
	19	33.0	18.34	90.12	36.3	0.2
	20	33.6	19.55	92.07	35.7	3.8
(2022)-June	21	34.0	20.0	90.6	37.0	3.5
	22	32.0	21.7	89.2	38.2	5.6
	23	35.0	22.2	92.3	36.0	1.9
	24	36.3	23.6	91.0	39.6	10.2
(2022)-July	25	37.1	24.2	89.6	42.11	10.2
	26	36.5	25.6	88.5	39.8	40.2
	27	36.6	23.1	87.3	43.5	50.3
	28	37.3	26.5	85.0	42.2	21.9
(2022)-August	29	36.9	27.5	84.2	45.6	3.3
	30	37.0	26.1	81.0	44.3	1.1
	31	39.3	25.3	83.5	46.2	0.6
	32	38.6	28.0	79.0	43.8	9.5
	Total	1114.32	511.85	3575.99	1449.61	212.5
Mean		27.858	12.79625	89.39975	36.24025	5.31

***Source:** Punjab agriculture university Ludhiana. (Punjab, 2021-21



Graph 3.1 Average air temperature (°C) and rainfall (mm) during (November 2020-21 to August 2022) in the wheat-green gram cropping system.



Graph 3.2. Average relative humidity (%) in the wheat-green gram cropping system (November 2020-21 to August 2022).

3.3 Soil characteristics

To assess the physiochemical properties and fertility state of the soil, samples of soil were taken with the aid of an auger from 10 chosen at random locations within the study region. To form a mixture, soil samples were combined, which were then examined for physiochemical characteristics in the laboratory. In Table 3.3, the analysis findings are displayed.

Table 3.3 Physical composition of the soil in the experimental field

Sr. No.	Particulars	Analyzed Value (%)	Group/Class	Method used
1.	Sand (%)	56.28	Sandy loam	International Pipette method (Black, 1965)
2.	Silt (%)	35.61		
3.	Clay (%)	9.11		
4.	Bulk density (Mg m ⁻³)	1.52		Soil core method (Black, 1965)

Table 3.4 Physio-chemical composition of the soil in the experimental field

Sr. No	Particulars	Method used	Test value	Normal range	Interpretation
A.	Chemical properties				
1.	Soil pH	Glass electrode pH meter (Piper, 1967)	8.0	6.5-7.5	High (Slightly alkaline)
2.	Electric Conductivity (ds m ⁻¹)	Solubridge method (Black and Evans, 1965)	0.194	< 4.00	Non-saline
3.	Available Nitrogen N(kg ha ⁻¹)	Alkaline permanganate method (Subbiah and Asija, 1956)	183	280-560	Low
4.	Available Phosphorus P(kg ha ⁻¹)	Olsen's method (Olsen, 1954)	20.21	12.5-25	Medium
5.	Available Potassium K(kg ha ⁻¹)	Flame Photometric method (Jackson, 1967)	182.8	135-335	Medium
6.	Organic carbon (%)	Walkey and Black method (Black, 1965)	0.79	0.12-1.13	Medium

3.4 Cropping history of study place

The study on the last 5 consecutive years of cultivation is shown in Table 3.5

Table 3.5: Crop history of research plot

S. No.	Year	<i>Kharif</i>	<i>Rabi</i>	<i>Spring</i>
1.	2016-17	Paddy	Chickpea	Spring green gram
2.	2017-18	Paddy	Wheat	Spring maize
3.	2018-19	Paddy	Wheat	Spring green gram
4.	2019-20	Paddy	Chickpea	Spring green gram
5.	2020-21	Paddy	Wheat	Fallow

3.5 Experimental Details and Layout

The study was layout using a Randomised Block Design with 3 replications. Eight (8) different treatment combinations included applying various herbicide molecules pre- and PoE, either unaided or combined with hand weeding.

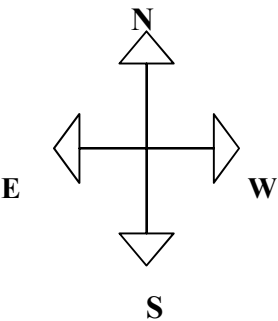
Table 3.6 Experimental detail in wheat

Crop	Wheat (2020-21)	Wheat (2021-22)
Variety	PBW343 (Unnat)	PBW343 (Unnat)
Design	RBD	RBD
Treatment	08	08
Replication	03	03
Gross plot extent	9 m x 8 m = 72 m ²	9 m x 8 m = 72 m ²
Net plot extent	8.5 m x 7.5 m = 63.75 m ²	8.5 m x 7.5 m = 63.75 m ²
Total trial area	72 m x 26 m = 1872 m ²	72 m x 26 m = 1872 m ²
Spacing	22.5 cm row to row	22.5 cm row to row
Sowing date	15 th November, 2020	17 th November, 2020
Harvesting date	20 th April, 2021	23 th April, 2021
Space between plots	0.5m	0.5m
Space between replications	1m	1m

Table 3.7 Experimental detail in green gram

Crop	Green gram (2021)	Green gram (2022)
Variety	ML818	ML818
Design	RBD	RBD
Treatment	08	08
Replication	03	03
Gross plot extent	9 m x 8 m = 72 m ²	9 m x 8 m = 72 m ²
Net plot extent	8.5 m x 7.5 m = 63.75 m ²	8.5 m x 7.5 m = 63.75 m ²
Total trial area	72 m x 26 m = 1872 m ²	72 m x 26 m = 1872 m ²
Space	30cm x 10cm	30cm x 10cm
Sowing date	15 th June, 2021	15 th June, 2022
Harvesting date	28 th August, 2021	29 th August, 2022
Space between plot	0.5 m	0.5 m
Space between replication	1 m	1 m

3.6 Research Layout (Design)



R-I

R-II

R-III

Irrigation channel				
T ₁	W A T E R	T ₈	W A T E R	T ₂
T ₂		T ₅		T ₃
T ₃		T ₁		T ₄
T ₄	W A Y	T ₂	W A Y	T ₅
T ₅		T ₇		T ₆
T ₆		T ₃		T ₈
T ₇		T ₄		T ₁
T ₈		T ₆		T ₇



Wheat experimental area after sowing



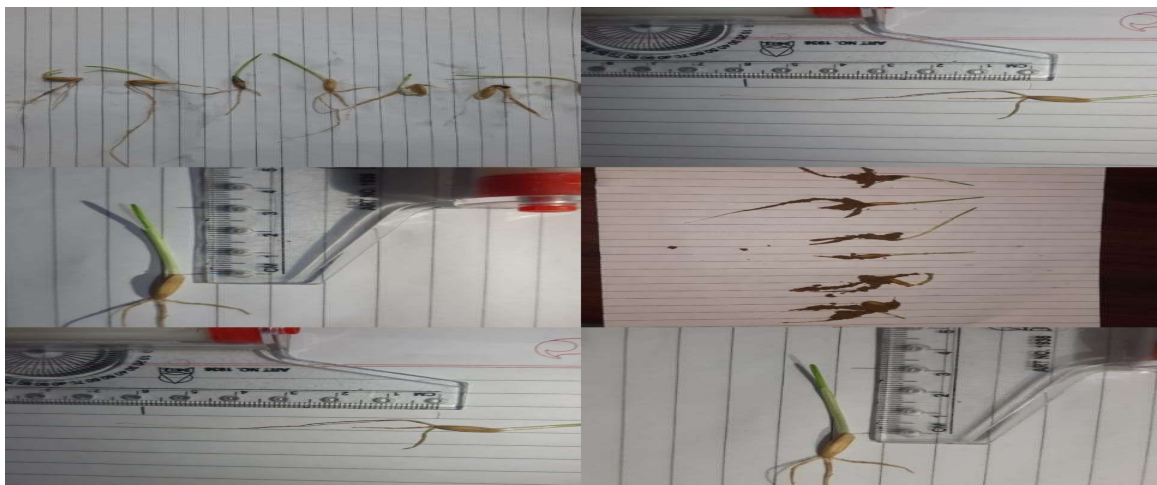
Lab work



Wheat crop at early stage and maturity stage



Harvesting of wheat crop



Herbicide persistence study by Oat (Field bioassay method)



Land preparation in green gram



Field work in green gram



General field view of green gram



Herbicide persistence study by Cucumber (Field bioassay method)

Table 3.8 Herbicide detail on study in wheat

S. No.	Usage	Dosage (g ha ⁻¹)	Time of use	Trade name
T ₁	Pyroxasulfone 85 % WG + Pendimethalin 30 % EC	120 + 850	PE (2 days after sowing)	Awkira +Bunker
T ₂	Pyroxasulfone 85 % WP + Pendimethalin 30 % EC	110 + 800	PE (2 days after sowing)	Awkira +Bunker
T ₃	Sulfosulfuron 75 % + Metsulfuron 5% WG	40	PoE (35 days after sowing)	Total
T ₄	Hand weeding	-	30 and 60 days after sowing	-
T ₅	Sulfosulfuron 75 % + Metsulfuron 5% WG	35	PoE (35 days after sowing)	Total
T ₆	Clodinafop-propargyl 15 % WP	400	PoE (35 days after sowing)	Zhataka
T ₇	2, 4-D Na 80 % WP	750	PoE (35 days after sowing)	Weedmar- 80
T ₈	Weedy check (control)	-	-	-

Table 3.9 Herbicide detail on study in green gram

S. No.	Usage	Dosage (g ha ⁻¹)	Time of use	Trade name
T ₁	Imazethapyr 10 % SL	60	PE (2 days after sowing)	Tata vaar
T ₂	Pendimethalin 30 % EC	1000	PE (2 days after sowing)	Stomp 30 EC
T ₃	Pendimethalin 30 % EC + Imazethapyr 10 % SL	1000 + 50	PoE (30 days after sowing)	Stomp 30 EC + Tata vaar
T ₄	Hand weeding	-	20 and 40 days after sowing	-
T ₅	Quizalofop p ethyl 5 % EC	75	PoE (30 days after sowing)	Targa super
T ₆	Imazethapyr 35 % + Imazamax 35 % WG (RM)	75	PoE (30 DAS)	Bingo
T ₇	Sodium Aciflourfen 16.5 % and Clodinafop- propargyl 8 % EC	180	PoE (30 DAS)	IRIS
T ₈	Weedy check (control)	-	-	-

3.7 Test crop

Table 3.10 Characteristics of wheat variety

Sr. No.	Character	PBW343 (Unnat)
1.	Type of seed	Certified seed
2.	Year of released	2017
3.	Germination (%)	85
4.	Purity (%)	98
5.	Seed yield (q ha ⁻¹)	47
6.	Tolerance to disease	Brown rust and moderately resistant to yellow rust
7.	Duration	155 days
8.	Suitable for area	Punjab, Haryana, Delhi and HP.

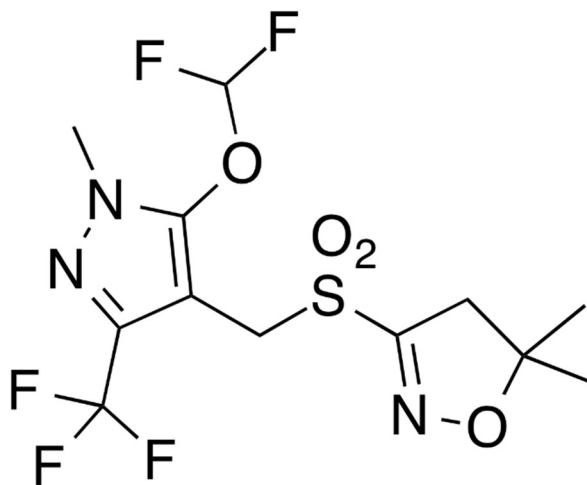
Table 3.11 Characteristics of green gram variety

Sr. No.	Character	ML818
1.	Nature for seed	Certified seed
2.	Year of released	2003
3.	Germination (%)	86
4.	Purity (%)	98
5.	Seed yield (q ha ⁻¹)	13.27
6.	Tolerance to disease	Yellow vein mosaic or Mungbean Yellow Mosaic Virus (MYMV), Cercospora leaf spot disease
7.	Days to maturity	72 days
8.	Suitable for area	Whole Punjab

3.8 Brief information about the herbicides used in the experiment in wheat-green gram

3.8.1 Pyroxasulfone 85 % WG

1. Chemical structure:-



2. Group of herbicide: - Very long chain of fatty acid (Thiobencarb)

3. Common Name: - Pyroxasulfone 85 % WP

4. Trade Name: - Awkira

6. Empirical formula: - $C_{12}H_{14}F_5N_3O_4S$

7. Molecular weight: - $391.316 \text{ g mol}^{-1}$

8. Melting point: - 130.7°C

9. Using time: - PE

10. Kind of Weed control: - Yearly monocot and dicot weeds

11. Recommended crop: - Wheat, Maize and Soybean

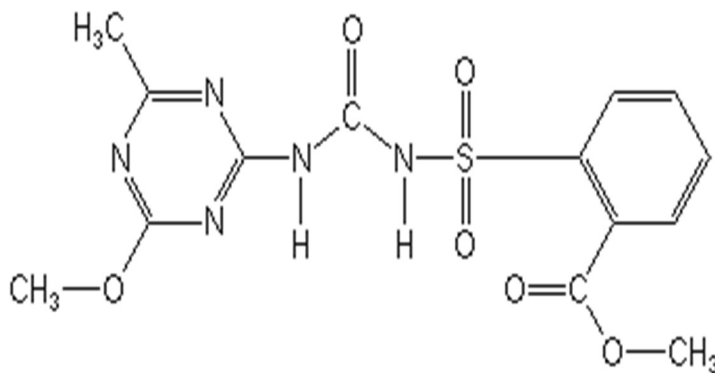
12. Mode of action

Pyroxasulfone expressively reduces the shoot elongation of germinated seeds but has minimum influence on the germination of *Lolium multiflorum* and *Echinochloa spp.*

These damage symptoms are very similar to those caused by herbicides that block very long-chain fatty acid elongase (VLCFAE). Inhibition of shoot and seedling growth.

3.8.2 Metsulfurone 5% WG

1. Chemical structure:-



2. Group of herbicide: - Sulfonylurea

3. Common Name: - Metsulfurone 5% WG

4. Trade Name: - Total

5. Empirical formula: - $C_{13}H_{13}N_5O_6S$

6. Molecular weight: - $367.34 \text{ g mol}^{-1}$

7. Melting point: - 163°C

8. Using time: - PoE

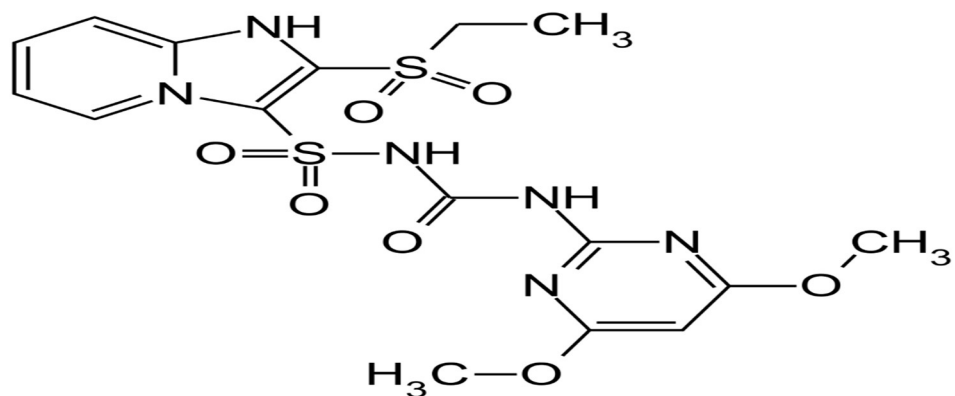
9. Kind of Weed control: - dicot weeds

10. Recommended crop: - Wheat

11. Mode of action- Prevent ALS

3.8.3 Sulfosulfuron 75 % WG

1. Chemical structure:-



2. Group of herbicide: - Sulfonylurea

3. Common Name: - Sulfosulfuron 75 % WG

4. Trade Name: - Total

5. Empirical formula: - $C_{16}H_{18}N_6O_7S_2$

6. Molecular weight: - 470.5 g mol^{-1}

7. Melting point: - 201.5°C

8. Using time: - PoE

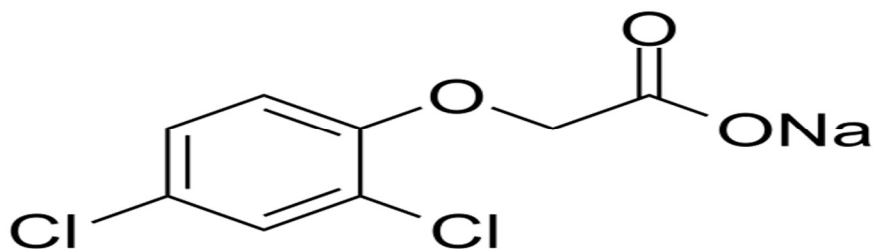
9. Kind of Weed control: - yearly monocot and dicot weeds

10. Recommended crop: - Wheat

11. Mode of action- Prevent ALS

3.8.4 2, 4-D NA 80 % WP

1. Chemical structure:-



2. Group of herbicide: - 2, 4-Dichlorophenoxyacetic acid

3. Common Name: - 2, 4-D Na 80 WP

4. Trade Name: - Weedmar-80

5. Empirical formula: - $C_8H_5Cl_2NaO_3$

6. Molecular weight: - $243.02 \text{ g mol}^{-1}$

7. Melting point: - $201.1 - 201.7^\circ\text{C}$

8. Using time: - PoE

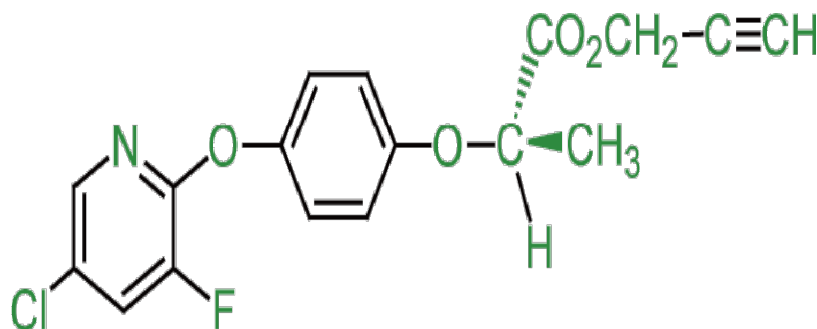
9. Kind of Weed control: - dicot weeds

10. Recommended crop: - Sugarcane, Wheat, Maize etc.

11. Mode of action- Action like IAA (Synthetic auxins).

3.8.5 Clodinafop-propargyl

1. Chemical structure:-



2. Group of herbicide: - Aryloxyphenoxy propionate

3. Common Name: - Clodinafop-propargyl 15 % WP

4. Trade Name: - Zhataka

5. Empirical formula: - $C_{17}H_{13}ClFNO_4$

6. Molecular weight: - 349.7

7. Melting point: - 48-57 °C

8. Using time: - PoE

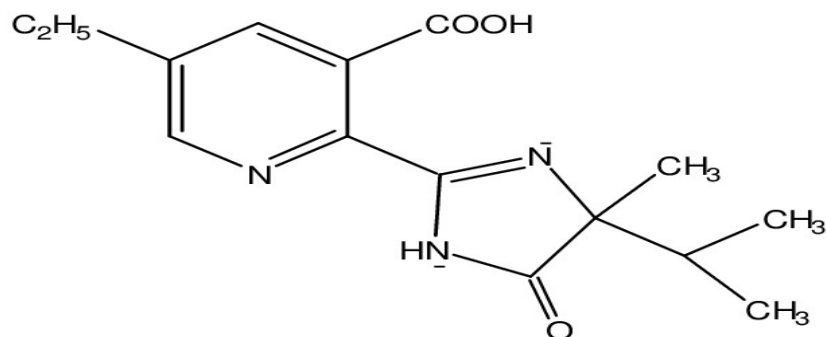
9. Kind of Weed control: - Yearly monocot and dicot weeds

10. Recommended crop: - Wheat

11. Mode of action- Inhibition ACCase enzyme

3.8.6 Imazethapyr

1. Chemical structure:-



2. Group of herbicide: - Imidazolinone

3. Common Name: - Imazethapyr 10 % SL

4. Trade Name: - Tata vaar

5. Empirical formula: - C₁₅H₁₉N₃O₃

6. Molecular weight: - 289.34 g mol⁻¹

7. Melting point: - 169-173 °C

8. Using time: - PoE

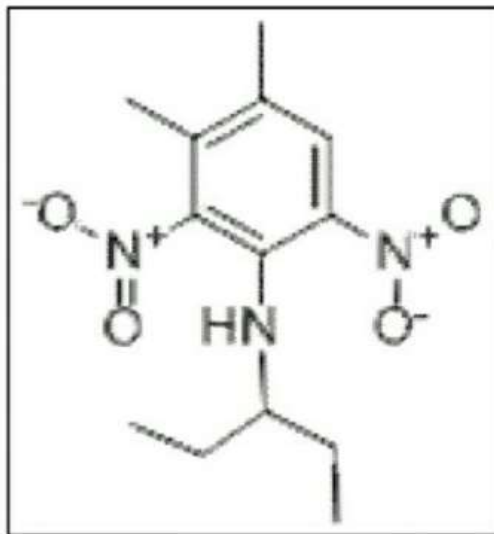
9. Kind of Weed control: - Yearly monocot and dicot weed

10. Recommended crop: - Pigeon pea, Green gram, Blackgram, Cow pea, Soybean, Groundnut

11. Mode of action- Inhibit ALS

3.8.7 Pendimethalin

1. Chemical structure:-



2. Group of herbicide: - Dinitroanilines

3. Common Name: - Pendimethalin 30 EC

4. Trade Name: - Stomp 30 EC

5. Empirical formula: - $C_{13}H_{19}N_3O_4$

6. Molecular weight: - $281.31 \text{ g mol}^{-1}$

7. Melting point: - $47\text{-}58^\circ\text{C}$

8. Using time: - PE and PoE

9. Kind of Weed control: - Yearly monocot and dicot weeds

10. Recommended crop: - Green gram, tobacco, sorghum, rice, peanut

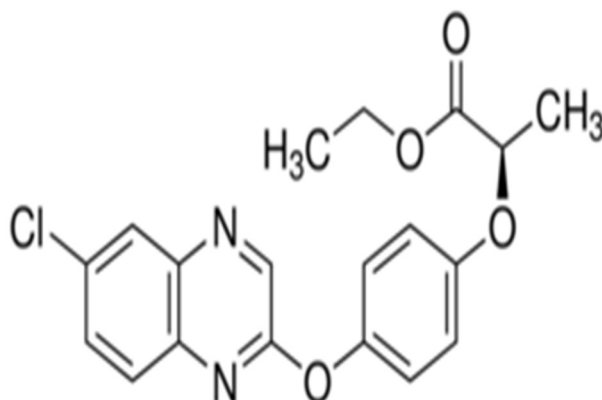
11. Mode of action

Pendimethalin suppresses the growth of weeds and reduces their population, especially during the crops critical development stage. Pendimethalin prevents production of microtubules. It attaches to the main microtubule protein tubulin, which results in the

loss of microtubules and the lack of the spindle apparatus. This stops the chromosomes from aligning and separating during mitosis. Dinitroaniline-induced microtubule loss frequently causes the root tip to expand because the cells in this area cannot divide or elongate. Pendimethalin acts herbicidal by being absorbed by the roots and coleoptiles. Initial effects on roots, particularly the formation of lateral or secondary roots, show that pendimethalin slows root and shoot growth. Limiting root growth has the secondary effect of causing primary roots to become thicker and stubby, especially at the tips and to hinder shoot growth. The majority of the impacted weeds do not emerge from the ground, but those that do usually have one or two leaves suppression of microtubule assembly. Root and shoot inhibitors.

3.8.8 Quizalofop-p-ethyl

1. Chemical structure:-



2. Group of herbicide: - Aryloxyphenoxy propionate cyclohexanedione

3. Common Name: - Quizalofop-p-ethyl 5 % EC

4. Trade Name: - Targa super

5. Empirical formula: - $C_{19}H_{17}ClN_2O_4$

6. Molecular weight: - 372.8 g mol^{-1}

7. Melting point: - 75°C

8. Using time: - Early PoE

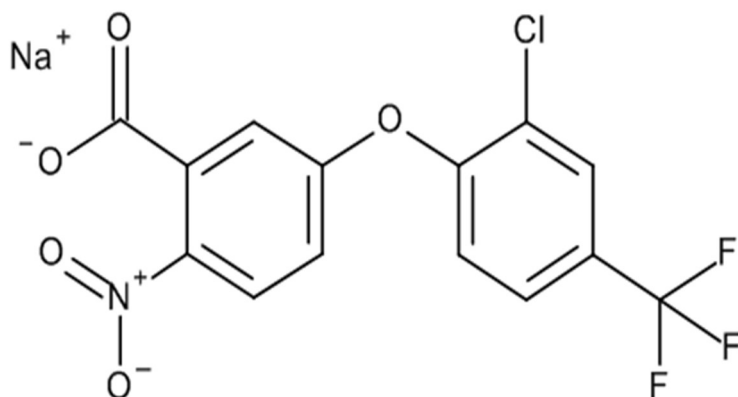
9. Kind of Weed control: - Yearly monocot and dicot weeds

10. Recommended crop: - Green gram, Soybean, Sugabeet and field bean.

11. Mode of Action: - Prevent of ALS

3.8.9 Sodium Acifulourfen

1. Chemical structure:-



2. Group of herbicide: - Na Acifluorfen- Diphenyl ether. Aryloxy phenoxy propionate

3. Common Name: - Sodium Acifluorfen 16.5 % EC

4. Trade Name: - IRIS

5. Empirical formula: - $C_{14}H_6ClF_3NO_5.Na$ or $C_{14}H_6ClF_3NNaO_5$

6. Molecular weight: - $383.64 \text{ g mol}^{-1}$

7. Melting point: - $124-125^\circ\text{C}$

8. Using time: - PoE

9. Kind of weed control: - Yearly monocot and dicot weeds

10. Recommended crop: - Soybean, Green gram and Blackgram

11. Mode of action: - Inhibit enzyme A C C-ase

3.9 Calender opertions

Table 3.12: Calendar of operation in wheat

S. No.	Cultural operations	Implement / method used	2020-21	2021-22
1	Pre sowing irrigation	Flooding	05-11-2020	08-11-2021
2	Ploughing and harrowing	Tractor drawn cultivator and disc harrow	10-11-2020	12-11-2021
3	Soil sampling	Auger of soil	11-11-2020	14-11-2021
4	Planking	Tractor drawn planker	13-11-2020	14-11-2021
4	Layout preparation	Manual	14-11-2020	14-11-2021
5	Seed treatment, fertilizer use and sowing	fertilizer cum seed drill	15-11-2020	17-11-2021
6	Irrigation	Controlled flow	16-11-2020	20-11-2021
7	Use of herbicide PE weedicide with water	Knapsack sprayer with flat fan nozzle 500 litre ha ⁻¹	20-11-2020	22-11-2021
8.	HW (One month after sowing)	Manual	15-12-2020	17-12-2021
9.	Use of herbicide PoE herbicide used water	Knapsack sprayer with flat fan nozzle 500 litre ha ⁻¹	25-12-2020	28-12-2021
10.	HW (Two month after sowing)	Manual	15-01-2021	16-01-2022
11.	Irrigation	Controlled flood	16-01-2021	20-01-2022
12.	Irrigation	Controlled flow	20-02-2021	22-02-2022
13.	Irrigation	Controlled flow	15-03-2021	19-03-2022
14.	Harvesting	Manual	20-04-2021	23-04-2022
15.	Threshing and Winnowing	Manual	27-04-2021	28-04-2022

Table 3.13: Calendar of operations in green gram

S. No.	Cultural operation	Implement / method used	2021	2022
1.	Ploughed and harrowed	Tractor drawn cultivator and disc harrow	16-07-2021	17-07-2022
2	Soil sampling	Auger of soil	17-07-2021	18-07-2022
3	Planking	Tractor drawn planker	19-07-2021	20-07-2022
4	Layout preparation	Manual	21-07-2021	22-07-2022
5	Seed treatment, fertilizer use and sowing	fertilizer cum seed drill	23-07-2021	25-07-2022
6	Irrigation	Controlled flow	24-07-2021	26-07-2022
7	Use of weedicide PE weedicide water used	Knapsack sprayer with flat nozzle 500 litre ha ⁻¹	26-07-2021	28-07-2022
8	HW 20 DAS	Manual	12-08-2021	15-08-2022
9	Use of weedicide PoE herbicide with water	Knapsack sprayer with flat nozzle 500 litre ha ⁻¹	24-08-2021	24-08-2022
10	HW 40 DAS	Manual	03-09-2021	05-09-2022
11	Irrigation	Controlled flood	05-09-2021	06-09-2022
12	Irrigation	Controlled flow	25-09-2021	28-09-2022
13	Harvesting	Manual	05-10-2021	09-10-2022
14	Threshing and Winnowing	Manual	09-10-2021	12-10-2022

3.10 Field operations

3.10.1 Pre-sowing irrigation

One week before field preparation, pre-sowing irrigation was performed to ensure that the soil had enough moisture for the seeds to germinate properly. Irrigation flooded the entire field. Floods both aid in weed control and help to remove chemicals used in the cultivation of previous crops.

Land preparation with the use of tractor 1 ploughing afterward 2 harrowing to make the fine crushed bed. The area is kept level with the use of planker.

3.10.2 Seeds and sowing

Table 3.14 Seeds and sowing in wheat-green gram cropping system

Sr. No.	Categories	Wheat	Green gram
1	Seed treatment	Thiuram 3 g per kg seed	Rhizobium 25 g per kg seed
2	Spacing	22.5 cm row to row	30 cm x 10 cm
3	Rate of seed	100 kg	12 kg ha ⁻¹
4	Time of sowing	15 November	15 June
5	Method of sowing	Line sowing	Dibbling
6	Depth of sowing	5 cm	6 cm

3.10.3 Fertilizer use

Fertilizer in the suggested amount of 120: 60: 40 kg Nitrogen: Phosphorus: Potassium ha⁻¹ useful with urea, SSP, and MOP, respectively, by way of basal at the time of sowing in rows uniformly to per plot. A top dressing dose was applied one month after sowing under wheat crop.

The required nutritional dosage in green gram is 20:50:00 kg Nitrogen: Phosphorus: Potassium ha⁻¹ useful with urea, SSP, and MOP, respectively, by way of basal at the time

of sowing in rows uniformly to per plot and a top dressing dose were applied one month after sowing.

3.3.10.4 Post-sowing irrigation

Depending on the amount of soil moisture, irrigation was applied to the wheat crop four to five times. Irrigating the field using flooding techniques. The crown root initiation stage, which occurs at 21 DAS, is the most crucial growth stage for irrigation.

A green gram crop needs the lowest amount of moisture possible to grow and develop. In green gram, irrigation is required after one at the time of seeding. Crops require two to three irrigations. Under green gram, the first moisture-sensitive stage is blooming, and the second is pod development.

3.10.5 Gap filling and thinning

Gap filling was ready in areas where germination did not occur after the wheat crop had fully germinated.

Filling in the gaps in areas where germination does not occur is necessary for maintaining sufficient space and the best crop stand, thinned is mostly required in green gram.

3.10.6 Weed control methods

Weed control methods used per plot.

i) Manual weeding

HW use on 30 and 60 DAS in (T₄), One HW (60 DAS) in (T₆ and T₇) in wheat and 20 and 40 DAS in green gram under (T₄) treatment.

ii) Herbicidal weed control

Weed control treatments use per plot in wheat. Herbicide T₁: Pyroxasulfone @ 120 g PE combined with pendimethalin @ 850 g PE, T₂: Pyroxasulfone @ 110 g PE combined with pendimethalin @ 800 g PE, T₃: Sulfosulfuron mixed with Metsulfuron @ 40 g PoE, T₄: Two HW (30 and 60 DAS) , T₅: Sulfosulfuron combined with Metsulfuron @ 35 g PoE, T₆: Clodinafop propargyl @ 400 g PoE combined with HW (60 DAS), T₇: 2, 4-D Na

0.750 kg PoE combined with HW (60 DAS) and T₈: Weedy check (Control). Herbicides are mixed with water on five hundred L per hectare carrier and application in individual plots. The quantity of herbicide was calculated above mentioned, per plot, herbicide was mixed in water and sprayed total plot by knapsack sprayer using a flat fan nozzle as blind application.

Weed control treatments use per plot in green gram. Herbicide T₁: Imazethapyr 60 g PE, T₂: PE Pendimethalin @ 1000 g, T₃: PE Pendimethalin @ 1000 g combined with Imazethapyr @ 50 g PoE, T₄: Two HW (20 and 40 DAS), T₅: PoE Quizalofop p ethyl @ 75 g, T₆: PoE Imazethapyr combined with Imazamax @ 75 g, T₇: Sodium Aciflurofen combined with Clodinafop propargyl @ 180 g PoE and T₈: Weedy check. Herbicides are mixed with water on five hundred L per hectare carrier and application in individual plots. The quantity of herbicide was calculated above mentioned, per plot, herbicide was mixed in water and sprayed total plot by knapsack sprayer using a flat fan nozzle as blind application.

Dose calculation for herbicides:

$$\text{Herbicides required} = \frac{\text{Recommended dose } (\frac{kg}{ha})}{\text{Active ingredient (a.i.)}} \times 100$$

3.10.7 Harvesting

When the crop was fully mature, it was manually harvested with the use of a sickle. Following manual harvesting with sickles of the net plot, double line boundary plant per border collected separately per plot. The harvest per plot was wrapped on the pack and permitted dry to sun 2 days per plot. Gathered packs were brought to the threshing floor after being sun-dried and weighed plot-wise for biological yield using a spring balance.

3.10.8 Threshed and winnowing

After harvesting the biomass is threshed separately using a wooden stick per plot. The seeds are cleaned with the help of supa manually. After threshing the grain is separated from straw help of supa in winnowing and the seeds are cleaned after being weighed.

3.11 Observation schedule

The subsequent headings are used for describing investigational notes on crop and weeds.

3.11.1 Observation in weeds

3.11.1.1 Species-wised and count of total weeds

Species-wised and total weed count are recorded at monthly intervals (30, 60, 90, 120 DAS and at harvest). The data was taken 25 cm x 25 cm quadrat in the region per plot that was chosen randomly in a wheat field.

In green gram field species-wised and total weed count are recorded at 20 day intervals (20, 40, 60 DAS and at harvest). The data was taken 25 cm x 25 cm quadrat in the region per plot that was chosen randomly.

3.11.1.2 Count total weeds

Count of total weeds is noted at 30 days intervals (30, 60, 90, 120 DAS and at harvest). All weeds were gathered in 25cm x 25cm quadrat in the region per plot that was chosen randomly in a wheat field.

Count of total weeds are noted at 20 days intervals (20, 40, 60 DAS and at harvest). All weeds were gathered in 25cm x 25cm quadrat in the region per plot that was chosen randomly in the green gram field.

3.11.1.3 Species-wised and total weeds dry weight

In wheat species-wised and total weeds, dry weight was noted at monthly intervals up to harvest. Weeds present in 25cm x 25cm per quadrat in the net plot weeds were cut near the ground, moved to HAO (Hot Air Oven) then dried at 65-70 °C in constant weight of weeds. Weeds dry weight taken in weighing balance. Weed dry weight was noted according to several weed species.

In green gram species-wised and total weeds dry weight was noted at 20 days intervals up to harvest. Weeds present in 25cm x 25cm per quadrat in the net plot were cut near the ground, moved to HAO (Hot Air Oven) then dried at 65-70 °C in constant

weight of weeds. Weeds dry weight taken in weighing balance according to several weed species.

3.11.1.4 Total weeds dry weight

In wheat, total weed dry weight was noted at monthly intervals up to harvest. Weeds present in 25 cm x 25 cm per quadrat in net plot weeds were cut near the ground after weeds moved to HAO (Hot Air Oven) and then dried at 65-70 °C in constant weight of weeds. Weeds dry weight taken in weighing balance according to several weed species.

In green gram total weeds dry weight was noted at 20 day intervals up to harvest. Weeds present in 25 cm x 25 cm per quadrat in net plot weeds were cut near the ground after weeds moved to HAO (Hot Air Oven) and then dried at 65-70 °C in constant weight of weeds. Weeds dry weight taken in weighing balance according to several weed species.

3.11.1.5 WI (%)

The decrease in produce (seed yield) brought on by the presence of weeds is likened to a weed-free environment. It was expressed in percent and calculated with the use succeeding formula,

$$\text{Weed Index (\%)} = \frac{\text{Maximum seed yield} - \text{Seed yield from treated plot}}{\text{Maximum seed yield}} \times 100$$

3.11.1.6 WCE (%)

WCE is calculated at monthly intervals up to harvest based on the weed dry weight compared to the weedy check and stated in % by Mani *et al.*, 1973.

$$\text{WCE (\%)} = \frac{DWC - DWT}{DWC} \times 100$$

Wherever,

DWC = Weeds dry weight in Weedy check plot (g)

DWT = Weeds dry weight in treatment plot (g)

3.12 Observation on crop

3.12.1 Crop study in wheat

3.12.1.1 Plant count

Plant were counted per meter square area extent per net plot at 30 DAS then the average population was recorded.

3.12.1.2 Plant height

The plant height was assessed from the plant base e.g. near land to the tip of the plant in randomly 5 marked plants on every net plot recorded at monthly intervals up to harvest. It is expressed in cm. The average value of per plot is worked out.

3.12.1.3 Total tillers m⁻²

Total tillers m⁻² per net plot were recorded at monthly intervals up to harvest. The average value per plot is computed.

3.12.1.4. LAI

Leaves area to ground area extent by plant.

$$LAI = \frac{\text{Leaf area (cm square)}}{\text{Ground area (cm square)}}$$

3.12.1.5 Fresh weight per plant (g plant⁻¹)

Fresh weight (g plant⁻¹) was measured at 30 days intervals up to harvest. 5 randomly plant every individual plot were selected. Plants were uprooted carefully with active roots. The below stem part was separate from the above stem part of the plant. The weight of samples was taken in a weighing balance then the average value was calculated.

3.12.1.6 Plant dry weight (g plant⁻¹)

Plant dry weight (g plant⁻¹) was measured at 30 days intervals up to harvest. 5 randomly plant every individual plot were selected. Plants were uprooted carefully with active roots. The below stem part was separate from the above stem part of the plant. After drying under the sun the sample it moved to the oven at 60 °C for two days to record the constant weight plant. Weight on samples taken in weighing balance then average value calculated.

3.12.1.7 Developmental studies

Everyday fields were observed the date was noted when 50 percent of plants of the study plot reached the exact crown root initiation phase. From the date of seeding to 21 days counted (21 DAS).

Everyday fields were observed and the date was noted when 50 percent of the plants of the study plot reach the exact flowering phase. From the date of seeding to 110 days (110 DAS) were counted.

3.12.1.8 CGR_a

CGR of wheat was recorded at monthly intervals. CGR is known as a rise in dry weight per unit of land for some time. The unit of CGR is g m⁻² day⁻¹.

$$CGR = \frac{W_2 - W_1}{T_2 - T_1} \times 1/A$$

3.12.1.9 RGR_b

RGR of wheat was recorded at monthly intervals. RGR is dry matter increase in per unit already present of dry matter. The unit of RGR is g g⁻¹ day⁻¹.

$$RGR = \frac{\log eW_2 - \log eW_1}{T_2 - T_1}$$

3.12.1.10 Yield and yield attributes

3.12.1.10.1 No. of spikes m⁻²

To study the influence of different weed control approaches on no. of spikes m⁻² in wheat, the total number of spikes are recorded per meter square per plot then calculate average value.

3.12.1.10.2 No. on spikelet spike⁻¹

Five spikes are randomly selected per plot counting the spikelets spike⁻¹, the average spikelet is counted then the average value is calculated.

3.12.1.10.3 Length of spike (cm)

Five spikes were selected randomly per plot and spike length were measured in meter scale and average value calculating.

3.11.1.10.4 No. of grains spike⁻¹

Five spikes were chosen randomly per plot and manually threshed. The grain per spike was counted then calculated average value.

3.12.1.10.5 Test weight (g)

After harvesting and threshing of crops, random samples of grain were taken per plot area. 1000 seed weights were taken in weighing balance and calculating the average value.

3.12.1.10.6 Seed yield (t ha⁻¹)

Following threshing, winnowing and drying, the crop production for every net plot was recorded and then converted the value into t ha⁻¹.

3.12.1.10.7 Straw yield (t ha⁻¹)

After harvesting of crop per net plot were sun drying and bundles were tied in separately after the weight of the bundle (biological yield) was recorded in weighing balance. After subtraction of seed yield from the bundle straw yield was noted down. Straw yields were converted into t ha⁻¹.

3.12.1.10.8 HI

HI is the value produced of seed per hectare (economic yield) seed produced per hectare and straw yield per hectare (biological yield) (Donald, 1962.)

$$HI (\%) = \frac{\text{Economical yield}}{\text{Biological yield}} \times 100$$

Where,

Economic yield = Seed yield

Biological yield = Seed yield + Straw yield.

3.12.2 Study on green gram crop

3.12.2.1 Plant population

Plant Populations were counted in meter squares for every net plot on 20 DAS and calculated average population.

3.12.2.2 Plant height

Plant height measured from the plant base e.g. near land to tip of plant randomly 5 marked plants selected on every net plot at 20 days intervals up to harvest. It is expressed in cm. The average value per plot is calculated.

3.11.2.3 Branches per plant

Branches per plant counted randomly 5 marked plants for every net plot. The mean value per plot is calculated and noted every 20 days intervals up to harvest.

3.12.2.4. LAI_a

Leaves area to ground area extent by plant.

$$LAI = \frac{\text{Leaf area (cm square)}}{\text{Ground area (cm square)}}$$

3.12.2.5 Root nodules plant⁻¹

Nodules plant⁻¹ recorded 20 and 40 DAS. Selected five plants randomly in the border rows per plot. Plants were carefully excavated along with the soil of an effective root zone per plot. Plant roots were carefully washed in a sieve with running water then separated and counted of effective root nodules plant⁻¹.

3.12.2.6 Fresh weight (g plant⁻¹)

Fresh weight (g plant⁻¹) was observed at 20 day intervals up to harvest. 5 random plants were selected in individual plots. Plants were uprooted carefully with active roots. The below stem part was separate from the above stem part of the plant. Weight on samples taken in weighing balance then average value calculated.

3.12.2.7 Plant dry weight (g plant⁻¹)

Plant dry weight (g plant⁻¹) was observed at 20 days intervals up to harvest. 5 random plants were selected on every individual plot. Plants were uprooted carefully with active roots. The below stem part was separate from the above stem part of the plant. After drying of sun the sample it moved to the oven at 60 °C for two days to record the constant weight

of the dry plant. The weight of samples was taken in weighing balance and the average value was calculated.

3.12.2.8 CGR_a

CGR of wheat was recorded in month intervals. CGR is known as a rise in dry weight per unit of land for some time. The unit of CGR is g m⁻² day⁻¹.

$$CGR = \frac{W_2 - W_1}{T_2 - T_1} \times 1/A$$

3.12.2.9 RGR_b

RGR of wheat was recorded in month intervals. RGR is dry matter increase in per unit already present of dry matter. The unit of RGR is g g⁻¹ day⁻¹.

$$RGR = \frac{\log eW_2 - \log eW_1}{T_2 - T_1}$$

3.12.2.10 Yield and yields attributes

3.12.2.10.1 Pods per plant

To study the impact of weed control approaches on pod formation, total pods counted 5 selected randomly marked crops per plot after the mean value was calculated.

3.12.2.10.2 Seeds per pod

Five marked plants were randomly selected from mature pods per plot. Counted Seeds per pod then average value calculated.

3.12.2.10.3 Length of pod

Randomly selected five pods per plot and the length of pods was measured with the help of a meter scale and average value calculation.

3.12.2.10.4 Test weight (g)

After harvesting and threshing of crops, random samples of grain were taken per plot. 1000 seed weight taken in g and average value calculated.

3.12.2.10.5 Seed yield ($q\ ha^{-1}$)

Threshing, winnowing, and drying after seed yield for every net plot recorded then convert into $q\ ha^{-1}$.

3.12.2.10.6 Straw yield ($q\ ha^{-1}$)

After the harvested crop per net plot was sun drying and bundles tied in separately after the weight of the bundle (biological yield) were recorded in weighing balance. After subtraction of seed yield from the bundle straw yield was noted down. Straw yield converted into $q\ ha^{-1}$.

3.12.2.10.7 HI

HI is the value produce of seed per hectare (economic yield) and seed produce per hectare and straw yield per hectare (biological yield) (Donald, 1962.).

$$\text{Harvest Index (\%)} = \frac{\text{Economical yield}}{\text{Biological yield}} \times 100$$

Whereas,

Economic yield = Seed yield

Biological yield = Seed yield + Straw yield.

3.13 Herbicide persistence studies bioassay

Bioassays are experiments that use living plant seeds to test the toxicity of chemicals.

1. Field bioassay

Complex samples of soils recorded double depths 0 to 15 and 15 to 30 cm per plot on monthly distance afterward herbicide use (30 Days interval up to harvest) on wheat-green gram cropping system. Sample of soils taken in per plot then move in 2 mm sieved to pit. The size of the pit is 12 cm x 10 cm x 2 cm and the fill volume of half a kg of sieved soil. 10 grains of cucumber were grown at about five cm depth on every pit in green gram field soil and oat seed in wheat field soil. Pits were watered every day. 10 days later crops were uprooted with an active root zone and remove the soil with the help of water. Root

length and shoot length were measured and the average value was calculated. Root and shoot length were used for comparing the values of estimating herbicides presence in soil.

3.14 Economics

Economics on wheat-green gram effect weed control approaches on crop produce per plot. The costs required for the cultivation of crop is the cost of cultivation. The total return is calculated based on harvested produce sales in the market. Net return subtracting total return into the cost of cultivation. The B: C ratio is by using the below formula:

Net return (₹) = Total returns (₹) – Cultivation of cost (₹)

$$\text{Benefit: cost relation} = \frac{\text{Net earnings (₹/ha)}}{\text{Total Expenditure (₹/ha)}} \times 100$$

3.15 Statistical study

The RBD method was used to set up the experiment. Statistics achieved for several factors were tabularized and exposed to numerical study. Statistics for total dry weight of weeds were shown to the transformation of square root viz. $\sqrt{(x+0.5)}$ before calculating of analysis of variance. The impact of treatment was tested with the 'F' test, anywhere the 'F' test revealed their significance, the levels of treatment were compared by CD at a 5% level of probability. The ANOVA calculation of the basis of the formula stated by Gomez and Gomez, 1984.

Table 3.15: Statistics of ANOVA

Cause on variance	D.F.	SS	MSS	F Cal	F Tab (5%)	CD 5 %
Replication (r)	(3-1 = 2)	RSS	RMS	RMS/EMS	—	
Treatment (t)	(8-1= 7)	TrSS	TrMS	TrMS/EMS	—	
Error	(2 X 7=14)	ESS	EMS			
Total	23	TSS				

- (a) $S.E.m \pm = \sqrt{(EMS/r)}$
 (b) $C.D. = S.E.m \times \sqrt{(2)} \times t (p=0.05) \text{ at error d.f}$
 (c) $C.V. (\%) = \sqrt{(EMS/GM)} \times 100$

Where,

r = Number of repetition

t = Total of treatment

$d. f.$ = Degree of freedom

$M.S.S.$ = Mean sum of square

EMS = Error mean squares

$C.D.$ = Critical difference

IV. RESULTS AND DISCUSSION

The experiment entitled **Efficacy of pre-emergence and post-emergence herbicides on weed Control in Wheat-Green gram cropping system under Trans-gangetic plains of Punjab** were conducted in the year *rabi*, 2020-21, 2021-22 and *kharif*, 2020-21, 2021-22 at Lovely Professional University, Jalandhar, (Punjab). The goal of this section aimed to study the variations in treatment patterns seen at various stages of development as well as growth. The outcomes of the study were outlined and presented in this section.

4.1 Evaluation of weeds

4.1.1 Weed observed in the test site

The most common weeds found in the research area were grasses and broad leaf weeds at different stages of development. Both grasses and broadleaf weeds may be seen in the field. Table 4.1 and Table 4.2 detect these types of weeds.

Table 4.1 Weed population found on study location

Sr. No.	Common Name	Botanical Name	Family
A	Monocot		
1.	Little seed canary grass	<i>Phalaris minor</i>	Poaceae
2.	Bermuda grass	<i>Cynodon dactylon</i>	Poaceae
B	Sedges		
3.	Purple nutsedge	<i>Cyperus rotundus</i>	Cyperaceae
C	Dicot		
4.	Hemp	<i>Cannabis sativa</i>	Cannabaceae
5.	Common lambs quarter	<i>Chenopodium album</i>	Chenopodiaceae
6.	Rough medik	<i>Medicago denticulate</i>	Fabaceae
7.	Congress grass	<i>Parthenium hysterophorus</i>	Asteraceae

**Table 4.2 Weed flora observed in wheat crop in weedy check (Control) treatment
(Pooled data of 2020-21 and 2021-22)**

Sr. No.	Specie of weeds	30	60	90	120	At harvest
1.	<i>Phalaris minor</i>	✓	✓	✓	✓	✓
2.	<i>Cynodon dactylon</i>	✓	✓	✓	✓	✓
3.	<i>Cyperus rotundus</i>	✓	✓	✓	✓	✓
4.	<i>Cannabis sativa</i>	✓	✓	✓	✓	✓
5.	<i>Chenopodium album</i>	✓	✓	✓	✓	✓
6.	<i>Medicago denticulate</i>	✓	✓	✓	✓	✓
7.	<i>Parthenium hysterophorus</i>	✓	✓	✓	✓	✓

✓ Represents presence of weed

Table 4.3 Influence of different herbicide treatments on count (No. m⁻²) of *Phalaris minor* in wheat (2020-21 and 2021-22).

Treatm ent	30 DAS (2020- 21)	30 DAS (2021- 22)	Pool data	60 DAS (2020- 21)	60 DAS (2021- 22)	Pool data	90 DAS (2020- 21)	90 DAS (2021- 22)	Pool data	120 DAS (2020- 21)	120 DAS (2021- 22)	Pool data	Harve st (2020- 21)	Harvest (2021- 22)	Pool data
T ₁	1.14** (1.30)*	1.15 (1.34)	1.14 (1.32)	1.17 (1.39)	1.19 (1.42)	1.18 (1.41)	1.43 (2.05)	1.46 (2.15)	1.44 (2.10)	1.43 (2.07)	1.44 (2.10)	1.44 (2.09)	1.40 (1.96)	1.42 (2.04)	1.41 (2.00)
T ₂	1.18 (1.41)	1.20 (1.46)	1.20 (1.44)	1.21 (1.48)	1.23 (1.53)	1.22 (1.51)	1.54 (2.39)	1.56 (2.44)	1.55 (2.42)	1.45 (2.12)	1.47 (2.16)	1.46 (2.14)	1.42 (2.02)	1.47 (2.18)	1.44 (2.10)
T ₃	2.23 (5.00)	2.26 (5.12)	2.24 (5.06)	1.86 (3.48)	1.87 (3.50)	1.86 (3.49)	1.63 (2.68)	1.63 (2.66)	1.63 (2.67)	1.60 (2.56)	1.63 (2.59)	1.60 (2.58)	1.57 (2.48)	1.60 (2.56)	1.58 (2.52)
T ₄	2.28 (5.20)	2.28 (5.24)	2.26 (5.22)	1.06 (1.14)	1.10 (1.21)	1.08 (1.18)	1.00 (1.00)	1.03 (1.06)	1.01 (1.03)	0.99 (0.99)	1.01 (1.03)	1.00 (1.01)	0.99 (0.99)	1.01 (1.03)	1.00 (1.01)
T ₅	2.08 (4.36)	2.09 (4.40)	2.09 (4.38)	1.87 (3.53)	1.89 (3.60)	1.88 (3.57)	1.59 (2.53)	1.61 (2.61)	1.60 (2.57)	1.51 (2.30)	1.49 (2.24)	1.50 (2.27)	1.47 (2.17)	1.51 (2.29)	1.49 (2.23)
T ₆	2.43 (5.92)	2.44 (5.99)	2.44 (5.96)	1.75 (3.07)	1.76 (3.10)	1.75 (3.09)	1.04 (1.09)	1.09 (1.19)	1.06 (1.14)	1.02 (1.04)	1.01 (1.03)	1.02 (1.04)	1.02 (1.04)	1.01 (1.03)	1.02 (1.04)
T ₇	2.49 (6.24)	2.51 (6.30)	2.50 (6.27)	1.54 (2.39)	1.56 (2.45)	1.55 (2.42)	0.83 (0.69)	0.86 (0.74)	0.84 (0.72)	0.95 (0.92)	0.99 (0.98)	0.97 (0.95)	0.92 (0.85)	0.97 (0.95)	0.97 (0.90)
T ₈	2.57 (6.63)	2.61 (6.85)	2.59 (6.74)	2.61 (6.85)	2.64 (6.97)	2.62 (6.91)	2.61 (6.82)	2.67 (7.18)	2.64 (7.00)	2.60 (6.80)	2.66 (7.1)	2.63 (6.95)	2.69 (6.75)	2.65 (7.07)	2.62 (6.91)
SE m (±)	0.06	0.09	0.08	0.10	0.06	0.08	0.16	0.08	0.12	0.19	0.10	0.15	0.19	0.12	0.16
CD (p = 0.05)	0.18	0.27	0.23	0.31	0.18	0.25	0.48	0.24	0.36	0.59	0.30	0.45	0.57	0.37	0.47

*Values given in parenthesis are the mean of original values. **Data subjected to ($\sqrt{x+0.5}$) square root transformation, SE m (±): Standard Error of mean, CD: Critical Difference and DAS: Days after sowing

Treatments: T₁: Pyroxasulfone @ 120 g ha⁻¹ (PE) + Pendimethalin @ 850 g ha⁻¹ (PE), T₂: Pyroxasulfone @ 110 g ha⁻¹ (PE) Pendimethalin @ 800 g ha⁻¹ (PE), T₃: Sulfosulfuron + Metsulfuron @ 40 g ha⁻¹ (PE), T₄: Two hand weeding (30 and 60 DAS), T₅: Sulfosulfuron + Metsulfuron @ 35 g ha⁻¹ (PoE), T₆: Clodinafop-propargyl @ 400 g ha⁻¹ (PoE) + one hand weeding (60 DAS), T₇: 2, 4-D Na @ 750 g ha⁻¹ (PoE) + one hand weeding (60 DAS) and T₈: Weedy check (Control).

4.1.2 Species-wised and total weed count (No. m⁻²)

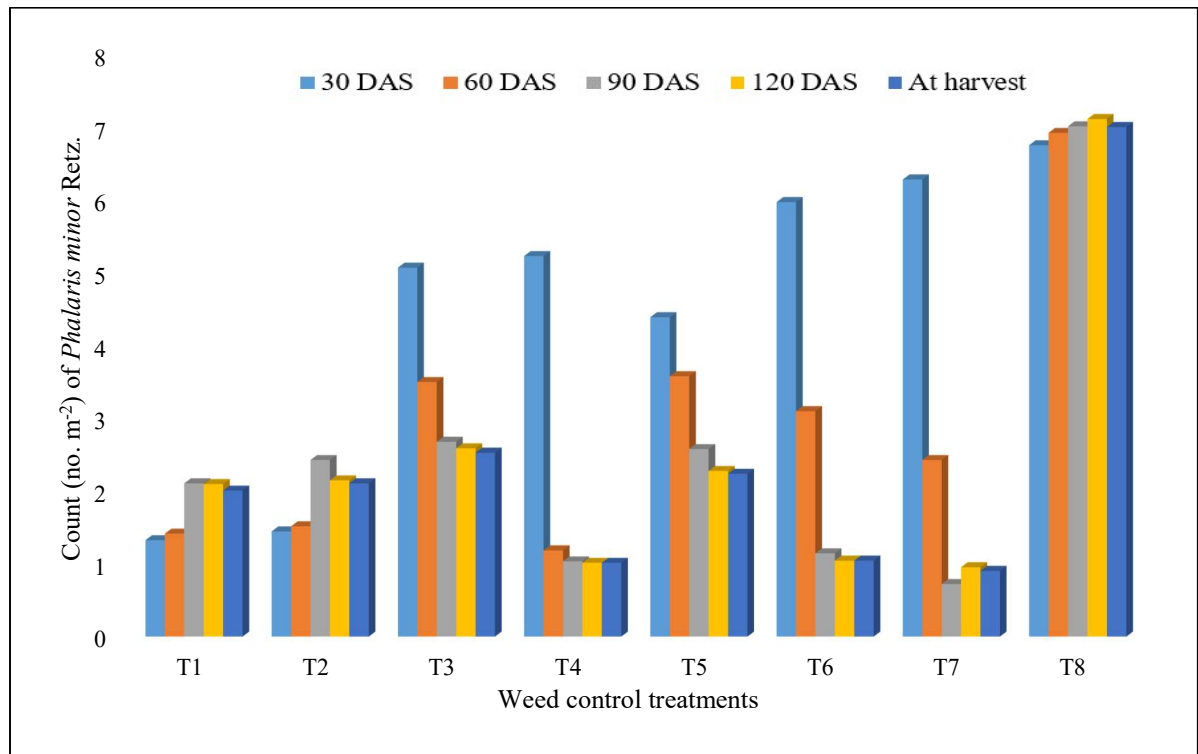
4.1.2.1 *Phalaris minor*

The data from the years 2020-2021 and 2020-2022 are displayed in Table 4.3 and are depicted in graph 4.1. The data focuses on the impact of monthly weed control treatments on the *Phalaris minor* population.

According to data of 2020-2021 and 2021-2022 Table 4.3, all weed management techniques significantly reduce the *Phalaris minor* Population as compared to the weedy check. The greatest count of *Phalaris minor* Retz was seen in all treatments 30 days after sowing, with the exception of the combinations of pyroxasulfone 120 g PE and pendimethalin 850 g PE and pyroxasulfone 110 g PE and pendimethalin 800 g PE. At 60 DAS saw the highest weed incidence in sulfosulfuron mixed with metsulfuron @ 40 g PoE and sulfosulfuron mixed with metsulfuron 35 g (PoE). The lowest observed number of *Phalaris minor* Retz was in HW (30 and 60 DAS). Pyroxasulfone 110 g PE and 800 g (PE) and pyroxasulfone 120 g PE and pendimethalin were the next two combinations. At 90 DAS the maximum count were recorded use sulfosulfuron combined with metsulfuron 40 g PoE and sulfosulfuron combined with metsulfuron 35 g PoE and minimum count of *Phalaris minor* Retz. PoE 2, 4- D Na 0.75 kg combined with HW (60 DAS) followed HW (30 and 60 DAS) and clodinafop- propargyl 400 g PoE + HW (60 DAS). 120 DAS and harvest maximum weed count were recorded in use of sulfosulfuron combined with metsulfuron 40 g PoE and sulfosulfuron combined with metsulfuron 35 g PoE. The lower in 2, 4-D Na 0.750 kg PoE combined with HW (60 DAS) and HW (30 and 60 DAS) by way of associated to other herbicidal over a weedy check.

Combined data for the years 2020-2021 and 2021-2022 is displayed. Lower amounts of *Phalaris minor* Retz were observed in PE as compared to PoE, as shown in Table 4.3 and shown on Graph 4.1, which were labelled 30 days later. After 60 days, the results showed that the highest numbers of seeded severe weeds were found in sulfosulfuron combined with metsulfuron 35 g (PoE) and sulfosulfuron mixed with metsulfuron 40 g PoE, and lower in HW (30 and 60 DAS). Pyroxasulfone 120 g PE with pendimethalin 850 g PE followed. Lower weed totals were seen in PoE 2, 4-D Na 0.75 kg in combination with HW (60 DAS) and HW (30 and 60 DAS) S collected 90 days after

seeding. According to data collected 120 days after sowing, the harvest showed a lower count of *Phalaris minor* Retz in PoE 2, 4-D Na 0.75 kg combined with HW (60 DAS) and HW (60 days after sowing). In contrast to the other methods, there was an extreme difference in the amounts of sulfosulfuron combined with metsulfuron 35 g PoE and 40 g PoE. Kaur *et al.*, 2019 reported nearly similar results.



Graph 4.1 Influence of different herbicide treatments on count (No. m⁻²) of *Phalaris minor* Retz. in wheat (Pooled data of 2020-21 and 2021-22).

Table 4.4 Influence of different herbicide treatments on count (No. m⁻²) of *Cynodon dactylon* (L.) in wheat (2020-2021 and 2021-2022).

Treatme nt	30 DAS (2020- 21)	30 DAS (2021- 22)	Pool data	60 DAS (2020- 21)	60 DAS (2021- 22)	Pool data	90 DAS (2020- 21)	90 DAS (2021- 22)	Pool data	120 DAS (2020- 21)	120 DAS (2021- 22)	Pool data	Harve st (2020- 21)	Harve st (2021- 22)	Pool data
T ₁	1.24** (1.55)*	1.26 (1.61)	1.25 (1.58)	1.28 (1.64)	1.30 (1.70)	1.29 (1.67)	1.32 (1.76)	1.34 (1.80)	1.33 (1.78)	1.38 (1.92)	1.41 (1.99)	1.14 (1.96)	1.35 (1.84)	1.37 (1.90)	1.36 (1.87)
T ₂	1.30 (1.70)	1.31 (1.74)	1.31 (1.72)	1.31 (1.73)	1.35 (1.84)	1.33 (1.79)	1.35 (1.84)	1.37 (1.89)	1.36 (1.87)	1.40 (1.97)	1.41 (2.00)	1.41 (1.99)	1.37 (1.90)	1.40 (1.97)	1.39 (1.94)
T ₃	1.90 (3.61)	1.92 (3.69)	1.91 (3.65)	1.78 (3.19)	1.80 (3.24)	1.79 (3.22)	1.71 (2.95)	1.72 (2.97)	1.72 (2.96)	1.68 (2.83)	1.72 (2.96)	1.70 (2.90)	1.66 (2.77)	1.67 (2.80)	1.67 (2.79)
T ₄	1.88 (3.55)	1.90 (3.61)	1.89 (3.58)	1.04 (1.09)	1.10 (1.21)	1.07 (1.15)	1.00 (1.00)	1.03 (1.06)	1.01 (1.03)	1.04 (1.09)	1.08 (1.17)	1.06 (1.13)	0.99 (0.99)	1.03 (1.06)	1.01 (1.03)
T ₅	1.94 (3.77)	1.96 (3.84)	1.95 (3.81)	1.61 (2.60)	1.66 (2.76)	1.63 (2.68)	1.53 (2.34)	1.54 (2.40)	1.53 (2.37)	1.54 (2.38)	1.56 (2.46)	1.55 (2.42)	1.51 (2.28)	1.51 (2.30)	1.51 (2.29)
T ₆	1.85 (3.45)	1.89 (3.58)	1.87 (3.52)	1.65 (2.74)	1.68 (2.84)	1.67 (2.79)	1.06 (1.14)	1.09 (1.20)	1.08 (1.17)	1.10 (1.22)	1.14 (1.30)	1.12 (1.26)	1.04 (1.09)	1.02 (1.04)	1.03 (1.07)
T ₇	2.03 (4.15)	2.06 (4.26)	2.05 (4.21)	1.55 (2.43)	1.60 (2.58)	1.58 (2.51)	0.96 (0.93)	1.00 (1.00)	0.98 (0.97)	1.02 (1.04)	1.04 (1.09)	1.03 (1.07)	0.97 (0.94)	1.00 (1.00)	0.98 (0.97)
T ₈	2.09 (4.39)	2.10 (4.41)	2.02 (4.40)	2.11 (4.48)	2.18 (4.78)	2.15 (4.63)	2.16 (4.69)	2.18 (4.77)	2.17 (4.73)	2.15 (4.66)	2.18 (4.78)	2.17 (4.72)	2.15 (4.63)	2.18 (4.77)	2.16 (4.70)
SE m (±)	0.11	0.09	0.10	0.15	0.11	0.13	0.17	0.12	0.15	0.21	0.14	0.18	0.25	0.14	0.20
CD (p = 0.05)	0.32	0.26	0.29	0.45	0.32	0.39	0.51	0.38	0.45	0.63	0.41	0.52	0.75	0.41	0.58

*Values given in parenthesis are the mean of original values. ** Data subjected to ($\sqrt{x+0.5}$) square root transformation, SE_m(±): Standard Error of mean, CD: Critical Difference and DAS: Days after sowing

Treatments: T₁: Pyroxasulfone @ 120 g ha⁻¹ (PE) + Pendimethalin @ 850 g ha⁻¹ (PE), T₂: Pyroxasulfone @ 110 g ha⁻¹ (PE) Pendimethalin @ 800 g ha⁻¹ (PE), T₃: Sulfosulfuron + Metsulfuron @ 40 g ha⁻¹ (PE), T₄: Two hand weeding (30 and 60 DAS), T₅: Sulfosulfuron + Metsulfuron @ 35 g ha⁻¹ (PoE), T₆: Clodinafop-propargyl @ 400 g ha⁻¹ (PoE) + one hand weeding (60 DAS), T₇: 2, 4-D Na @ 750 g ha⁻¹ (PoE) + one hand weeding (60 DAS) and T₈: Weedy check (Control).

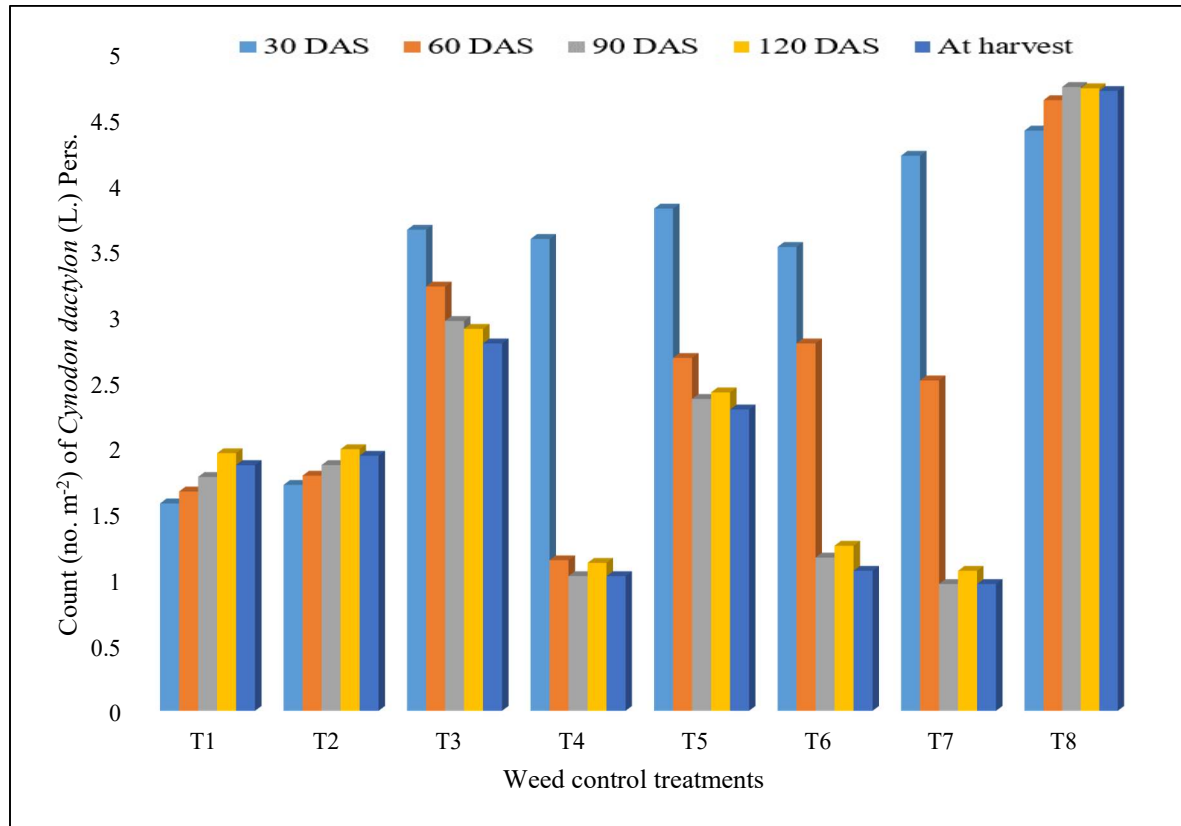
4.1.2.2 *Cynodon dactylon* L.

Based on data from the years 2020-2021 and 2021-2022, which are displayed in Table 4.4 and depicted in graph 4.2, the effect of weed control treatments at monthly intervals till harvest was observed in the population of *Cynodon dactylon* L.

Table 4.4 displays data from 2020-2021 and 2021-2022, which indicates that all weed control methods significantly decreased the population of *Cynodon dactylon* L. as compared to weedy check. With the exception of pyroxasulfone 120 g PE paired with pendimethalin 850 g PE and pyroxasulfone 110 g PE mixed with pendimethalin 800 g PE, all treatments showed an excessive total of 30 DAS of *Cynodon dactylon* L. At 60 DAS sulfosulfuron combined with metsulfuron 40 g PoE and sulfosulfuron combined with metsulfuron 35 g PoE were the sites with the most notable weed counts. Following the application of pyroxasulfone 110 g PE coupled with pendimethalin 850 g PE and pyroxasulfone 120 g PE combined, the minimal count of *Cynodon dactylon* L. was reported in the HW (60 days after planting). The highest count of *Cynodon dactylon* L. were seen at 90 DAS while using sulfosulfuron combined with metsulfuron 40 g PoE and sulfosulfuron mixed with metsulfuron 35 g PoE. Clodinafop-propargyl 400 g PoE mixed with HW (60 DAS) and PoE 2, 4-D Na 0.75 kg combined with HW (60 DAS) subsequent to HW (60 DAS). When using sulfosulfuron paired with metsulfuron 40 g PoE and sulfosulfuron mixed with metsulfuron 35 g PoE, harvest maximum weed count and 120 DAS were noted. PoE 2, 4-D Na 0.75 kg in combination with HW (60 DAS) and HW (30 and 60 DAS) is the lowest when compared to different herbicide applications made on weedy check.

Table 4.4 presents cumulative data for the years 2020-2021 and 2021-2022, which is depicted in graph 4.2. The data indicates that 30 days after sowing, a lower total of *Cynodon dactylon* L. was found in PE treatments compared to PoE treatments. The highest weed counts were observed at 60 DAS in sulfosulfuron + metsulfuron 35 g PoE mixed with sulfosulfuron combined with metsulfuron 40 g PoE. Thirty and sixty DAS had the lowest weed counts in HW, after pyroxasulfone 120 g PE combined with pendimethalin 850 g PE. The lowest amount of weeds were found in PoE 2, 4-D Na 0.75 kg together with HW (60 DAS) and HW (30 and 60 DAS) at 90 days after seeding. In comparison to the other methods in relation to Weedy check, lower counts of *Cynodon dactylon* L. were recorded

120 days after sowing and harvest in PoE 2, 4-D Na 0.75 kg combined HW (60 DAS) and hand weeding (30 and 60 DAS), with the highest counts in sulfosulfuron combined with metsulfuron 40 g PoE and sulfosulfuron combined with metsulfuron 35 g PoE..



Graph 4.2 Influence of different herbicide treatments on count (No. m⁻²) of *Cynodon dactylon* (L.) in wheat (Pooled data of 2020-21 and 2021-22).

Table 4.5 Influence of different herbicide treatments on count (No. m⁻²) of *Cyperus rotundus* L. in wheat (2020-2021 and 2021-2022).

Treatme nt	30 DAS (2020- 21)	30 DAS (2021- 22)	Pool data	60 DAS (2020- 21)	60 DAS (2021- 22)	Pool data	90 DAS (2020- 21)	90 DAS (2021- 22)	Pool data	120 DAS (2020- 21)	120 DAS (2021- 22)	Pool data	Harve st (2020- 21)	Harves t (2021- 22)	Pool data
T ₁	1.20** (1.44)*	1.22 (1.49)	1.21 (1.46)	2.23 (1.52)	1.24 (1.55)	1.23 (1.53)	1.24 (1.55)	1.27 (1.61)	1.26 (1.58)	1.26 (1.61)	1.29 (1.65)	1.27 (1.63)	1.26 (1.58)	1.27 (1.61)	1.26 (1.59)
T ₂	1.24 (1.55)	1.26 (1.58)	1.25 (1.56)	2.28 (1.64)	1.30 (1.70)	1.29 (1.67)	1.29 (1.64)	1.30 (1.67)	1.28 (1.66)	1.28 (1.64)	1.30 (1.69)	1.29 (1.66)	1.28 (1.62)	1.30 (1.67)	1.28 (1.64)
T ₃	2.11 (4.48)	2.12 (4.51)	2.12 (4.49)	1.99 (3.97)	1.99 (3.96)	1.99 (3.96)	1.71 (2.93)	1.74 (3.00)	1.72 (2.97)	1.72 (2.95)	1.74 (3.02)	1.72 (2.98)	1.68 (2.83)	1.72 (2.94)	1.69 (2.88)
T ₄	2.15 (4.63)	2.17 (4.70)	2.16 (4.66)	1.04 (1.09)	1.06 (1.12)	1.05 (1.10)	1.33 (1.79)	1.36 (1.84)	1.34 (1.82)	1.36 (1.84)	1.37 (1.89)	1.36 (1.86)	1.33 (1.77)	1.36 (1.81)	1.34 (1.79)
T ₅	2.18 (4.76)	2.19 (4.81)	2.18 (4.78)	1.97 (3.90)	1.99 (3.98)	1.98 (3.94)	1.76 (3.11)	1.80 (3.21)	1.77 (3.16)	1.77 (3.14)	1.79 (3.20)	1.78 (3.17)	1.73 (3.00)	1.78 (3.17)	1.76 (3.08)
T ₆	2.13 (4.56)	2.15 (4.61)	2.14 (4.58)	1.83 (3.36)	1.85 (3.42)	1.84 (3.39)	1.35 (1.84)	1.40 (1.96)	1.37 (1.90)	1.40 (1.97)	1.42 (2.02)	1.41 (1.99)	1.36 (1.87)	1.37 (1.86)	1.37 (1.86)
T ₇	2.14 (4.59)	2.16 (4.66)	2.15 (4.62)	1.74 (3.06)	1.76 (3.11)	1.76 (3.08)	1.31 (1.73)	1.37 (1.88)	1.34 (1.81)	1.33 (1.76)	1.35 (1.81)	1.33 (1.78)	1.31 (1.73)	1.33 (1.77)	1.32 (1.75)
T ₈	2.20 (4.88)	2.23 (4.94)	2.21 (4.91)	2.19 (4.83)	2.23 (4.97)	2.22 (4.90)	2.20 (4.88)	2.24 (4.99)	2.22 (4.94)	2.19 (4.82)	2.42 (5.98)	2.21 (4.90)	2.18 (4.79)	2.22 (4.97)	2.20 (4.88)
SE m (±)	0.10	0.07	0.09	0.12	0.10	0.11	0.16	0.12	0.14	0.20	0.13	0.17	0.22	0.14	0.18
CD (p = 0.05)	0.32	0.23	0.28	0.36	0.30	0.33	0.48	0.36	0.42	0.61	0.38	0.50	0.67	0.41	0.54

*Values given in parenthesis are the mean of original values. **Data subjected to ($\sqrt{x+0.5}$) square root transformation, SE m (±): Standard Error of mean, CD: Critical Difference and DAS: Days after sowing

Treatments: T₁: Pyroxasulfone @ 120 g ha⁻¹ (PE) + Pendimethalin @ 850 g ha⁻¹ (PE), T₂: Pyroxasulfone @ 110 g ha⁻¹ (PE) Pendimethalin @ 800 g ha⁻¹ (PE), T₃: Sulfosulfuron + Metsulfuron @ 40 g ha⁻¹ (PE), T₄: Two hand weeding (30 and 60 DAS), T₅: Sulfosulfuron + Metsulfuron @ 35 g ha⁻¹ (PoE), T₆: Clodinafop-propargyl @ 400 g ha⁻¹ (PoE) + one hand weeding (60 DAS), T₇: 2, 4-D Na @ 750 g ha⁻¹ (PoE) + one hand weeding (60 DAS) and T₈: Weedy check (Control).

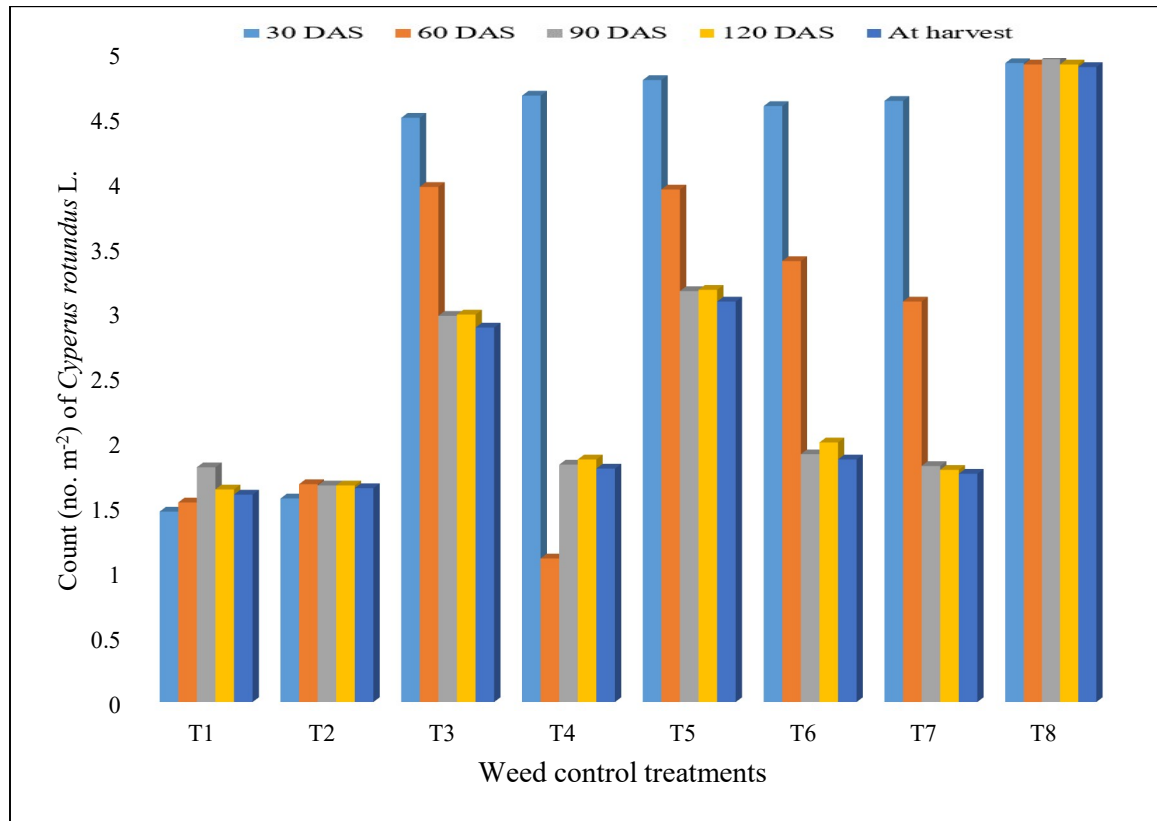
4.1.2.3 *Cyperus rotundus* L.

Based on data from the years 2020-2021 and 2021-2022, which are displayed in Table 4.5 and depicted in graph 4.3, the effect of weed control treatments at monthly intervals till harvest was observed in the population of *Cyperus rotundus* L.

The population of *Cyperus rotundus* L. in the years 2020-2021 and 2021-2022, as shown in Table 4.5, was decreased by all weed control techniques used to keep weeds at 30 days sowing, the highest count of *Cyperus rotundus* L. was seen in all treatments, with the exception of pyroxasulfone 110 g PE and pyroxasulfone 120 g PE mixed with pendimethalin 800 g PE. Serum sulfosulfuron + metsulfuron 40 g PoE and Serum sulfosulfuron + metsulfuron 35 g PoE showed an extremely high density of weeds 60 days after seeding. In HW (30 and 60 DAS), the lowest number of *Cyperus rotundus* L. was seen when pyroxasulfone 110 g PE was mixed with pendimethalin 800 g PE, followed by pyroxasulfone 120 g PE. At 90 DAS pyroxasulfone minimum count of PoE 2, 4-D Na 0.75 kg together with HW (60 DAS), and highest in sulfosulfuron combined with metsulfuron 40 g PoE following sulfosulfuron combined with metsulfuron 35 g PoE were seen in the combination of 110 g PE with pendimethalin 800 g PE and pyroxasulfone 120 g PE with pendimethalin 850 g PE. Sulfosulfuron combined with metsulfuron 40 g PoE adjacent to sulfosulfuron mixed with metsulfuron 35 g PoE, the harvest maximum weed count and 120 DAS were noted. The minimum for pyroxasulfone is 120 g PE plus 850 g pendimethalin PoE, followed by 110 g PE plus 850 g pendimethalin PoE, and finally PoE 2, 4-D Na 0.75 kg plus HW (60 DAS).

Table 4.5 and the corresponding graph 4.3 give cumulative data for the years 2020-2021 and 2020-2022, which indicates that 30 days later, the total amount of *Cyperus rotundus* L. reported in PE treatment was lower than that of PoE treatments. The highest recorded weed count in 60 DAS was found in sulfosulfuron mixed with metsulfuron 35 g PoE, while the lowest was found in HW (30 and 60 DAS) and with pyroxasulfone 120 g PE combined with pendimethalin 850 g PE. Pyroxasulfone 120 g PE mixed with pendimethalin 850 g PE had a minimum weed count of 90 DAS, and this was followed by pyroxasulfone 110 g PE combined with pendimethalin 850 g PoE and PoE 2, 4-D Na 0.75 kg combined with HW (60 DAS). Minimum number of *Cyperus rotundus* L. harvested 120

days after growth was recorded in pyroxasulfone after using pyroxasulfone, 120 g of PE in comparison to other treatments, the highest levels were seen in sulfosulfuron coupled with metsulfuron 40 g PoE, followed by sulfosulfuron mixed with metsulfuron 35 g PoE. 110 g PE and PoE 2, 4-D Na 0.75 kg combined with HW (60 DAS).



Graph 4.3 Influence of different herbicide treatments on count (No. m⁻²) of *Cyperus rotundus* (L.) in wheat (Pooled data of 2020-21 then 2021-22).

Table 4.6 Influence of different herbicide treatments on count (No. m⁻²) of *Cannabis sativa* L. in wheat (2020-2021 and 2021-2022).

Treatment	30 DAS (2020-21)	30 DAS (2021-22)	Pool data	60 DAS (2020-21)	60 DAS (2021-22)	Pool data	90 DAS (2020-21)	90 DAS (2021-22)	Pool data	120 DAS (2020-21)	120 DAS (2021-22)	Pool data	Harvest t (2020-21)	Harvest (2021-22)	Pool data
T ₁	0.95** (0.90)*	1.01 (1.02)	0.98** (0.96)*	0.99 (0.98)	1.01 (1.02)	1.00 (1.00)	1.06 (1.13)	1.09 (1.20)	1.08 (1.17)	1.08 (1.18)	1.11 (1.24)	1.10 (1.21)	1.08 (1.18)	1.09 (1.19)	1.09 (1.19)
T ₂	0.98 (0.96)	1.02 (1.04)	1.00 (1.00)	1.06 (1.13)	1.10 (1.21)	1.08 (1.17)	1.12 (1.26)	1.13 (1.29)	1.13 (1.28)	1.12 (1.26)	1.45 (1.31)	1.13 (1.29)	1.13 (1.28)	1.11 (1.25)	1.12 (1.27)
T ₃	2.03 (4.11)	2.05 (4.19)	2.04 (4.15)	1.70 (2.89)	1.74 (3.03)	1.72 (2.96)	1.46 (2.14)	1.48 (2.18)	1.47 (2.16)	1.20 (1.45)	1.23 (1.52)	1.22 (1.49)	1.18 (1.41)	1.20 (1.44)	1.94 (1.43)
T ₄	2.48 (6.16)	2.50 (6.26)	2.49 (6.21)	1.03 (1.08)	1.07 (1.14)	1.05 (1.11)	1.04 (1.09)	1.05 (1.11)	1.05 (1.10)	1.02 (1.05)	1.04 (1.09)	1.03 (1.07)	0.99 (0.99)	1.02 (1.05)	1.00 (1.02)
T ₅	2.30 (5.28)	2.32 (2.36)	2.31 (5.32)	1.72 (2.96)	1.81 (3.26)	1.76 (3.11)	1.51 (2.28)	1.52 (2.32)	1.52 (2.30)	1.46 (2.15)	1.49 (2.23)	1.47 (2.19)	1.72 (1.96)	1.49 (2.24)	1.44 (2.10)
T ₆	2.07 (4.29)	2.09 (4.37)	2.08 (4.33)	1.68 (2.81)	1.71 (2.91)	1.69 (2.86)	1.06 (1.13)	1.08 (1.17)	1.08 (1.15)	1.12 (1.26)	1.15 (1.32)	1.14 (1.29)	1.11 (1.24)	1.14 (1.30)	1.12 (1.27)
T ₇	2.41 (5.83)	2.44 (5.95)	2.43 (5.89)	1.59 (2.52)	1.65 (2.64)	1.61 (2.58)	1.00 (1.00)	1.03 (1.07)	1.01 (1.04)	1.07 (1.15)	1.09 (1.18)	1.07 (1.17)	1.06 (1.13)	1.09 (1.19)	1.08 (1.16)
T ₈	2.42 (5.84)	2.48 (6.16)	2.45 (6.00)	2.76 (7.63)	2.64 (6.97)	2.70 (7.3)	2.71 (7.32)	2.72 (7.38)	2.71 (7.35)	2.69 (7.24)	2.72 (7.42)	2.71 (7.33)	2.69 (7.22)	2.72 (3.38)	2.70 (7.30)
SE _m (±)	0.08	0.09	0.09	0.11	0.13	0.12	0.14	0.13	0.14	0.17	0.14	0.16	0.16	0.11	0.14
CD (p = 0.05)	0.23	0.26	0.25	0.33	0.38	0.36	0.41	0.40	0.41	0.52	0.42	0.47	0.50	0.32	0.41

*Values given in parenthesis are the mean of original values. **Data subjected to ($\sqrt{x+0.5}$) square root transformation, SE_m(±): Standard Error of mean, CD: Critical Difference and DAS: Days after sowing

Treatments: T₁: Pyroxasulfone @ 120 g ha⁻¹ (PE) + Pendimethalin @ 850 g ha⁻¹ (PE), T₂: Pyroxasulfone @ 110 g ha⁻¹ (PE) Pendimethalin @ 800 g ha⁻¹ (PE), T₃: Sulfosulfuron + Metsulfuron @ 40 g ha⁻¹ (PE), T₄: Two hand weeding (30 and 60 DAS), T₅: Sulfosulfuron + Metsulfuron @ 35 g ha⁻¹ (PoE), T₆: Clodinafop-propargyl @ 400 g ha⁻¹ (PoE) + one hand weeding (60 DAS), T₇: 2, 4-D Na @ 750 g ha⁻¹ (PoE) + one hand weeding (60 DAS) and T₈: Weedy check (Control).

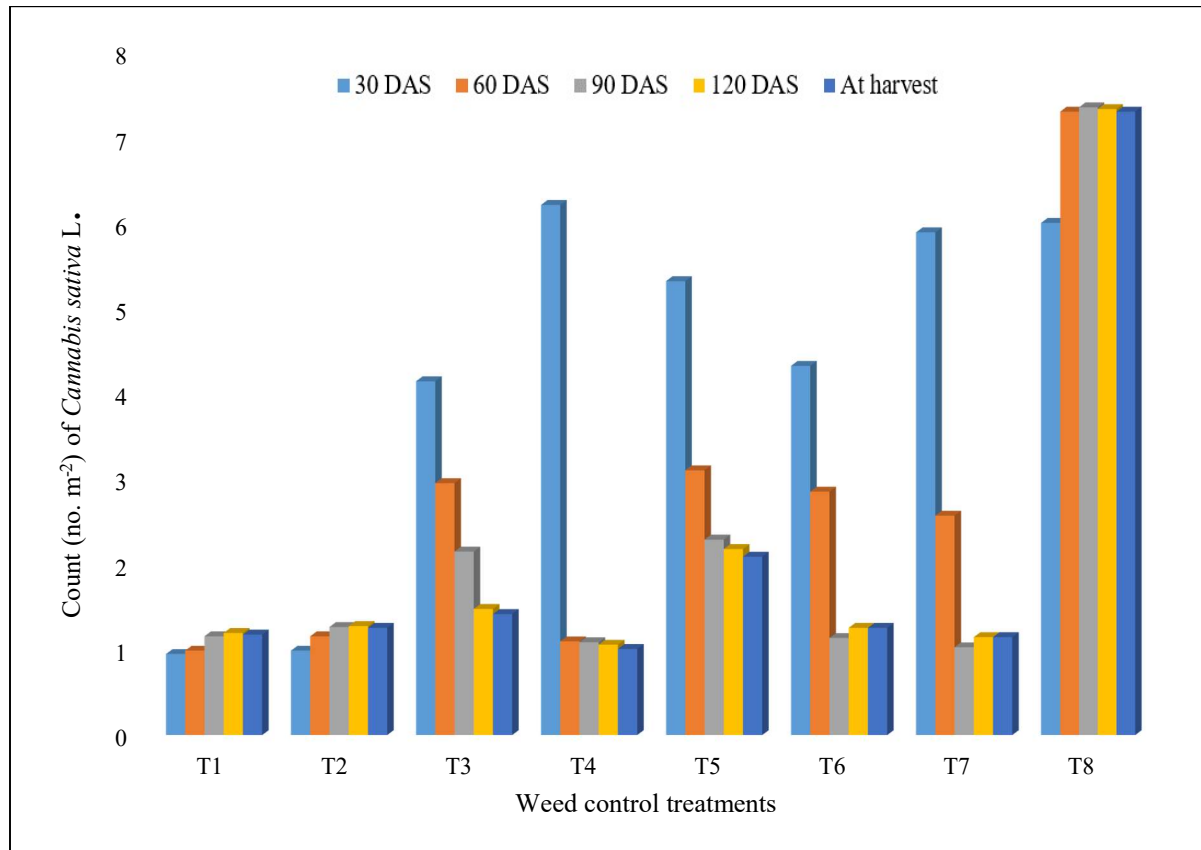
4.1.2.4 *Cannabis sativa* L.

Based on data from the years 2020-2021 and 2021-2022, which are displayed in Table 4.6 and depicted in graph 4.4, the effect of weed control treatments at monthly intervals till harvest was seen in the population of *Cannabis sativa* L.

Data from 2020-2021 and 2021-2022 on the total amount of *Cannabis sativa* L. in Table 4.6 demonstrate that, thanks to all weed management techniques, the overall population of *Cannabis sativa* L. is significantly under control over weedy check. With the exception of pyroxasulfone, all treatments had a maximum count of *Cannabis sativa* L. of 30 DAS at 120 g PE combined with 850 g PE, and pyroxasulfone at 110 g PE mixed with 800 g PE. Maximum weed count was measured in 60 DAS in sulfosulfuron + metsulfuron 40 g PoE, then in sulfosulfuron + metsulfuron 35 g PoE and clodinafop-propargyl 400 g PoE + HW (60 DAS). The lowest quantity of *Cannabis sativa* L. detected in pyroxasulfone was 120 g PE mixed with 850 g PE, followed by HW (30 and 60 DAS) pyroxasulfone 110 g PE mixed with 800 g PE. The highest count of 90 DAS was observed when sulfosulfuron and metsulfuron 40 g PoE was used, followed by sulfosulfuron and metsulfuron 35 g PoE. The lowest count was observed when *Cannabis sativa* L. PoE 2, 4-D Na 0.75 kg combined with HW (60 DAS), followed by HW (30 and 60 DAS) and clodinafop-propargyl 400 g PoE integrated with HW (60 DAS). sulfosulfuron mixed with metsulfuron 40 g PoE and harvest maximum weed count were reported with the usage of sulfosulfuron combined with metsulfuron 35 g and 120 DAS, respectively. The lower in PoE 2, 4-D Na 0.75 kg combined with HW (60 DAS) followed by pyroxasulfone 120 g PE combined with pendimethalin 850 g PE and HW (30 and 60 DAS) over a Weedy check.

The years 2020-2021 and 2021-2022 display cumulative statistics. A lower count of *Cannabis sativa* L. was reported in PE treatment as compared to PoE treatments, as Table 4.6, as displayed on Graph 4.4, illustrates. HW (30 and 60 DAS) came after pyroxasulfone 110 g PE combined with pendimethalin 800 g PE, and maximum weed counts were noted 60 days after sowing in sulfosulfuron combined with metsulfuron 35 g PoE, followed by sulfosulfuron combined with metsulfuron 40 g PoE. At 90 DAS the lower weed count were recorded in PoE 2, 4-D Na 0.75 kg combined with HW (60 DAS) followed by HW (60 DAS) and clodinafop-propargyl 400 g PoE combined with HW (60

DAS) . *Cannabis sativa* L. was found in PoE 2, 4-D Na 0.75 kg combined with HW (60 DAS) and HW (30 and 60 DAS) at the lowest count at harvest, and in sulfosulfuron combined with metsulfuron 40 g PoE and sulfosulfuron combined with metsulfuron 35 g PoE as compared to the remaining treatments, which were similar to the Weedy check.



Graph 4.4 Influence of different herbicide treatments on count (No. m⁻²) of *Cannabis sativa* L. in wheat (2020-2021 and 2021-2022).

Table 4.7 Influence of different herbicide treatments on count (No. m⁻²) of *Chenopodium album* L. in wheat (2020-2021 and 2021-2022).

Treatme nt	30 DAS (2020- 21)	30 DAS (2021- 22)	Pool data	60 DAS (2020- 21)	60 DAS (2021- 22)	Pool data	90 DAS (2020- 21)	90 DAS (2021- 22)	Pool data	120 DAS (2020- 21)	120 DAS (2021- 22)	Pool data	Harve st (2020- 21)	Harve st (2021- 22)	Pool data
T ₁	0.94** (0.89)*	1.05 (1.11)	1.00 (1.00)	1.04 (1.09)	1.06 (1.13)	1.05 (1.11)	1.08 (1.16)	1.09 (1.20)	1.09 (1.18)	1.14 (1.31)	1.18 (1.39)	1.16 (1.35)	1.14 (1.30)	1.14 (1.31)	1.14 (1.31)
T ₂	1.00 (1.00)	1.07 (1.14)	1.38 (1.07)	1.08 (1.17)	1.11 (1.24)	1.10 (1.21)	1.09 (1.18)	1.11 (1.23)	1.10 (1.21)	1.18 (1.39)	1.22 (1.48)	1.20 (1.44)	1.17 (1.37)	1.16 (1.35)	1.17 (1.36)
T ₃	2.54 (6.45)	2.56 (6.55)	2.55 (6.50)	1.67 (2.79)	1.71 (2.91)	1.69 (2.85)	1.33 (1.76)	1.36 (1.84)	1.34 (1.80)	1.39 (1.92)	1.41 (2.00)	1.40 (1.96)	1.38 (1.91)	1.39 (1.92)	1.38 (1.92)
T ₄	2.39 (5.70)	2.42 (5.86)	2.40 (5.78)	1.00 (1.00)	1.04 (1.09)	1.02 (1.05)	1.04 (1.07)	1.07 (1.14)	1.05 (1.11)	1.09 (1.19)	1.11 (1.23)	1.10 (1.21)	1.08 (1.18)	1.08 (1.16)	1.08 (1.17)
T ₅	2.61 (6.79)	2.62 (6.85)	2.61 (6.82)	1.72 (2.97)	1.75 (3.07)	1.74 (3.02)	1.36 (1.86)	1.38 (1.90)	1.37 (1.88)	1.40 (2.07)	1.46 (2.13)	1.45 (2.10)	1.43 (2.06)	1.42 (2.00)	1.42 (2.03)
T ₆	2.30 (5.29)	2.33 (5.45)	2.32 (5.37)	1.44 (2.06)	1.46 (2.14)	1.45 (2.10)	1.30 (1.69)	1.33 (1.76)	1.31 (1.73)	1.29 (1.67)	1.33 (1.76)	1.31 (1.72)	1.23 (1.51)	1.24 (1.53)	1.23 (1.52)
T ₇	2.67 (7.13)	2.70 (7.27)	2.68 (7.20)	1.37 (1.88)	1.42 (2.02)	1.40 (1.95)	1.02 (1.04)	1.04 (1.07)	1.03 (1.06)	1.08 (1.18)	1.11 (1.24)	1.10 (1.21)	1.04 (1.08)	1.05 (1.10)	1.04 (1.09)
T ₈	1.51 (9.68)	1.53 (9.74)	3.12 (9.71)	3.14 (9.88)	3.19 (10.16)	3.17 (10.02)	3.21 (10.29)	3.22 (10.37)	3.21 (10.33)	3.20 (10.26)	3.22 (10.34)	3.21 (10.30)	3.19 (10.19)	3.22 (10.37)	3.20 (10.27)
SE m (±)	0.07	0.09	0.08	0.10	0.11	0.11	0.15	0.12	0.14	0.18	0.13	0.16	0.20	0.14	0.17
CD (p = 0.05)	0.22	0.28	0.25	0.30	0.32	0.31	0.45	0.38	0.42	0.54	0.40	0.47	0.59	0.41	0.50

*Values given in parenthesis are the mean of original values. **Data subjected to ($\sqrt{x+0.5}$) square root transformation, SE m (±): Standard Error of mean, CD: Critical Difference and DAS: Days after sowing

Treatments: T₁: Pyroxasulfone @ 120 g ha⁻¹ (PE) + Pendimethalin @ 850 g ha⁻¹ (PE), T₂: Pyroxasulfone @ 110 g ha⁻¹ (PE) Pendimethalin @ 800 g ha⁻¹ (PE), T₃: Sulfosulfuron + Metsulfuron @ 40 g ha⁻¹ (PE), T₄: Two hand weeding (30 and 60 DAS), T₅: Sulfosulfuron + Metsulfuron @ 35 g ha⁻¹ (PoE), T₆: Clodinafop-propargyl @ 400 g ha⁻¹ (PoE) + one hand weeding (60 DAS), T₇: 2, 4-D Na @ 750 g ha⁻¹ (PoE) + one hand weeding (60 DAS) and T₈: Weedy check (Control).

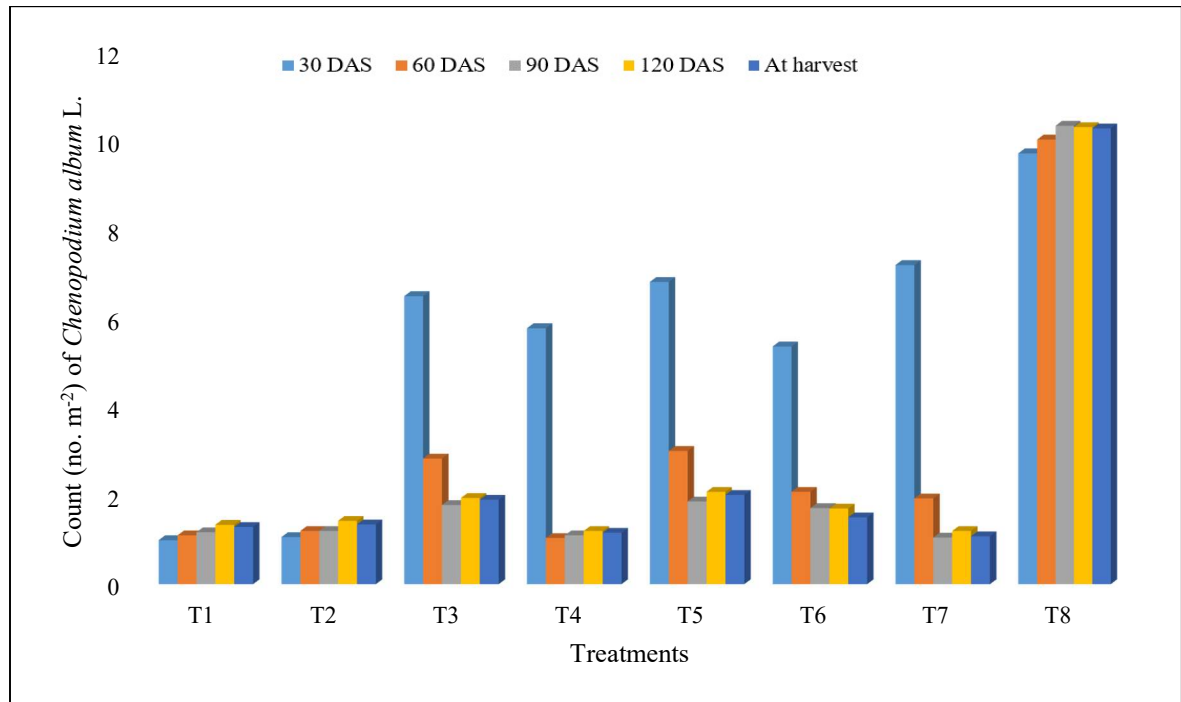
4.1.2.5 *Chenopodium album* L.

Based on data from the years 2020-2021 and 2021-2022, as displayed in Table 4.7 and depicted in graph 4.5, the population of *Chenopodium album* L. was studied to determine the impact of weed control treatments applied every month until harvest.

Table 4.7, which displays data for the years 2020-2021 and 2021-2022, indicates that weed control interventions significantly decreased the population of *Chenopodium album* L. over weedy check. All treatments, with the exception of pyroxasulfone 120 g PE coupled with pendimethalin 850 g PE and pyroxasulfone 110 g PE mixed with pendimethalin 850 g PE, showed a 30 DAS severe count of *Chenopodium album* L. The highest amount of weeds detected in 60 DAS was in 40 g PoE of sulfosulfuron mixed with metsulfuron, 35 g PoE of sulfosulfuron combined with metsulfuron, and 400 g PoE of clodinafop-propargyl combined with HW (60 DAS). The minimum count of *Chenopodium album* L. were recorded in HW (30 and 60 DAS) followed by pyroxasulfone 120 g PE combined with pendimethalin 850 g PE and pyroxasulfone 110 g PE combined with pendimethalin 800 g PE. Ninety days after growth, the highest number was noted in the utilization combining sulfosulfuron with metsulfuron 40 g PoE and minimum count of *Chenopodium album* L, followed by sulfosulfuron mixed with metsulfuron 35 g PoE. In order of combination, PoE 2, 4-D Na 0.75 kg with HW (60 DAS), HW (30 and 60 DAS), and pyroxasulfone 120 g PE with pendimethalin 850 g PE came first. Sulfosulfuron mixed with metsulfuron 40 g PoE and later sulfosulfuron combined with metsulfuron 35 g PoE were used, and harvest maximum weed count was noted at 120 DAS. Pyroxasulfone 120 g PE mixed with pendimethalin 850 g PE and HW (30 and 60 DAS) were the next highest values in PoE 2, 4-D Na 0.75 kg coupled with HW (60 DAS).

The cumulative results for the years 2020–2021 and 2021–2022 are displayed in Table 4.7, and graph 4.5 illustrates the month-by-month decrease in *Chenopodium album* L. counts in PE versus PoE treatments. Extreme weed totals were observed in lower HW (30 and 60 DAS) and in sulfosulfuron combined with metsulfuron 35 g PoE, followed by sulfosulfuron mixed with metsulfuron 40 g PoE. 2 4-D Na 0.750 kg PE mixed with HW (60 DAS) showed a 90 DAS lower weed population than HW (30 and 60 DAS) and pyroxasulfone 120 g PE combined with pendimethalin 850 g PE. 120 DAS and harvest

minimum count of *Chenopodium album* L. recorded in PoE 2, 4- D Na 0.75 kg combined with hand weeding (60 DAS) followed by HW (30 and 60 DAS) and maximum in sulfosulfuron combined with metsulfuron 35 g PoE then sulfosulfuron combined with metsulfuron 40 g PoE as compare to other weed control approaches over a weedy check.



Graph 4.5 Influence of different herbicide treatments on count (No. m⁻²) of *Chenopodium album* L. in wheat (Pooled data of 2020-2021 and 2021-2022).

Table 4.8 Influence of different herbicide treatments on count (No. m⁻²) of *Medicago denticulate* Willd. in wheat (2020-2021 and 2021-2022).

Treatment	30 DAS (2020- 21)	30 DAS (2021- 22)	Pool data	60 DAS (2020- 21)	60 DAS (2021- 22)	Pool data	90 DAS (2020- 21)	90 DAS (2021- 22)	Pool data	120 DAS (2020- 21)	120 DAS (2021- 22)	Pool data	Harves t (2020- 21)	Harves t (2021- 22)	Pool data
T ₁	1.94** (0.88)*	0.97 (0.94)	0.95 (0.91)	0.97 (0.94)	0.99 (0.99)	0.98 (0.97)	1.04 (1.09)	1.08 (1.16)	1.06 (1.13)	1.07 (1.16)	1.09 (1.20)	1.09 (1.18)	1.07 (1.15)	1.08 (1.17)	1.08 (1.16)
T ₂	0.95 (0.91)	0.99 (0.99)	0.97 (0.95)	0.99 (0.99)	1.03 (1.06)	1.01 (1.03)	1.08 (1.18)	1.10 (1.22)	1.09 (1.20)	1.10 (1.21)	1.14 (1.29)	1.11 (1.25)	1.09 (1.19)	1.09 (1.20)	1.09 (1.20)
T ₃	2.29 (5.24)	2.32 (5.36)	2.30 (5.30)	1.81 (3.27)	1.84 (3.37)	1.82 (3.32)	1.52 (2.33)	1.50 (2.27)	1.51 (2.30)	1.50 (2.25)	1.52 (2.33)	1.51 (2.29)	1.48 (2.20)	1.49 (2.24)	1.48 (2.22)
T ₄	2.68 (7.18)	2.69 (7.24)	2.69 (7.21)	1.02 (1.04)	1.06 (1.13)	1.01 (1.09)	1.06 (1.13)	1.10 (1.23)	1.08 (1.18)	1.09 (1.19)	1.12 (1.27)	1.11 (1.24)	1.07 (1.16)	1.08 (1.18)	1.08 (1.17)
T ₅	2.58 (6.66)	2.61 (6.80)	2.59 (6.73)	1.70 (2.89)	1.74 (3.03)	1.72 (2.96)	1.50 (2.26)	1.52 (2.31)	1.51 (2.29)	1.52 (2.30)	1.55 (2.39)	1.53 (2.35)	1.50 (2.26)	1.50 (2.24)	1.50 (2.25)
T ₆	2.74 (7.50)	2.76 (7.62)	2.75 (7.56)	1.56 (2.44)	1.60 (2.56)	1.50 (2.50)	1.09 (1.20)	1.14 (1.29)	1.12 (1.25)	1.11 (1.25)	1.14 (1.30)	1.33 (1.78)	1.11 (1.24)	1.51 (2.26)	1.32 (1.75)
T ₇	2.48 (6.13)	2.50 (6.27)	2.49 (6.20)	1.38 (1.90)	1.45 (2.10)	1.41 (2.00)	1.00 (1.00)	1.04 (1.09)	1.02 (1.05)	1.08 (1.16)	1.12 (1.24)	1.09 (1.20)	1.06 (1.13)	1.06 (1.12)	1.06 (1.13)
T ₈	3.45 (11.91)	3.48 (12.09)	3.46 (12.00)	3.52 (12.36)	3.54 (12.52)	3.53 (12.44)	3.55 (12.58)	3.56 (12.66)	3.55 (12.62)	3.53 (12.47)	3.56 (12.69)	3.55 (12.58)	3.52 (12.42)	3.54 (12.56)	3.53 (12.49)
SE m (±)	0.08	0.11	0.10	0.11	0.11	0.11	0.15	0.12	0.14	0.17	0.13	0.15	0.19	0.11	0.15
CD (p = 0.05)	0.25	0.33	0.29	0.34	0.33	0.34	0.46	0.36	0.41	0.53	0.41	0.47	0.57	0.35	0.46

*Values given in parenthesis are the mean of original values. **Data subjected to ($\sqrt{x+0.5}$) square root transformation, SE m (±): Standard Error of mean, CD: Critical Difference and DAS: Days after sowing

Treatments: T₁: Pyroxasulfone @ 120 g ha⁻¹ (PE) + Pendimethalin @ 850 g ha⁻¹ (PE), T₂: Pyroxasulfone @ 110 g ha⁻¹ (PE) Pendimethalin @ 800 g ha⁻¹ (PE), T₃: Sulfosulfuron + Metsulfuron @ 40 g ha⁻¹ (PE), T₄: Two hand weeding (30 and 60 DAS), T₅: Sulfosulfuron + Metsulfuron @ 35 g ha⁻¹ (PoE), T₆: Clodinafop-propargyl @ 400 g ha⁻¹ (PoE) + one hand weeding (60 DAS), T₇: 2, 4-D Na @ 750 g ha⁻¹ (PoE) + one hand weeding (60 DAS) and T₈: Weedy check (Control).

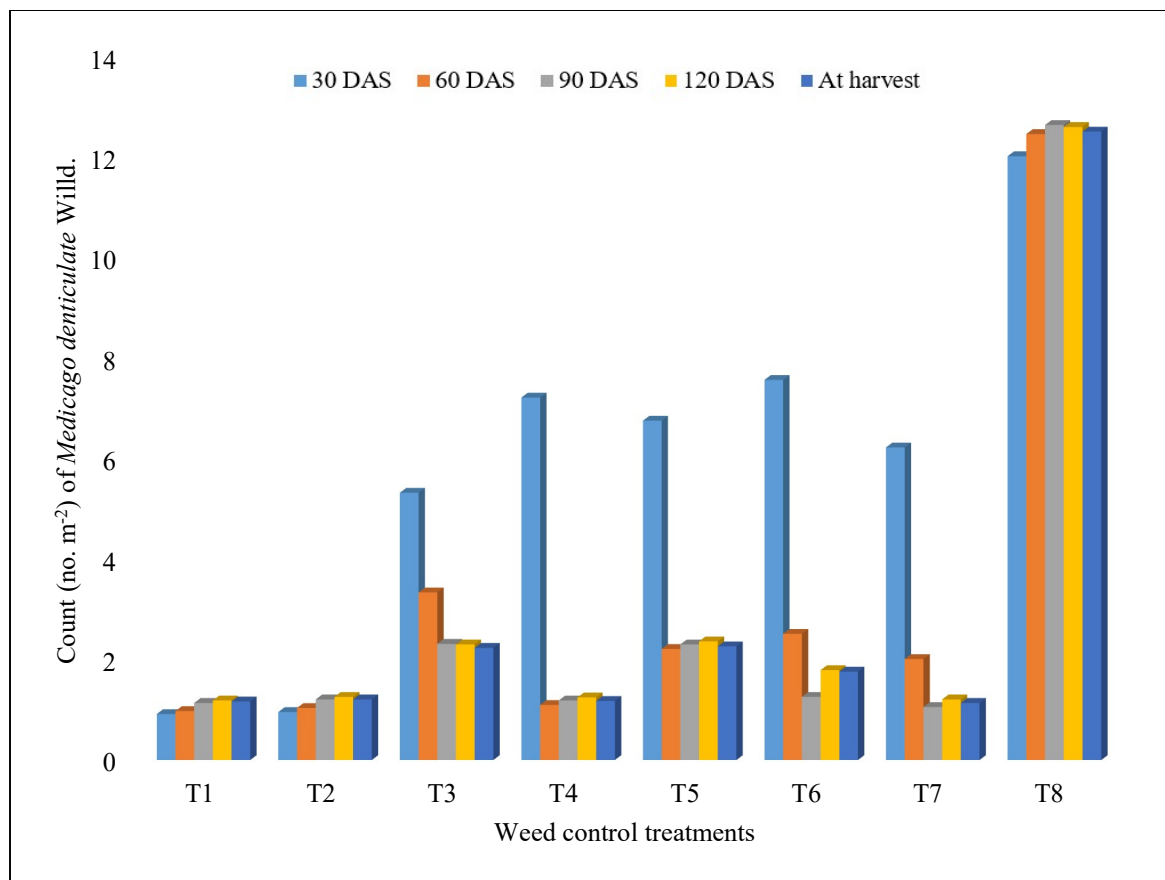
4.1.2.6 *Medicago denticulate* Willd.

Based on data from the years 2020-2021 and 2021-2022, as displayed in Table 4.8 and depicted in graph 4.6, the effect of weed control treatments applied at monthly intervals till harvest was observed in the population of *Medicago denticulate*.

The data presented in Table 4.8 for the years 2020-2021 and 2021-2022, which represents the population of *Medicago denticulate* indicates that the population was decreased by all weed control treatments used during the weedy check period. With the exception of pyroxasulfone 120 g PE paired with pendimethalin 850 g PE and pyroxasulfone 110 g PE mixed with pendimethalin 800 g PE, all treatments had a maximum count of *Medicago denticulate* of 30 DAS. The highest recorded weed count in 60 DAS was found in 40 g PoE of sulfosulfuron mixed with metsulfuron, then 35 g PoE of sulfosulfuron combined with metsulfuron and 400 g PoE of clodinafop-propargyl combined with HW (60 DAS). The minimum count of *Medicago denticulate* Willd. were recorded in the pyroxasulfone 120 g PE combined with pendimethalin 850 g PE followed by pyroxasulfone 110 g PE combined with pendimethalin 800 g PE and HW (60 DAS). 90 DAS maximum count were recorded in use sulfosulfuron combined with metsulfuron 40 g PoE then sulfosulfuron combined with metsulfuron 35 g PoE and minimum count of *Medicago denticulate* Willd. PoE 2, 4- D Na 0.75 kg combined with HW (60 DAS) followed HW (30 and 60 DAS) and pyroxasulfone 120 g PE combined with pendimethalin 850 g PE. 120 DAS and harvest weed count were recorded in use of sulfosulfuron combined with metsulfuron 40 g PoE then sulfosulfuron combined with metsulfuron 35 g PoE. The minimum in PoE 2, 4- D Na 0.75 kg combined with HW (60 DAS) followed by pyroxasulfone 120 g PE combined with pendimethalin 850 g PE and HW (60 DAS) as compare to other treatments over a weedy check.

Table 4.8 and Graph 4.6 provide cumulative data from 2020-2021 and 2020-2022, respectively, about the month-by-month total of *Medicago denticulate* Willd. used in PE and PoE treatments. Maximum weed counts were observed in lower pyroxasulfone 120 g PE combined with pendimethalin 850 g PE, pyroxasulfone 110 g PE combined with pendimethalin 800 g PE, and HW (30 and 60 DAS) for both sulfosulfuron combined with metsulfuron 35 g PoE and sulfosulfuron combined with metsulfuron 40 g PoE. 90 DAS

minimum weed count were recorded in PoE 2, 4- D Na 0.75 kg combined with HW (60 DAS) followed by HW (30 and 60 DAS) and extreme in sulfosulfuron combined with metsulfuron 35 g PoE then sulfosulfuron combined with metsulfuron 40 g PoE. Lower counts of *Medicago denticulate* Willd. were observed at 120 DAS in pyroxasulfone 120 g PE combined with pendimethalin 850 g PE, PoE 2, 4-D Na 0.75 kg combined with HW (60 DAS) and HW (30 and 60 DAS), and maximum in sulfosulfuron combined with metsulfuron 35 g combined with PoE and sulfosulfuron combined with metsulfuron 40 g PoE in comparison to the remaining treatments over a weedy check.



Graph. 4.6 Influence of different herbicide treatments on count (No. m⁻²) of *Medicago denticulate* Willd. in wheat (2020-2021 and 2021-2022).

Table 4.9 Influence of different herbicide treatments on count (No. m⁻²) of *Parthenium hysterophorus* L. in wheat (2020-2021 and 2021-2022).

Treatmen t	30 DAS (2020- 21)	30 DAS (2021- 22)	Pool data	60 DAS (2020- 21)	60 DAS (2021- 22)	Pool data	90 DAS (2020- 21)	90 DAS (2021- 22)	Pool data	120 DAS (2020- 21)	120 DAS (2021- 22)	Pool data	Harve st (2020- 21)	Harve st (2021- 22)	Pool data
T ₁	0.87** (0.77)*	0.90 (0.81)	0.89 (0.79)	0.96 (0.93)	1.02 (1.04)	0.99 (0.99)	1.02 (1.05)	1.05 (1.11)	1.03 (1.08)	1.07 (1.15)	1.10 (1.21)	1.08 (1.18)	1.07 (1.14)	1.07 (1.16)	1.07 (1.15)
T ₂	0.92 (0.85)	0.97 (0.94)	0.94 (0.90)	0.98 (0.97)	1.04 (1.09)	1.01 (1.03)	1.05 (1.11)	1.09 (1.19)	1.07 (1.15)	1.08 (1.18)	1.12 (1.26)	1.10 (1.22)	1.08 (1.17)	1.08 (1.15)	1.08 (1.16)
T ₃	1.48 (2.21)	1.51 (2.30)	1.50 (2.26)	1.37 (1.89)	1.40 (1.97)	1.39 (1.93)	1.38 (1.92)	1.40 (1.98)	1.40 (1.96)	1.36 (1.85)	1.1.39 (1.95)	1.37 (1.90)	1.30 (1.70)	1.33 (1.77)	1.31 (1.74)
T ₄	1.51 (2.30)	1.17 (1.39)	1.35 (1.85)	1.00 (1.00)	1.05 (1.10)	1.02 (1.05)	1.09 (1.20)	1.07 (1.13)	1.09 (1.16)	1.04 (1.10)	1.06 (1.14)	1.05 (1.12)	0.99 (0.99)	0.98 (0.96)	0.98 (0.98)
T ₅	1.53 (2.36)	1.18 (1.41)	1.37 (1.89)	1.39 (1.93)	1.41 (2.00)	1.40 (1.97)	1.33 (1.79)	1.37 (1.89)	1.35 (1.84)	1.34 (1.80)	1.39 (1.94)	1.36 (1.87)	1.34 (1.80)	1.36 (1.84)	1.34 (1.82)
T ₆	1.42 (2.03)	1.39 (1.95)	1.41 (1.99)	1.34 (1.79)	1.36 (1.84)	1.34 (1.82)	1.00 (1.00)	1.03 (1.06)	1.01 (1.03)	1.05 (1.12)	1.09 (1.20)	1.07 (1.16)	1.06 (1.13)	1.05 (1.10)	1.05 (1.12)
T ₇	1.45 (2.10)	1.50 (2.25)	1.47 (2.18)	1.02 (1.04)	1.04 (1.08)	1.03 (1.06)	0.96 (0.93)	1.01 (1.03)	0.99 (0.98)	0.93 (0.88)	0.95 (0.92)	0.94 (0.90)	0.89 (0.80)	0.93 (0.88)	0.91 (0.84)
T ₈	1.60 (2.58)	1.64 (2.70)	1.62 (2.64)	1.60 (2.57)	1.66 (2.76)	1.63 (2.67)	1.60 (2.57)	1.66 (2.78)	1.63 (2.68)	1.59 (2.55)	1.64 (2.71)	1.62 (2.63)	1.58 (2.50)	1.64 (2.70)	1.61 (2.60)
SE m (±)	0.11	0.06	0.09	0.16	0.11	0.14	0.17	0.13	0.15	0.19	0.12	0.16	0.18	0.13	0.16
CD (p = 0.05)	0.34	0.18	0.26	0.47	0.34	0.41	0.51	0.39	0.45	0.59	0.38	0.49	0.56	0.40	0.48

*Values given in parenthesis are the mean of original values. ** Data subjected to ($\sqrt{x+0.5}$) square root transformation, SE m (±): Standard Error of mean, CD: Critical Difference and DAS: Days after sowing

Treatments: T₁: Pyroxasulfone @ 120 g ha⁻¹ (PE) + Pendimethalin @ 850 g ha⁻¹ (PE), T₂: Pyroxasulfone @ 110 g ha⁻¹ (PE) Pendimethalin @ 800 g ha⁻¹ (PE), T₃: Sulfosulfuron + Metsulfuron @ 40 g ha⁻¹ (PE), T₄: Two hand weeding (30 and 60 DAS), T₅: Sulfosulfuron + Metsulfuron @ 35 g ha⁻¹ (PoE), T₆: Clodinafop-propargyl @ 400 g ha⁻¹ (PoE) + one hand weeding (60 DAS), T₇: 2, 4-D Na @ 750 g ha⁻¹ (PoE) + one hand weeding (60 DAS) and T₈: Weedy check (Control).

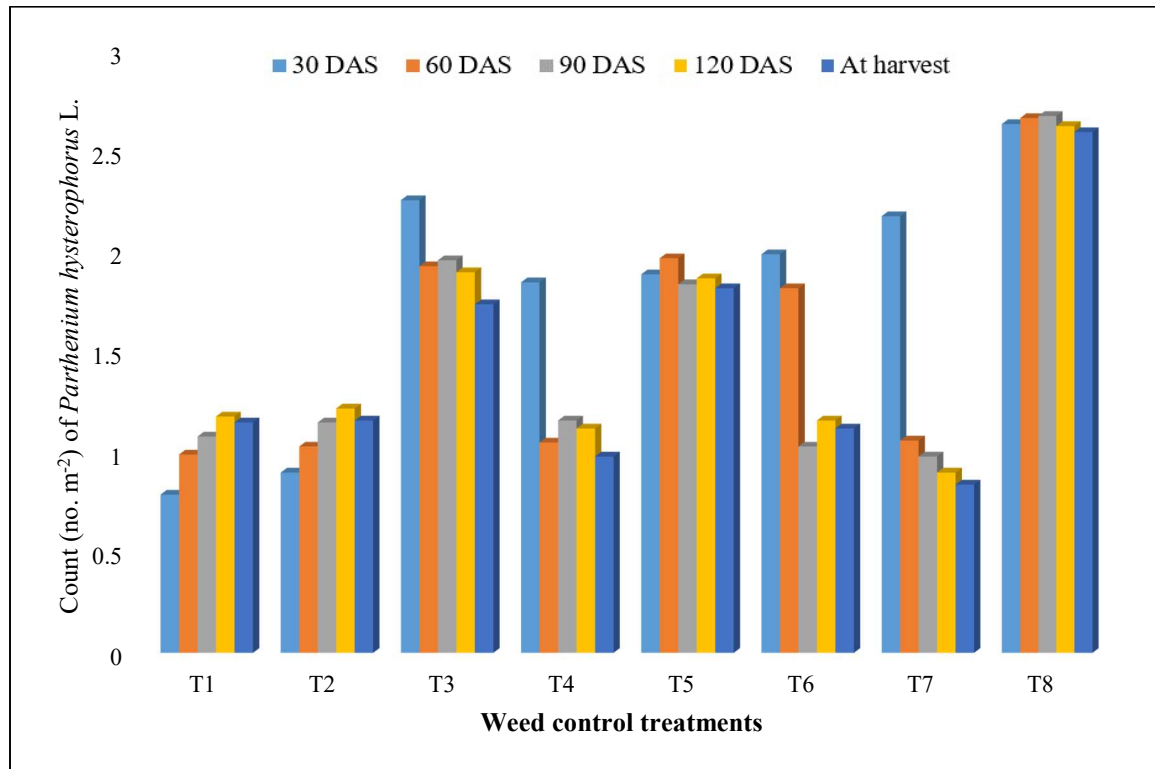
4.1.2.7 *Parthenium hysterophorus* L.

Based on data from the years 2020-2021 and 2021-2022, as displayed in Table 4.9 and depicted in graph 4.7, the effect of weed control treatments at monthly intervals till harvest was observed in the *Parthenium hysterophorus* L. population.

The population of *Parthenium hysterophorus* L. is shown in Table 4.9 with data from 2020-2021 and 2021-2022, which indicates how well different weed management methods lower the population of *Parthenium hysterophorus* L. over weedy check. Based on data collected at 30 DAS, the highest amount of *Parthenium hysterophorus* L. was found in all treatments, with the exception of pyroxasulfone, which was paired with 850 g PE and 110 g PE and pendimethalin 800 g PE. The highest reported weed count in 60 DAS was found in 35 g PoE of sulfosulfuron mixed with metsulfuron, 40 g PoE of sulfosulfuron combined with metsulfuron, and 400 g PoE of clodinafop-propargyl combined with HW (60 DAS). At 90 DAS maximum count were recorded in the use sulfosulfuron combined with metsulfuron 35 g PoE then sulfosulfuron combined with metsulfuron 40 g PoE and minimum count of *Parthenium hysterophorus* L. PoE 2, 4- D Na 0.75 kg combined with HW (60 DAS) followed two hands weeding (30 and 60 DAS) and clodinafop propargyl 400 g PoE HW (60 DAS). Using sulfosulfuron mixed with metsulfuron 40 g PoE and sulfosulfuron combined with metsulfuron 35 g PoE, the highest weed count was reported at 120 DAS and harvest. Comparing PoE 2, 4-D Na 0.75 kg with HW (60 DAS) and HW (30 and 60 DAS) against other treatments during a Weedy check, this is the lowest value.

Table 4.9 and Graph 4.7 give cumulative data for the years 2020-2021 and 2020-2022, respectively. The data indicates that 30 days after seeding, a lower total of *Parthenium hysterophorus* L. was observed in PE treatments compared to PoE treatments. In lower pyroxasulfone 120 g PE combined with pendimethalin 850 g PE, followed by pyroxasulfone 110 g PE combined with pendimethalin 850 g PE and HW (30 and 60 DAS), extreme weed counts were recorded in sulfosulfuron combined with metsulfuron 35 g PoE and sulfosulfuron combined with metsulfuron 40 g PoE. 90 DAS minimum weed count were noted in PoE 2, 4- D Na 0.75 kg combined with HW (60 DAS) followed by HW (30 and 60 DAS) and clodinafop propargyl 400 g PoE combined with HW (60 DAS) and maximum in sulfosulfuron combined with metsulfuron 35 g PoE and sulfosulfuron

combined with metsulfuron 40 g PoE. In comparison to the other treatments over a Weedy check, the minimum count of *Parthenium hysterophorus* L. was recorded at harvest at 120 DAS in pyroxasulfone 120 g PE combined with pendimethalin 850 g PE after PoE 2, 4-D Na 0.75 kg combined with HW (60 DAS) and HW (60 DAS), and extreme in sulfosulfuron combined with metsulfuron 35 g PoE and sulfosulfuron combined with metsulfuron 40 g PoE.



Graph. 4.7 Influence of different herbicide treatments on count (No. m⁻²) of *Parthenium hysterophorus* L. in wheat (2020-2021 and 2021-2022).

Table 4.10 Influence of different herbicide treatments on count (No. m⁻²) of total weed count in wheat (2020-2021 and 2021-2022).

Treat ment	30 DAS (2020- 21)	30 DAS (2021- 22)	Pool data	60 DAS (2020- 21)	60 DAS (2021- 22)	Pool data	90 DAS (2020- 21)	90 DAS (2021- 22)	Pool data	120 DAS (2020- 21)	120 DAS (2021- 22)	Pool data	Harvest (2020- 21)	Harvest (2021- 22)	Pool data
T ₁	2.80** (7.86)*	2.87 (8.26)	2.83 (8.06)	2.91 (8.50)	2.97 (8.83)	2.94 (8.67)	3.12 (9.79)	3.19 (10.23)	3.16 (10.01)	3.14 (9.87)	3.22 (10.37)	3.18 (10.12)	3.19 (10.19)	3.13 (9.85)	3.16 (10.02)
T ₂	2.90 (8.46)	2.97 (8.86)	2.94 (8.66)	3.01 (9.11)	3.26 (10.67)	3.14 (9.89)	3.25 (10.60)	3.13 (9.85)	3.19 (10.23)	2.97 (8.84)	3.27 (10.75)	3.13 (9.80)	2.96 (8.80)	3.27 (10.72)	3.12 (9.76)
T ₃	4.65 (21.70)	4.72 (22.29)	4.69 (22.00)	4.27 (18.31)	4.32 (18.72)	4.30 (18.52)	4.04 (16.33)	3.87 (14.99)	3.95 (15.66)	3.91 (15.35)	3.82 (14.61)	3.87 (14.98)	3.83 (14.72)	3.87 (15.04)	3.85 (14.88)
T ₄	4.79 (22.07)	4.63 (21.48)	4.66 (21.78)	2.72 (7.44)	2.86 (8.20)	2.80 (7.82)	2.82 (7.95)	2.89 (8.36)	2.85 (8.16)	3.12 (7.99)	2.84 (8.07)	2.83 (8.03)	2.81 (7.92)	2.82 (8.00)	2.82 (7.96)
T ₅	4.67 (21.87)	4.61 (21.33)	4.64 (21.60)	4.25 (18.12)	4.35 (18.94)	4.30 (18.53)	4.02 (16.17)	4.07 (16.64)	4.05 (16.41)	3.93 (15.49)	3.94 (15.54)	3.93 (15.52)	3.92 (15.38)	3.92 (15.44)	3.92 (15.41)
T ₆	4.84 (23.47)	4.90 (24.09)	4.87 (23.78)	4.09 (16.74)	4.11 (16.93)	4.10 (16.84)	3.01 (9.09)	3.10 (9.63)	3.05 (9.36)	3.01 (9.10)	3.07 (9.43)	3.03 (9.22)	3.00 (9.06)	3.03 (9.20)	3.02 (9.13)
T ₇	4.91 (24.20)	4.98 (24.89)	4.95 (24.55)	3.73 (13.97)	3.81 (14.57)	3.77 (14.27)	2.70 (7.32)	2.80 (7.88)	2.75 (7.60)	2.71 (7.35)	2.79 (7.79)	2.75 (7.57)	2.70 (7.32)	2.78 (7.77)	2.74 (7.51)
T ₈	5.10 (26.06)	5.17 (26.74)	5.13 (26.40)	5.11 (26.17)	5.22 (27.25)	5.16 (26.71)	5.22 (27.26)	5.32 (28.32)	5.27 (27.79)	5.21 (27.23)	5.31 (28.27)	5.26 (27.75)	5.21 (27.20)	5.31 (28.23)	5.26 (27.72)
SE m (±)	0.06	0.06	0.06	0.07	0.09	0.08	0.10	0.11	0.11	0.12	0.13	0.13	0.12	0.13	0.13
CD (p = 0.05)	0.17	0.19	0.18	0.21	0.26	0.24	0.31	0.33	0.32	0.36	0.39	0.38	0.36	0.39	0.38

*Values given in parenthesis are the mean of original values. **Data subjected to ($\sqrt{x+0.5}$) square root transformation, SE_m(±): Standard Error of mean, CD: Critical Difference and DAS: Days after sowing

Treatments: T₁: Pyroxasulfone @ 120 g ha⁻¹ (PE) + Pendimethalin @ 850 g ha⁻¹ (PE), T₂: Pyroxasulfone @ 110 g ha⁻¹ (PE) Pendimethalin @ 800 g ha⁻¹ (PE), T₃: Sulfosulfuron + Metsulfuron @ 40 g ha⁻¹ (PE), T₄: Two hand weeding (30 and 60 DAS), T₅: Sulfosulfuron + Metsulfuron @ 35 g ha⁻¹ (PoE), T₆: Clodinafop-propargyl @ 400 g ha⁻¹ (PoE) + one hand weeding (60 DAS), T₇: 2, 4-D Na @ 750 g ha⁻¹ (PoE) + one hand weeding (60 DAS) and T₈: Weedy check (Control).

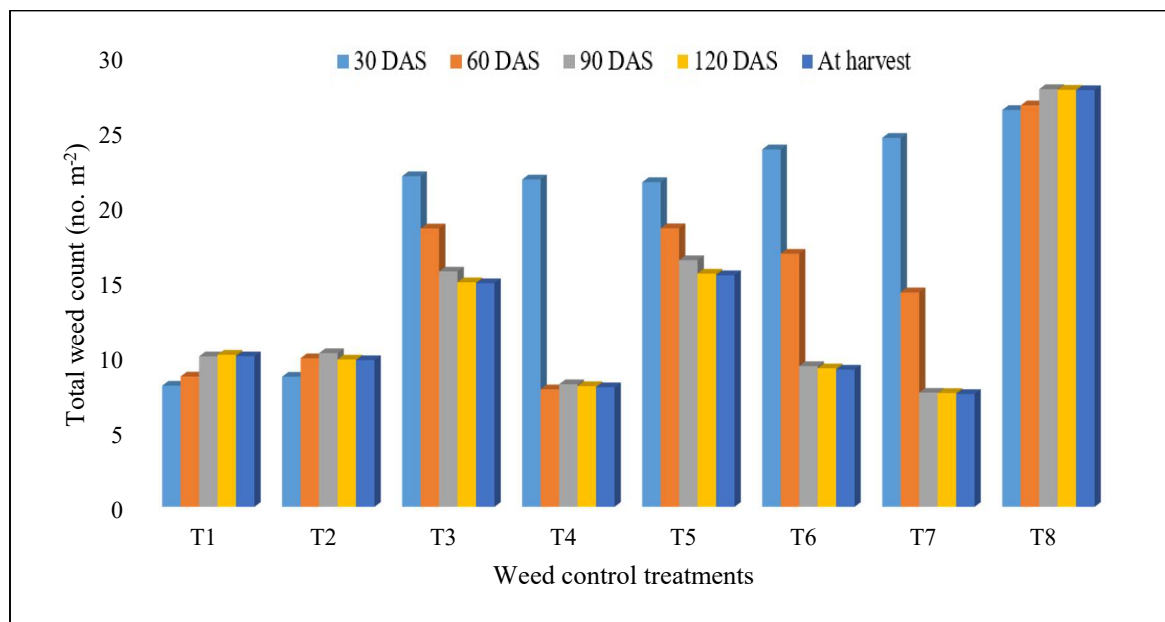
4.1.2.8 Total weed count (No. m⁻²)

Based on data from the years 2020-2021 and 2021-2022, which are displayed in Table 4.10 and depicted in graph 4.8, about the population of total weed count and the impact of weed control treatments applied every month till harvest.

The population of total weed count was reduced by all weed management treatments of total weed count over weedy check, according to data from 2020-2021 and 2021-2022, as indicated in Table 4.10. 30 DAS was the largest amount of weed population in all treatments, with the exception of the combinations of pyroxasulfone 110 g PE and pendimethalin 800 g PE. The highest reported weed count in 60 DAS was found in sulfosulfuron 40 g PoE in combination with metsulfuron, 35 g PoE in sulfosulfuron and 400 g PoE in clodinafop-propargyl with HW. Pyroxasulfone 120 g PE with pendimethalin 850 g PE and Pyroxasulfone 110 g PE with pendimethalin 800 g PE were the next two samples, with the minimum count of the whole weed population being recorded in HW (30 and 60 DAS). At 90 days after seeding, the highest count was obtained using sulfosulfuron and metsulfuron 35 g PoE, followed by sulfosulfuron and metsulfuron 40 g PoE. The lowest count of the total count of weed PoE 2, 4-D Na 0.75 kg combined with HW (60 DAS), pyroxasulfone 120 g PE combined with pendimethalin 850 g PE, and HW (60 DAS) were used. Sulfosulfuron mixed with metsulfuron 35 g PoE and later sulfosulfuron combined with metsulfuron 40 g PoE were used, and harvest maximum weed count was noted at 120 DAS. In comparison to other treatments over a Weedy check, the minimum in PoE 2, 4-D Na 0.75 kg coupled with HW (60 DAS) and HW (30 and 60 DAS) was seen. These results were really obtained by Johnson *et al.* (2018), Kaur *et al.* (2019), and Bayat *et al.* (2020). Pre-emergence Pyroxasulfone application, followed by its combination with pendimethalin, controls the overall number of weeds and increases seed output (3.5 tons per hectare) in wheat crops.

In comparison to PoE treatments, cumulative data for the years 2020-2021 and 2021-2022 are displayed on Table 4.10 and illustrated in Graph 4.8 following a month-by-month minimum count of the total count of weeds. A lower total count of weed was recorded in the HW (30 and 60 DAS), followed by pyroxasulfone 120 g PE combined with pendimethalin 850 g PE and pyroxasulfone 110 g PE combined with pendimethalin 800 g

PE. The maximum weed count was recorded in sulfosulfuron combined with metsulfuron 35 g PoE and sulfosulfuron combined with metsulfuron 40 g PoE. PoE 2, 4-D Na 0.75 kg combined with HW (60 DAS) and HW (30 and 60 DAS) were the highest weed counts at 90 DAS clodinafop-propargyl 400 g PoE combined with HW (60 DAS) and sulfosulfuron combined with metsulfuron 35 g PoE and sulfosulfuron combined with metsulfuron 40 g PoE were the lowest weed counts. Compared to the remaining samples, PoE 2, 4-D Na 0.75 kg combined with HW (60 DAS), HW (30 and 60 DAS), clodinafop-propargyl 400 g PoE combined with HW (60 DAS), and extreme sulfosulfuron combined with metsulfuron 35 g PoE and sulfosulfuron combined with metsulfuron 40 g PoE recorded lower counts of all weeds at harvest.



Graph. 4.8 Influence of different herbicide treatments on total weed count (No. m⁻²) in wheat (Pooled data of 2020-2021 and 2021-2022).

Table 4.11 Influence of different herbicide treatments on dry weight (g m⁻²) of *Phalaris minor* in wheat (2020-2021 and 2021-2022).

Treat ment	30 DAS (2020- 21)	30 DAS (2021- 22)	Pool data	60 DAS (2020- 21)	60 DAS (2021- 22)	Pool data	90 DAS (2020- 21)	90 DAS (2021- 22)	Pool data	120 DAS (2020- 21)	120 DAS (2021- 22)	Pool data	Harvest (2020- 21)	Harvest (2021- 22)	Pool data
T ₁	0.26** (0.07)*	0.28 (0.081)	0.28 (0.07)	0.39 (0.15)	0.45 (0.20)	0.42 (0.17)	0.47 (0.22)	0.54 (0.29)	0.50 (0.25)	0.68 (0.46)	0.71 (0.51)	0.70 (0.48)	0.69 (0.48)	0.74 (0.55)	0.71 (0.51)
T ₂	0.28 (0.079)	0.29 (0.087)	0.29 (0.08)	0.40 (0.161)	0.41 (0.17)	0.41 (0.10)	0.51 (0.26)	0.56 (0.31)	0.53 (0.28)	0.70 (0.49)	0.75 (0.56)	0.72 (0.52)	0.72 (0.52)	0.77 (0.60)	0.74 (0.56)
T ₃	0.76 (0.58)	0.79 (0.62)	0.77 (0.60)	0.63 (0.40)	0.69 (0.48)	0.66 (0.44)	0.55 (0.30)	0.61 (0.37)	0.58 (0.33)	0.66 (0.44)	0.69 (0.47)	0.67 (0.45)	0.67 (0.45)	0.74 (0.54)	0.70 (0.49)
T ₄	0.78 (0.61)	0.76 (0.58)	0.78 (0.59)	0.35 (0.12)	0.41 (0.17)	0.38 (0.14)	0.28 (0.08)	0.31 (0.09)	0.29 (0.08)	0.31 (0.09)	0.32 (0.103)	0.32 (0.10)	0.47 (0.23)	0.40 (0.16)	0.43 (0.19)
T ₅	0.67 (0.45)	0.70 (0.49)	0.69 (0.47)	0.65 (0.42)	0.69 (0.47)	0.67 (0.44)	0.53 (0.28)	0.57 (0.33)	0.55 (0.30)	0.63 (0.40)	0.69 (0.48)	0.66 (0.44)	0.73 (0.54)	0.67 (0.46)	0.70 (0.50)
T ₆	0.87 (0.76)	0.82 (0.67)	0.85 (0.71)	0.58 (0.34)	0.62 (0.39)	0.60 (0.36)	0.29 (0.086)	0.30 (0.09)	0.30 (0.08)	0.31 (0.09)	0.33 (0.105)	0.32 (0.10)	0.41 (0.17)	0.33 (0.11)	0.37 (0.14)
T ₇	0.91 (0.83)	0.86 (0.74)	0.89 (0.78)	0.48 (0.23)	0.53 (0.28)	0.50 (0.25)	0.24 (0.06)	0.27 (0.07)	0.26 (0.06)	0.31 (0.09)	0.33 (0.101)	0.31 (0.09)	0.38 (0.15)	0.30 (0.09)	0.34 (0.12)
T ₈	0.95 (0.90)	0.97 (0.94)	0.96 (0.92)	1.38 (1.91)	1.46 (2.12)	1.42 (2.01)	1.48 (2.19)	1.50 (2.25)	1.49 (2.22)	1.92 (3.70)	1.96 (3.850)	1.94 (3.77)	1.97 (3.92)	1.94 (3.77)	1.95 (3.84)
SE m (±)	0.03	0.02	0.03	0.04	0.03	0.04	0.06	0.06	0.06	0.07	0.07	0.07	0.06	0.08	0.07
CD (p = 0.05)	0.08	0.05	0.07	0.13	0.10	0.12	0.17	0.17	0.17	0.21	0.20	0.21	0.21	0.24	0.23

*Values given in parenthesis are the mean of original values. **Data subjected to ($\sqrt{x+0.5}$) square root transformation, SE m (±): Standard Error of mean, CD: Critical Difference and DAS: Days after sowing

Treatments: T₁: Pyroxasulfone @ 120 g ha⁻¹ (PE) + Pendimethalin @ 850 g ha⁻¹ (PE), T₂: Pyroxasulfone @ 110 g ha⁻¹ (PE) Pendimethalin @ 800 g ha⁻¹ (PE), T₃: Sulfosulfuron + Metsulfuron @ 40 g ha⁻¹ (PE), T₄: Two hand weeding (30 and 60 DAS), T₅: Sulfosulfuron + Metsulfuron @ 35 g ha⁻¹ (PoE), T₆: Clodinafop-propargyl @ 400 g ha⁻¹ (PoE) + one hand weeding (60 DAS), T₇: 2, 4-D Na @ 750 g ha⁻¹ (PoE) + one hand weeding (60 DAS) and T₈: Weedy check (Control).

4.1.3 Species-wised and total dry weight of weeds

The species-wised and total dry weight of weeds were recorded at monthly interval until harvest

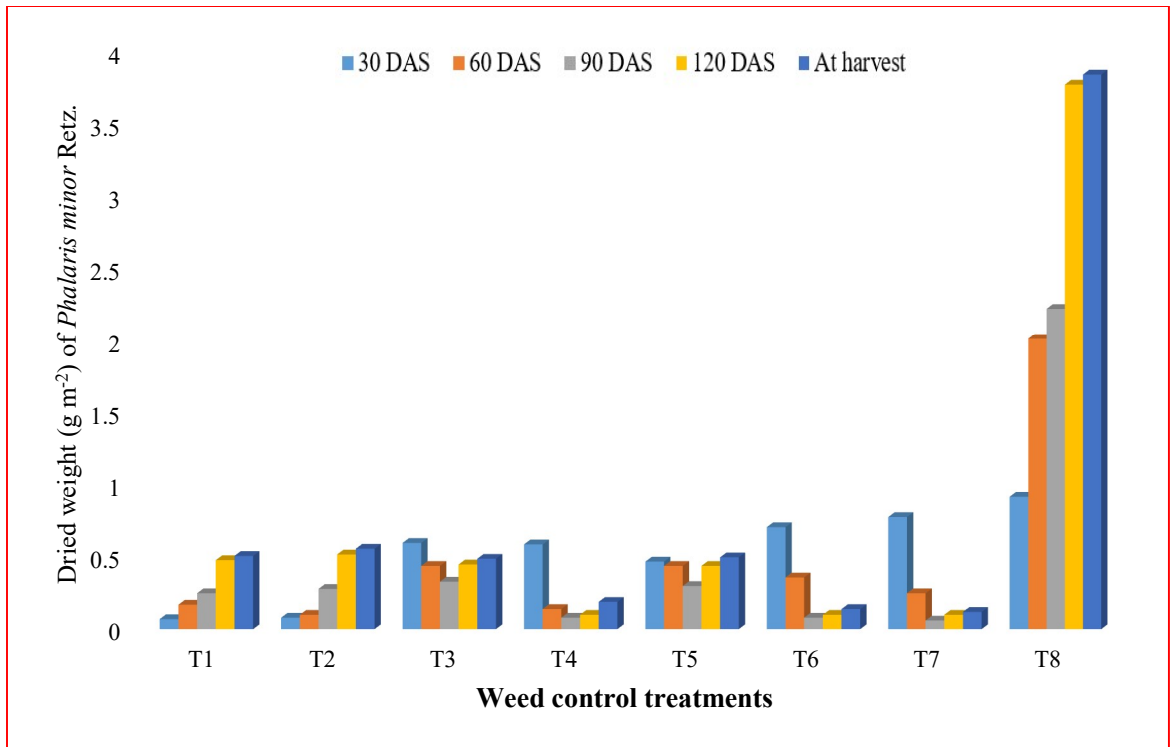
4.1.3.1 *Phalaris minor*

In the year 2020-2021 and 2021-2022 data on the dry weight of *Phalaris minor* effect of weed control treatments at month intervals up to harvest as shown in Table 4.11 and represented in graph 4.9.

Table 4.11 shows that data from 2020-2021 and 2021-2022 based on the dry weight of weed management treatments significantly decreased the dry weight of *Phalaris minor* over the weedy check. With the exception of two treatments pyroxasulfone 120 g PE combined with pendimethalin 850 g PE and pyroxasulfone 110 g PE mixed with pendimethalin 800 g PE the maximum dry weight of *Phalaris minor* Retz was measured on 30 DAS. Sulfosulfuron mixed with metsulfuron 35 g PoE showed a 60 DAS greater dry weight than sulfosulfuron combined with metsulfuron 40 g PoE. In HW (30 and 60 DAS), *Phalaris minor* Retz had the lowest dry weight. Pyroxasulfone 120 g PE paired with pendimethalin 850 g PE and pyroxasulfone 110 g PE mixed with pendimethalin 800 g PE were the next two combinations. *Phalaris minor* Retz's lower dry weight and the maximum dry weight of 35 g PoE and 40 g PoE of sulfosulfuron mixed with metsulfuron were measured at 90 DAS. Clodinafop-propargyl 400 g PoE combined with HW (60 DAS) and PoE 2, 4-D Na 0.75 kg mixed with HW (60 DAS) came next, followed by HW (30 and 60 DAS). 120 DAS and harvest the maximum weed dry weight were noted in use of sulfosulfuron combined with metsulfuron 40 g PoE then sulfosulfuron combined with metsulfuron 35 g PoE. The lower in PoE 2, 4- D Na 0.75 kg combined with HW (60 DAS) which is at par with HW (30 and 60 DAS) as compared to other treatments over a weedy check.

Total statistics displayed for the years 2020-2021 and 2021-2022 in comparison to PoE treatments, PE treatments showed a reduced dry weight of *Phalaris minor* Retz on 30 DAS, as shown by Table 4.11 and the corresponding graph 4.9. In HW (30 and 60 DAS), the lowest weed dry weight was recorded by pyroxasulfone 120 g PE mixed with

pendimethalin 850 g PE. The greatest weed dry weight was recorded by sulfosulfuron paired with metsulfuron 35 g PoE, followed by sulfosulfuron combined with metsulfuron 40 g PoE. 90 DAS the minimum weed dry weight were recorded in PoE 2, 4- D Na 0.75 kg combined with HW (60 DAS) and HW (30 and 60 DAS). At 120 DAS then harvest lower dry weight for *Phalaris minor* recorded on PoE 2, 4- D Na 0.75 kg combined with HW (60 DAS) and HW (30 and 60 DAS) and highest in sulfosulfuron combined with metsulfuron 40 g PoE then sulfosulfuron combined with metsulfuron 35 g PoE as compared to a Weedy check.



Graph. 4.9 Influence of different herbicide treatments on dry weight (g m^{-2}) of *Phalaris minor* in wheat (2020-2021 and 2021-2022).

Table 4.12 Influence of different herbicide treatments on dry weight (g m⁻²) of *Cynodon dactylon* (L.) Pers. in wheat (2020-2021 and 2021-2022).

Treatme nt	30 DAS (2020- 21)	30 DAS (2021- 22)	Pool data	60 DAS (2020- 21)	60 DAS (2021- 22)	Pool data	90 DAS (2020- 21)	90 DAS (2021- 22)	Pool data	120 DAS (2020- 21)	120 DAS (2021- 22)	Pool data	Harve st (2020- 21)	Harve st (2021- 22)	Pool data
T ₁	0.30** (0.09)*	0.31 (0.097)	0.31 (0.094)	0.35 (0.121)	0.36 (0.130)	0.35 (0.13)	0.44 (0.190)	0.45 (0.199)	0.44 (0.19)	0.58 (0.33)	0.58 (0.340)	0.58 (0.34)	0.62 (0.39)	0.63 (0.39)	0.62 (0.39)
T ₂	0.31 (0.098)	0.32 (0.103)	0.32 (0.101)	0.35 (0.124)	0.37 (0.127)	0.36 (0.13)	0.46 (0.210)	0.47 (0.218)	0.46 (0.21)	0.61 (0.37)	0.61 (0.378)	0.61 (0.37)	0.64 (0.41)	0.65 (0.41)	0.64 (0.41)
T ₃	0.61 (0.37)	0.64 (0.41)	0.63 (0.390)	0.37 (0.320)	0.58 (0.340)	0.57 (0.33)	0.66 (0.431)	0.66 (0.436)	0.66 (0.43)	0.77 (0.59)	0.77 (0.596)	0.77 (0.59)	0.82 (0.68)	0.83 (0.68)	0.82 (0.68)
T ₄	0.64 (0.41)	0.69 (0.48)	0.67 (0.445)	0.41 (0.170)	0.42 (0.174)	0.41 (0.17)	0.42 (0.173)	0.42 (0.177)	0.42 (0.18)	0.50 (0.25)	0.51 (0.261)	0.51 (0.26)	0.52 (0.27)	0.53 (0.27)	0.52 (0.27)
T ₅	0.59 (0.35)	0.66 (0.43)	0.62 (0.390)	0.54 (0.290)	0.54 (0.296)	0.54 (0.29)	0.67 (0.450)	0.67 (0.455)	0.67 (0.45)	0.79 (0.63)	0.80 (0.634)	0.79 (0.63)	0.84 (0.71)	0.84 (0.71)	0.84 (0.71)
T ₆	0.65 (0.42)	0.67 (0.45)	0.66 (0.435)	0.50 (0.250)	0.51 (0.260)	0.51 (0.26)	0.45 (0.21)	0.38 (0.15)	0.42 (0.18)	0.52 (0.27)	0.53 (0.280)	0.53 (0.28)	0.54 (0.29)	0.54 (0.28)	0.54 (0.29)
T ₇	0.68 (0.46)	0.70 (0.49)	0.69 (0.475)	0.47 (0.220)	0.48 (0.23)	0.48 (0.23)	0.40 (0.160)	0.41 (0.167)	0.40 (0.16)	0.48 (0.23)	0.48 (0.234)	0.48 (0.23)	0.50 (0.25)	0.51 (0.25)	0.50 (0.25)
T ₈	0.77 (0.60)	0.84 (0.71)	0.81 (0.655)	1.16 (1.35)	1.22 (1.50)	1.20 (1.43)	1.33 (1.77)	1.34 (1.80)	1.34 (1.79)	1.45 (2.10)	1.47 (2.15)	1.46 (2.13)	1.49 (2.22)	1.50 (2.24)	1.49 (2.23)
SE m (±)	0.03	0.02	0.03	0.05	0.06	0.06	0.08	0.09	0.09	0.07	0.07	0.07	0.06	0.07	0.07
CD (p = 0.05)	0.09	0.06	0.08	0.14	0.19	0.17	0.24	0.27	0.26	0.21	0.21	0.21	0.18	0.21	0.20

*Values given in parenthesis are the mean of original values. **Data subjected to ($\sqrt{x+0.5}$) square root transformation, SE m (±): Standard Error of mean, CD: Critical Difference and DAS: Days after sowing

Treatments: T₁: Pyroxasulfone @ 120 g ha⁻¹ (PE) + Pendimethalin @ 850 g ha⁻¹ (PE), T₂: Pyroxasulfone @ 110 g ha⁻¹ (PE) Pendimethalin @ 800 g ha⁻¹ (PE), T₃: Sulfosulfuron + Metsulfuron @ 40 g ha⁻¹ (PE), T₄: Two hand weeding (30 and 60 DAS), T₅: Sulfosulfuron + Metsulfuron @ 35 g ha⁻¹ (PoE), T₆: Clodinafop-propargyl @ 400 g ha⁻¹ (PoE) + one hand weeding (60 DAS), T₇: 2, 4-D Na @ 750 g ha⁻¹ (PoE) + one hand weeding (60 DAS) and T₈: Weedy check (Control).

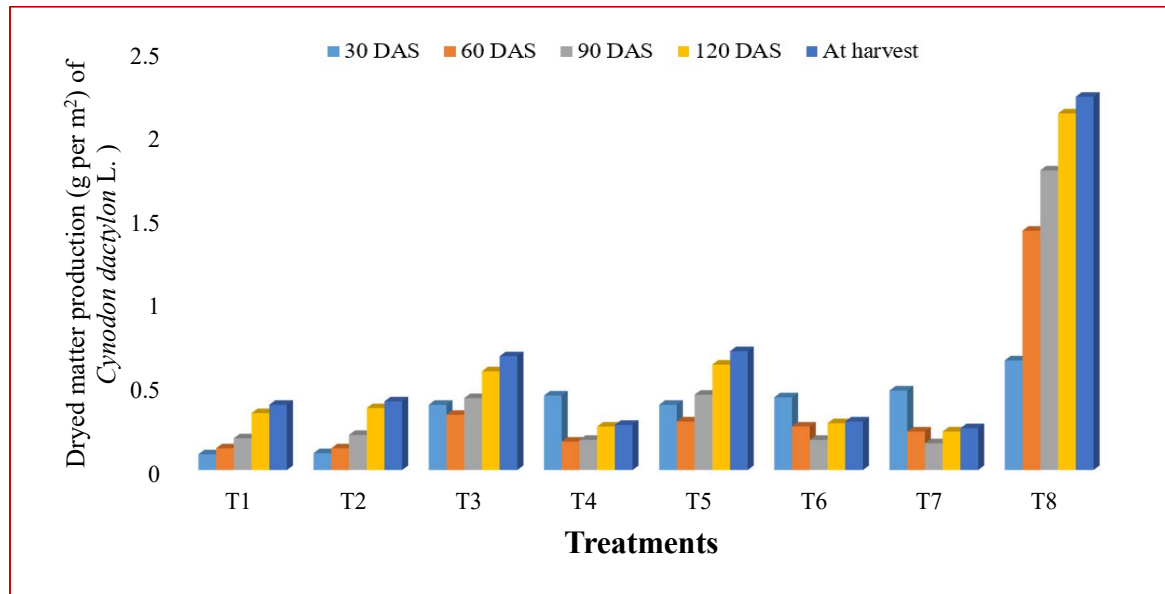
4.1.3.2 *Cynodon dactylon* L.

Data on the dry weight of *Cynodon dactylon* L. in the years 2020-2021 and 2021-2022 on the impact of weed control treatments at monthly intervals till harvest are displayed in Table 4.12 and depicted in graph 4.10.

Data from 2020-2021 and 2021-2022 on the dry weight of *Cynodon dactylon* L. in Table 4.12 showed that the dry weight of *Cynodon dactylon* L. was altered by weed control treatments over weedy check. With the exception of pyroxasulfone 120 g PE paired with pendimethalin 850 g PE and pyroxasulfone 110 g PE mixed with pendimethalin 800 g PE, the maximum dry weight of *Cynodon dactylon* L. in all weed control treatments was 30 DAS. Sulfosulfuron paired with metsulfuron 40 g PoE and sulfosulfuron mixed with metsulfuron 35 g PoE were found to have the greatest weed dry weight at 60 DAS. The lowest dry weight of *Cynodon dactylon* L. was found in the mixture of 120 g PE and 850 g PE of pyroxasulfone, and it was followed by 110 g PE and 800 g PE of pendimethalin and HW (30 and 60 DAS). At 90 days after grown the maximum dry weight were noted use sulfosulfuron combined with metsulfuron 35g PoE then sulfosulfuron combined with metsulfuron 40 g PoE and lower dry weight of *Cynodon dactylon* L. PoE 2, 4- D Na 0.75 kg combined with HW (60 DAS) followed HW (30 and 60 DAS) and pyroxasulfone 120 g PE combined with pendimethalin 850 g PE. At 120 days later sowing then harvest the highest weed dry weight were recorded in the use sulfosulfuron combined with metsulfuron 35 g PoE then sulfosulfuron combined with metsulfuron 40 g PoE. The minimum in PoE 2, 4- D Na 0.75 kg combined with HW (60 DAS) followed HW (60 DAS) and clodinafop propargyl 400 g PoE combined with HW (60 DAS) as compared to other treatments over a weedy check.

As compared to PoE treatments, PE treatments recorded a 30 DAS reduced dry weight of *Cynodon dactylon* L.; these cumulative data are displayed in the years 2020-2021 and 2021-2022, on Table 4.12 and depicted in graph 4.10. At 60 days after seeding, the highest recorded weed dry weight was found in sulfosulfuron plus metsulfuron 40 g PoE, followed by sulfosulfuron plus metsulfuron 35 g PoE. The lowest was found in pyroxasulfone 120 g PE plus pendimethalin 850 g PE, which was comparable to pyroxasulfone 110 g PE plus pendimethalin 800 g PE and HW (30 and 60 DAS). Weed

dry weight was seen to be decreased at 90 DAS in PoE 2, 4-D Na 0.75 kg in combination with HW (60 DAS), HW (60 DAS), and Pyroxasulfone. At 120 then harvest minimum dry weight of *Cynodon dactylon* L. recorded in PoE 2, 4- D Na 0.75 kg combined with HW (two month grown after) and HW (60 DAS) and maximum in sulfosulfuron combined with metsulfuron 35 g PoE and sulfosulfuron combined with metsulfuron 40 g PoE as compared to weedy check.



Graph 4.10 Influence of different herbicide treatments on dry weight (g m^{-2}) of *Cynodon dactylon* (L.) in wheat (Pooled data of 2020-2021 and 2021-2022).

Table 4.13 Influence of different herbicide treatments on dry weight (g m⁻²) of *Cyperus rotundus* L. in wheat (2020-2021 and 2021-2022).

Treat ment	30 DAS (2020- 21)	30 DAS (2021- 22)	Pool data	60 DAS (2020- 21)	60 DAS (2021- 22)	Pool data	90 DAS (2020- 21)	90 DAS (2021- 22)	Pool data	120 DAS (2020- 21)	120 DAS (2021- 22)	Pool data	Harve st (2020- 21)	Harve st (2021- 22)	Pool data
T ₁	0.17** (0.028)*	0.18 (0.031)	0.17 (0.030)	0.37 (0.135)	0.37 (0.14)	0.37 (0.138)	0.43 (0.183)	0.44 (0.190)	0.43 (0.187)	0.49 (0.24)	0.50 (0.248)	0.49 (0.244)	0.48 (0.24)	0.52 (0.28)	0.50 (0.26)
T ₂	0.18 (0.030)	0.19 (0.037)	0.18 (0.034)	0.38 (0.140)	0.38 (0.147)	0.38 (0.144)	0.44 (0.194)	0.45 (0.199)	0.44 (0.197)	0.51 (0.26)	0.52 (0.267)	0.51 (0.264)	0.52 (0.274)	0.52 (0.275)	0.52 (0.275)
T ₃	0.36 (0.13)	0.38 (0.142)	0.37 (0.136)	0.53 (0.28)	0.53 (0.286)	0.53 (0.283)	0.64 (0.41)	0.65 (0.423)	0.65 (0.417)	0.72 (0.52)	0.73 (0.530)	0.72 (0.525)	0.73 (0.540)	0.74 (0.542)	0.74 (0.541)
T ₄	0.40 (0.16)	0.41 (0.169)	0.41 (0.165)	0.30 (0.089)	0.31 (0.095)	0.30 (0.092)	0.37 (0.135)	0.37 (0.140)	0.37 (0.138)	0.42 (0.174)	0.43 (0.184)	0.42 (0.179)	0.46 (0.22)	0.41 (0.17)	0.43 (0.19)
T ₅	0.41 (0.17)	0.42 (0.177)	0.42 (0.174)	0.55 (0.30)	0.56 (0.31)	0.55 (0.305)	0.66 (0.435)	0.66 (0.440)	0.66 (0.438)	0.74 (0.546)	0.74 (0.550)	0.74 (0.548)	0.74 (0.550)	0.75 (0.560)	0.74 (0.555)
T ₆	0.37 (0.14)	0.38 (0.145)	0.38 (0.143)	0.48 (0.23)	0.49 (0.237)	0.48 (0.234)	0.37 (0.14)	0.39 (0.156)	0.37 (0.148)	0.42 (0.18)	0.44 (0.191)	0.43 (0.186)	0.48 (0.24)	0.38 (0.15)	0.43 (0.19)
T ₇	0.39 (0.15)	0.39 (0.153)	0.39 (0.152)	0.49 (0.24)	0.50 (0.248)	0.49 (0.244)	0.35 (0.12)	0.36 (0.131)	0.35 (0.126)	0.39 (0.156)	0.40 (0.160)	0.40 (0.158)	0.41 (0.165)	0.41 (0.170)	0.41 (0.168)
T ₈	0.47 (0.22)	0.48 (0.23)	0.47 (0.225)	1.00 (1.00)	1.06 (1.13)	1.03 (1.065)	1.11 (1.23)	1.11 (1.39)	1.14 (1.310)	1.23 (1.52)	1.33 (1.76)	1.28 (1.640)	1.34 (1.80)	1.29 (1.68)	1.23 (1.71)
SE m (±)	0.03	0.01	0.02	0.03	0.04	0.04	0.05	0.05	0.05	0.06	0.07	0.07	0.06	0.07	0.07
CD (p = 0.05)	0.08	0.04	0.06	0.10	0.11	0.11	0.16	0.16	0.16	0.19	0.21	0.20	0.17	0.20	0.19

*Values given in parenthesis are the mean of original values. **Data subjected to ($\sqrt{x+0.5}$) square root transformation, SE m (±): Standard Error of mean, CD: Critical Difference and DAS: Days after sowing

Treatments: T₁: Pyroxasulfone @ 120 g ha⁻¹ (PE) + Pendimethalin @ 850 g ha⁻¹ (PE), T₂: Pyroxasulfone @ 110 g ha⁻¹ (PE) Pendimethalin @ 800 g ha⁻¹ (PE), T₃: Sulfosulfuron + Metsulfuron @ 40 g ha⁻¹ (PE), T₄: Two hand weeding (30 and 60 DAS), T₅: Sulfosulfuron + Metsulfuron @ 35 g ha⁻¹ (PoE), T₆: Clodinafop-propargyl @ 400 g ha⁻¹ (PoE) + one hand weeding (60 DAS), T₇: 2, 4-D Na @ 750 g ha⁻¹ (PoE) + one hand weeding (60 DAS) and T₈: Weedy check (Control).

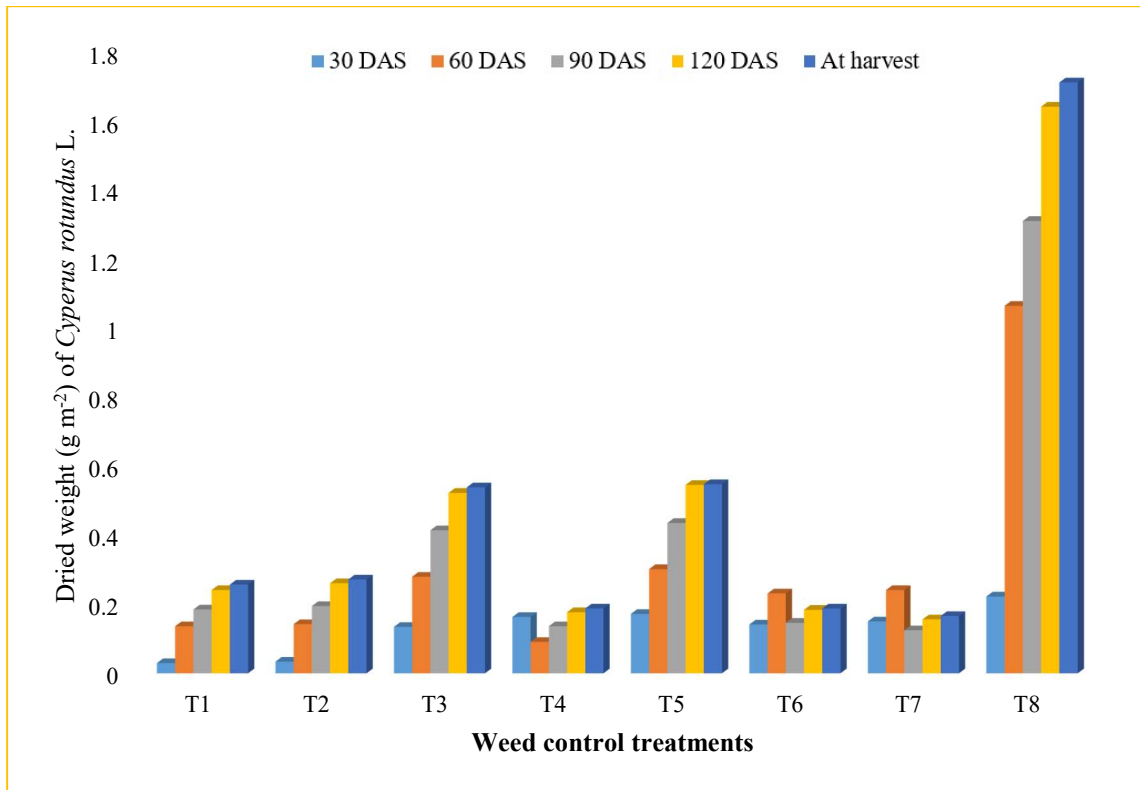
4.1.3.3 *Cyperus rotundus* L.

The dry weight of *Cyperus rotundus* L. in the years 2020-2021 and 2021-2022 as well as the impact of weed control treatments at monthly intervals till harvest are displayed in Table 4.13 and depicted in graph 4.11.

All weed control strategies significantly decreased the dry weight of *Cyperus rotundus* L. over to weedy check, as indicated by the data in Table 4.13 *Cyperus rotundus* L. for the years 2020–2021 and 2021–2022. The maximum dry weight of *Cyperus rotundus* L. in all treatments was 30 DAS, with the exception of the combinations of pyroxasulfone 110 g PE and pendimethalin 800 g PE (120 g PE and 110 g PE, respectively). The highest reported weed dry weight in 60 DAS was found in sulfosulfuron + metsulfuron 35 g PoE, followed by sulfosulfuron + metsulfuron 40 g PoE. In HW (30 and 60 DAS), *Cyperus rotundus* L. was shown to have a lower dry weight. Pyroxasulfone 120 g PE paired with pendimethalin 850 g PE and pyroxasulfone 110 g PE mixed with pendimethalin 800 g PE were the next two combinations. Maximum HW (30 and 60 DAS) and lowest HW (90 DAS) dry weight PoE 2, 4-D Na 0.75 kg in combination with HW (60 DAS) in sulfosulfuron combined with metsulfuron 35 g PoE and sulfosulfuron combined with metsulfuron 40 g PoE. Sulfosulfuron mixed with metsulfuron 35 g PoE and sulfosulfuron combined with metsulfuron 40 g PoE were the greatest weed dry weight that was reported at harvest, measured at 120 DAS. The lower in PoE 2, 4- D Na 0.75 kg combined with HW (60 DAS) followed by HW (30 and 60 DAS) and clodinafop- propargyl 400 g PoE combined with HW (60 DAS) as compared to over a weedy check.

The cumulative data for the years 2020-2021 and 2021-2022 displayed in Table 4.13 and graph 4.11 indicates that, one month after seeding, PE treatments had lower dry weights for *Cyperus rotundus* L. than PoE treatments. The combination of Sulfosulfuron and Metsulfuron resulted in the highest weed dry weight after 60 days of sowing, followed by sulfosulfuron and metsulfuron 35 g PoE, and the lowest in HW (60 DAS) with pyroxasulfone 120 g PE and pendimethalin 850 g PE. PoE 2, 4-D Na 0.75 kg mixed with HW (60 DAS) and pyroxasulfone 120 g PE combined with pendimethalin 850 g PE had the lowest weed dry weight in 90 DAS. These were followed by HW (60 DAS) and pyroxasulfone. At harvest, *Cyperus rotundus* L. was shown to have a reduced dry weight

of 120 DAS in pyroxasulfone 120 g PE, PoE 2, 4-D Na 0.75 kg mixed with HW (60 DAS), and HW (30 and 60 DAS). Maximums were seen in the combinations of 35 g PoE and 40 g PoE of sulfosulfuron and metsulfuron when compared to the other treatments using the Weedy check as a comparison.



Graph. 4.11 Influence of different herbicide treatments on dry weight (g m^{-2}) of *Cyperus rotundus* L. in wheat (2020-2021 and 2021-2022).

Table 4.14 Influence of different herbicide treatments on dry weight (g m⁻²) of *Cannabis sativa* L. in wheat (2020-2021 and 2021-2022).

Treat ment	30 DAS (2020- 21)	30 DAS (2021- 22)	Pool data	60 DAS (2020- 21)	60 DAS (2021- 22)	Pool data	90 DAS (2020- 21)	90 DAS (2021- 22)	Pool data	120 DAS (2020- 21)	120 DAS (2021- 22)	Pool data	Harve st (2020- 21)	Harve st (2021- 22)	Pool data
T ₁	0.14** (0.020)*	0.18 (0.031)	0.16 (0.026)	0.20 (0.039)	0.21 (0.044)	0.20 (0.042)	0.23 (0.054)	0.24 (0.060)	0.24 (0.057)	0.32 (0.10)	0.41 (0.167)	0.37 (0.134)	0.49 (0.24)	0.50 (0.246)	0.49 (0.243)
T ₂	0.15 (0.022)	0.19 (0.037)	0.17 (0.030)	0.21 (0.043)	0.23 (0.051)	0.22 (0.047)	0.24 (0.058)	0.26 (0.067)	0.25 (0.063)	0.33 (0.11)	0.42 (0.169)	0.38 (0.140)	0.50 (0.25)	0.51 (0.258)	0.50 (0.254)
T ₃	0.30 (0.09)	0.31 (0.099)	0.31 (0.095)	0.31 (0.095)	0.31 (0.099)	0.31 (0.097)	0.28 (0.076)	0.28 (0.081)	0.24 (0.079)	0.37 (0.14)	0.39 (0.151)	0.39 (0.146)	0.41 (0.17)	0.45 (0.21)	0.43 (0.19)
T ₄	0.32 (0.10)	0.35 (0.123)	0.33 (0.112)	0.19 (0.035)	0.20 (0.041)	0.19 (0.038)	0.31 (0.046)	0.23 (0.051)	0.22 (0.049)	0.29 (0.087)	0.31 (0.096)	0.30 (0.092)	0.32 (0.104)	0.30 (0.094)	0.31 (0.098)
T ₅	0.31 (0.096)	0.32 (0.10)	0.31 (0.098)	0.32 (0.10)	0.35 (0.122)	0.33 (0.111)	0.29 (0.082)	0.30 (0.090)	0.29 (0.086)	0.40 (0.16)	0.42 (0.176)	0.41 (0.168)	0.44 (0.20)	0.48 (0.24)	0.46 (0.22)
T ₆	0.31 (0.099)	0.32 (0.102)	0.32 (0.101)	0.28 (0.078)	0.28 (0.081)	0.28 (0.080)	0.22 (0.048)	0.24 (0.057)	0.23 (0.053)	0.30 (0.092)	0.31 (0.099)	0.31 (0.096)	0.34 (0.116)	0.32 (0.108)	0.33 (0.112)
T ₇	0.35 (0.12)	0.33 (0.132)	0.34 (0.126)	0.24 (0.059)	0.25 (0.065)	0.25 (0.062)	0.21 (0.045)	0.23 (0.053)	0.22 (0.049)	0.29 (0.082)	0.30 (0.091)	0.29 (0.087)	0.31 (0.102)	0.32 (0.108)	0.32 (0.105)
T ₈	0.39 (0.15)	0.41 (0.170)	0.40 (0.160)	0.54 (0.29)	0.56 (0.312)	0.55 (0.301)	0.59 (0.35)	0.60 (0.362)	0.60 (0.356)	0.77 (0.60)	0.85 (0.72)	0.81 (0.660)	0.91 (0.84)	0.87 (0.76)	0.89 (0.80)
SE m (±)	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.04	0.04	0.05	0.06	0.06
CD (p = 0.05)	0.08	0.07	0.08	0.05	0.07	0.06	0.09	0.08	0.09	0.10	0.12	0.11	0.16	0.18	0.17

*Values given in parenthesis are the mean of original values. **Data subjected to ($\sqrt{x+0.5}$) square root transformation, SE m (±): Standard Error of mean, CD: Critical Difference and DAS: Days after sowing

Treatments: T₁: Pyroxasulfone @ 120 g ha⁻¹ (PE) + Pendimethalin @ 850 g ha⁻¹ (PE), T₂: Pyroxasulfone @ 110 g ha⁻¹ (PE) Pendimethalin @ 800 g ha⁻¹ (PE), T₃: Sulfosulfuron + Metsulfuron @ 40 g ha⁻¹ (PE), T₄: Two hand weeding (30 and 60 DAS), T₅: Sulfosulfuron + Metsulfuron @ 35 g ha⁻¹ (PoE), T₆: Clodinafop-propargyl @ 400 g ha⁻¹ (PoE) + one hand weeding (60 DAS), T₇: 2, 4-D Na @ 750 g ha⁻¹ (PoE) + one hand weeding (60 DAS) and T₈: Weedy check (Control).

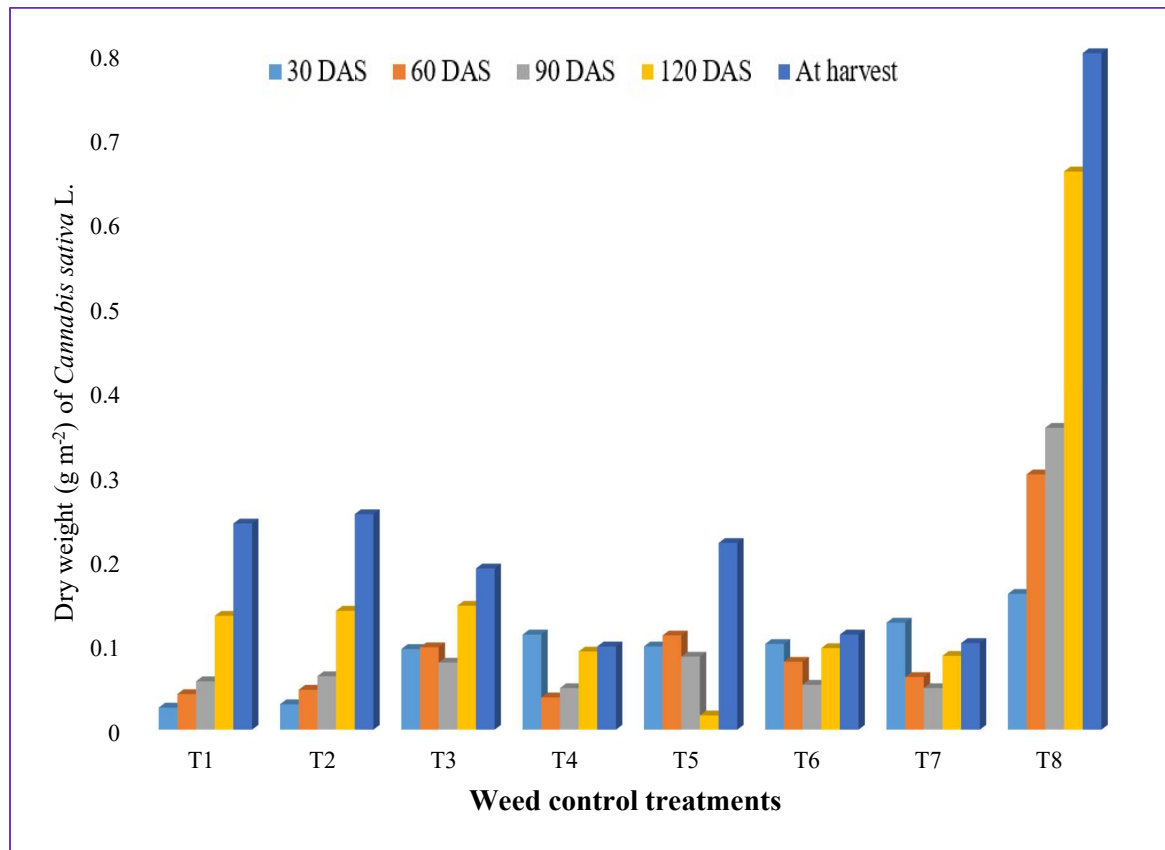
4.1.3.4 *Cannabis sativa* L.

Data on the dry weight of *Cannabis sativa* L. in the years 2020-2021 and 2021-2022 are displayed in Table 4.14 and are depicted in graph 4.12. The data also shows the impact of different weed management methods at monthly intervals till harvest.

The dry weight of *Cannabis sativa* L. in Table 4.14 for the years 2020-2021 and 2021-2022, indicates that all weed control treatments have a minimum dry weight of *Cannabis sativa* L. over the Weedy check. *Cannabis sativa* L. lowest dry weight at 30 DAS in all treatments, with the exception of pyroxasulfone 120 g PE and pendimethalin 850 g PE and are mixed, followed by pyroxasulfone 110 g PE and pendimethalin 800 g PE. Sixty days after sowing, the highest dry weight of weeds was seen in sulfosulfuron plus metsulfuron 35 g PoE, clodinafop-propargyl 400 g PoE plus HW (60 DAS), and sulfosulfuron plus metsulfuron 40 g PoE. At 90 DAS, the usage of sulfosulfuron combined with metsulfuron 40 g PoE was found to have the maximum dry weight, followed by sulfosulfuron mixed with metsulfuron 35 g PoE and lower dry weight of *Cannabis sativa* L. After HW (60 DAS) and pyroxasulfone 120 g PE mixed with pendimethalin 850 g PE, PoE 2, 4-D Na 0.75 kg was added. Maximum weed dry weight was seen while using sulfosulfuron paired with metsulfuron 40 g PoE, followed by sulfosulfuron mixed with metsulfuron 35 g PoE, 120 days after planting and harvest. The lowest in PoE 2, 4-D Na 0.75 kg combined with HW (60 DAS) was found after clodinafop propargyl 400 g PoE mixed with HW (60 DAS) and HW (30 and 60 DAS).

Table 4.14 presents cumulative data for the years 2020-2021 and 2021-2022, along with a graph on the month sowing that shows reduced dry weight of *Cannabis sativa* L. in PE treatments compared to PoE treatments. Sulfosulfuron combined with metsulfuron 35 g PoE and sulfosulfuron combined with metsulfuron 40 g PoE showed the highest weed dry weight at 60 DAS, while HW (30 and 60 DAS) showed the lowest. Pyroxasulfone 120 g PE combined with pendimethalin 850 g PE and pyroxasulfone 110 g PE combined with pendimethalin 800 g PE were the next two combinations. Weed dry weight was 90 DAS lower in PoE 2, 4-D Na 0.75 kg in combination with HW (60 DAS). After harvesting at 120 DAS, the dry weight of *Cannabis sativa* L. was shown to be lower in PoE 2, 4-D Na 0.75 kg coupled with HW (60 DAS) and HW (30 and 60 DAS), with the highest dry

weights found in sulfosulfuron mixed with metsulfuron 40 g PoE and 35 g PoE when compared to the weedy check.



Graph 4.12 Influence of different herbicide treatments on dry weight (g m^{-2}) of *Cannabis sativa* L. in wheat (Pooled data of 2020-2021 and 2021-2022).

Table 4.15 Influence of different herbicide treatments on dry weight (g m^{-2}) of *Chenopodium album* L. in wheat (2020-2021 and 2021-2022).

Treat ment	30 DAS (2020- 21)	30 DAS (2021- 22)	Pool data	60 DAS (2020- 21)	60 DAS (2021- 22)	Pool data	90 DAS (2020- 21)	90 DAS (2021- 22)	Pool data	120 DAS (2020- 21)	120 DAS (2021- 22)	Pool data	Harve st (2020- 21)	Harve st (2021- 22)	Pool data
T ₁	0.26** (0.066)*	0.28 (0.076)	0.27 (0.071)	0.63 (0.098)	0.32 (0.103)	0.32 (0.101)	0.38 (0.145)	0.39 (0.152)	0.39 (0.149)	0.46 (0.21)	0.47 (0.223)	0.47 (0.217)	0.58 (0.34)	0.59 (0.344)	0.58 (0.342)
T ₂	0.27 (0.071)	0.29 (0.085)	0.28 (0.078)	0.35 (0.12)	0.36 (0.129)	0.33 (0.125)	0.40 (0.158)	0.40 (0.161)	0.40 (0.160)	0.48 (0.23)	0.49 (0.239)	0.48 (0.235)	0.60 (0.358)	0.60 (0.360)	0.60 (0.359)
T ₃	0.57 (0.32)	0.57 (0.330)	0.57 (0.325)	0.46 (0.21)	0.48 (0.227)	0.47 (0.219)	0.52 (0.27)	0.53 (0.277)	0.52 (0.274)	0.58 (0.34)	0.59 (0.352)	0.59 (0.346)	0.74 (0.56)	0.72 (0.52)	0.73 (0.54)
T ₄	0.62 (0.38)	0.63 (0.391)	0.62 (0.386)	0.29 (0.085)	0.31 (0.094)	0.30 (0.090)	0.99 (0.098)	0.32 (0.10)	0.99 (0.099)	0.41 (0.17)	0.43 (0.189)	0.42 (0.180)	0.52 (0.27)	0.53 (0.284)	0.53 (0.277)
T ₅	0.69 (0.47)	0.70 (0.484)	0.69 (0.477)	0.50 (0.247)	0.51 (0.258)	0.50 (0.253)	0.57 (0.32)	0.58 (0.337)	0.57 (0.329)	0.63 (0.394)	0.63 (0.402)	0.63 (0.398)	0.78 (0.62)	0.76 (0.59)	0.77 (0.60)
T ₆	0.65 (0.42)	0.66 (0.432)	0.65 (0.426)	0.38 (0.141)	0.39 (0.151)	0.38 (0.146)	0.38 (0.146)	0.39 (0.154)	0.39 (0.150)	0.45 (0.20)	0.55 (0.307)	0.50 (0.254)	0.67 (0.46)	0.69 (0.48)	0.68 (0.47)
T ₇	0.69 (0.48)	0.68 (0.468)	0.69 (0.474)	0.36 (0.13)	0.37 (0.139)	0.37 (0.135)	0.32 (0.10)	0.33 (0.109)	0.32 (0.105)	0.39 (0.15)	0.41 (0.166)	0.40 (0.158)	0.49 (0.24)	0.50 (0.251)	0.50 (0.246)
T ₈	0.74 (0.55)	0.88 (0.77)	0.81 (0.660)	0.93 (0.86)	0.98 (0.96)	0.95 (0.910)	1.05 (1.10)	1.14 (1.31)	1.10 (1.205)	1.16 (1.35)	1.33 (1.76)	1.25 (1.555)	0.45 (2.10)	1.59 (2.54)	1.52 (2.30)
SE m ($\pm$)	0.02	0.04	0.03	0.05	0.06	0.06	0.07	0.06	0.07	0.10	0.10	0.10	0.06	0.10	0.08
CD (p = 0.05)	0.05	0.13	0.09	0.16	0.19	0.18	0.20	0.18	0.19	0.30	0.31	0.31	0.18	0.30	0.24

*Values given in parenthesis are the mean of original values. **Data subjected to ($\sqrt{x+0.5}$) square root transformation, SE m ($\pm$): Standard Error of mean, CD: Critical Difference and DAS: Days after sowing

Treatments: T₁: Pyroxasulfone @ 120 g ha⁻¹ (PE) + Pendimethalin @ 850 g ha⁻¹ (PE), T₂: Pyroxasulfone @ 110 g ha⁻¹ (PE) Pendimethalin @ 800 g ha⁻¹ (PE), T₃: Sulfosulfuron + Metsulfuron @ 40 g ha⁻¹ (PE), T₄: Two hand weeding (30 and 60 DAS), T₅: Sulfosulfuron + Metsulfuron @ 35 g ha⁻¹ (PoE), T₆: Clodinafop-propargyl @ 400 g ha⁻¹ (PoE) + one hand weeding (60 DAS), T₇: 2, 4-D Na @ 750 g ha⁻¹ (PoE) + one hand weeding (60 DAS) and T₈: Weedy check (Control).

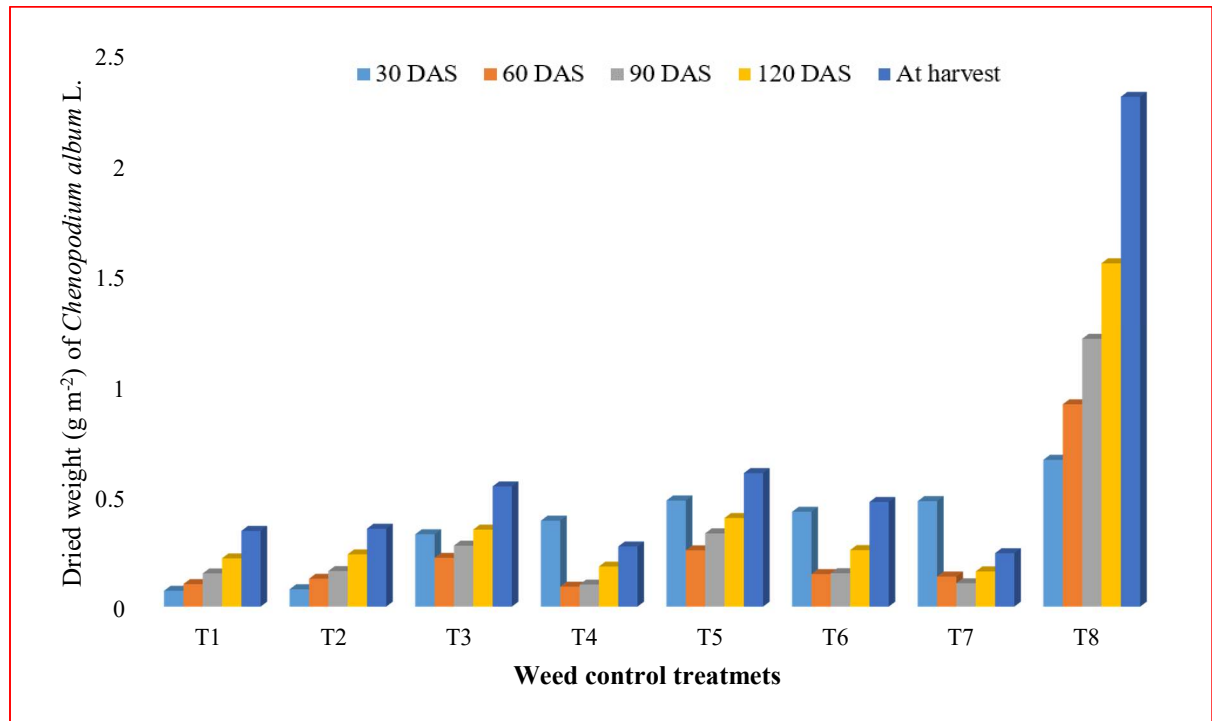
4.1.3.5 *Chenopodium album* L.

Data on the dry weight of *Chenopodium album* L. in the years 2020-2021 and 2021-2022 are displayed in Table 4.15 and are depicted in graph 4.13. The data also shows the impact of weed control treatments at monthly intervals till harvest.

Table 4.15, which displays data from 2020-2021 and 2021-2022, demonstrates that weed control treatments resulted in reduced dry weight of *Chenopodium album* L. compared to weedy check. The maximum dry weight of *Chenopodium album* L. was measured on 30 DAS for all treatments, with the exception of pyroxasulfone 120 g PE and pyroxasulfone 110 g PE coupled with pendimethalin 850 g PE. Sulfosulfuron paired with metsulfuron 35 g PoE, sulfosulfuron mixed with metsulfuron 40 g PoE, and clodinafop propargyl 400 g PoE combined with HW (60 DAS) all showed 60 DAS greater weed dry weight. The lower dry weight of *Chenopodium album* L. were recorded in HW (30 and 60 DAS) followed by pyroxasulfone 120 g PE combined with pendimethalin 850 g PE and pyroxasulfone 110 g PE combined with pendimethalin 800 g PE. Maximum dry weights of 35 g PoE and 40 g PoE of sulfosulfuron combined with metsulfuron were recorded at 90 DAS. *Chenopodium album* L. 2, 4-D Na 0.750 kg PoE combined with HW (60 DAS) was the lowest dry weight, followed by HW (30 and 60 DAS) and pyroxasulfone 120 g PE combined with pendimethalin 850 g PE. The application of sulfosulfuron combined with metsulfuron 35 g PoE and Harvest Highest Weed dry Weight was noted at 120 DAS, followed by sulfosulfuron paired with metsulfuron 40 g PoE. HW (30 and 60 DAS) and pyroxasulfone 120 g PE mixed with pendimethalin 850 g PE overtook the minimum in PoE 2, 4-D Na 0.75 kg combined with HW (60 DAS) over a weedy check.

The years 2020-2021 and 2021-2022 display cumulative statistics. Table 4.15 and the accompanying graph 4.13 demonstrate that, one month after seeding, PE treatments recorded a lower dry weight of *Chenopodium album* L. than PoE treatments. Sulfosulfuron combined with metsulfuron 35 g PoE and sulfosulfuron combined with metsulfuron 40 g PoE and lower HW (30 and 60 DAS) were found to have the highest weed dry weight at 60 DAS. Pyroxasulfone 120 g PE combined with pendimethalin 850 g PE and pyroxasulfone 110 g PE combined with pendimethalin 800 g PE were next. At harvest, lower dry weight of *Chenopodium album* L. was noted in PoE 2, 4-D Na 0.75 kg combined

with HW (60 DAS) and HW (30 and 60 DAS), and maximum in sulfosulfuron combined with metsulfuron 35 g PoE and sulfosulfuron combined with metsulfuron 40 g PoE as compared to rest of the treatments over a weedy check. At 90 DAS, minimum weed dry weight were recorded in PoE 2, 4-D Na 0.75 kg combined with HW (60 DAS), followed by HW (60 DAS) and pyroxasulfone 120 g PE combined with pendimethalin 850 g PE.



Graph 4.13 Influence of different herbicide treatments on dry weight (g m^{-2}) of *Chenopodium album* L. in wheat (Pooled data of 2020-2021 and 2021-2022).

Table 4.16 Influence of different herbicide treatments on dry weight (g m⁻²) of *Medicago denticulate* in Wheat (2020-2021 and 2021-2022).

Treat ment	30 DAS (2020- 21)	30 DAS (2021- 22)	Pool data	60 DAS (2020- 21)	60 DAS (2021- 22)	Pool data	90 DAS (2020- 21)	90 DAS (2021- 22)	Pool data	120 DAS (2020- 21)	120 DAS (2021- 22)	Pool data	Harve st (2020- 21)	Harve st (2021- 22)	Pool data
T ₁	0.17** (0.029)*	0.18 (0.034)	0.18 (0.032)	0.21 (0.046)	0.23 (0.052)	0.22 (0.049)	0.27 (0.071)	0.29 (0.082)	0.28 (0.077)	0.31 (0.097)	0.32 (0.100)	0.31 (0.099)	0.37 (0.140)	0.38 (0.147)	0.38 (0.144)
T ₂	0.18 (0.030)	0.20 (0.039)	0.19 (0.035)	0.22 (0.049)	0.24 (0.058)	0.23 (0.054)	0.28 (0.077)	0.30 (0.089)	0.29 (0.083)	0.32 (0.105)	0.33 (0.111)	0.33 (0.108)	0.38 (0.148)	0.39 (0.155)	0.39 (0.152)
T ₃	0.42 (0.178)	0.43 (0.184)	0.43 (0.181)	0.25 (0.064)	0.28 (0.076)	0.26 (0.070)	0.95 (0.91)	0.99 (0.99)	0.97 (0.950)	0.35 (0.12)	0.35 (0.123)	0.35 (0.122)	0.39 (0.149)	0.40 (0.152)	0.40 (0.151)
T ₄	0.41 (0.165)	0.41 (0.170)	41 (0.168)	0.19 (0.035)	0.21 (0.044)	0.20 (0.040)	0.23 (0.055)	0.24 (0.060)	0.24 (0.058)	0.28 (0.076)	0.28 (0.080)	0.28 (0.078)	0.31 (0.097)	0.32 (0.100)	0.31 (0.099)
T ₅	0.39 (0.15)	0.40 (0.157)	0.39 (0.154)	0.26 (0.068)	0.28 (0.079)	0.27 (0.074)	0.32 (0.10)	0.34 (0.119)	0.33 (0.110)	0.39 (0.15)	0.41 (0.165)	0.40 (0.158)	0.43 (0.189)	0.44 (0.194)	0.44 (0.192)
T ₆	0.44 (0.19)	0.45 (0.199)	0.44 (0.195)	0.29 (0.087)	0.31 (0.094)	0.30 (0.091)	0.25 (0.063)	0.26 (0.070)	0.26 (0.067)	0.30 (0.091)	0.31 (0.099)	0.31 (0.095)	0.36 (0.129)	0.36 (0.132)	0.36 (0.131)
T ₇	0.41 (0.17)	0.42 (0.178)	0.42 (0.174)	0.30 (0.084)	0.30 (0.092)	0.30 (0.088)	0.21 (0.044)	0.22 (0.050)	0.22 (0.047)	0.27 (0.072)	0.29 (0.084)	0.28 (0.078)	0.30 (0.091)	0.31 (0.099)	0.31 (0.095)
T ₈	0.47 (0.22)	0.48 (0.23)	0.47 (0.225)	0.57 (0.33)	0.59 (0.35)	0.58 (0.340)	0.68 (0.46)	0.75 (0.57)	0.72 (0.515)	0.77 (0.60)	0.87 (0.76)	0.82 (0.680)	0.85 (0.72)	0.86 (0.740)	0.85 (0.730)
SE m (±)	0.03	0.03	0.03	0.04	0.04	0.04	0.03	0.03	0.03	0.03	0.06	0.05	0.06	0.05	0.06
CD (p = 0.05)	0.08	0.09	0.09	0.10	0.11	0.12	0.09	0.08	0.09	0.10	0.17	0.14	0.18	0.15	0.17

*Values given in parenthesis are the mean of original values. **Data subjected to ($\sqrt{x+0.5}$) square root transformation, SE m (±): Standard Error of mean, CD: Critical Difference and DAS: Days after sowing

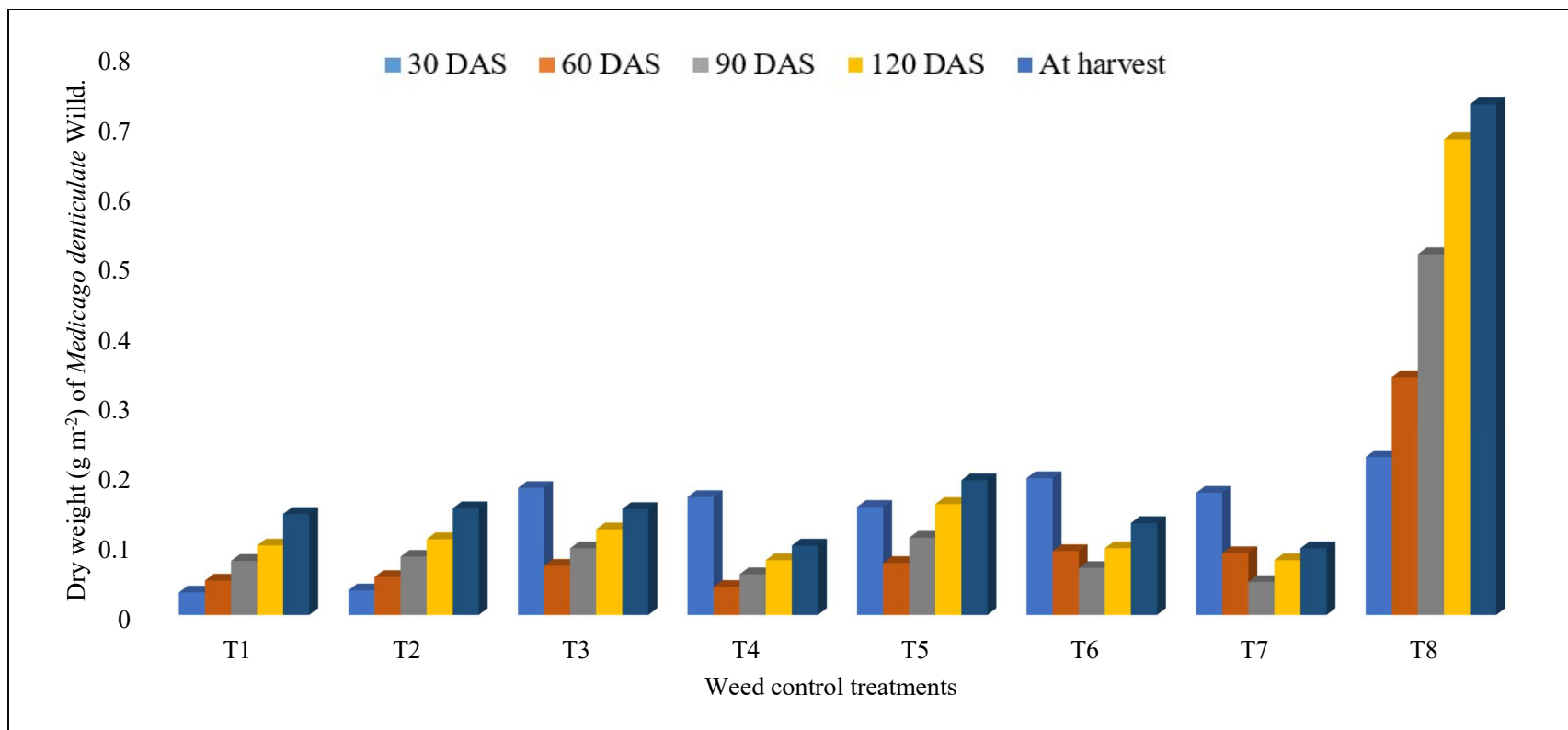
Treatments: T₁: Pyroxasulfone @ 120 g ha⁻¹ (PE) + Pendimethalin @ 850 g ha⁻¹ (PE), T₂: Pyroxasulfone @ 110 g ha⁻¹ (PE) Pendimethalin @ 800 g ha⁻¹ (PE), T₃: Sulfosulfuron + Metsulfuron @ 40 g ha⁻¹ (PE), T₄: Two hand weeding (30 and 60 DAS), T₅: Sulfosulfuron + Metsulfuron @ 35 g ha⁻¹ (PoE), T₆: Clodinafop-propargyl @ 400 g ha⁻¹ (PoE) + one hand weeding (60 DAS), T₇: 2, 4-D Na @ 750 g ha⁻¹ (PoE) + one hand weeding (60 DAS) and T₈: Weedy check (Control).

4.1.3.6 *Medicago denticulate*

Data on the dry weight of *Medicago denticulate* impact of weed control treatments at monthly intervals up to harvest for the years 2020-2021 and 2021-2022 are displayed in Table 4.16 and are depicted in graph 4.14.

Data from 2020-2021 and 2021-2022 on *Medicago denticulate* dry weight in Table 4.16 indicate that weed switch treatments reduce *Medicago denticulate* dry weight below weedy check. With the exception of pyroxasulfone 120 g PE paired with pendimethalin 850 g PE and pyroxasulfone 110 g PE mixed with pendimethalin 800 g PE, the maximum dry weight of *Medicago denticulate* in all treatments was 30 DAS. The highest documented dry weight of weeds in 60 days was 35 g PoE for sulfosulfuron mixed with metsulfuron, 40 g PoE for sulfosulfuron paired with metsulfuron, and 400 g PoE for clodinafop-propargyl combined with HW (60 DAS). The minimum dry weight of *Medicago denticulate* were recorded in the HW (60 DAS) followed by pyroxasulfone 120 g PE combined with pendimethalin 850 g PE and pyroxasulfone 110 g PE combined with pendimethalin 800 g PE. 90 DAS the maximum dry weight were recorded in the use of sulfosulfuron combined with metsulfuron 35 g PoE then sulfosulfuron combined with metsulfuron 40 g PoE then minimum count of *Medicago denticulate* PoE use of 2, 4- D Na 0.75 kg combined with HW (60 DAS) followed HW (30 and 60 DAS) and clodinafop-propargyl 400 g PoE combined with HW (60 DAS). At 120 DAS and harvest highest weed dry weight were recorded in the use of sulfosulfuron combined with metsulfuron 35 g PoE and sulfosulfuron combined with metsulfuron 40 g PoE. Clodinafop-propargyl 400 g PoE combined with HW (60 DAS) over a weedy check, HW (30 and 60 DAS), and 4-D Na 0.75 kg combined with HW (60 DAS) were the minimal values in PoE.

Combined data for the years 2020-2021 and 2021-2022 is displayed. *Medicago denticulate* dry weight was reduced in PE treatment compared to PoE treatments, as indicated by Table 4.16 presentation of Graph 4.14 on 30 DAS. The highest recorded dry weight of weeds in 60 days was found in 35 grams of sulfosulfuron combined with metsulfuron, 40 g of sulfosulfuron combined with metsulfuron, and in lower HW (60 DAS), pyroxasulfone 120 g of PE combined with pendimethalin 850 g of PE and pyroxasulfone 110 g of PE combined with pendimethalin 800 g.



Graph 4.14 Influence of different herbicide treatments on dry weight (g m⁻²) of *Medicago denticulate* Willd. in wheat (Pooled data of 2020-2021 and 2021-2022).

Table 4.17 Influence of different herbicide treatments on dry weight (g m⁻²) of *Parthenium hysterophorus* L. in wheat (2020-2021 and 2021-2022).

Treatm ent	30 DAS (2020- 21)	30 DAS (2021- 22)	Pool data	60 DAS (2020- 21)	60 DAS (2021- 22)	Pool data	90 DAS (2020- 21)	90 DAS (2021- 22)	Pool data	120 DAS (2020- 21)	120 DAS (2021- 22)	Pool data	Harves t (2020- 21)	Harvest (2021-22)	Pool data
T ₁	0.14** (0.023)*	0.17 (0.030)	0.16 (0.027)	0.21 (0.045)	0.22 (0.050)	0.22 (0.048)	0.25 (0.064)	0.26 (0.070)	0.26 (0.067)	0.30 (0.089)	0.31 (0.096)	0.30 (0.093)	0.35 (0.124)	0.36 (0.127)	0.35 (0.126)
T ₂	0.16 (0.025)	0.18 (0.034)	0.17 (0.030)	0.22 (0.050)	0.25 (0.061)	0.24 (0.056)	0.26 (0.068)	0.28 (0.076)	0.27 (0.072)	0.31 (0.094)	0.31 (0.099)	0.29 (0.097)	0.36 (0.131)	0.37 (0.135)	0.36 (0.133)
T ₃	0.36 (0.132)	0.38 (0.141)	0.37 (0.137)	0.32 (0.108)	0.31 (0.104)	0.32 (0.106)	0.33 (0.111)	0.35 (0.124)	0.34 (0.118)	0.38 (0.144)	0.39 (0.149)	0.38 (0.147)	0.44 (0.198)	0.46 (0.21)	0.45 (0.204)
T ₄	0.37 (0.14)	0.39 (0.150)	0.38 (0.145)	0.19 (0.038)	0.20 (0.040)	0.20 (0.039)	0.24 (0.059)	0.25 (0.065)	0.25 (0.062)	0.29 (0.084)	0.30 (0.091)	0.30 (0.088)	0.35 (0.120)	0.35 (0.124)	0.35 (0.122)
T ₅	0.38 (0.147)	0.40 (0.157)	0.39 (0.152)	0.29 (0.087)	0.30 (0.091)	0.029 (0.089)	0.35 (0.123)	0.36 (0.128)	0.35 (0.126)	0.41 (0.169)	0.42 (0.173)	0.41 (0.171)	0.50 (0.254)	0.51 (0.260)	0.51 (0.257)
T ₆	0.40 (0.16)	0.41 (0.168)	0.40 (0.164)	0.27 (0.078)	0.30 (0.088)	0.28 (0.083)	0.25 (0.064)	0.27 (0.072)	0.26 (0.068)	0.30 (0.090)	0.31 (0.095)	0.30 (0.093)	0.36 (0.129)	0.36 (0.131)	0.36 (0.130)
T ₇	0.35 (0.126)	0.36 (0.132)	0.36 (0.129)	0.27 (0.074)	0.28 (0.080)	0.28 (0.077)	0.23 (0.052)	0.24 (0.060)	0.24 (0.056)	0.28 (0.079)	0.29 (0.082)	0.28 (0.081)	0.33 (0.112)	0.34 (0.116)	0.34 (0.114)
T ₈	0.42 (0.18)	0.45 (0.20)	0.44 (0.190)	0.59 (0.35)	0.61 (0.37)	0.60 (0.360)	0.69 (0.47)	0.70 (0.49)	0.69 (0.480)	0.77 (0.60)	0.80 (0.64)	0.79 (0.620)	0.91 (0.820)	0.91 (0.832)	0.91 (0.826)
SE m (±)	0.03	0.03	0.03	0.04	0.03	0.04	0.03	0.04	0.04	0.05	0.04	0.05	0.05	0.06	0.06
CD (p = 0.05)	0.09	0.10	0.10	0.13	0.11	0.12	0.09	0.11	0.10	0.14	0.13	0.14	0.16	0.19	0.18

*Values given in parenthesis are the mean of original values. **Data subjected to ($\sqrt{x+0.5}$) square root transformation, SE m (±): Standard Error of mean, CD: Critical Difference and DAS: Days after sowing

Treatments: T₁: Pyroxasulfone @ 120 g ha⁻¹ (PE) + Pendimethalin @ 850 g ha⁻¹ (PE), T₂: Pyroxasulfone @ 110 g ha⁻¹ (PE) Pendimethalin @ 800 g ha⁻¹ (PE), T₃: Sulfosulfuron + Metsulfuron @ 40 g ha⁻¹ (PE), T₄: Two hand weeding (30 and 60 DAS), T₅: Sulfosulfuron + Metsulfuron @ 35 g ha⁻¹ (PoE), T₆: Clodinafop-propargyl @ 400 g ha⁻¹ (PoE) + one hand weeding (60 DAS), T₇: 2, 4-D Na @ 750 g ha⁻¹ (PoE) + one hand weeding (60 DAS) and T₈: Weedy check (Control).

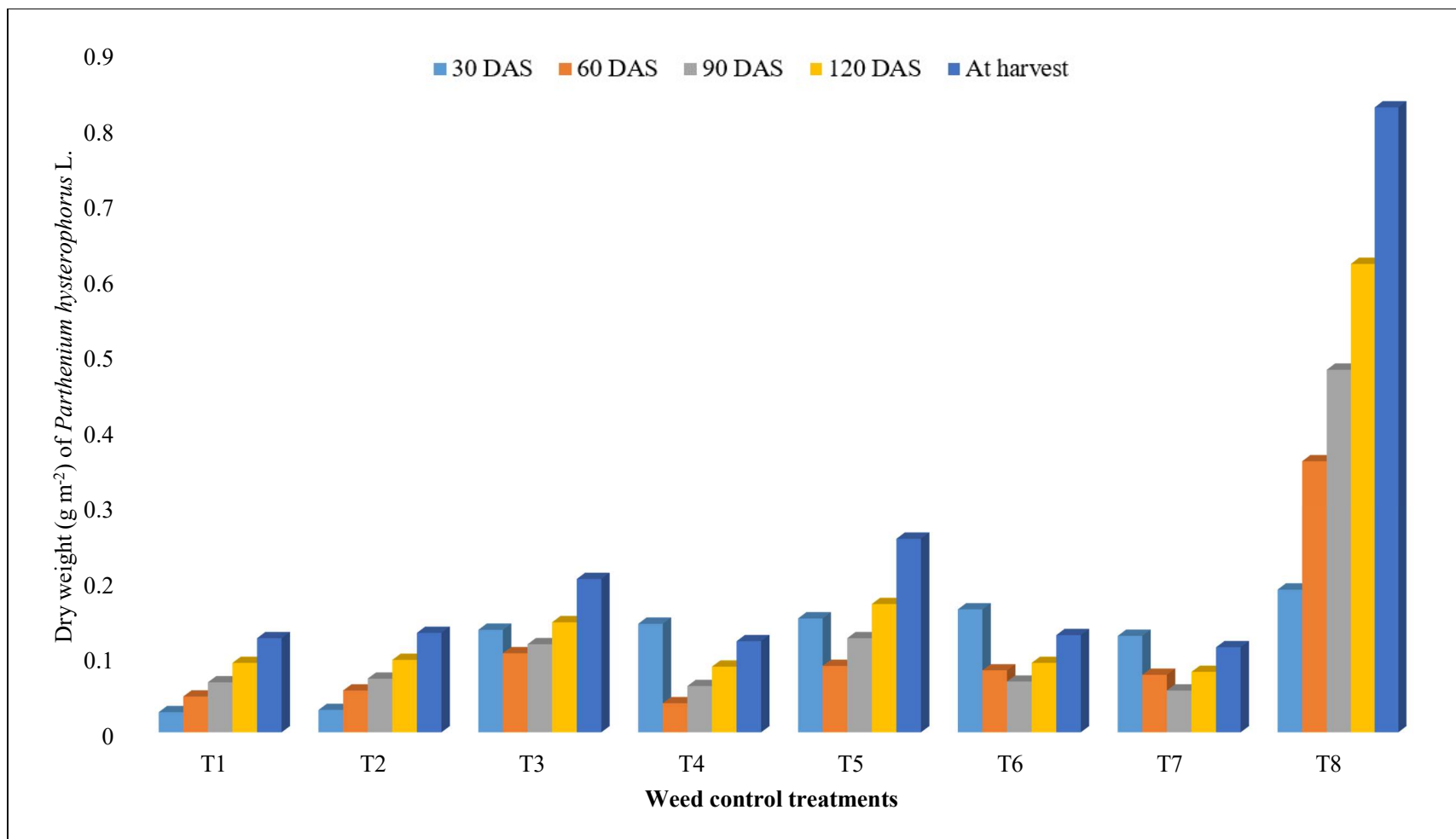
4.1.3.7 *Parthenium hysterophorus* L.

Data on the dry weight of *Parthenium hysterophorus* L. in the years 2020-2021 and 2021-2022 on the impact of weed control treatments at monthly intervals till harvest are displayed in Table 4.17 and depicted in graph 4.15.

Data from 2020-2021 and 2021-2022 on *Parthenium hysterophorus* L. dry weight in Table 4.17 indicate that weed control treatments reduce *Parthenium hysterophorus* L. dry weight relative to the weedy check. 30 days after the maximum dry weight showing in all treatments, with the exception of pyroxasulfone 120 g PE mixed with pendimethalin 850 g and pyroxasulfone 110 g PE mixed pendimethalin 850 g PE. The highest amount of dry weight weed was found 60 days after planting in the following combinations of sulfosulfuron plus metsulfuron 35 g PoE, sulfosulfuron plus metsulfuron 40 g PoE, and clodinafop-propargyl 400 g PoE plus HW (60 DAS). After pyroxasulfone 120 g PE combined with pendimethalin 850 g PE and pyroxasulfone 110 g PE mixed with pendimethalin 800 g PE, the lowest dry weight of *Parthenium hysterophorus* L. was measured in the HW (30 and 60 DAS). Ninety days after sowing, the highest dry weights were observed when sulfosulfuron and metsulfuron were combined at 35 g PoE and 40 g PoE, respectively. *Parthenium hysterophorus* L. PoE 2, 4-D Na 0.75 kg was the lowest dry weight when HW (30 and 60 DAS) was followed by clodinafop propargyl 400 g PoE and HW (60 DAS). When using sulfosulfuron paired with metsulfuron 35 g PoE and sulfosulfuron mixed with metsulfuron 40 g PoE, the highest weed dry weight was observed 120 days after seeding and harvest. PoE 2, 4-D Na 0.75 kg in combination with HW (60 DAS), HW (30 and 60 DAS), and 120 g PE of pyroxasulfone over a weedy check was the least.

The years 2020-2021 and 2021-2022 display cumulative statistics. Less dry weight of *Parthenium hysterophorus* L. was seen in PE treatments as compared to PoE treatments, as indicated by graph 4.15, which was displayed 30 days after sowing (Table 4.17). The highest recorded dry weight of weeds after 60 days of growth was found in 35 g PoE and 40 g PoE of sulfosulfuron combined with metsulfuron, as well as in minimum HW (30 and 60 DAS). These were followed by pyroxasulfone 120 g PE combined with pendimethalin 850 g PE and pyroxasulfone 110 g PE combined with pendimethalin 800 g PE. The least

amount of weed dry weight was found in PoE 2, 4-D Na 0.75 kg combined with HW (60 DAS), followed by HW (30 and 60 DAS) and pyroxasulfone 120 g PE combined with pendimethalin 850 g PE. The most amount of weed dry weight was found in the combination of sulfosulfuron and metsulfuron 35 g PoE and sulfosulfuron and metsulfuron 40 g PoE. The lowest dry weight of *Parthenium hysterophorus* L. was observed on data of 120 DAS and harvest in pyroxasulfone 120 g PE combined with pendimethalin 850 g PoE, followed by PoE 2, 4-D Na 0.75 kg combined with HW (60 DAS) and HW (30 and 60 DAS), and the highest dry weight was found in sulfosulfuron combined with metsulfuron 35 g PoE and sulfosulfuron combined with metsulfuron 40 g PoE.



Graph 4.15 Influence of different herbicide treatments on dry weight (g m⁻²) of *Parthenium hysterophorus* L. in wheat (Poole data of 2020-2021 and 2021-2022).

Table 4.18 Influence of different herbicide treatments on total dry weight of weeds (g m⁻²) in wheat (2020-2021 and 2021-2022).

Treatm ent	30 DAS (2020- 21)	30 DAS (2021- 22)	Pool data	60 DAS (2020- 21)	60 DAS (2021- 22)	Pool data	90 DAS (2020- 21)	90 DAS (2021- 22)	Pool data	120 DAS (2020- 21)	120 DAS (2021- 22)	Pool data	Harve st (2020- 21)	Harves t (2021- 22)	Pool data
T ₁	0.57** (0.326)*	0.62 (0.382)	0.59 (0.35)	0.80 (0.634)	0.85 (0.73)	0.82 (0.68)	0.96 (0.93)	1.02 (1.04)	0.99 (0.99)	1.24 (1.53)	1.30 (1.68)	1.27 (1.61)	1.40 (1.96)	1.37 (1.87)	1.91 (1.92)
T ₂	0.60 (0.355)	0.65 (0.422)	0.62 (0.39)	0.83 (0.687)	0.86 (0.74)	0.84 (0.71)	1.01 (1.02)	1.06 (1.12)	1.03 (1.07)	1.29 (1.66)	1.35 (1.82)	1.32 (1.74)	1.44 (2.07)	1.38 (1.91)	1.41 (1.99)
T ₃	1.34 (1.80)	1.39 (1.92)	1.36 (1.86)	1.47 (2.17)	1.53 (2.35)	1.50 (2.26)	1.60 (2.57)	1.64 (2.70)	1.62 (2.64)	1.46 (2.14)	1.61 (2.60)	1.54 (2.37)	1.69 (2.84)	1.71 (2.93)	1.70 (2.89)
T ₄	1.41 (1.98)	1.44 (2.06)	1.42 (2.02)	0.76 (0.572)	0.81 (0.66)	1.79 (0.62)	1.23 (1.52)	1.26 (1.58)	1.24 (1.55)	0.97 (0.94)	1.00 (1.00)	0.98 (0.97)	1.10 (1.22)	1.12 (1.25)	1.11 (1.24)
T ₅	1.35 (1.83)	1.41 (1.99)	1.38 (1.91)	1.23 (1.51)	1.27 (1.62)	1.25 (1.57)	1.34 (1.79)	1.38 (1.90)	1.36 (1.85)	1.57 (2.45)	1.61 (2.58)	1.59 (2.52)	1.75 (3.05)	1.76 (3.09)	1.75 (3.07)
T ₆	1.48 (2.20)	1.47 (2.17)	1.48 (2.19)	1.39 (1.92)	1.14 (1.30)	1.27 (1.61)	1.21 (1.46)	1.23 (1.52)	1.22 (1.49)	1.01 (1.02)	1.09 (1.18)	1.05 (1.10)	1.17 (1.37)	1.18 (1.39)	1.17 (1.38)
T ₇	1.53 (2.34)	1.51 (2.29)	1.52 (2.32)	1.38 (1.90)	1.06 (1.13)	1.23 (1.52)	0.76 (0.58)	0.80 (0.64)	0.78 (0.61)	0.93 (0.86)	0.96 (0.92)	0.94 (0.89)	1.06 (1.13)	1.13 (1.27)	1.10 (1.20)
T ₈	1.68 (2.82)	1.80 (3.25)	1.74 (3.04)	2.28 (5.22)	2.60 (6.74)	2.45 (5.98)	2.75 (7.57)	2.86 (8.17)	2.81 (7.87)	3.24 (10.47)	3.41 (11.64)	3.33 (11.06)	3.47 (12.07)	3.57 (12.72)	3.52 (12.40)
SE m (±)	0.08	0.11	0.10	0.11	0.09	0.10	0.08	0.09	0.09	0.10	0.10	0.10	0.13	0.13	0.13
CD (p = 0.05)	0.24	0.35	0.30	0.33	0.27	0.30	0.25	0.28	0.27	0.29	0.32	0.31	0.38	0.40	0.39

*Values given in parenthesis are the mean of original values. **Data subjected to ($\sqrt{x+0.5}$) square root transformation, SE m (±): Standard Error of mean, CD: Critical Difference and DAS: Days after sowing

Treatments: T₁: Pyroxasulfone @ 120 g ha⁻¹ (PE) + Pendimethalin @ 850 g ha⁻¹ (PE), T₂: Pyroxasulfone @ 110 g ha⁻¹ (PE) Pendimethalin @ 800 g ha⁻¹ (PE), T₃: Sulfosulfuron + Metsulfuron @ 40 g ha⁻¹ (PE), T₄: Two hand weeding (30 and 60 DAS), T₅: Sulfosulfuron + Metsulfuron @ 35 g ha⁻¹ (PoE), T₆: Clodinafop-propargyl @ 400 g ha⁻¹ (PoE) + one hand weeding (60 DAS), T₇: 2, 4-D Na @ 750 g ha⁻¹ (PoE) + one hand weeding (60 DAS) and T₈: Weedy check (Control).

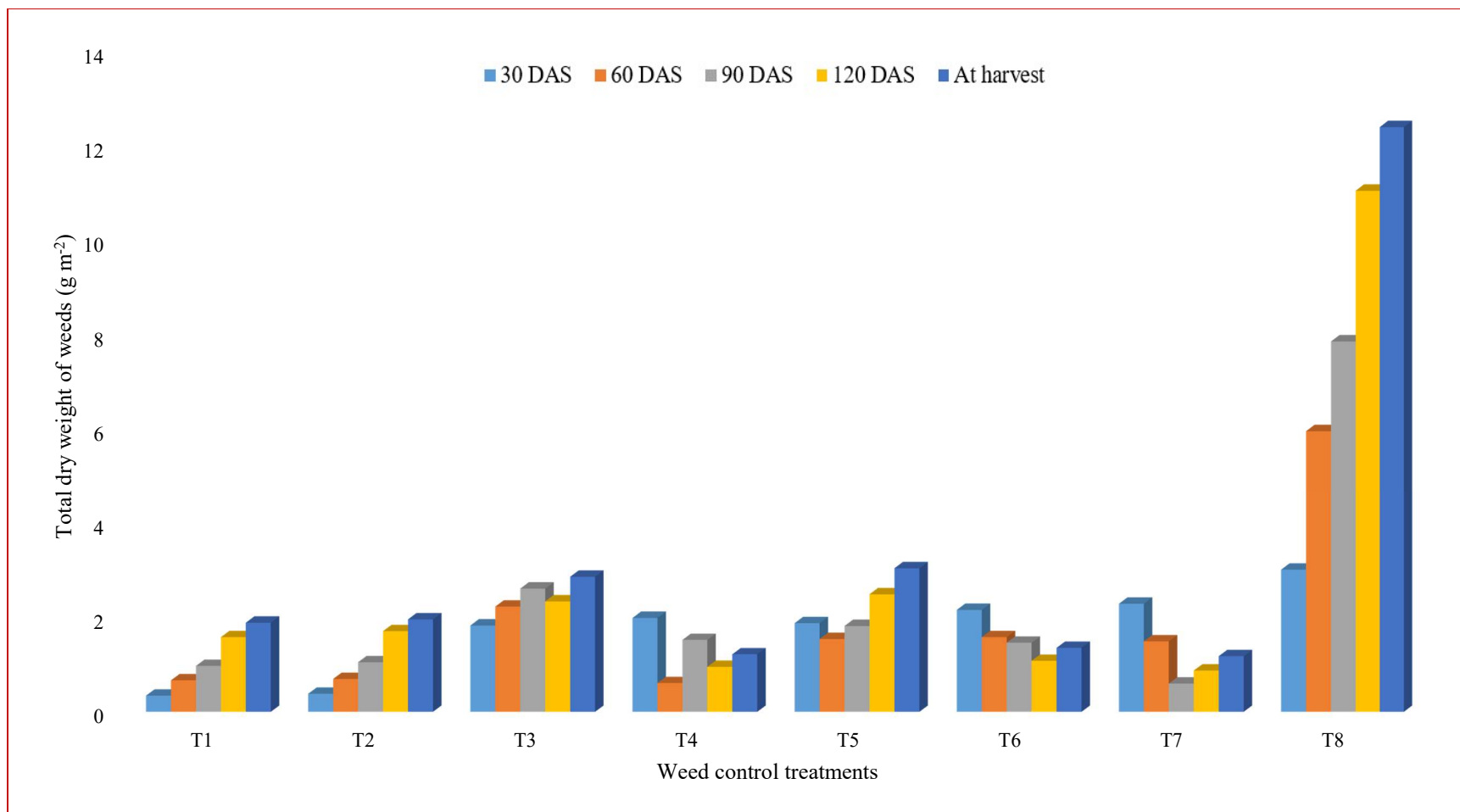
4.1.3.8 Total dry weight of weeds (g m⁻²)

Data on the total dry weight of weeds in the years 2020-2021 and 2021-2022 and the impact of weed control treatments at monthly intervals up until harvest are displayed in Table 4.18 and depicted in graph 4.16.

The total dry weight of weeds in Table 4.18 for the years 2020-2021 and 2021-2022 indicates that the weed control treatments have a minimal total dry weight of weeds over the weedy check. The exception of pyroxasulfone, all treatments had a maximum count of 30 DAS for the total weed population of 120 g PE combined with pendimethalin 850 g PE and 110 g PE combined with 800 g PE. The combination of sulfosulfuron and metsulfuron 35 g PoE was shown to have the largest weed dry weight 60 days after sowing. This was followed by the combination of sulfosulfuron and metsulfuron 40 g PoE and clodinafop-propargyl 400 g PoE with HW (60 DAS). The minimum dry weight of total weed population were recorded in HW (30 and 60 DAS) after pyroxasulfone 120 g PE combination with pendimethalin 850 g PE and pyroxasulfone 110 g PE combination with pendimethalin 800 g PE. At 90 DAS maximum dry weight were recorded in use of sulfosulfuron combination with metsulfuron 35 g PoE and sulfosulfuron combination with metsulfuron 40 g PoE and minimum dry weight of total weed population PoE 2, 4-D Na 0.75 kg combination with HW (60 DAS) followed pyroxasulfone 120 g PE combination with pendimethalin 850 g PE and pyroxasulfone 120 g PE combination with pendimethalin 800 g PE. Similar results were reported by Bayat *et al.* (2020) and Preston *et al.* (2014). The utilization of a combination of sulfosulfuron and metsulfuron 35 g PoE and sulfosulfuron and metsulfuron 40 g PoE was observed for 120 DAS and harvest extreme dry weed weight. Clodinafop-propargyl 400 g PoE combination with HW (60 DAS) and HW (30 and 60 DAS) was shown to be less effective than 2, 4-D Na 0.75 kg combination over a weedy check. Kaur *et al.* (2019) reported similar outcomes.

The years 2020-2021 and 2021-2022 display cumulative statistics. In comparison to PoE treatments, PE treatments recorded a minimal dry weight of the total weed dry weight at 30 DAS, as indicated by graph 4.16 in Table 4.18. The highest recorded weed dry weight in the 60 DAS was found in the combination of sulfosulfuron and metsulfuron 35 g PoE and sulfosulfuron and metsulfuron 40 g PoE. The lowest recorded total dry weight

of the weed population was found in the HW (30 and 60 DAS) and pyroxasulfone 120 g PE combined with pendimethalin 850 g PE, followed by pyroxasulfone 110 g PE combined with pendimethalin 800 g PE. The combinations of PoE 2, 4-D Na 0.75 kg and HW (60 DAS) had the lowest recorded weed dry weight 90 days after sowing, followed by pyroxasulfone 120 g PE and pendimethalin 850 g PE and pyroxasulfone 110 g PE and pendimethalin 800 g PE, and the combinations of sulfosulfuron and metsulfuron 40 g PoE and sulfosulfuron and metsulfuron 35 g PoE. harvest the lowest total dry weight of the weed population that was reported in PoE 2, 4-D Na 0.75 kg combination with HW (60 DAS), then clodinafop propargyl 400 g PoE combination with HW (30 and 60 DAS) (60 DAS) Use of pyroxasulfone 120 g PE combination with pendimethalin 850 g PE reduce the weed dry weight of all weed species resulted increased WCE and got the weed free situation for crop.



Graph 4.16 Influence of different herbicide treatments on total dry weight of weeds (g m⁻²) in wheat (Pooled data of 2020-2021 and 2021-2022).

Table 4.19 Influence of different herbicide treatments on weed control efficiency (%) of *Phalaris minor* in wheat (2020-2021 and 2021-2022).

Treatment	30 DAS (2020-21)	30 DAS (2021-22)	Pool data	60 DAS (2020-21)	60 DAS (2021-22)	Pool data	90 DAS (2020-21)	90 DAS (2021-22)	Pool data	120 DAS (2020-21)	120 DAS (2021-22)	Pool data	Harvest (2020-21)	Harvest (2021-22)	Pool data
T ₁	92.22	91.38	91.80	92.17	90.56	91.37	89.95	87.11	88.53	87.56	86.75	87.16	87.76	85.41	86.71
T ₂	91.22	90.74	90.98	91.57	91.98	91.78	88.12	86.22	87.17	86.75	85.45	86.10	86.73	84.08	85.41
T ₃	35.55	34.04	34.80	79.05	77.35	78.20	86.30	83.55	84.93	88.10	87.79	87.95	86.15	85.68	86.24
T ₄	32.23	32.29	32.26	93.71	91.98	92.85	96.34	95.60	95.97	97.32	97.30	97.34	94.13	95.76	95.05
T ₅	50.00	47.86	48.93	78.01	77.83	77.92	87.21	85.33	86.27	89.18	87.53	88.36	86.22	87.80	86.98
T ₆	15.55	28.72	22.14	82.19	81.60	81.90	96.07	95.95	96.01	97.32	97.27	97.30	95.66	97.08	96.35
T ₇	7.70	21.26	14.48	87.95	86.79	87.37	97.26	96.80	97.03	97.43	97.38	97.41	96.17	97.61	96.88
T ₈	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

SE_m (±): Standard Error of mean, CD: Critical Difference and DAS: Days after sowing

Treatments: T₁: Pyroxasulfone @ 120 g ha⁻¹ (PE) + Pendimethalin @ 850 g ha⁻¹ (PE), T₂: Pyroxasulfone @ 110 g ha⁻¹ (PE) + Pendimethalin @ 800 g ha⁻¹ (PE), T₃: Sulfosulfuron + Metsulfuron @ 40 g ha⁻¹ (PE), T₄: Two hand weeding (30 and 60 DAS), T₅: Sulfosulfuron + Metsulfuron @ 35 g ha⁻¹ (PoE), T₆: Clodinafop-propargyl @ 400 g ha⁻¹ (PoE) + one hand weeding (60 DAS), T₇: 2, 4-D Na @ 750 g ha⁻¹ (PoE) + one hand weeding (60 DAS) and T₈: Weedy check (Control).

4.1.4 Species-wise and total WCE (%)

The species wise and total WCE were recorded at monthly interval up to harvest.

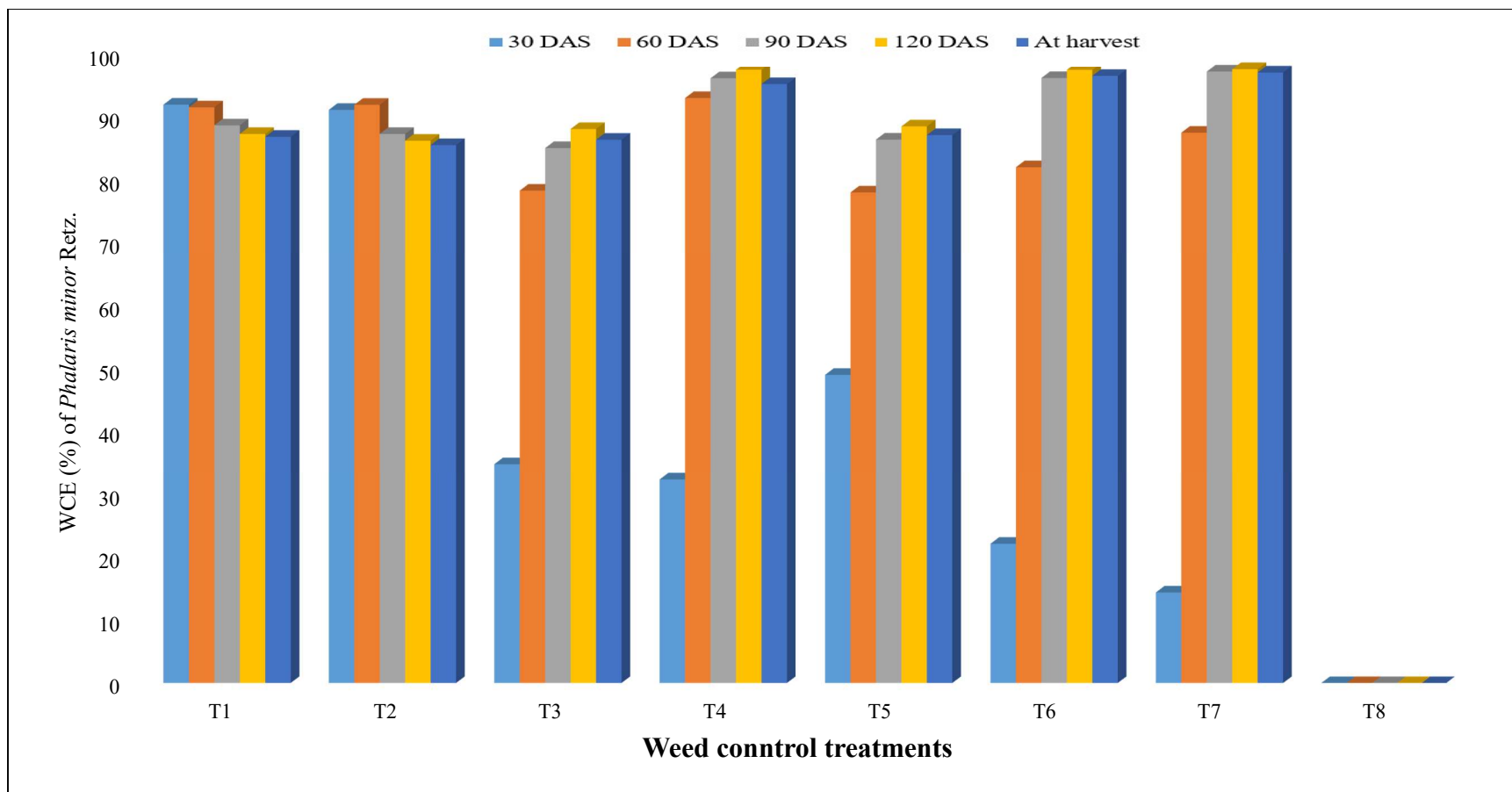
4.1.4.1 *Phalaris minor* Retz.

The data on WCE of *Phalaris minor* for the years 2020-2021 and 2021-2022 illustrates the impact of weed control treatments applied at monthly intervals till harvest, as shown in Table 4.19 and depicted in graph 4.17.

All herbicide control treatments significantly increase the WCE of *Phalaris minor* as compared to weedy check, according to data on the WCE of Table 4.19 of *Phalaris minor* Retz for the years 2020-2021 and 2021-2022. With the exception of the combinations of pyroxasulfone 120 g PE mixed with pendimethalin 850 g PE and pyrosulfone 110 g PE combined with pendimethalin 850 g PE, all treatments had a minimum WCE of 30 DAS of *Phalaris minor*. In both the sulfosulfuron combination with metsulfuron 35 g PoE and the sulfosulfuron combination with metsulfuron 40 g PoE, 60 DAS minimum WCE were reported. The highest WCE of *Phalaris minor* was seen in HW (30 and 60 DAS), and was succeeded by the combinations of pyroxasulfone 120 g PE mixed with pendimethalin 850 g PE and Pyroxasulfone 110 g PE combined with pendimethalin 800 g PE. At 90 DAS the minimum WCE were recorded in the use of sulfosulfuron combination with metsulfuron 35 g PoE and sulfosulfuron combination with metsulfuron 40 g PoE and maximum WCE of *Phalaris minor* PoE 2, 4-D Na 0.75 kg combination with HW (60 DAS) followed HW (30 and 60 DAS) and clodinafop propargyl 400 g PoE combination with HW (60 DAS). When using sulfosulfuron in combined with metsulfuron 40 g PoE and sulfosulfuron in combination with metsulfuron 35 g PoE, reduced WCE was seen at 120 days and harvest. PoE 2, 4-D Na 0.75 kg combination with HW (60 DAS) is the maximum; this combination is comparable to HW (30 and 60 DAS) over a weedy check. Kaur *et al.*, 2019 and Kaur and Kaur, 2019 reported findings that were quite comparable.

Total statistical data displayed for the years 2020-2021 and 2021-2022 The largest WCE of *Phalaris minor* were observed in PE treatment as compared to PoE treatments, as indicated by Table 4.19, which depicted graph 4.17 one month after planting. 60 Seconds

WCE was highest in HW (30 and 60 DAS), followed by pyroxasulfone 120 g PE combination with pendimethalin 850 g PE and pyroxasulfone 110 g PE combination with pendimethalin 800 g PE. Lower WCE were recorded in sulfosulfuron combination with metsulfuron 35 g PoE and sulfosulfuron combination with metsulfuron 40 g PoE. The next combination with the greatest WCE was clodinafop propargyl 400 g PoE combination with HW (60 DAS) and HW (twice at 90 DAS), which was noted in PoE 2, 4-D Na 0.75 kg combination with HW (60 DAS). Maximal WCE on *Phalaris minor* Retz. were seen in PoE 2, 4-D Na 0.75 kg combination with HW (60 DAS) and HW (30 and 60 DAS), and decreased in sulfosulfuron combination with metsulfuron 35 g PoE and sulfosulfuron combination with metsulfuron 40 g PoE as compared to a weedy check. These results were obtained at harvest time.



Graph 4.17 Influence of different herbicide treatments on weed control efficiency (%) of *Phalaris minor* in wheat (Pooled data of 2020-2021 and 2021-2022).

Table 4.20 Influence of different herbicide treatments on weed control efficiency (%) of *Cynodon dactylon* (L.) in wheat (2020-2021 and 2021-2022).

Treatment	30 DAS (2020-21)	30 DAS (2021-22)	Pool data	60 DAS (2020-21)	60 DAS (2021-22)	Pool data	90 DAS (2020-21)	90 DAS (2021-22)	Pool data	120 DAS (2020-21)	120 DAS (2021-22)	Pool data	Harvest (2020-21)	Harvest (2021-22)	Pool data
T ₁	85.00	86.34	85.67	90.81	91.33	91.07	89.26	88.94	89.10	84.04	84.19	84.12	82.43	82.19	82.31
T ₂	83.66	85.49	84.58	90.59	91.53	91.06	88.13	87.89	88.01	82.38	82.42	82.40	81.53	81.38	81.46
T ₃	38.33	42.25	40.29	76.29	77.33	76.81	72.82	75.78	74.30	71.90	72.28	72.09	69.36	69.55	69.46
T ₄	31.66	32.39	32.03	87.40	88.40	87.90	90.22	90.17	90.20	88.09	87.86	87.98	87.83	87.59	87.71
T ₅	41.66	39.44	40.55	78.51	80.27	79.39	74.57	74.72	74.65	70.00	70.51	70.26	68.01	68.17	68.09
T ₆	30.00	36.62	33.31	81.48	82.67	82.08	88.14	91.67	89.90	87.14	86.98	87.06	86.93	87.14	87.04
T ₇	23.33	30.99	27.16	83.70	84.67	84.19	90.96	90.72	90.84	89.04	89.12	89.08	88.73	88.44	88.59
T ₈	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

SE_m (±): Standard Error of mean, CD: Critical Difference and DAS: Days after sowing

Treatments: T₁: Pyroxasulfone @ 120 g ha⁻¹ (PE) + Pendimethalin @ 850 g ha⁻¹ (PE), T₂: Pyroxasulfone @ 110 g ha⁻¹ (PE) Pendimethalin @ 800 g ha⁻¹ (PE), T₃: Sulfosulfuron + Metsulfuron @ 40 g ha⁻¹ (PE), T₄: Two hand weeding (30 and 60 DAS), T₅: Sulfosulfuron + Metsulfuron @ 35 g ha⁻¹ (PoE), T₆: Clodinafop-propargyl @ 400 g ha⁻¹ (PoE) + one hand weeding (60 DAS), T₇: 2, 4-D Na @ 750 g ha⁻¹ (PoE) + one hand weeding (60 DAS) and T₈: Weedy check (Control).

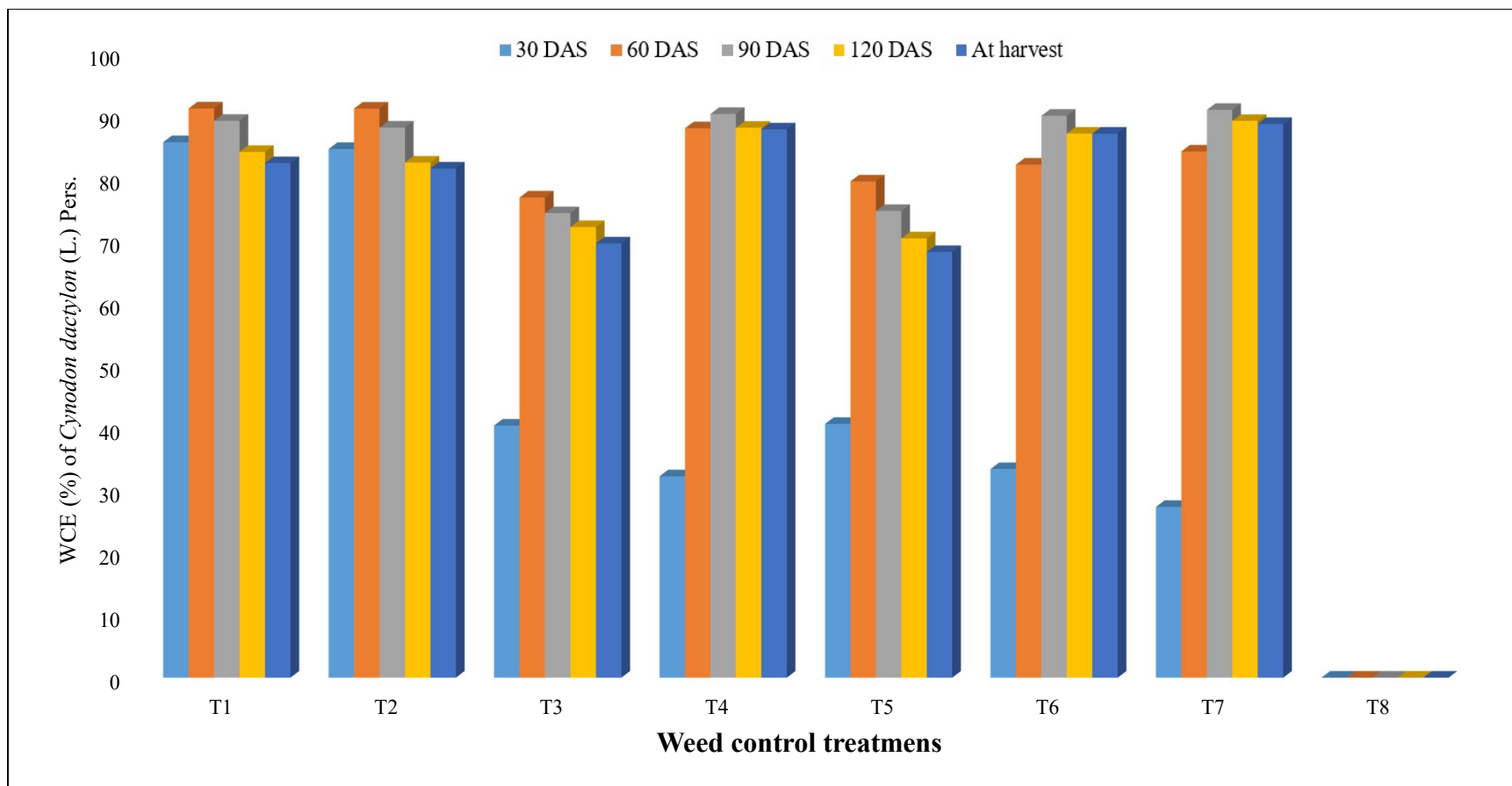
4.1.4.2 *Cynodon dactylon* L.

Data on the WCE of *Cynodon dactylon* L. in the years 2020-2021 and 2021-2022 are displayed in Table 4.19 and are depicted in graph 4.17. The data also reveals the impact of weed control treatments at monthly intervals till harvest.

Table 4.20 of *Cynodon dactylon* L. displays data on WCE for 2020-2021 and 2021-2022. All weed control treatments significantly increase *Cynodon dactylon* L. WCE over weedy check. 30 DAS minimal WCE of *Cynodon dactylon* L. was seen in all treatments, with the exception of the combinations of pyroxasulfone 110 g PE mixed with pendimethalin 800 g PE and pyroxasulfone 120 g PE combined with pendimethalin 850 g PE. For both the 40 g PoE and 35 g PoE combinations of sulfosulfuron and metsulfuron, a minimum WCE of 60 DAS was observed. The maximum WCE of *Cynodon dactylon* L. were recorded in pyroxasulfone 120 g PE combined with pendimethalin 850 g PE followed by pyroxasulfone 110 g PE combined with pendimethalin 850 g PE and HW (30 and 60 DAS). 90 DAS lower WCE were recorded in use of sulfosulfuron combined with metsulfuron 40 g PoE and sulfosulfuron combined with metsulfuron 35 g PoE maximum WCE of *Cynodon dactylon* L. 2, 4-D Na 750 g PoE combined with HW (60 DAS) followed by HW (30 and 60 DAS) and pyroxasulfone 120 g PE combined with pendimethalin 850 g PE. Tiwari *et al.* (2011) reported very comparable results. When using sulfosulfuron paired with metsulfuron 35 g PoE and sulfosulfuron mixed with metsulfuron 40 g PoE, harvest the least WCE was seen at 120 DAS. The highest concentration of PoE was found in combination with 4-D Na 0.75 kg and HW (60 DAS), which was followed by HW (60 DAS) and clodinafop propargyl 400 g PoE over a Weedy check.

When comparing PE treatments to POE treatments, cumulative data from the years 2020-2021 and 2021-2022 are displayed in Table 4.20 and graph 4.18 at the month after planting maximum WCE of *Cynodon dactylon* L. 60 DAS minimum WCE were found in 35 g PoE and 40 g PoE of sulfosulfuron combined with metsulfuron, and maximum WCE were found in 120 g PE of pyroxasulfone combined with pendimethalin 850 g PE and, pyroxasulfone 110 g PE combined with pendimethalin 800 g PE and HW (30 and 60 DAS). Maximum WCE of 90 DAS was recorded in PoE 2, 4-D Na 0.75 kg in combination with HW (60 DAS), and pyroxasulfone 120 g PE in combination with pendimethalin 850 g PE.

HW (30 and 60 DAS) was the next after them. The highest WCE of *Cynodon dactylon* L. was seen 120 days after growth and harvest in PoE 2, 4-D Na 0.75 kg coupled with HW (60 DAS) and HW (30 and 60 DAS), and significantly lower in sulfosulfuron combined with metsulfuron 35 g PoE and sulfosulfuron mixed with metsulfuron 40 g PoE over a weedy check.



Graph 4.18 Influence of different herbicide treatments on weed control efficiency (%) of *Cynodon dactylon* (L.) in wheat (Pooled data of 2020-2021 and 2021-2022).

Table 4.21 Influence of different herbicide treatments on weed control efficiency (%) of *Cyperus rotundus* L. in wheat (2020-2021 and 2021-2022).

Treatme nt	30 DAS (2020- 21)	30 DAS (2021- 22)	Pool data	60 DAS (2020- 21)	60 DAS (2021- 22)	Pool data	90 DAS (2020- 21)	90 DAS (2021- 22)	Pool data	120 DAS (2020- 21)	120 DAS (2021- 22)	Pool data	Harve st (2020- 21)	Harvest (2021- 22)	Pool data
T ₁	87.27	86.52	86.90	86.50	87.61	87.06	85.12	86.33	85.73	84.21	85.91	85.06	86.67	83.33	85.00
T ₂	86.36	83.91	85.14	86.00	86.99	86.50	84.22	85.68	84.95	82.89	84.83	83.86	81.85	82.03	81.94
T ₃	40.90	38.26	39.58	72.00	74.69	73.35	66.66	69.57	68.12	65.78	69.89	67.84	64.23	64.58	64.41
T ₄	27.30	26.52	26.91	91.10	91.59	91.35	89.02	89.93	89.48	88.55	89.55	89.05	87.78	89.88	88.89
T ₅	22.72	23.04	22.88	70.00	72.57	71.29	64.63	68.35	66.49	64.07	68.75	66.41	63.57	63.40	63.49
T ₆	36.36	36.96	36.66	77.00	79.03	78.02	88.61	88.78	88.70	88.15	89.15	88.65	87.70	88.27	88.44
T ₇	31.80	33.48	32.64	79.00	78.05	78.53	90.24	90.58	90.41	89.73	90.91	90.32	89.07	88.89	88.98
T ₈	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

SE_m (±): Standard Error of mean, CD: Critical Difference and DAS: Days after sowing

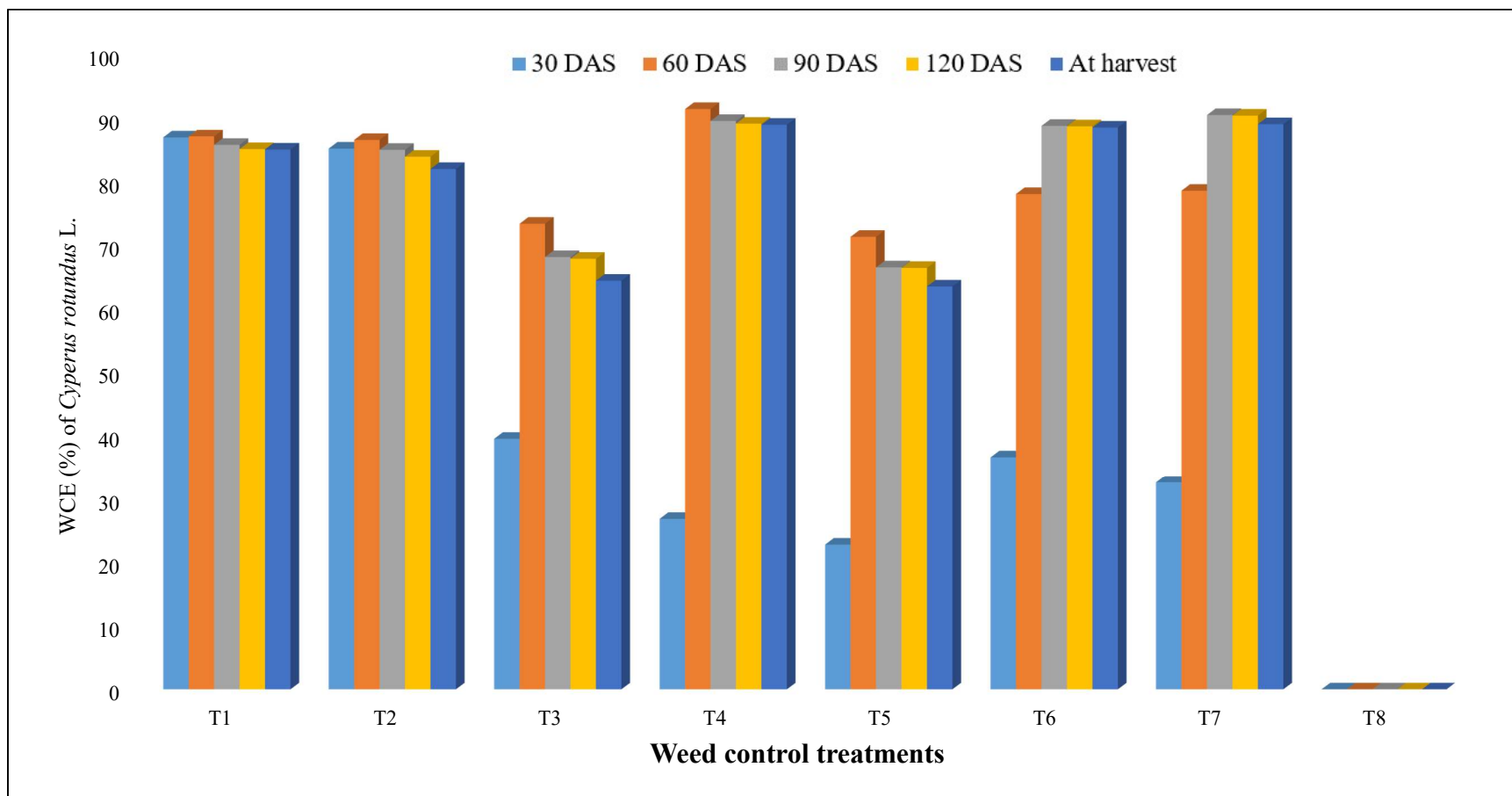
Treatments: T₁: Pyroxasulfone @ 120 g ha⁻¹ (PE) + Pendimethalin @ 850 g ha⁻¹ (PE), T₂: Pyroxasulfone @ 110 g ha⁻¹ (PE) Pendimethalin @ 800 g ha⁻¹ (PE), T₃: Sulfosulfuron + Metsulfuron @ 40 g ha⁻¹ (PE), T₄: Two hand weeding (30 and 60 DAS), T₅: Sulfosulfuron + Metsulfuron @ 35 g ha⁻¹ (PoE), T₆: Clodinafop-propargyl @ 400 g ha⁻¹ (PoE) + one hand weeding (60 DAS), T₇: 2, 4-D Na @ 750 g ha⁻¹ (PoE) + one hand weeding (60 DAS) and T₈: Weedy check (Control).

4.1.4.3 *Cyperus rotundus* L.

Data on WCE of *Cyperus rotundus* L. for the years 2020-2021 and 2021-2022 are displayed in Table 4.21 and are depicted in graph 4.19. The data also reveals the impact of weed control treatments at monthly intervals till harvest.

Data from 2020-2021 and 2021-2022 on *Cyperus rotundus* L. WCE in Table 4.21 demonstrate that, in comparison to Weedy check, all weed management techniques significantly increase WCE. WCE was at 30 DAS lower in all treatments with the exception of pyroxasulfone 120 g PE combined with 850 g PE and pyroxasulfone 110 g PE combined with 800 g PE pendimethalin. Sulfosulfuron paired with metsulfuron 35 g PoE and sulfosulfuron mixed with metsulfuron 40 g PoE showed 60 DAS reduced WCE. The maximum WCE of *Cyperus rotundus* L. were seen in HW (30 and 60 DAS), which were followed by the combinations of pyroxasulfone 110 g PE and pendimethalin 800 g and pyroxasulfone 120 g PE. 90 DAS maximum WCE of 2, 4-D Na 750 g PoE combined with HW (60 DAS) and HW (30 and 60 DAS) and lower in sulfosulfuron combined with metsulfuron 40 g PoE and sulfosulfuron combined with metsulfuron 35 g PoE. 120 DAS and harvest lower WCE were recorded use of sulfosulfuron combined with metsulfuron 35 g PoE and sulfosulfuron combined with metsulfuron 40 g PoE. Maximum in PoE 2, 4- D Na 0.750 kg combined with HW (60 DAS) followed by HW (60 DAS) and clodinafop propargyl 400 g PoE combined with HW (60 DAS) compared to weedy check.

Cumulative data for the years 2020-2021 and 2021-2022 on Table 4.21 is displayed in graph 4.19 one month after *Cyperus rotundus* L. sowing, with higher WCE in PE treatments than in PoE treatments. Maximum WCE was seen in HW (60 DAS), followed by pyroxasulfone 120 g PE mixed with pendimethalin 850 g PE. Minimum WCE were observed in sulfosulfuron combined with metsulfuron 35 g PoE and sulfosulfuron combined with metsulfuron 40 g PoE. Maximum WCE of 90 DAS were observed in 2, 4-D Na 750 g PoE in combination with HW (60 DAS), then HW (30 and 60 DAS). *Cyperus rotundus* L. severe WCE was seen at 120 days after cultivation and harvest in pyroxasulfone 120 g PE mixed with pendimethalin 850 g PE, 2, 4-D Na 750 g PoE combined with HW (60 DAS), and HW (30 and 60 DAS). Comparable to the Weedy check.



Graph 4.19 Influence of different herbicide treatments on weed control efficiency (%) of *Cyperus rotundus* L. in wheat (Pooled data of 2020-2021 and 2021-2022)

Table 4.22 Influence of different herbicide treatments on weed control efficiency (%) of *Cannabis sativa* L. in wheat (2020-2021 and 2021-2022).

Treatment	30 DAS (2020- 21)	30 DAS (2021- 22)	Pool data	60 DAS (2020- 21)	60 DAS (2021- 22)	Pool data	90 DAS (2020- 21)	90 DAS (2021- 22)	Pool data	120 DAS (2020- 21)	120 DAS (2021- 22)	Pool data	Harve st (2020- 21)	Harvest (2021- 22)	Pool data
T ₁	86.66	81.76	84.21	86.55	85.90	86.23	84.57	83.43	84.00	83.33	76.81	80.07	71.43	67.63	69.53
T ₂	85.33	78.24	81.79	85.17	83.65	84.41	83.42	81.49	82.46	81.66	76.53	79.10	70.24	66.05	68.15
T ₃	40.00	41.76	40.88	67.24	68.27	67.76	78.28	77.62	77.95	76.66	79.03	77.85	76.76	72.37	74.07
T ₄	33.33	27.65	30.49	87.93	86.86	87.40	86.85	85.91	86.38	85.50	86.67	86.09	84.62	86.63	85.63
T ₅	36.00	41.18	38.59	65.51	60.90	63.21	76.57	75.14	75.86	73.33	75.56	74.45	76.19	68.42	72.31
T ₆	34.00	40.00	37.00	73.10	74.04	73.57	86.28	84.25	85.27	84.66	86.25	85.46	80.95	85.66	83.31
T ₇	20.00	22.35	21.18	79.65	79.17	79.41	87.14	85.36	86.25	86.33	87.36	86.85	87.86	85.79	86.82
T ₈	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

SE_m (±): Standard Error of mean, CD: Critical Difference and DAS: Days after sowing

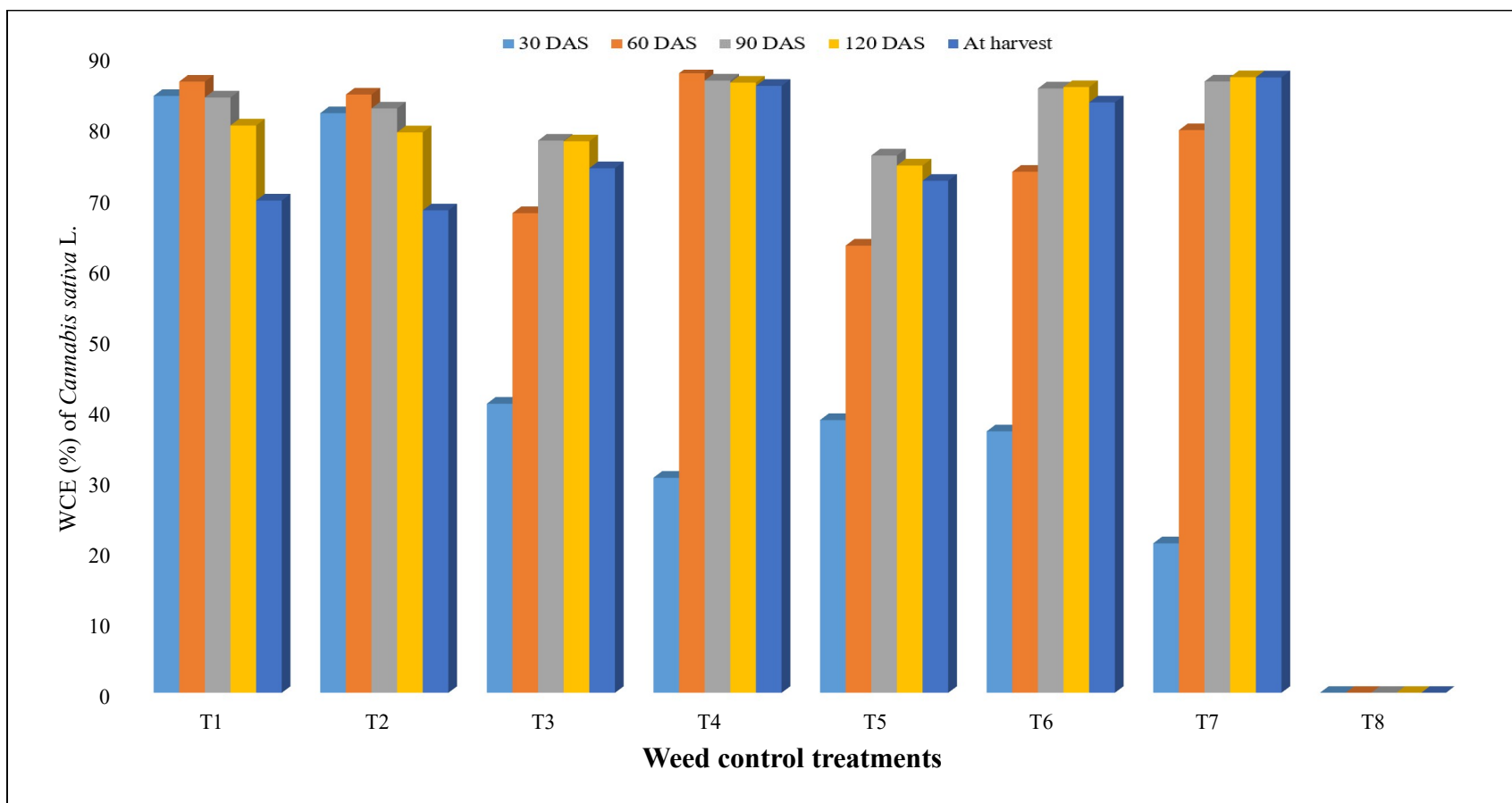
Treatments: T₁: Pyroxasulfone @ 120 g ha⁻¹ (PE) + Pendimethalin @ 850 g ha⁻¹ (PE), T₂: Pyroxasulfone @ 110 g ha⁻¹ (PE) + Pendimethalin @ 800 g ha⁻¹ (PE), T₃: Sulfosulfuron + Metsulfuron @ 40 g ha⁻¹ (PE), T₄: Two hand weeding (30 and 60 DAS), T₅: Sulfosulfuron + Metsulfuron @ 35 g ha⁻¹ (PoE), T₆: Clodinafop-propargyl @ 400 g ha⁻¹ (PoE) + one hand weeding (60 DAS), T₇: 2, 4-D Na @ 750 g ha⁻¹ (PoE) + one hand weeding (60 DAS) and T₈: Weedy check (Control).

4.1.4.4 *Cannabis sativa* L.

Data on the WCE of *Cannabis sativa* L. in the years 2020-2021 and 2021-2022 are displayed in Table 4.22 and are depicted in graph 4.20 at monthly intervals till harvest.

Data on the WCE of *Cannabis sativa* L. from 2020-2021 and 2021-2022 in Table 4.22 demonstrate that weed control treatments significantly increase WCE of *Cannabis sativa* L. in comparison to the weedy check. With the exception of pyroxasulfone 120 g PE paired with pendimethalin 850 g PE and pyroxasulfone 110 g PE mixed with pendimethalin 800 g PE, all treatments had a 30 DAS maximum WCE of *Cannabis sativa* L. At 60 DAS minimum WCE were recorded in sulfosulfuron combined with metsulfuron 35 g PoE followed by sulfosulfuron combined with metsulfuron 40 g PoE and clodinafop-propargyl 400 g PoE combined with HW (60 DAS). The maximum WCE of *Cannabis sativa* L. were noted in HW (30 and 60 DAS) followed by pyroxasulfone 120 g PE combined with pendimethalin 850 g PE and pyroxasulfone 110 g PE combined with pendimethalin 800 g PE. 90 DAS minimum WCE were noted in the use of sulfosulfuron combined with metsulfuron 35 g PoE and sulfosulfuron combined with metsulfuron 40 g PoE and maximum WCE of *Cannabis sativa* L. PoE 2, 4- D Na 0.75 kg combined with HW (60 DAS) followed HW (30 and 60 DAS) and clodinafop- propargyl 400 g PoE combined with HW (60 DAS). The lowest WCE was seen while using 35 g of sulfuron and metsulfuron at harvest time (120 DAS), followed by 40 g of sulfosulfuron n and metsulfuron. The maximum in 2, 4-D Na 0.750 g PoE combined with HW (60 DAS) was similar to the weedy check, and was followed by HW (30 and 60 DAS) and clodinafop propargyl 400 g PoE combined with HW (60 DAS). Tiwar *et al.* 2011 and Dixit *et al.* 2014 obtained very similar results.

The largest WCE of *Cannabis sativa* L. was reported in the PE treatment as opposed to the PoE treatments one month after planting WCE decreased by 60 DAS in sulfosulfuron plus metsulfuron 35 g PoE and sulfosulfuron plus metsulfuron 40 g PoE. The reduction in WCE peaked in HW (30 and 60 DAS) after pyroxasulfone 120 g PE combined with pendimethalin 850 g PE and pyroxasulfone 110 g PE combined with pendimethalin 800 g PE. HW (30 and 60 DAS) recorded the highest dry weight of weeds at 90 DAS and 120 DAS.



Graph 4.20 Influence of different herbicide treatments on weed control efficiency (%) of *Cannabis sativa* L. in wheat (Pooled data of 2020-2021 and 2021-2022).

Table 4.23 Influence of different herbicide treatments on weed control efficiency (%) of *Chenopodium album* L. in wheat (2020-2021 and 2021-2022).

Treatment	30 DAS (2020- 21)	30 DAS (2021- 22)	Pool data	60 DAS (2020- 21)	60 DAS (2021- 22)	Pool data	90 DAS (2020- 21)	90 DAS (2021- 22)	Pool data	120 DAS (2020- 21)	120 DAS (2021- 22)	Pool data	Harve st (2020- 21)	Harvest (2021- 22)	Pool data
T ₁	88.00	90.13	89.07	88.60	89.27	88.94	86.81	88.40	87.61	84.44	87.33	85.89	83.81	86.61	85.21
T ₂	87.09	88.96	88.03	86.04	86.56	86.30	85.63	87.71	86.67	82.96	86.42	84.69	83.33	85.83	84.58
T ₃	41.81	57.14	49.48	75.58	76.35	75.97	75.45	78.85	77.15	74.81	80.00	77.41	73.33	79.53	76.43
T ₄	30.90	49.22	40.06	90.11	90.21	90.16	89.90	92.37	91.14	87.40	89.26	88.33	87.14	88.98	88.06
T ₅	14.54	37.14	25.84	71.27	73.13	72.20	70.90	74.27	72.59	70.81	77.16	73.99	70.48	76.59	73.54
T ₆	23.63	43.90	33.77	83.60	84.27	83.94	86.72	88.24	87.48	85.18	82.56	83.87	83.81	81.10	82.46
T ₇	12.72	39.22	25.97	84.88	85.52	85.20	90.90	91.68	91.29	88.88	90.57	89.73	88.57	90.16	89.36
T ₈	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

SE_m (±): Standard Error of mean, CD: Critical Difference and DAS: Days after sowing

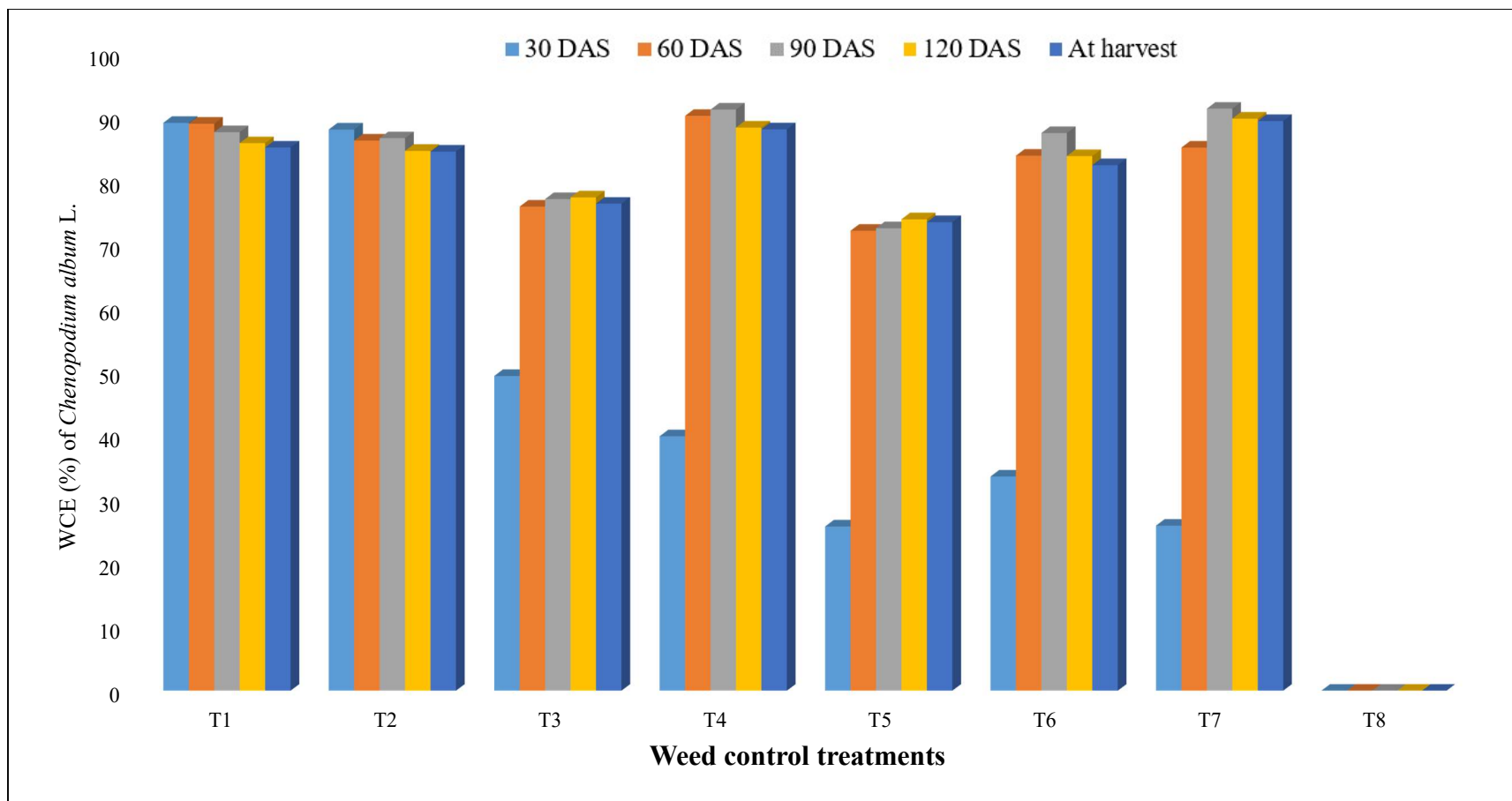
Treatments: T₁: Pyroxasulfone @ 120 g ha⁻¹ (PE) + Pendimethalin @ 850 g ha⁻¹ (PE), T₂: Pyroxasulfone @ 110 g ha⁻¹ (PE) + Pendimethalin @ 800 g ha⁻¹ (PE), T₃: Sulfosulfuron + Metsulfuron @ 40 g ha⁻¹ (PE), T₄: Two hand weeding (30 and 60 DAS), T₅: Sulfosulfuron + Metsulfuron @ 35 g ha⁻¹ (PoE), T₆: Clodinafop-propargyl @ 400 g ha⁻¹ (PoE) + one hand weeding (60 DAS), T₇: 2, 4-D Na @ 750 g ha⁻¹ (PoE) + one hand weeding (60 DAS) and T₈: Weedy check (Control).

4.1.4.5 *Chenopodium album* L.

Data on the WCE of *Chenopodium album* L. in the years 2020-2021 and 2021-2022 are displayed in Table 4.23 and are depicted in graph 4.21 at monthly intervals till harvest.

The WCE of Table 4.23 of *Chenopodium album* L. for the years 2020-2021 and 2021-2022 indicates that weed control treatments significantly increase the WCE of *Chenopodium album* L. in comparison to weedy check. 30 DAS WCE of *Chenopodium album* L. were seen in all treatments, with the exception of the combinations of pyroxasulfone 120 g PE and pendimethalin 850 g PE. Sulfosulfuron coupled with metsulfuron 35 g PoE, sulfosulfuron combined with metsulfuron 40 g PoE and clodinafop-propargyl 400 g PoE paired with HW (60 DAS) were the combinations with the lowest minimum WCE. The maximum WCE of *Chenopodium album* L. were noted in HW (30 and 60 DAS) after pyroxasulfone 120 g PE combined with pendimethalin 850 g PE and pyroxasulfone 110 g PE combined with pendimethalin 800 g PoE. 90 DAS lower WCE were recorded in use of sulfosulfuron combined with metsulfuron 35 g PoE and sulfosulfuron combined with metsulfuron 40 g PoE and the maximum WCE of *Chenopodium album* L. 2, 4-D Na 750 g PoE combined with HW (60 DAS) followed HW (60 DAS) and pyroxasulfone 120 g PE combined with pendimethalin 850 g PE. Sulfosulfuron paired with metsulfuron 35 g PoE and sulfosulfuron mixed with metsulfuron 40 g PoE were shown to have the lowest WCE at 120 DAS and harvest. Clodinafop-propargyl 400 g PoE combined with HW (60 DAS) over weedy check was the greatest in PoE 2, 4-D Na 0.75 kg combined with HW (60 DAS), followed by HW (60 DAS). Kaur & Kaur, 2019 and Dixit *et al.* 2014 both reported similar results.

At 30 and 60 DAS minimum WCE and maximum HW were observed in sulfosulfuron combined with metsulfuron 35 g PoE and sulfosulfuron combined with metsulfuron 40 g PoE. Pyroxasulfone 120 g PE combined with pendimethalin 850 g PE and pyroxasulfone 110 g PE combined with pendimethalin 800 g PE were the next highest WCE and HW values. At 90 DAS and at harvest maximum WCE were measured in 2, 4-D Na 0.750 g PoE together with HW (60 DAS) over a weedy check.



Graph 4.21 Influence of different herbicide treatments on weed control efficiency (%) of *Chenopodium album* L. in wheat (Pooled data of 2020-2021 and 2021-2022).

Table 4.24 Influence of different herbicide treatments on weed control efficiency (%) of *Medicago denticulate* Willd. in wheat (2020-2021 and 2021-2022).

Treatment	30 DAS (2020- 21)	30 DAS (2021- 22)	Pool data	60 DAS (2020- 21)	60 DAS (2021- 22)	Pool data	90 DAS (2020- 21)	90 DAS (2021- 22)	Pool data	120 DAS (2020- 21)	120 DAS (2021- 22)	Pool data	Harve st (2020- 21)	Harvest (2021- 22)	Pool data
T ₁	86.81	85.22	86.02	86.06	85.14	85.60	84.56	85.61	85.09	83.83	86.84	85.34	80.55	80.14	80.35
T ₂	86.36	83.04	84.70	85.15	83.43	84.29	83.26	84.39	83.83	82.50	85.39	83.95	79.30	79.05	79.18
T ₃	19.00	20.00	19.50	80.60	78.29	79.45	80.46	82.63	81.55	80.00	83.82	81.91	79.30	79.46	79.38
T ₄	25.00	26.09	25.55	89.39	87.43	88.41	88.04	89.47	88.76	87.33	89.47	88.40	86.52	86.49	86.51
T ₅	31.80	31.74	31.77	79.39	77.43	78.41	78.26	79.12	78.69	75.00	78.29	76.65	73.75	73.78	73.77
T ₆	13.63	13.48	13.56	73.63	73.14	73.39	86.30	87.72	87.01	84.83	86.97	85.90	82.08	82.16	82.12
T ₇	17.24	22.61	19.93	74.54	73.71	74.13	90.43	91.23	90.83	88.00	88.95	88.48	87.36	86.62	86.99
T ₈	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

SE m (±): Standard Error of mean, CD: Critical Difference and DAS: Days after sowing

Treatments: T₁: Pyroxasulfone @ 120 g ha⁻¹ (PE) + Pendimethalin @ 850 g ha⁻¹ (PE), T₂: Pyroxasulfone @ 110 g ha⁻¹ (PE) + Pendimethalin @ 800 g ha⁻¹ (PE), T₃: Sulfosulfuron + Metsulfuron @ 40 g ha⁻¹ (PE), T₄: Two hand weeding (30 and 60 DAS), T₅: Sulfosulfuron + Metsulfuron @ 35 g ha⁻¹ (PoE), T₆: Clodinafop-propargyl @ 400 g ha⁻¹ (PoE) + one hand weeding (60 DAS), T₇: 2, 4-D Na @ 750 g ha⁻¹ (PoE) + one hand weeding (60 DAS) and T₈: Weedy check (Control).

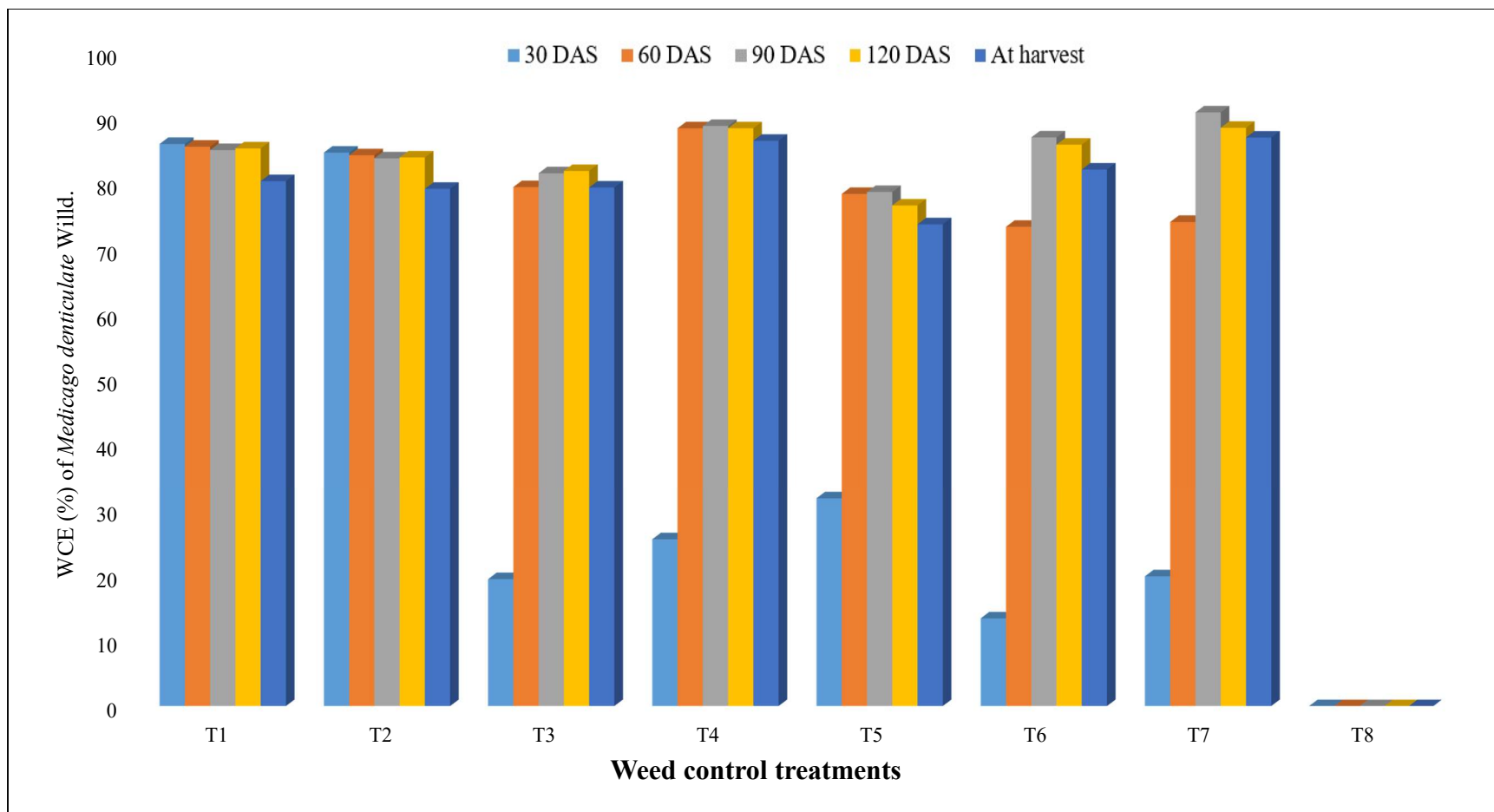
4.1.4.6 *Medicago denticulate* Willd.

Data on the WCE of *Medicago denticulate* in the years 2020-2021 and 2021-2022 are displayed in Table 4.24 and are depicted in graph 4.22 at monthly intervals till harvest.

Data for WCE in 2020-2021 and 2021-2022 *Medicago denticulate* Table 4.24 demonstrates that weed control treatments significantly increase *Medicago denticulate* Willd. WCE over weedy check. For all treatments, with the exception of pyroxasulfone 120 g PE combined with pendimethalin 850 g PE and pyroxasulfone 110 g PE combined with pendimethalin 800 g PE, the highest WCE of *Medicago denticulate* Willd was 30 DAS. In clodinafop-propargyl 400 g PoE combined with HW (60 DAS) after PoE 2, 4-D Na 0.75 kg mixed with HW (60 DAS), a minimum WCE of 60 DAS was observed. Pyroxasulfone 120 g PE combined with pendimethalin 850 g PE and pyroxasulfone 110 g PE mixed with pendimethalin 800 g PE were the next highest WCE of *Medicago denticulate* Willd in HW (30 and 60 DAS). When using sulfosulfuron in combination with metsulfuron 35 g PoE and sulfosulfuron 40 g PoE, as well as the supreme count of *Medicago denticulate* Willd, 90 DAS minimum WCE were observed. Clodinafop-propargyl 400 g PoE combined with HW (60 DAS) and 2, 4-D Na 750 g PoE mixed with HW (60 DAS) were administered after HW (30 and 60 DAS). Kaur and Kaur, 2019 and Bhoir *et al.*, 2016 both published findings that were comparable. At 120 DAS and harvest minimum WCE were noted in use of sulfosulfuron combined with metsulfuron 35 g PoE and sulfosulfuron combined with metsulfuron 40 g PoE. The maximum in PoE 2, 4- D Na 0.75 kg combined with HW (60 DAS) followed by HW (60 DAS) and clodinafop-propargyl 400 g PoE combined with HW (60 DAS) over weedy check.

Cumulative data shown in the years 2020-2021 and 2021-2022 Table 4.24 represented graph 4.22 at month later seeding maximum WCE of *Medicago denticulate* Willd were recorded in PE treatment as compared to PoE treatments. 60 DAS minimum WCE were recorded in clodinafop- propargyl 400 g PoE combined with HW (60 DAS) followed by PoE 2, 4- D Na 0.75 kg combined with HW (60 DAS) and sulfosulfuron combined with metsulfuron 35 g PoE and in maximum HW (60 DAS) followed by pyroxasulfone 120 g PE combined with pendimethalin 850 g PE and pyroxasulfone 110 g PE combined with pendimethalin 800 g PE. At 90 DAS higher WCE sulfosulfuron coupled

with metsulfuron 35 g PoE and sulfosulfuron combined with metsulfuron 40 g PoE had the lowest WCE at 90 DAS, followed by HW (30 and 60 DAS) and clodinafop propargyl 400 g PoE mixed with HW (60 DAS). The highest WCE of *Medicago denticulate* Willd was harvested at 120 DAS and reported in PoE 2, 4-D Na 0.75 kg mixed with HW (60 DAS), clodinafop-propargyl 400 g PoE combined with HW (60 DAS), and HW (60 DAS). Reduced in 35 g PoE of sulfosulfuron in combination with metsulfuron and 40 g PoE in combination with a weedy check.



Graph 4.22 Influence of different herbicide treatments on weed control efficiency (%) of *Medicago denticulate* Willd. in wheat (Pooled data of 2020-2021 and 2021-2022).

Table 4.25 Influence of different herbicide treatments on weed control efficiency (%) of *Parthenium hysterophorus* L. in wheat (2020-2021 and 2021-2022).

Treatment	30 DAS (2020- 21)	30 DAS (2021- 22)	Pool data	60 DAS (2020- 21)	60 DAS (2021- 22)	Pool data	90 DAS (2020- 21)	90 DAS (2021- 22)	Pool data	120 DAS (2020- 21)	120 DAS (2021- 22)	Pool data	Harvest (2020- 21)	Harvest (2021- 22)	Pool data
T ₁	87.22	85.00	86.11	87.14	86.49	86.82	86.38	85.71	86.05	85.16	85.00	85.08	84.87	84.74	84.81
T ₂	86.11	83.00	84.56	85.71	83.51	84.61	85.53	84.49	85.01	84.3	84.53	84.42	84.02	83.77	83.90
T ₃	26.60	29.50	28.05	77.14	77.30	77.22	76.38	74.69	75.54	76.00	76.72	76.36	75.85	74.76	75.31
T ₄	22.22	25.00	23.61	89.14	89.19	89.17	87.44	86.73	87.09	86.00	85.78	85.89	85.36	85.10	85.23
T ₅	18.33	21.50	19.92	75.14	75.41	75.28	73.82	73.88	73.85	71.83	72.97	72.40	79.02	68.75	73.89
T ₆	11.11	16.00	13.56	77.71	76.22	76.97	86.38	85.31	85.85	85.00	85.16	85.08	84.26	84.25	84.26
T ₇	30.00	34.00	32.00	78.85	78.38	78.62	88.93	87.76	88.35	86.83	87.19	87.01	86.34	86.06	86.20
T ₈	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

SE m (±): Standard Error of mean, CD: Critical Difference and DAS: Days after sowing

Treatments: T₁: Pyroxasulfone @ 120 g ha⁻¹ (PE) + Pendimethalin @ 850 g ha⁻¹ (PE), T₂: Pyroxasulfone @ 110 g ha⁻¹ (PE) + Pendimethalin @ 800 g ha⁻¹ (PE), T₃: Sulfosulfuron + Metsulfuron @ 40 g ha⁻¹ (PE), T₄: Two hand weeding (30 and 60 DAS), T₅: Sulfosulfuron + Metsulfuron @ 35 g ha⁻¹ (PoE), T₆: Clodinafop-propargyl @ 400 g ha⁻¹ (PoE) + one hand weeding (60 DAS), T₇: 2, 4-D Na @ 750 g ha⁻¹ (PoE) + one hand weeding (60 DAS) and T₈: Weedy check (Control).

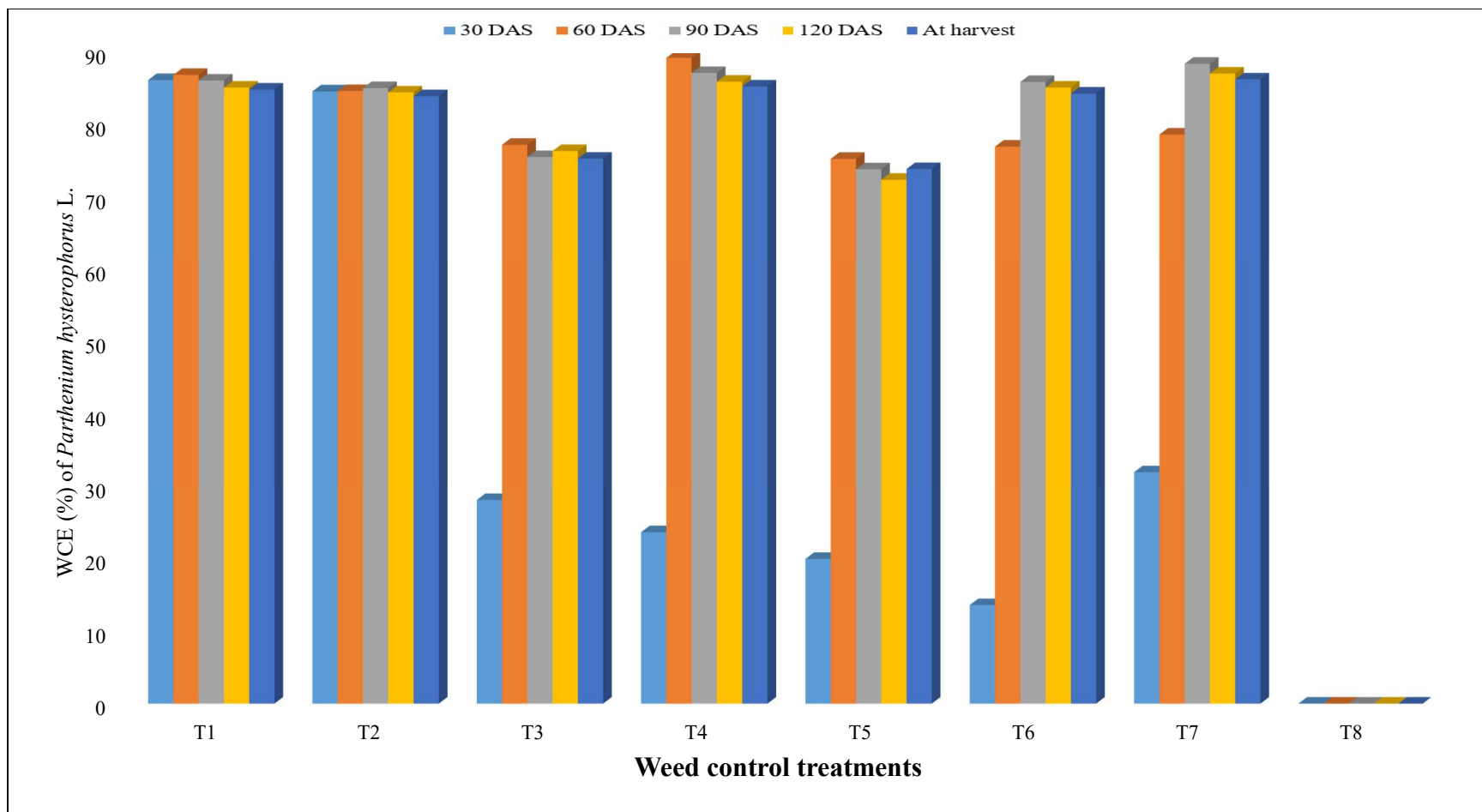
4.1.4.7 *Parthenium hysterophorus* L.

Data on WCE of *Medicago denticulate* in the years 2020-2021 and 2021-2022 are displayed in Table 4.25 and are depicted in graph 4.23. The influence of weed control treatments at monthly intervals up to harvest is also indicated.

Table 4.25 of *Parthenium hysterophorus* L. displays data on WCE for the years 2020-2021 and 2021-2022, which indicates that weed control treatments increase *Parthenium hysterophorus* L. WCE in comparison to weedy check. With the exception of pyroxasulfone 120 g PE paired with pendimethalin 850 g PE and pyroxasulfone 110 g PE mixed with pendimethalin 800 g PE, all treatments had a 30 DAS maximum WCE of *Parthenium hysterophorus* L. Sulfosulfuron coupled with metsulfuron 35 g PoE, sulfosulfuron combined with metsulfuron 40 g PoE, and clodinafop-propargyl 400 g PoE paired with HW (60 DAS) were the combinations with the lowest minimum WCE reported. Maximum WCE of *Parthenium hysterophorus* L. were recorded in HW (30 and 60 DAS) after pyroxasulfone 120 g PE combined with pendimethalin 850 g PE and pyroxasulfone 110 g PE combined with pendimethalin 800 g PE. 90 DAS minimum WCE were recorded in use of sulfosulfuron combined with metsulfuron 35 g PoE and sulfosulfuron combined with metsulfuron 40 g PoE and maximum WCE of *Parthenium hysterophorus* L. PoE 2, 4-D Na 0.75 kg combined with HW (60 DAS) followed HW (30 and 60 DAS) and clodinafop-propargyl 400 g PoE combined with HW (60 DAS). The utilization of sulfurfuron combined with metsulfuron 35 g PoE and sulfurfuron mixed with metsulfuron 40 g PoE was seen at 120 DAS and harvest minimal WCE. At the maximum in PoE 2, 4-D Na 0.75 kg in combination with HW (60 DAS) and HW (30 and 60 DAS), as well as 120 g PE of pyroxasulfone in combination with 850 g PE of pendimethalin over weedy check.

Cumulative data shown in the year 2020-2021 and 2021-2022 shown in Table 4.25 represented in graph 4.23 on 30 DAS highest WCE of *Parthenium hysterophorus* L. were recorded in PE treatment as compared to PoE treatments. 60 DAS minimum WCE were recorded in sulfosulfuron combined with metsulfuron 35 g PoE and sulfosulfuron combined with metsulfuron 40 g PoE and in maximum HW (60 DAS) followed by pyroxasulfone 120 g PE combined with pendimethalin 850 g PE and pyroxasulfone 110 g

PE combined with pendimethalin 800 g PE. Maximum WCE were found in PoE 2, 4-D Na 0.75 kg in combination with HW (60 DAS) at 90 DAS. HW (30 and 60 DAS) and pyroxasulfone were next in line reduced WCE. Pyroxasulfone was used to record the highest WCE of *Parthenium hysterophorus* L. at 120 DAS. In comparison to the weedy check, there was a minimum in sulfosulfuron combined with metsulfuron 35 g PoE and sulfosulfuron combined with metsulfuron 40 g PoE. PoE 2, 4-D Na 0.75 kg combined with HW (60 DAS) and HW (30 and 60 DAS) were the next highest levels.



Graph 4.23 Influence of different herbicide treatments on weed control efficiency (%) of *Parthenium hysterophorus* L. in wheat (Pooled data of 2020-2021 and 2021-2022).

Table 4.26 Influence of different herbicide treatments on weed control efficiency (%) of total weed population in wheat (2020-2021 and 2021-2022).

Treatment	30 DAS (2020- 21)	30 DAS (2021- 22)	Pool data	60 DAS (2020- 21)	60 DAS (2021- 22)	Pool data	90 DAS (2020- 21)	90 DAS (2021- 22)	Pool data	120 DAS (2020- 21)	120 DAS (2021- 22)	Pool data	Harve st (2020- 21)	Harve st (2021- 22)	Pool data
T ₁	88.43	88.25	88.34	90.83	89.17	90.00	89.17	89.51	89.34	85.37	85.57	85.47	84.00	85.30	84.65
T ₂	87.47	87.02	87.25	88.71	89.02	88.87	81.92	86.29	84.11	84.15	84.36	84.26	82.83	84.98	83.91
T ₃	46.36	40.92	43.64	64.38	65.13	64.76	70.70	66.95	68.83	78.08	77.66	77.87	76.49	76.97	76.73
T ₄	30.31	36.62	33.47	90.60	90.21	90.41	82.14	80.66	81.40	91.02	91.41	91.22	89.91	90.17	90.04
T ₅	35.00	38.77	36.89	62.31	75.96	69.14	79.08	76.74	77.91	76.70	77.84	77.27	71.00	75.71	73.36
T ₆	22.37	33.23	27.80	55.84	80.71	68.28	81.85	81.40	81.63	90.38	89.86	90.12	88.64	89.07	88.86
T ₇	26.73	29.54	28.14	71.93	83.23	77.58	93.21	92.17	92.69	91.74	92.10	91.92	90.69	90.02	90.36
T ₈	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

SE_m (±): Standard Error of mean, CD: Critical Difference and DAS: Days after sowing

Treatments: T₁: Pyroxasulfone @ 120 g ha⁻¹ (PE) + Pendimethalin @ 850 g ha⁻¹ (PE), T₂: Pyroxasulfone @ 110 g ha⁻¹ (PE) Pendimethalin @ 800 g ha⁻¹ (PE), T₃: Sulfosulfuron + Metsulfuron @ 40 g ha⁻¹ (PE), T₄: Two hand weeding (30 and 60 DAS), T₅: Sulfosulfuron + Metsulfuron @ 35 g ha⁻¹ (PoE), T₆: Clodinafop-propargyl @ 400 g ha⁻¹ (PoE) + one hand weeding (60 DAS), T₇: 2, 4-D Na @ 750 g ha⁻¹ (PoE) + one hand weeding (60 DAS) and T₈: Weedy check (Control).

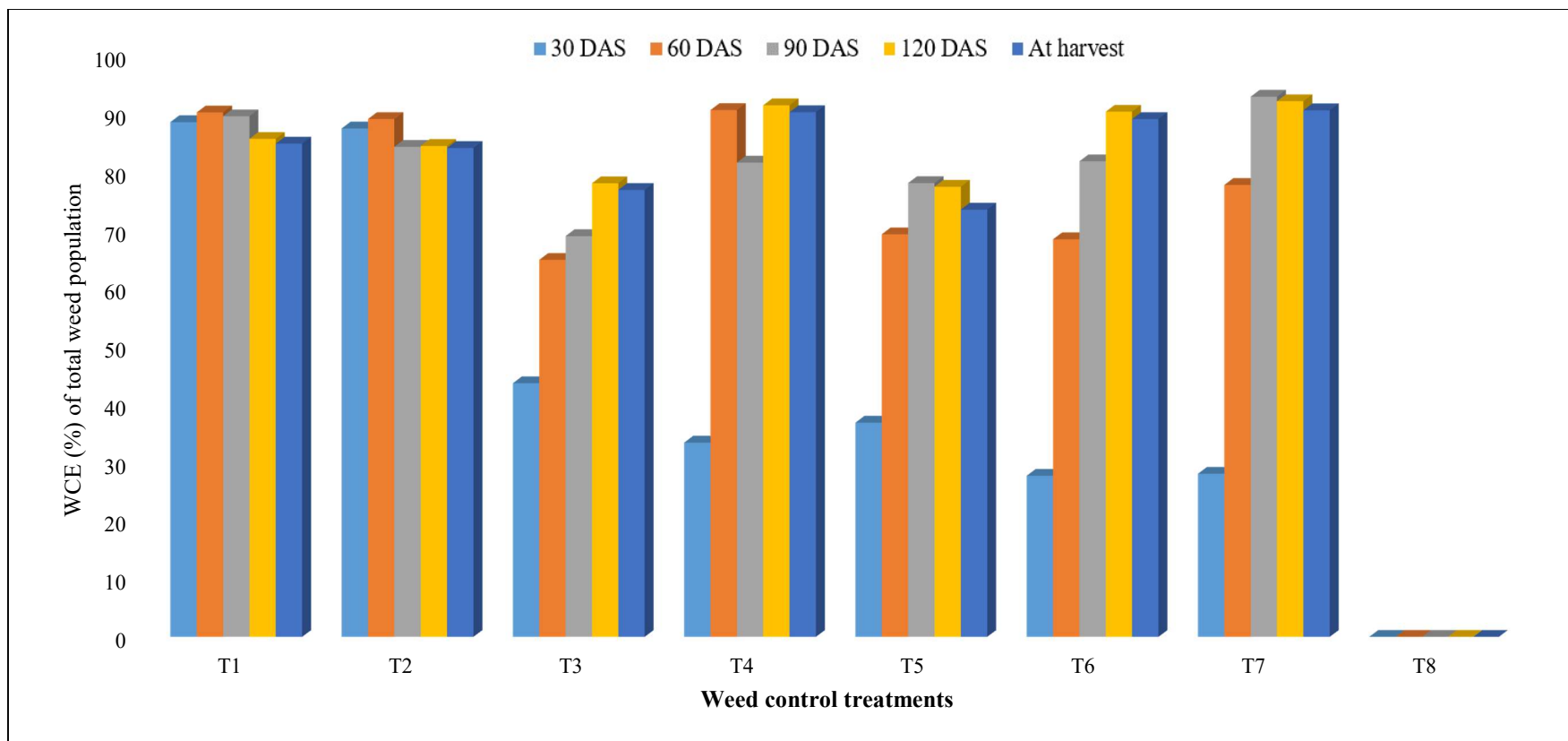
4.1.4.8 WCE of total weed population

Data on WCE of total weed population effect of weed management measures at monthly up to harvest for the years 2020-2021 and 2021-2022 are displayed in Table 4.26 and are depicted in graph 4.24.

WCE data for 2020-2021 and 2021-2022. In comparison to the weedy check, Table 4.26 of the total weed population demonstrates that weed control interventions increase the WCE of the entire weed population. With the exception of pyroxasulfone 120 g PE paired with pendimethalin 850 g PE and pyroxasulfone 110 g PE combined with pendimethalin 800 g PE, 30 DAS reduce the WCE of the whole weed population. Sulfosulfuron coupled with metsulfuron 35 g PoE, sulfosulfuron combined with metsulfuron 40 g PoE, and clodinafop-propargyl 400 g PoE paired with HW (60 DAS) were the combinations with the lowest minimum WCE reported. The maximum WCE of total weed population were recorded in HW (60 DAS) followed by pyroxasulfone 120 g PE combined with pendimethalin 850 g PE and pyroxasulfone 110 g PE combined with pendimethalin 850 g PE. 90 DAS the lower WCE were recorded in use of sulfosulfuron combined with metsulfuron 40 g PoE and sulfosulfuron combined with metsulfuron 35 g PoE and maximum WCE of total weed population PoE 2, 4- D Na 0.75 kg combined with HW (60 DAS) followed pyroxasulfone 120 g PE combined with pendimethalin 850 g PE and pyroxasulfone 120 g PE combined with pendimethalin 850 g PE. Sulfosulfuron mixed with metsulfuron 35 g PoE was used at 120 DAS and harvest minimum WCE was recorded, followed by sulfosulfuron combined with metsulfuron 40 g PoE. Clodinafop-propargyl 400 g PoE coupled with HW (60 DAS) over weedy check, and PoE 2, 4-D Na 0.75 kg combined with HW (60 DAS) and HW (30 and 60 DAS) were the highest. Tiwar *et al.* 2011, Dixit *et al.* 2014, Bhoir *et al.* 2016, and Kaur and Kaur, 2019 all workers reported results that were similar.

The cumulative data for the years 2020-2021 and 2021-2022 on Table 4.26 is depicted in graph 4.24. One month after sowing, the PE treatment recorded the greatest WCE of the whole weed population when compared to the PoE treatments. The maximum WCE of the entire weed population was recorded in HW (60 DAS), followed by pyroxasulfone 120 g PE combined with pendimethalin 850 g PE and pyroxasulfone 110 g

PE combined with pendimethalin 800 g PE. 60 DAS lower WCE were recorded in sulfosulfuron combined with metsulfuron 40 g PoE and sulfosulfuron combined with metsulfuron 35 g PoE. Maximum WCE were seen in PoE 2, 4-D Na 0.75 kg in combination with HW (60 DAS) at 90 DAS, with pyroxasulfone coming in second. Pendimethalin 850 g PE mixed with 120 g PE and lower in sulfosulfuron combined with metsulfuron 40 g PoE and sulfosulfuron combined with metsulfuron 35 g PoE, and pyroxasulfone 110 g PE combined with Pendimethalin 800 g PE. Maximum WCE of the total weed population was observed 120 days after sowing and harvest in PoE 2, 4-D Na 0.75 kg combined with HW (60 DAS), clodinafop-propargyl 400 g PoE combined with HW (60 DAS), HW (30 and 60 DAS), and sulfosulfuron combined with metsulfuron 35 g PoE and sulfosulfuron combined with metsulfuron 40 g PoE over weedy.



Graph. 4.24 Influence of different herbicide treatments on weed control efficiency (%) of total weed population in wheat (Pooled data of 2020-2021 and 2021-2022).

Table 4.27 Residual effect of different herbicide treatments on germination percentage of oat (2020-2021 and 2021-2022).

Treatment	30 DAS (2020- 21)	30 DAS (2021- 22)	Pool data	60 DAS (2020- 21)	60 DAS (2021- 22)	Pool data	90 DAS (2020- 21)	90 DAS (2021- 22)	Pool data	120 DAS (2020- 21)	120 DAS (2021- 22)	Pool data	Harve st (2020- 21)	Harvest (2021- 22)	Pool data
T ₁	46.23	47.18	46.71	61.56	62.39	61.98	68.36	70.22	69.29	72.16	73.31	72.74	83.31	83.46	83.39
T ₂	47.51	48.76	48.14	63.12	64.30	63.71	70.23	73.20	71.72	74.69	75.16	74.93	84.22	84.70	84.46
T ₃	48.57	48.84	48.71	65.20	66.13	65.67	69.86	71.44	70.65	71.16	70.21	70.69	84.69	84.75	84.72
T ₄	82.23	83.13	82.68	84.18	83.29	83.74	85.18	84.20	84.69	85.15	85.12	85.14	85.12	85.17	85.15
T ₅	81.44	82.21	81.83	48.17	44.18	46.18	59.89	60.17	60.03	69.76	66.44	68.10	84.36	84.41	84.39
T ₆	82.10	82.37	82.24	46.14	45.61	45.88	57.31	56.41	56.86	65.84	67.11	66.48	83.68	84.10	83.89
T ₇	80.20	80.14	80.17	47.45	50.52	48.99	55.68	57.67	56.68	67.33	69.84	68.59	82.44	83.74	83.09
T ₈	83.24	84.27	83.76	85.20	85.43	85.32	85.00	85.12	85.06	85.20	85.13	85.17	85.10	85.35	85.23
SE m (±)	0.79	0.66	0.73	1.08	0.62	0.85	1.22	0.95	1.09	1.35	1.15	1.25	1.57	1.11	1.34
CD (p = 0.05)	2.38	2.01	2.20	3.26	1.87	2.57	3.70	2.88	3.29	4.11	3.50	3.81	4.77	3.36	4.07

SE m (±): Standard Error of mean, CD: Critical Difference and DAS: Days after sowing

Treatments: T₁: Pyroxasulfone @ 120 g ha⁻¹ (PE) + Pendimethalin @ 850 g ha⁻¹ (PE), T₂: Pyroxasulfone @ 110 g ha⁻¹ (PE) + Pendimethalin @ 800 g ha⁻¹ (PE), T₃: Sulfosulfuron + Metsulfuron @ 40 g ha⁻¹ (PE), T₄: Two hand weeding (30 and 60 DAS), T₅: Sulfosulfuron + Metsulfuron @ 35 g ha⁻¹ (PoE), T₆: Clodinafop-propargyl @ 400 g ha⁻¹ (PoE) + one hand weeding (60 DAS), T₇: 2, 4-D Na @ 750 g ha⁻¹ (PoE) + one hand weeding (60 DAS) and T₈: Weedy check (Control).

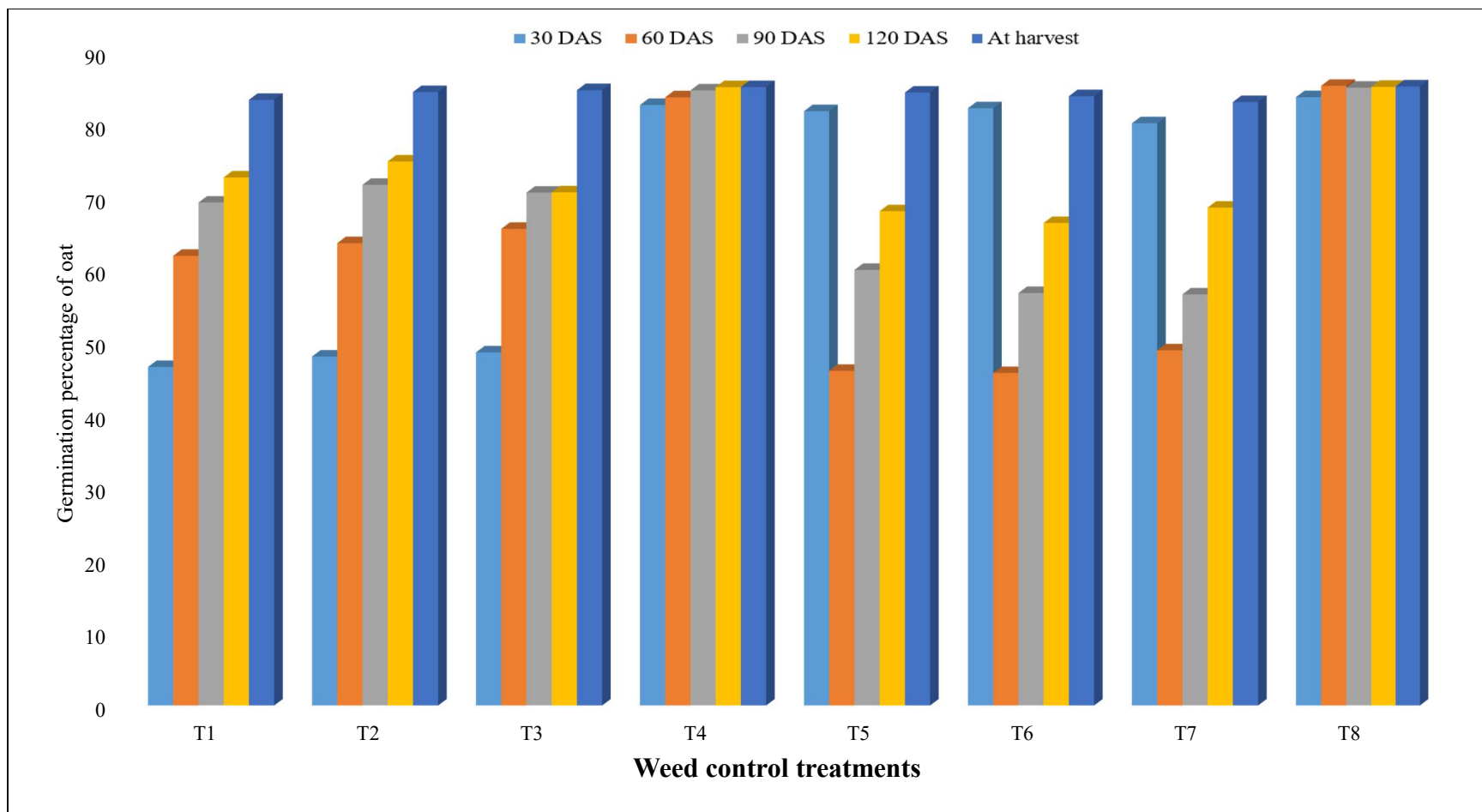
4.2 Herbicide Persistence studies (Bioassay)

4.2.1 Effect of herbicide residues on germination percentage of oat

The data on herbicide residues on germination percentage of oat is effect of weed control treatmentss at montly intervals until harvest as shown in Table 4.27 and graph 4.25.

In the years 2020-21 and 2021-22 data shown in Table 4.27 on 30 DAS minimum germination percentage of oat seed were observed in the PE use of pyroxasulfone 120 g PE combined with pendimethalin 850 g PE followed by pyroxasulfone 110 g PE combined with pendimethalin 800 g PE as compared to remaining herbicide treatments. 60 DAS highest germination percentage were detected in HW (30 and 60 DAS) as likened to remaining herbicidal treatments. Lower germination percentage observed in sulfosulfuron combined with metsulfuron 35 g PoE followed by PoE 2, 4- D Na 0.75 kg combined with HW (60 DAS) because it is applied at PoE. 90 DAS maximum germination percentage were observed in Pyroxasulfone 120 g PE combined with pendimethalin 850 g PE and pyroxasulfone 110 g PE combined with pendimethalin 800 g PE and minimum in 2, 4-D Na 0.750 g PoE combined with HW (60 DAS) and clodinafop propargyl 400 g PoE combined with HW (60 DAS). At 120 DAS and the lower residual effect observed in pyroxasulfone 120 g PE combined with pendimethalin 850 g PE and pyroxasulfone 110 g PE combined with pendimethalin 800 g PE, caused in experiential maximum germination percentage of cucumber seed likened to herbicidal treatments. Similar outcomes were stated by Joseph and Neal, 1996.

The cumulative data in 2020-21 and 2021-22 shown in Table 4.27 and graph 4.25 designated on 30 DAS sown minimum germination percentage were experiential in PE pyroxasulfone 120 g PE combined with pendimethalin 850 g PE and pyroxasulfone 110 g PE combined with pendimethalin 800 g PE because this herbicide more persistence in soil up to 30 DAS. At 60 days after grown same herbicides recorded effective growth of oat seed causes they reduce their activities in soil. The lower germination were in PoE treatment because of their high concentration in the soil as likened to HW. On harvest, all herbicidal treatments recorded expressively higher germination percentage as compared to weedy check.



Graph 4.25 Residual effect of different herbicide treatments on germination percentage of oat (Pooled data of 2020-2021 and 2021-2022).

Table 4.28 Residual effect of different herbicide treatments on root length (cm) of oat at 10 DAS (2020-2021 and 2021-2022).

Treatment	30 DAS (2020- 21)	30 DAS (2021- 22)	Pool data	60 DAS (2020- 21)	60 DAS (2021- 22)	Pool data	90 DAS (2020- 21)	90 DAS (2021- 22)	Pool data	120 DAS (2020- 21)	120 DAS (2021- 22)	Pool data	Harvest (2020- 21)	Harvest (2021- 22)	Pool data
T ₁	4.20	4.24	4.22	4.42	4.48	4.45	4.64	4.61	4.63	4.96	4.91	4.94	5.75	5.76	5.76
T ₂	4.46	4.41	4.44	4.58	4.60	4.59	4.69	4.66	4.68	4.98	4.97	4.98	5.80	5.84	5.82
T ₃	5.67	5.66	5.67	3.35	4.39	3.87	3.41	3.40	3.41	3.89	3.91	3.90	5.81	5.80	5.81
T ₄	5.91	5.85	5.88	5.80	5.70	5.70	5.60	5.50	5.50	5.80	5.50	5.60	5.87	5.86	5.87
T ₅	5.71	5.67	5.69	3.48	4.51	4.00	3.54	3.48	3.51	4.12	4.13	4.13	5.42	5.44	5.43
T ₆	5.49	5.38	5.44	3.65	3.70	3.68	3.67	3.70	3.69	4.23	4.30	4.27	5.67	5.70	5.69
T ₇	5.96	5.89	5.93	4.10	4.12	4.11	4.22	4.23	4.23	4.32	4.31	4.32	5.83	5.89	5.86
T ₈	6.00	5.95	5.98	6.10	5.99	6.05	6.05	6.02	6.04	6.11	6.08	6.10	6.03	6.10	6.07
SE m (±)	0.40	0.35	0.38	0.48	0.36	0.42	0.53	0.39	0.46	0.56	0.46	0.51	0.58	0.52	0.55
CD (p = 0.05)	1.21	1.07	1.14	1.47	1.10	1.29	1.59	1.17	1.38	1.69	1.39	1.54	1.74	1.59	1.67

SE m (±): Standard Error of mean, CD: Critical Difference and DAS: Days after sowing

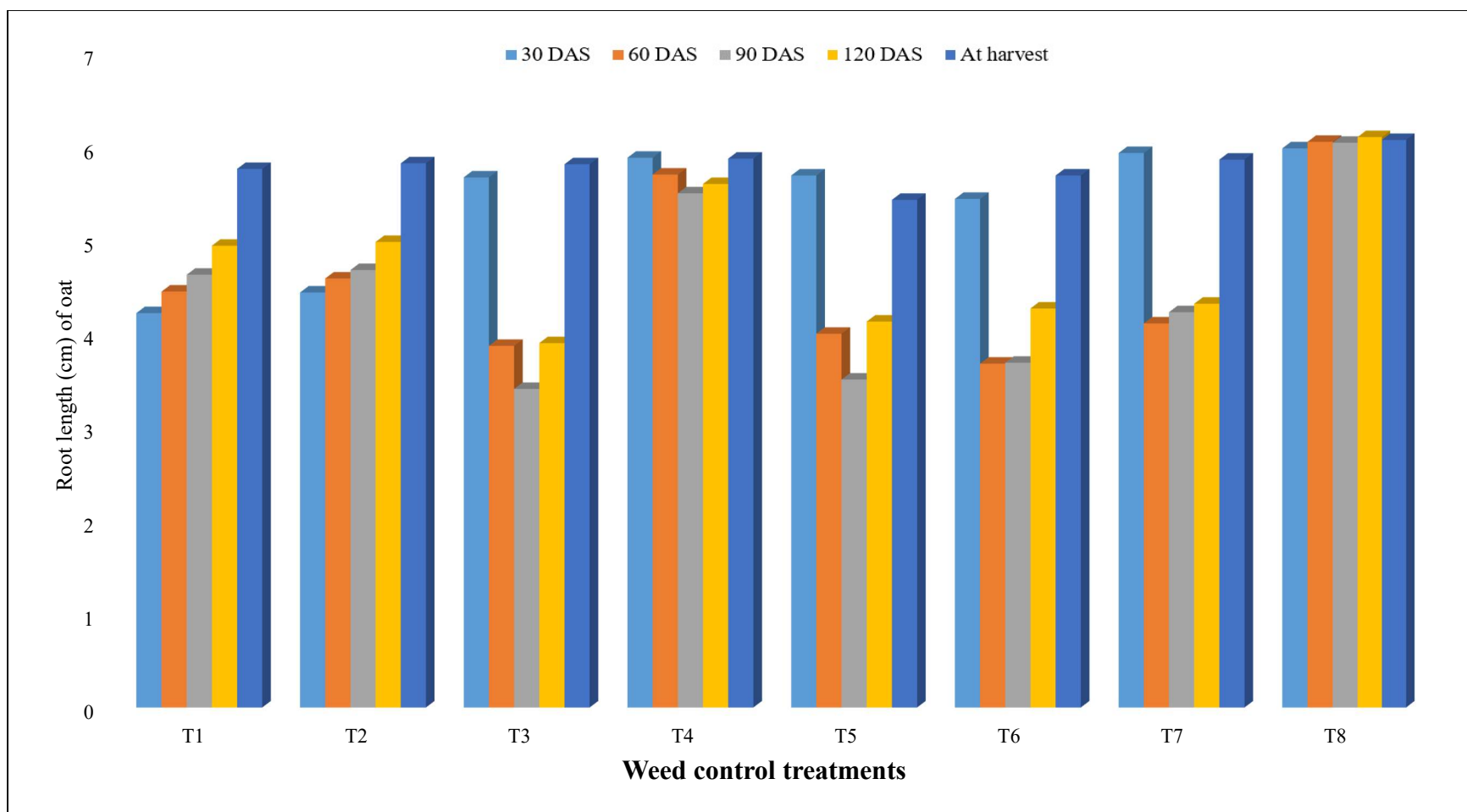
Treatments: T₁: Pyroxasulfone @ 120 g ha⁻¹ (PE) + Pendimethalin @ 850 g ha⁻¹ (PE), T₂: Pyroxasulfone @ 110 g ha⁻¹ (PE) Pendimethalin @ 800 g ha⁻¹ (PE), T₃: Sulfosulfuron + Metsulfuron @ 40 g ha⁻¹ (PE), T₄: Two hand weeding (30 and 60 DAS), T₅: Sulfosulfuron + Metsulfuron @ 35 g ha⁻¹ (PoE), T₆: Clodinafop-propargyl @ 400 g ha⁻¹ (PoE) + one hand weeding (60 DAS), T₇: 2, 4-D Na @ 750 g ha⁻¹ (PoE) + one hand weeding (60 DAS) and T₈: Weedy check (Control).

4.2.2 Effect of herbicide residues on root length (cm) of oat

The data on herbicide residues on root length of oat is expressively effect of weed control treatments at montly interval until harvest shown in Table 4.28 and graph 4.26.

In the years 2020-21 and 2021-22 data showd in Table 4.28 on month after sowing expressively minimum root length of oat seed were observed in the PE use of pyroxasulfone 120 g PE combined with pendimethalin 850 g PE followed by pyroxasulfone 110 g PE combined with pendimethalin 800 g PE in comparison with other herbicidal treatments. At 60 DAS highest root length were observed in HW (30 and 60 DAS). Lower root length observed in sulfosulfuron combined with metsulfuron 40 g PoE followed by sulfosulfuron combined with metsulfuron 35 g PoE and clodinafop propargyl 400 g PoE combined with HW (60 DAS) because it is applied at PoE. 90 DAS maximum root length observed in pyroxasulfone 120 g PE combined with pendimethalin 850 g PE and pyroxasulfone 110 g PE combined with pendimethalin 800 g PE and lower in sulfosulfuron combined with metsulfuron 40 g PoE followed by sulfosulfuron combined with metsulfuron 35 g PoE and clodinafop propargyl 400 g PoE combined with HW (60 DAS). 120 DAS and at harvest minimum residual effect detected in pyroxasulfone 120 g PE combined with pendimethalin 850 g PE and pyroxasulfone 110 g PE combined with pendimethalin 800 g PE, resulted in observed maximum root length of cucumber seed likened to remaining herbicidal treatments. Similar outcomes were stated by Joseph and Neal, 1996 and Watson and Checkel, 2001.

The cumulative data in 2020-21 and 2021-22 shown in Table 4.28 and graph 4.26 designated on 30 DAS presented lower root length were experiential in PE pyroxasulfone 120 g PE combined with pendimethalin 850 g PE and pyroxasulfone 110 g PE combined with pendimethalin 800 g PE because this herbicide more persistence in soil up to one month. At 60 DAS highest root length recorded in pyroxasulfone 120 g PE combined with pendimethalin 850 g PE and pyroxasulfone 110 g PE combined with pendimethalin 800 g PE herbicides recorded effective growth of oat seed causes they reduce their activities in soil. The lower root length were observed in PoE treatment because of their high concentration in soil as compared to HW. On harvest, remaining herbicidal treatments noted highest root length as compared to weedy check.



Graph 4.26 Residual effect of different herbicide treatments on root length (cm) of oat at 10 DAS (Pooled data of 2020-2021 and 2021-2022).

Table 4.29 Residual effect of different herbicide treatments on shoot length (cm) of oat at 10 DAS (2020-2021 and 2021-2022).

Treatmen t	30 DAS (2020- 21)	30 DAS (2021- 22)	Pool data	60 DAS (2020- 21)	60 DAS (2021- 22)	Pool data	90 DAS (2020- 21)	90 DAS (2021- 22)	Pool data	120 DAS (2020- 21)	120 DAS (2021- 22)	Pool data	Harvest (2020- 21)	Harvest (2021- 22)	Pool data
T ₁	2.76	2.71	2.74	2.84	2.81	2.83	3.13	3.20	3.17	3.37	3.41	3.39	3.82	3.84	3.83
T ₂	2.81	2.79	2.80	2.89	2.87	2.88	3.19	3.18	3.19	3.41	3.49	3.45	3.88	3.85	3.87
T ₃	3.69	3.74	3.72	2.62	2.60	2.61	2.84	2.91	2.88	3.20	3.27	3.24	3.94	3.98	3.96
T ₄	3.84	3.82	3.83	4.12	4.17	4.15	4.00	3.96	3.98	3.99	4.06	4.03	3.96	4.00	3.98
T ₅	3.96	3.90	3.93	2.74	2.80	2.77	3.25	3.32	3.29	3.32	3.39	3.36	4.01	4.06	4.04
T ₆	4.00	3.99	4.00	3.23	3.29	3.26	3.50	3.57	3.54	3.59	3.61	3.60	3.99	3.94	3.97
T ₇	3.89	3.86	3.88	2.91	2.96	2.94	3.27	3.34	3.31	3.27	3.32	3.30	4.00	3.98	3.99
T ₈	4.00	4.03	4.02	4.10	4.07	4.09	4.05	4.09	4.07	4.25	4.46	4.36	4.12	4.23	4.18
SE m (±)	0.32	0.39	0.36	0.35	0.36	0.36	0.40	0.51	0.46	0.48	0.47	0.48	0.51	0.51	0.51
CD (p = 0.05)	0.98	1.18	1.08	1.05	1.11	1.08	1.22	1.55	1.39	1.46	1.43	1.45	1.56	1.54	1.55

SE m (±): Standard Error of mean, CD: Critical Difference and DAS: Days after sowing

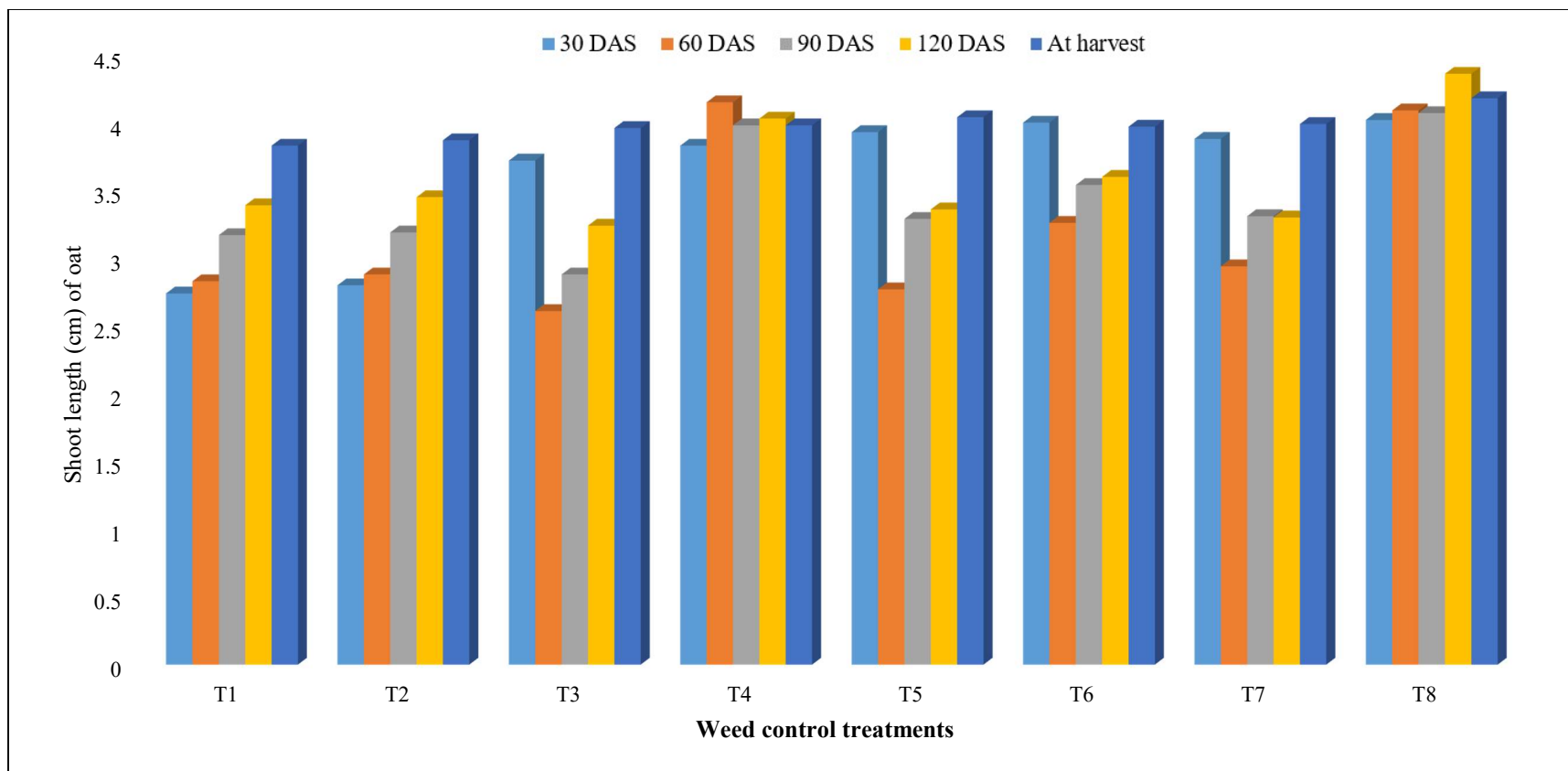
Treatments: T₁: Pyroxasulfone @ 120 g ha⁻¹ (PE) + Pendimethalin @ 850 g ha⁻¹ (PE), T₂: Pyroxasulfone @ 110 g ha⁻¹ (PE) Pendimethalin @ 800 g ha⁻¹ (PE), T₃: Sulfosulfuron + Metsulfuron @ 40 g ha⁻¹ (PE), T₄: Two hand weeding (30 and 60 DAS), T₅: Sulfosulfuron + Metsulfuron @ 35 g ha⁻¹ (PoE), T₆: Clodinafop-propargyl @ 400 g ha⁻¹ (PoE) + one hand weeding (60 DAS), T₇: 2, 4-D Na @ 750 g ha⁻¹ (PoE) + one hand weeding (60 DAS) and T₈: Weedy check (Control).

4.2.3 Effect of herbicide residues on shoot length (cm) of oat

The data on herbicide residues on shoot length of oat effect of weed control treatments at monthly interval until harvest shown in Table 4.29 and graph 4.27.

In years 2020-21 and 2021-22 data presented on Table 4.29 indicated on 30 DAS expressively lower shoot length of oat seed were observed in the PE use of pyroxasulfone 120 g PE combined with pendimethalin 850 g PE and pyroxasulfone 110 g PE combined with pendimethalin 800 g PE in comparison with the other herbicidal approaches. At 60 DAS highest shoot length were detected in HW twice (60 DAS) in comparison with other herbicidal treatments. Minimum shoot length observed in sulfosulfuron combined with metsulfuron 40 g PE followed by sulfosulfuron combined with metsulfuron 35 g PoE and clodinafop propargyl 400 g PoE combined with HW (60 DAS) because it is applied at PoE. 90 days after grown maximum shoot length were detected in pyroxasulfone 120 g PE combined with pendimethalin 850 g PE and pyroxasulfone 110 g PE combined with pendimethalin 800 g PE and lower in sulfosulfuron combined with metsulfuron 40 g PoE followed by sulfosulfuron combined with metsulfuron 35 g PoE and clodinafop- propargyl 400 g PoE combined with HW (60 DAS) over a weedy check. 120 DAS and at harvest minimum residual effect observed in pyroxasulfone 120 g PE combined with pendimethalin 850 g PE and pyroxasulfone 110 g PE combined with pendimethalin 800 g PE, resulted maximum shoot length of cucumber seed compared to remaining herbicidal treatments. Identical outcomes were stated by Joseph and Neal, 1996

The cumulative data in 2020-21 and 2021-22 showing in Table 4.29 and represented in graph 4.27 on 30 DAS expressively lower shoot length in PE use of pyroxasulfone 120 g PE combined with pendimethalin 850 g PE and pyroxasulfone 110 g PE combined with pendimethalin 800 g PE because this herbicide more persistence in soil up to 30 DAS. 60 DAS maximum shoot length recorded in pyroxasulfone 120 g PE combined with pendimethalin 850 g PE and pyroxasulfone 110 g PE combined with pendimethalin 800 g PE herbicides recorded effective growth of oat seed causes they reduce their activities in soil. The lower shoot length were observed in PoE treatment because of their high concentration in the soil as compared to weedy check.



Graph 4.27 Residual effect of different herbicide treatments on shoot length (cm) of oat at 10 DAS (Pooled data of 2020-2021 and 2021-2022).

Table 4.30 Influence of different herbicide treatments on plant population (No. m⁻²) in wheat at 30 DAS (2020-2021 and 2021-2022).

Treatment	30 DAS (2020-21)	30 DAS (2021-22)	Pool data
T₁	221.35	239.37	230.36
T₂	218.65	232.47	225.56
T₃	196.45	210.27	203.36
T₄	200.00	228.72	214.36
T₅	181.89	203.89	192.89
T₆	203.96	220.26	212.11
T₇	207.69	232.23	219.96
T₈	166.98	193.74	180.36
SE m (±)	1.44	1.76	1.60
CD (p = 0.05)	4.32	5.28	5.00

SE m (±): Standard Error of mean, CD: Critical Difference and DAS: Days after sowing

Treatments: T₁: Pyroxasulfone @ 120 g ha⁻¹ (PE) + Pendimethalin @ 850 g ha⁻¹ (PE), T₂: Pyroxasulfone @ 110 g ha⁻¹ (PE) Pendimethalin @ 800 g ha⁻¹ (PE), T₃: Sulfosulfuron + Metsulfuron @ 40 g ha⁻¹ (PE), T₄: Two hand weeding (30 and 60 DAS), T₅: Sulfosulfuron + Metsulfuron @ 35 g ha⁻¹ (PoE), T₆: Clodinafop-propargyl @ 400 g ha⁻¹ (PoE) + one hand weeding (60 DAS), T₇: 2, 4-D Na @ 750 g ha⁻¹ (PoE) + one hand weeding (60 DAS) and T₈: Weedy check (Control).

4.3 Study on wheat

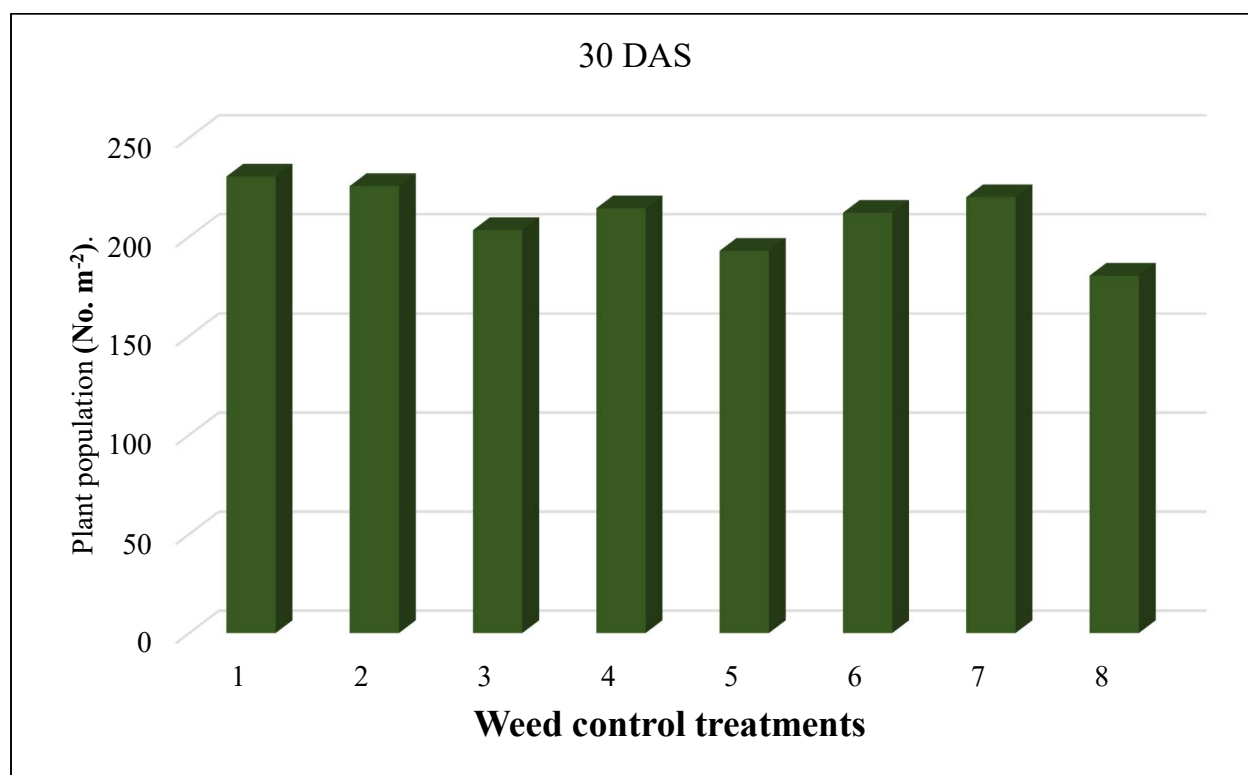
4.3.1 Plant population

The data on crop stand is effect of weed control treatments at monthly up to harvest shown in Table 4.30 and represented in graph 4.28.

In years 2020-21 and 2021-22 data shows in plant population shown in Table 4.30 higher over weedy check in weed control treatments. 30 DAS highest plant population were recorded in

PE treatments as compared to PoE treatments. A nearly similar outcome were described by Bhoir *et al.* 2016, Kaur and, 2019, and Bayat, 2020.

The cumulative statistics on 2020-21 and 2021-22 shown in Table 4.30 and represented in graph 4.28 on 30 day after sowing maximum plant population noted in PE treatment because arrest the weeds at initial growth stage as compared to PoE herbicide over a weedy check. .



Graph 4.28 Influence of different herbicide treatments on plant population (No. m⁻²) in wheat at 30 DAS (2020-2021 and 2021-2022).

Table 4.31 Influence of different herbicide treatments on Plant height (cm) in wheat at monthly intervals (2020-2021 and 2021-2022).

Treatm ent	30 DAS (2020- 21)	30 DAS (2021- 22)	Pool data	60 DAS (2020- 21)	60 DAS (2021- 22)	Pool data	90 DAS (2020- 21)	90 DAS (2021- 22)	Pool data	120 DAS (2020- 21)	120 DAS (2021- 22)	Pool data	Harve st (2020- 21)	Harves t (2021- 22)	Pool data
T₁	13.50	13.48	13.49	25.16	26.07	25.62	66.84	65.82	66.33	80.35	79.94	80.15	80.30	79.93	80.12
T₂	13.36	13.33	13.35	24.90	25.32	25.11	66.79	65.78	66.29	78.88	77.26	78.07	78.86	77.24	78.05
T₃	12.77	12.75	12.76	22.10	23.16	22.63	66.60	65.65	66.13	70.35	71.23	70.79	70.32	71.20	70.76
T₄	12.84	12.82	12.83	23.40	23.86	23.63	66.69	65.74	66.22	76.13	75.20	75.67	76.10	75.19	75.65
T₅	12.71	12.68	12.70	22.01	22.97	22.49	66.59	65.50	66.05	70.75	70.35	70.55	70.73	70.33	70.53
T₆	12.79	12.72	12.76	23.20	23.47	23.34	66.65	65.70	66.18	74.25	72.77	73.51	74.22	72.76	73.49
T₇	13.10	13.06	13.08	23.60	23.89	23.75	66.72	65.71	66.22	78.20	76.86	77.53	78.16	76.84	77.50
T₈	12.65	12.60	12.63	18.20	19.16	18.68	42.12	43.30	42.71	53.20	54.18	53.69	53.07	54.12	53.60
SE m (±)	0.49	0.63	0.56	0.51	0.87	0.69	0.66	0.76	0.71	0.74	0.92	0.83	0.87	0.58	0.73
CD (p = 0.05)	1.50	1.91	1.71	1.55	2.63	2.09	2.00	2.29	2.15	2.26	2.79	2.53	2.64	1.74	2.19

SE m (±): Standard Error of mean, CD: Critical Difference and DAS: Days after sowing

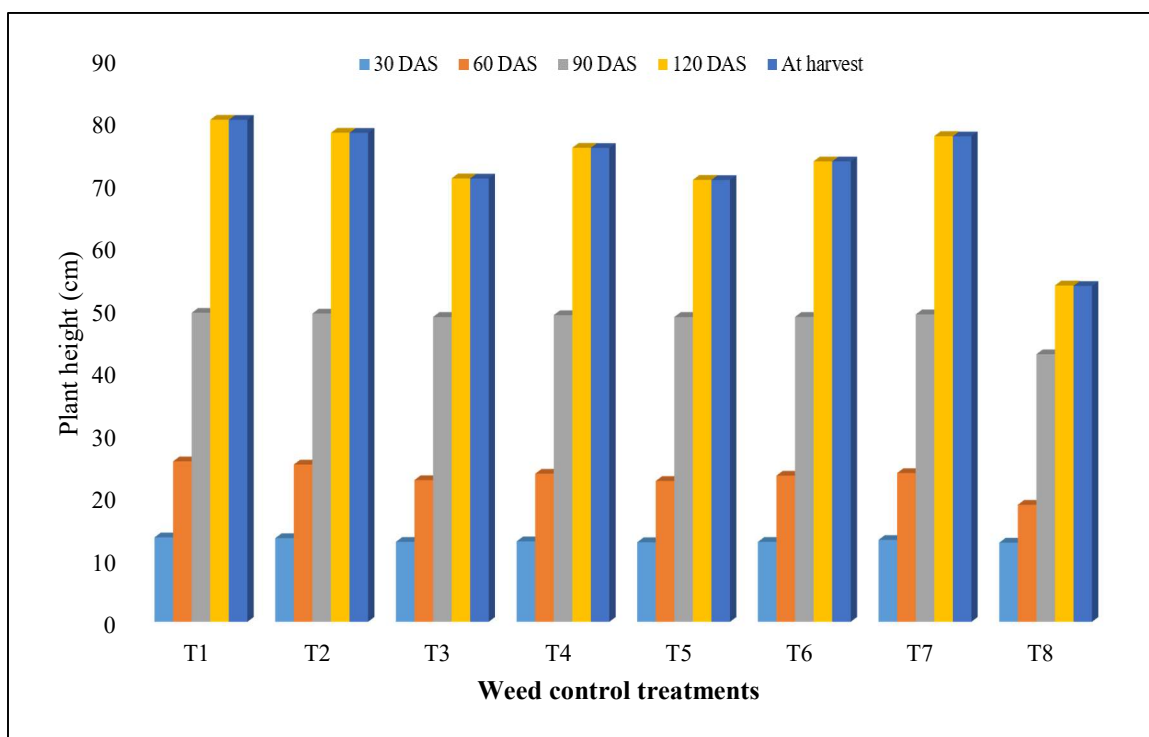
Treatments: T₁: Pyroxasulfone @ 120 g ha⁻¹ (PE) + Pendimethalin @ 850 g ha⁻¹ (PE), T₂: Pyroxasulfone @ 110 g ha⁻¹ (PE) Pendimethalin @ 800 g ha⁻¹ (PE), T₃: Sulfosulfuron + Metsulfuron @ 40 g ha⁻¹ (PE), T₄: Two hand weeding (30 and 60 DAS), T₅: Sulfosulfuron + Metsulfuron @ 35 g ha⁻¹ (PoE), T₆: Clodinafop-propargyl @ 400 g ha⁻¹ (PoE) + one hand weeding (60 DAS), T₇: 2, 4-D Na @ 750 g ha⁻¹ (PoE) + one hand weeding (60 DAS) and T₈: Weedy check (Control).

4.3.2 Plant height (cm)

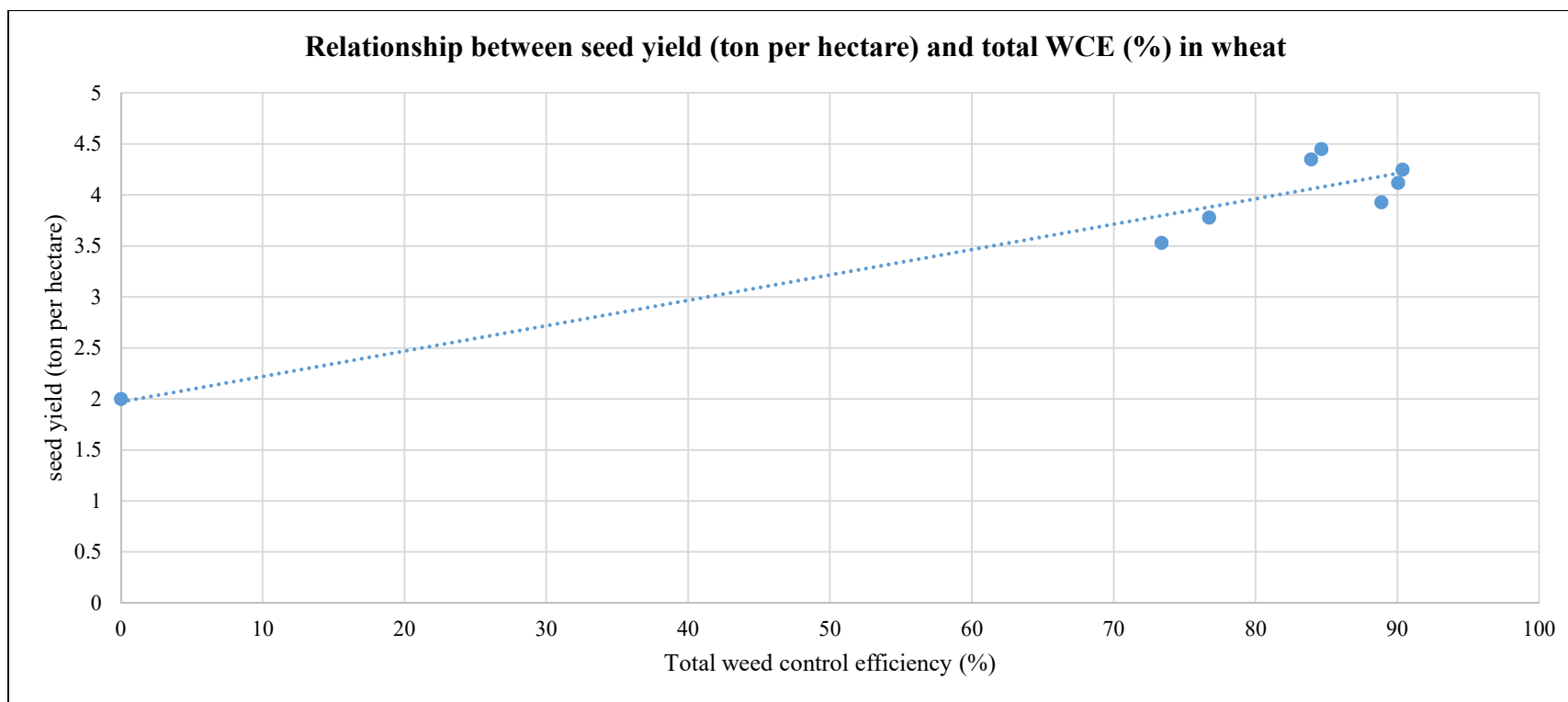
The results on plant height were effect of weed control treatments shown in Table 4.31 and representing in graph 4.29.

In the years 2020-21 and 2021-22 data shows Plant height in Table 4.31 all weed controller treatments increase Plant height in wheat over weedy check. When comparing PE herbicidal treatments to PoE herbicidal treatments, the 30 DAS greatest plant height was observed. In pyroxasulfone, 60 DAS taller plants were seen. Pendimethalin 850 g PE mixed with pyroxasulfone 120 g PE, lower plant height was seen in the sulfosulfuron combined with metsulfuron 35 g PoE and subsequently sulfosulfuron combined with metsulfuron 40 g PoE. Pyroxasulfone 110 g PE combined with pendimethalin 800 g PE and PoE 2, 4-D Na 0.75 kg combined with HW (60 DAS). Pyroxasulfone 120 g PE mixed with pendimethalin 850 g PE was used to increase plant height at 90 DAS. This was followed by pyroxasulfone 110 g PE combined with pendimethalin 800 g PE and PoE 2, 4-D Na 0.75 kg combined with HW (60 DAS), and lower lower Plant height was measured in both the 35 g PoE and 40 g PoE concentrations of pyroxasulfone. When using pyroxasulfone 35 g PoE and pyroxasulfone 40 g PoE, maximum taller plant and harvest minimum plant height were noticed. Pendimethalin 850 g PE and pyroxasulfone 120 g PE were combined. These similar result stated by Tiwari *et al.* 2011, Kaur and Kaur, 2019 and Bayat *et al.* 2020.

The maximum plant height was observed when pyroxasulfone 120 g PE combined with pendimethalin 850 g PE followed by pyroxasulfone 110 g PE combined with pendimethalin 800 g PE and PoE 2, 4-D Na 0.75 kg combined with HW (60 DAS) over weedy check. At 60, 90, and 120 DAS, lower plant height was recorded when using pyroxasulfone 35 g PoE and pyroxasulfone 40 g PoE. At harvest, the use of pyroxasulfone 120 g PE combined with pendimethalin 850 g PE and PoE 2, 4-D Na 0.75 kg combined with HW (60 DAS) resulted in the highest plant heights, while the use of sulfosulfuron combined with metsulfuron 35 g PoE and sulfosulfuron combined with metsulfuron 40 g PoE over weedy check resulted in the lowest plant heights. Higher plant heights are attained when the PE herbicide reduces the weed population during crucial times of crop weed competition.



Graph 4.29a Influence of different herbicide treatments on Plant height (cm) in wheat at monthly intervals (Pooled data of 2020-2021 and 2021-2022).



R=0.95

Graph. 4.29b Relationship between seed yield (t ha^{-1}) and Total WCE (%) in wheat on harvest (Pooled data of 2020-21 and 2021-2022).

Table 4.32 Influence of different herbicide treatments on number of tillers (m⁻²) in wheat at monthly intervals (2020-2021 and 2021-2022).

Treatm ent	30 DAS (2020- 21)	30 DAS (2021- 22)	Pool data	60 DAS (2020- 21)	60 DAS (2021- 22)	Pool data	90 DAS (2020- 21)	90 DAS (2021- 22)	Pool data	120 DAS (2020- 21)	120 DAS (2021- 22)	Pool data	Harves t (2020- 21)	Harvest (2021-22)	Pool data
T ₁	221.35	239.37	230.36	238.36	272.74	255.55	252.87	272.65	262.76	249.15	269.57	259.36	253.19	257.63	255.41
T ₂	218.65	232.47	225.56	230.4	256.34	243.37	241.58	264.86	253.22	240.48	264.14	252.31	249.66	250.74	250.2
T ₃	196.45	210.27	203.36	210.69	227.99	219.34	212.98	237.74	225.36	217.18	225.24	221.21	217.11	221.53	219.32
T ₄	200.00	228.72	214.36	216.36	238.68	227.52	226.39	244.13	235.26	226.38	240.06	233.22	229.63	232.81	231.22
T ₅	181.89	203.89	192.89	198.65	211.91	205.28	206.59	231.35	218.97	205.52	227.7	216.61	212.36	215.9	214.13
T ₆	203.96	220.26	212.11	214.98	230.14	222.56	216.47	240.25	228.36	215.69	234.73	225.21	218.15	225.79	221.97
T ₇	207.69	232.23	219.96	228.69	244.21	236.45	231.97	252.85	242.41	230.42	250.3	240.36	231.41	239.89	235.65
T ₈	166.98	193.74	180.36	177.69	194.93	186.31	169.22	210.78	190	171.22	204.48	187.85	170	201.12	185.56
SE m (±)	1.71	1.49	1.60	1.92	2.08	2.00	2.21	2.01	2.11	1.98	2.11	2.12	2.43	2.24	2.35
CD (p = 0.05)	5.13	4.47	5.16	5.76	6.24	6.26	6.63	6.03	6.46	5.94	6.34	6.49	7.29	6.65	7.07

SE m (±): Standard Error of mean, CD: Critical Difference and DAS: Days after sowing

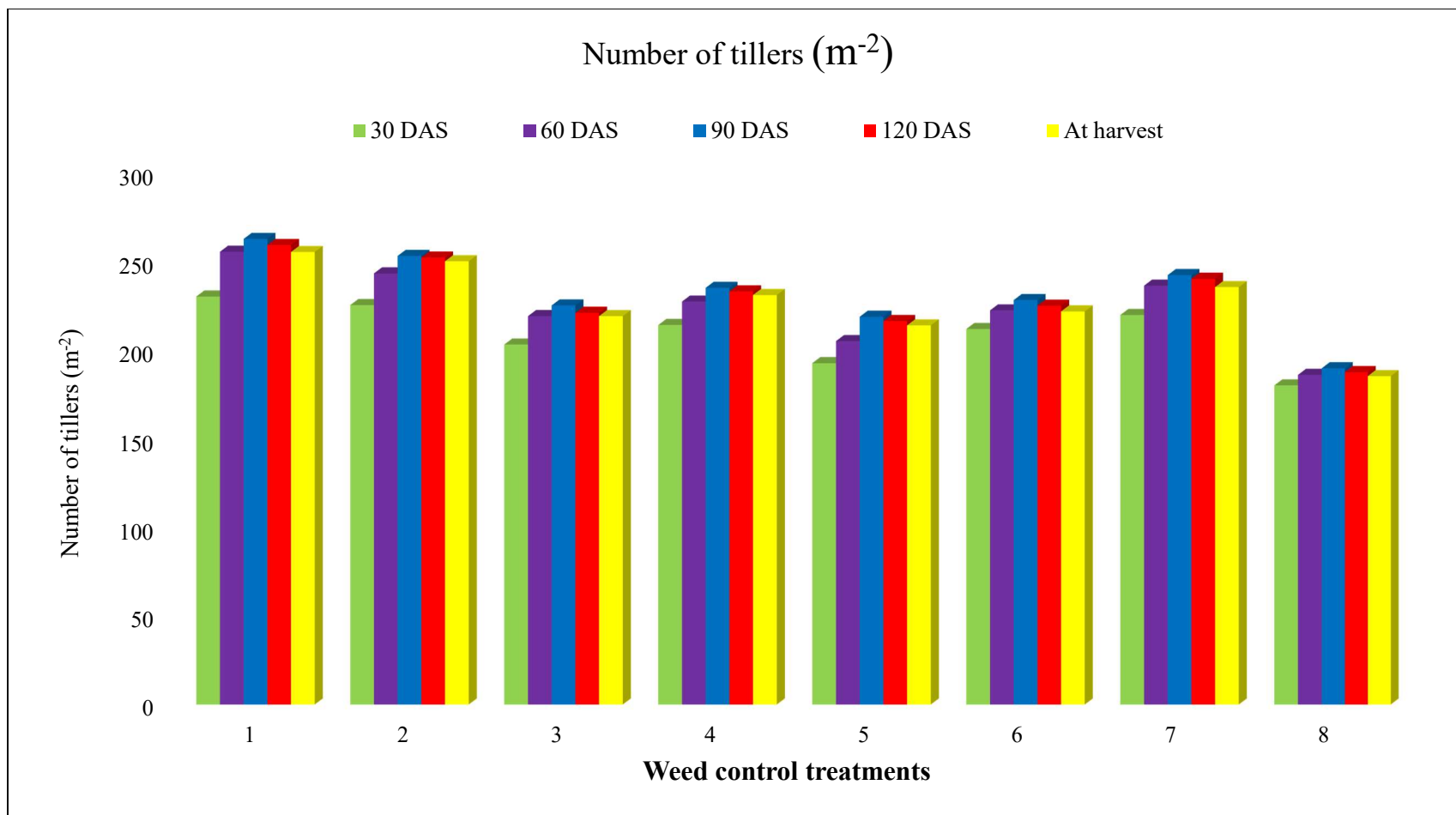
Treatments: T₁: Pyroxasulfone @ 120 g ha⁻¹ (PE) + Pendimethalin @ 850 g ha⁻¹ (PE), T₂: Pyroxasulfone @ 110 g ha⁻¹ (PE) Pendimethalin @ 800 g ha⁻¹ (PE), T₃: Sulfosulfuron + Metsulfuron @ 40 g ha⁻¹ (PE), T₄: Two hand weeding (30 and 60 DAS), T₅: Sulfosulfuron + Metsulfuron @ 35 g ha⁻¹ (PoE), T₆: Clodinafop-propargyl @ 400 g ha⁻¹ (PoE) + one hand weeding (60 DAS), T₇: 2, 4-D Na @ 750 g ha⁻¹ (PoE) + one hand weeding (60 DAS) and T₈: Weedy check (Control).

4.3.3 Number of tillers (m⁻²)

The impact of weed control treatments on the number of tillers per meter square is displayed in Table 4.32 and is depicted in Graph 4.30.

Table 4.32 displays the number of tillers per meter square for the years 2020-21 and 2021-22. In comparison to weedy check, At 30 DAS weed control treatments enhance the number of tillers in wheat. When comparing PE herbicidal treatments to PoE herbicidal treatments, a maximum of 30 DAS tillers per meter square were noted. PoE 2, 4-D Na 0.75 kg combined with HW (60 DAS) and the lowest number of tillers per meter square were recorded using sulfosulfuron combined with metsulfuron 35 g PoE and sulfosulfuron combined with metsulfuron 40 g PoE. At 60 and 90 DAS, the maximum number of tillers per meter square were recorded using pyroxasulfone 120 g PE combined with pendimethalin 850 g PE, followed by pyroxasulfone 110 g PE combined with pendimethalin 800 g PE. Sulfosulfuron combined with metsulfuron 35 g PoE and sulfosulfuron combined with metsulfuron 40 g PoE, as well as the maximum number of tillers per meter square, were recorded at 90 and 120 DAS and throughout harvest. In order to resemble weedy check, the following combinations were used: pyroxasulfone 120 g PE with pendimethalin 850 g PE, pyroxasulfone 110 g PE with pendimethalin 800 g PE, and PoE 2, 4-D Na 0.75 kg mixed with HW (60 DAS). Tiwari *et al.* 2011, Vyavahare and Bhilare, 2014, Amare *et al.* 2016, and Sasode *et al.* 2018 all reported the same result.

In comparison to PoE herbicide over weedy check, the cumulative statistics at 30 DAS maximum number of tillers per meter square were recorded in PE treatment because the weeds were arrested at the initial growth stage. Higher numbers of tillers per meter square were recorded when using pyroxasulfone 120 g PE combined with pendimethalin 850 g PE and PoE 2, 4-D Na 0.75 kg combined with HW (60 DAS) over weedy check, and lower numbers of tillers per meter square were recorded when using sulfosulfuron combined with metsulfuron 35 g PoE and sulfosulfuron combined with metsulfuron 40 g PoE at 60 and 90 DAS. The field is kept weed-free by using a combination of 120 g of pendimethalin and 850 g of pyroxasulfone PE, which results in a maximum tiller count. The PoE usage of 2, 4-D Na in combination with HW produced a near-maximum number of tillers in wheat following the PE's use.



Graph 4.30 Influence of different herbicide treatments on number of tillers (m^{-2}) in wheat at monthly intervals (Pooled data of 2020-2021 and 2021-2022).

Table 4.33 Influence of different herbicide treatments on leaf area index in wheat at monthly intervals (2020-2021 and 2021-2022).

Treatm ent	30 DAS (2020- 21)	30 DAS (2021- 22)	Pool data	60 DAS (2020- 21)	60 DAS (2021- 22)	Pool data	90 DAS (2020- 21)	90 DAS (2021-22)	Pool data	120 DAS (2020- 21)	120 DAS (2021- 22)	Pool data	Harvest (2020- 21)	Harvest (2021- 22)	Pool data
T ₁	0.89	0.97	0.93	1.95	1.97	1.96	2.41	2.44	2.43	2.43	2.46	2.45	2.42	2.46	2.44
T ₂	0.87	0.84	0.86	1.93	1.91	1.92	2.35	2.33	2.34	2.36	2.35	2.36	2.29	2.30	2.30
T ₃	0.81	0.85	0.83	1.84	1.86	1.85	2.12	2.14	2.13	2.14	2.16	2.15	2.20	2.18	2.19
T ₄	0.77	0.79	0.78	1.87	1.89	1.88	2.20	2.35	2.28	2.23	2.38	2.31	2.17	2.21	2.19
T ₅	0.74	0.76	0.75	1.81	1.82	1.82	2.08	2.04	2.06	2.10	2.08	2.09	2.10	2.06	2.08
T ₆	0.80	0.77	0.79	1.86	1.85	1.86	2.14	2.16	2.15	2.15	2.18	2.17	2.08	2.13	2.11
T ₇	0.84	0.81	0.83	1.89	1.93	1.91	2.28	2.29	2.29	2.30	2.31	2.31	2.20	2.16	2.18
T ₈	0.71	0.69	0.70	1.65	1.66	1.66	1.87	1.77	1.82	1.88	1.78	1.83	1.78	1.72	1.75
SE m (±)	0.09	0.05	0.07	0.13	0.08	0.11	0.18	0.15	0.17	0.23	0.12	0.18	0.22	0.18	0.20
CD (p = 0.05)	0.27	0.14	0.21	0.40	0.25	0.33	0.55	0.46	0.51	0.71	0.36	0.54	0.67	0.54	0.61

SE m (±): Standard Error of mean, CD: Critical Difference and DAS: Days after sowing

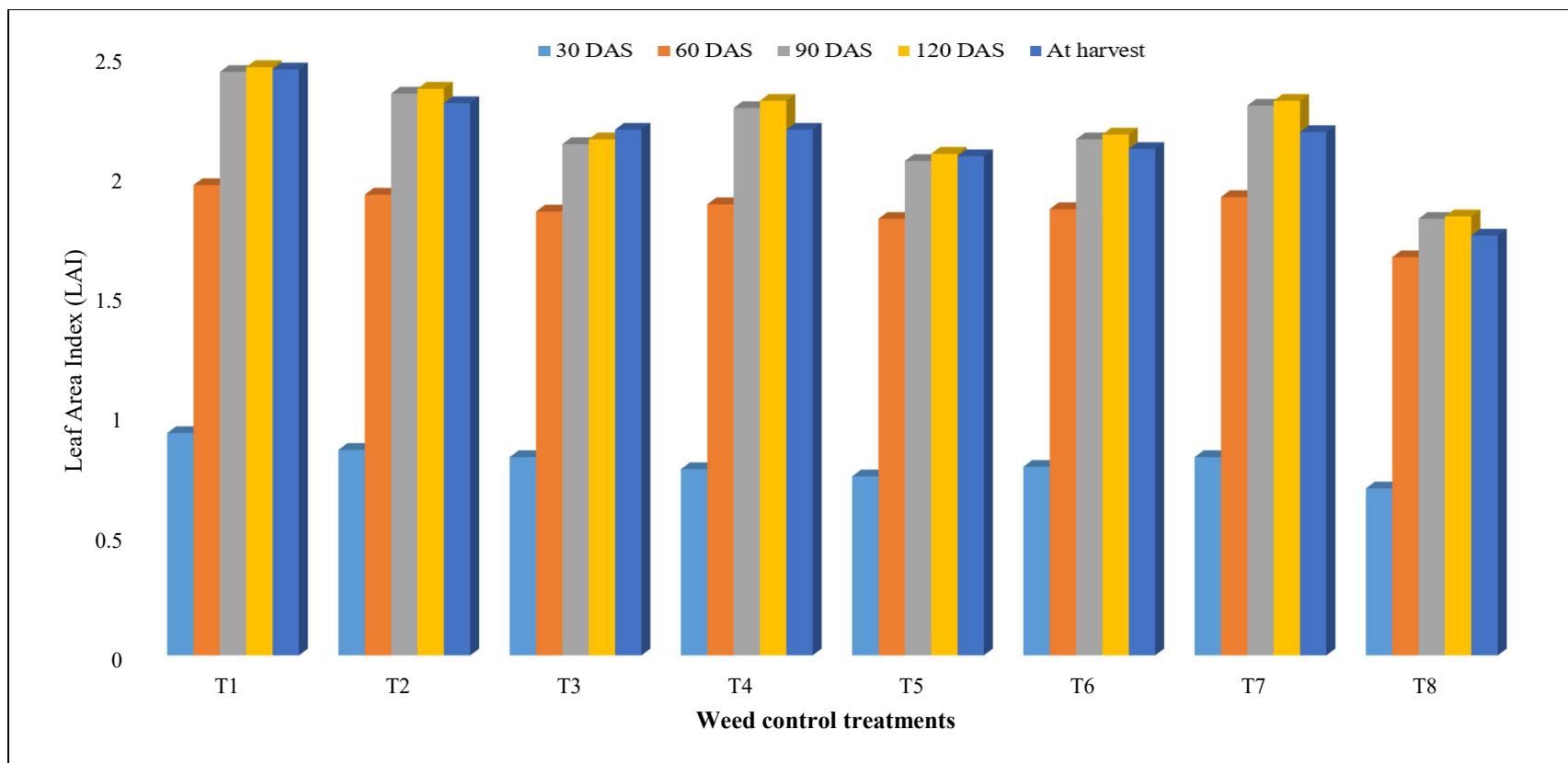
Treatments: T₁: Pyroxasulfone @ 120 g ha⁻¹ (PE) + Pendimethalin @ 850 g ha⁻¹ (PE), T₂: Pyroxasulfone @ 110 g ha⁻¹ (PE) Pendimethalin @ 800 g ha⁻¹ (PE), T₃: Sulfosulfuron + Metsulfuron @ 40 g ha⁻¹ (PE), T₄: Two hand weeding (30 and 60 DAS), T₅: Sulfosulfuron + Metsulfuron @ 35 g ha⁻¹ (PoE), T₆: Clodinafop-propargyl @ 400 g ha⁻¹ (PoE) + one hand weeding (60 DAS), T₇: 2, 4-D Na @ 750 g ha⁻¹ (PoE) + one hand weeding (60 DAS) and T₈: Weedy check (Control).

4.3.4 Leaf Area Index

The impact of weed control treatments on the LAI is displayed in Table 4.32 and is depicted in Graph 4.30.

The figures shown in Table 4.33 for the years 2020-21 and 2020-22 show that weed control treatments increase LAI on wheat over weedy check. When comparing PE herbicidal treatments to PoE treatments, the maximum LAI were seen on 30 DAS. LAI were noted PoE 2, 4-D Na 0.75 kg combined with HW (60 DAS), and lower LAI were noted in the combination of sulfosulfuron combined with metsulfuron 35 g PoE and sulfosulfuron combined with metsulfuron 40 g PoE. Pyroxasulfone 120 g PE combined with pendimethalin 850 g PE and pyroxasulfone 110 g PE combined with pendimethalin 800 g PE were observed. The usage of pyroxasulfone 120 g PE coupled with pendimethalin 850 g PE and PoE 2, 4-D was shown to cause increased LAI at 90 and 120 DAS. Pyroxasulfone 110 g PE mixed with pendimethalin 800 g PE was next. Lower LAI and 2, 4-D Na 0.75 kg in combination with HW (60 DAS) were seen in the sulfosulfuron combined with metsulfuron 35 g PoE and sulfosulfuron plus metsulfuron 40 g PoE. Reduced LAI was seen in sulfosulfuron combined with metsulfuron 35 g PoE and harvest reduced LAI in sulfosulfuron combined with metsulfuron 40 g PoE. Following the combination of pyroxasulfone 110 g PE with Pendimethalin 800 g PE and PoE 2, 4-D 0.75 kg in combination with HW (60 DAS), there was pyroxasulfone 120 g PE with Pendimethalin 850 g PE. Same results were stated by Dixit *et al.* 2016, and Johnson *et al.* 2018.

The data on LAI are presented in table 4.33 and graph 4.31 revealed that significant differences in grain yield were noticed due to weed management practices. Higher LAI were noted for pyroxasulfone 120 g PE combined with pendimethalin 850 g PE, followed by pyroxasulfone 110 g PE combined with pendimethalin 800 g PE and PoE 2, 4-D Na 0.75 kg combined with HW (60 DAS) over weedy check. At 60, 90, and 120 DAS, lower LAI were noted in the use of sulfosulfuron combined with metsulfuron 35 g PoE and sulfosulfuron combined with metsulfuron 40 g PoE over weedy check.



Graph 4.31 Influence of different herbicide treatments on LAI in wheat at monthly intervals (Pooled data of 2020-2021 and 2021-2022).

Table 4.34 Influence of different herbicide treatments on fresh weight (g plant⁻¹) in wheat at monthly intervals (2020-2021 and 2021-2022).

Treatment	30 DAS (2020- 21)	30 DAS (2021- 22)	Pool data	60 DAS (2020- 21)	60 DAS (2021- 22)	Pool data	90 DAS (2020- 21)	90 DAS (2021- 22)	Pool data	120 DAS (2020- 21)	120 DAS (2021- 22)	Pool data	Harvest t (2020- 21)	Harvest (2021- 22)	Pool data
T ₁	1.32	1.31	1.32	2.70	2.77	2.74	6.33	6.41	6.37	8.29	8.37	8.33	7.86	7.94	7.90
T ₂	1.29	1.33	1.31	2.45	2.50	2.48	6.26	6.45	6.36	8.26	8.34	8.30	7.81	7.89	7.85
T ₃	1.15	1.19	1.17	2.40	2.48	2.44	5.91	6.12	6.02	7.72	7.82	7.77	6.79	6.89	6.84
T ₄	1.22	1.25	1.24	2.51	2.66	2.59	6.16	6.38	6.27	7.93	7.99	7.96	7.58	7.72	7.65
T ₅	1.12	1.17	1.15	2.35	2.38	2.37	5.80	5.95	5.88	6.38	6.46	6.42	6.44	6.54	6.49
T ₆	1.18	1.21	1.20	2.22	2.35	2.29	6.12	6.35	6.24	7.79	7.91	7.85	7.06	7.18	7.12
T ₇	1.26	1.30	1.28	2.57	2.67	2.62	6.21	6.31	6.26	7.94	8.52	8.03	7.71	7.82	7.78
T ₈	1.11	1.12	1.12	2.10	2.17	2.14	3.55	3.61	3.57	5.18	5.28	5.23	4.86	5.10	4.98
SE m (±)	0.09	0.07	0.08	0.16	0.12	0.14	0.22	0.20	0.21	0.28	0.23	0.26	0.36	0.29	0.33
CD (p = 0.05)	0.28	0.21	0.25	0.49	0.35	0.42	0.68	0.62	0.65	0.84	0.70	0.77	1.08	0.87	0.98

SE m (±): Standard Error of mean, CD: Critical Difference and DAS: Days after sowing

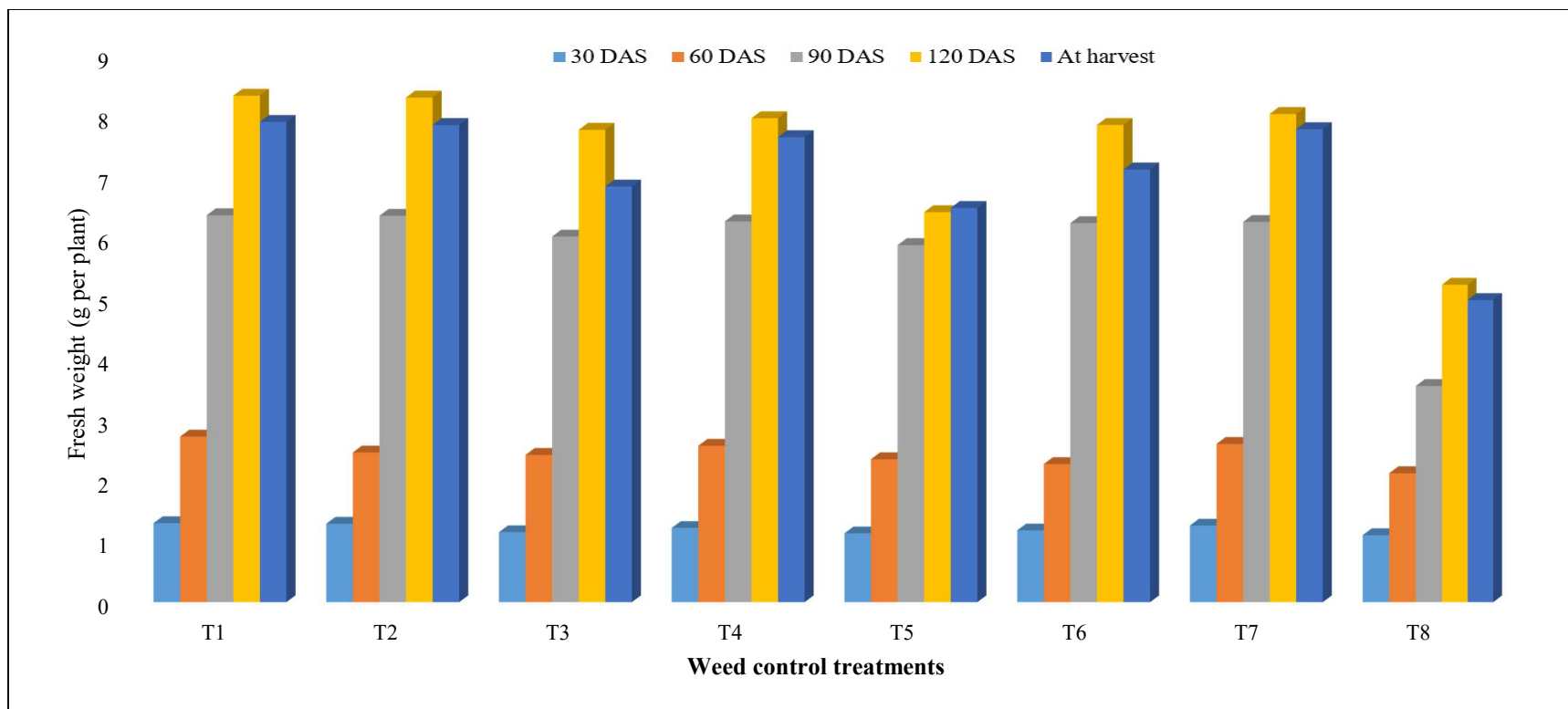
Treatments: T₁: Pyroxasulfone @ 120 g ha⁻¹ (PE) + Pendimethalin @ 850 g ha⁻¹ (PE), T₂: Pyroxasulfone @ 110 g ha⁻¹ (PE) Pendimethalin @ 800 g ha⁻¹ (PE), T₃: Sulfosulfuron + Metsulfuron @ 40 g ha⁻¹ (PE), T₄: Two hand weeding (30 and 60 DAS), T₅: Sulfosulfuron + Metsulfuron @ 35 g ha⁻¹ (PoE), T₆: Clodinafop-propargyl @ 400 g ha⁻¹ (PoE) + one hand weeding (60 DAS), T₇: 2, 4-D Na @ 750 g ha⁻¹ (PoE) + one hand weeding (60 DAS) and T₈: Weedy check (Control).

4.3.5 Fresh weight per plant

The impact of weed control treatments on fresh weight per plant is displayed in Table 4.34 and is depicted in Graph 4.32.

In year 2020-21 and 2020-22 show that plant fresh weight recorded was significantly influenced by the treatments tested at 30, 60, 90 DAS and at maturity. Pyroxasulfone 120 g PE combined with pendimethalin 850 g PE was used to increase fresh weight per plant at 30 and 60 DAS, while clodinafop-propargyl 400 g PoE combined with HW (60 DAS) was used to decrease fresh weight per plant, and sulfosulfuron combined with metsulfuron 35 g PoE and sulfosulfuron combined with metsulfuron 40 g PoE were used first. The maximum fresh weight per plant (g per plant) was observed in pyroxasulfone 120 g PE combined with pendimethalin 850 g PE, followed by pyroxasulfone 110 g PE combined with pendimethalin 850 g PE and PoE 2, 4-D Na 0.75 kg combined with HW (60 DAS), as compared to the unweeded check. At 120 DAS and harvest, lower fresh weight per plant (g per plant) were noted in sulfosulfuron combined with metsulfuron 35 g PoE and sulfosulfuron combined with metsulfuron 40 g PoE. Preston *et al.* (2014), Amare *et al.* (2016), and Kaur *et al.* (2019) reported comparable results.

Higher fresh weight per plant (g per plant) was observed with pyroxasulfone 120 g PE combined with pendimethalin 850 g PE followed by PoE 2, 4-D Na 0.75 kg combined with HW (60 DAS) and HW (30 and 60 DAS) over weedy check. At 30, 60, and harvest, lower fresh weight per plant (g per plant) were noted in the use of sulfosulfuron combined with metsulfuron 35 g PoE and sulfosulfuron combined with metsulfuron 40 g PoE and was found significantly superior compared to weedy check.



Graph 4.32 Influence of different herbicide treatments on fresh weight (g plant⁻¹) in wheat at monthly intervals (Pooled data of 2020-2021 and 2021-2022).

Table 4.35 Influence of different herbicide treatments on dry weight (g plant⁻¹) in wheat at monthly intervals (2020-2021 and 2021-2022).

Treatment	30 DAS (2020- 21)	30 DAS (2021 -22)	Pool data	60 DAS (2020 -21)	60 DAS (2021 -22)	Pool data	90 DAS (2020- 21)	90 DAS (2021 -22)	Pool data	120 DAS (2020 -21)	120 DAS (2021 -22)	Pool data	Harvest (2020- 21)	Harvest (2021- 22)	Pool data
T ₁	0.26	0.29	0.28	0.78	0.79	0.79	1.41	1.49	1.45	1.85	1.87	1.86	1.84	1.86	1.85
T ₂	0.25	0.27	0.26	0.74	0.76	0.75	1.36	1.43	1.40	1.79	1.83	1.81	1.77	1.80	1.79
T ₃	0.15	0.16	0.16	0.61	0.67	0.64	1.16	1.20	1.18	1.66	1.70	1.68	1.65	1.67	1.66
T ₄	0.21	0.26	0.24	0.69	0.71	0.70	1.22	1.28	1.25	1.76	1.79	1.78	1.78	1.76	1.77
T ₅	0.12	0.17	0.15	0.60	0.64	0.62	1.02	1.04	1.02	1.50	1.52	1.51	1.57	1.58	1.58
T ₆	0.18	0.21	0.20	0.64	0.68	0.66	1.19	1.21	1.20	1.70	1.73	1.72	1.68	1.70	1.69
T ₇	0.23	0.25	0.24	0.72	0.75	0.74	1.35	1.39	1.37	1.78	1.80	1.79	1.75	1.77	1.76
T ₈	0.10	0.11	0.11	0.48	0.50	0.49	0.91	0.99	0.95	1.20	1.24	1.22	1.18	1.17	1.18
SE m (±)	0.03	0.01	0.02	0.06	0.03	0.05	0.09	0.08	0.09	0.13	0.14	0.14	0.18	0.29	0.24
CD (p = 0.05)	0.08	0.04	0.06	0.19	0.08	0.14	0.27	0.25	0.26	0.40	0.43	0.42	0.56	0.88	0.72

SE m (±): Standard Error of mean, CD: Critical Difference and DAS: Days after sowing

Treatments: T₁: Pyroxasulfone @ 120 g ha⁻¹ (PE) + Pendimethalin @ 850 g ha⁻¹ (PE), T₂: Pyroxasulfone @ 110 g ha⁻¹ (PE) Pendimethalin @ 800 g ha⁻¹ (PE), T₃: Sulfosulfuron + Metsulfuron @ 40 g ha⁻¹ (PE), T₄: Two hand weeding (30 and 60 DAS), T₅: Sulfosulfuron + Metsulfuron @ 35 g ha⁻¹ (PoE), T₆: Clodinafop-propargyl @ 400 g ha⁻¹ (PoE) + one hand weeding (60 DAS), T₇: 2, 4-D Na @ 750 g ha⁻¹ (PoE) + one hand weeding (60 DAS) and T₈: Weedy check (Control).

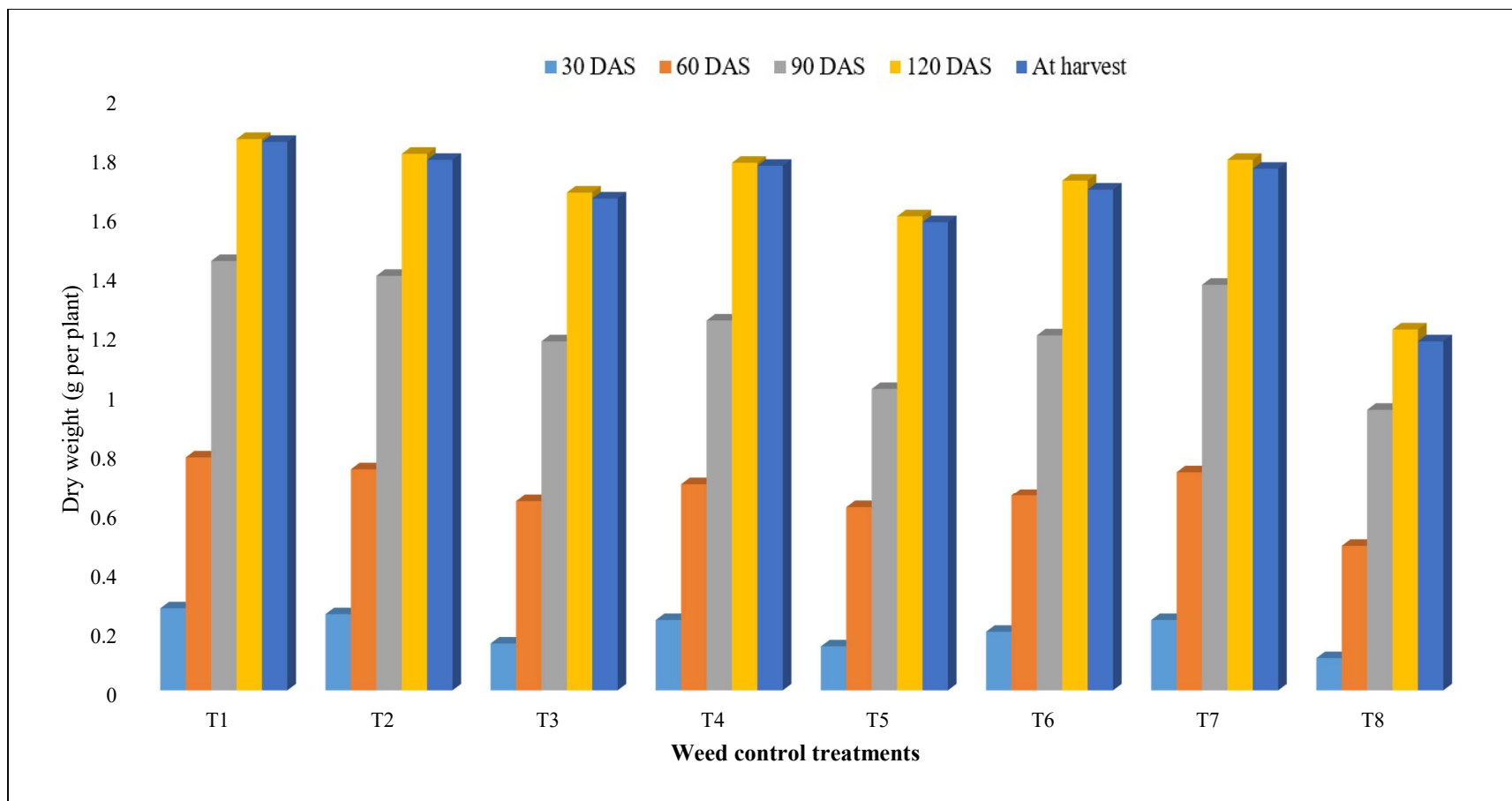
4.3.6 Dry weight per plant (g plant⁻¹)

Dry weight per plant recorded was significantly influenced by the treatments tested at 30, 60, 90 DAS and at maturity. The data are presented in table 4.35 and fig.4.33.

Data on dry weight per plant (g per plant) for the years 2020-21 and 2021-22 are available in Table 4.35. Weed control treatments increase plant dry weight in wheat above weedy check. Comparing PE herbicidal treatments to PoE herbicidal treatments, a 30 DAS increase in dry weight per plant was observed. The usage of pyroxasulfone 120 g PE mixed with pendimethalin 850 g PE resulted in the largest dry weight per plant on 60 DAS, which was followed by PoE 2, 4-D Na 0.75 kg combined with HW (60 DAS), and lesser dry weight per plant was detected. Sulfosulfuron combined with metsulfuron 35 g PoE, sulfosulfuron combined with metsulfuron 40 g PoE, and clodinafop-propargyl 400 g PoE mixed with HW (60 DAS).

Higher dry weight per plant was seen at 90 and 120 DAS when pyroxasulfone 120 g PE was used in combined with pendimethalin 850 g PE, pyroxasulfone 110 g and Pendimethalin 800 g PE followed by PoE 2, 4-D Na 0.75 kg plus HW (60 DAS) reduced dry weight per plant were seen while using 35 g of sulfosulfuron mixed with metsulfuron, 40 g of sulfosulfuron combined with metsulfuron, and 400 g of clodinafop-propargyl and HW (60 DAS). Similar outcomes were stated by Yamaji *et al.* 2014, Preston *et al.* 2014, Amare *et al.* 2016 and Kaur *et al.* 2019.

Lower dry weight per plant was noted in the use of sulfosulfuron combined with metsulfuron 35 g PoE and sulfosulfuron combined with metsulfuron 40 g PoE and clodinafop-propargyl 400 g PoE combined with HW (60 DAS) over weedy check. At 120 DAS and harvest maximum dry weight per plant were noted in the use of pyroxasulfone 120 g PE combined with pendimethalin 850 g PE, followed by pyroxasulfone 110 g PE combined with pendimethalin 800 g PE and PoE 2, 4-D Na 0.75 kg combined with HW (60 DAS).



Graph 4.33 Influence of different herbicide treatments on dry weight (g plant⁻¹) in wheat at monthly intervals (Pooled data of 2020-2021 and 2021-2022).

Table 4.36 Influence of different herbicide treatments on development studies (%) in wheat at monthly intervals (2020-2021 and 2021-2022).

Treatment	50 % Crown Root Initiation 21 DAS (2020-21)	50 % Crown Root Initiation 21 DAS (2021-22)	Pool data	50 % Flowering 110 DAS (2020-21)	50 % Flowering 110 DAS (2021-22)	Pool data
T₁	87.90	87.97	87.94	88.79	89.26	89.03
T₂	87.20	87.30	87.25	87.88	88.43	88.16
T₃	85.70	85.76	85.73	82.11	83.13	82.62
T₄	87.20	87.24	87.22	85.00	85.77	85.39
T₅	85.55	85.51	85.53	80.17	80.74	80.46
T₆	83.20	83.46	83.33	80.11	80.65	80.38
T₇	86.44	87.18	86.81	80.17	80.41	80.29
T₈	81.79	81.40	81.60	79.79	79.66	79.73
SE m (±)	0.37	0.53	0.45	0.41	0.53	0.47
CD (p = 0.05)	1.12	1.6	1.36	1.25	1.62	1.44

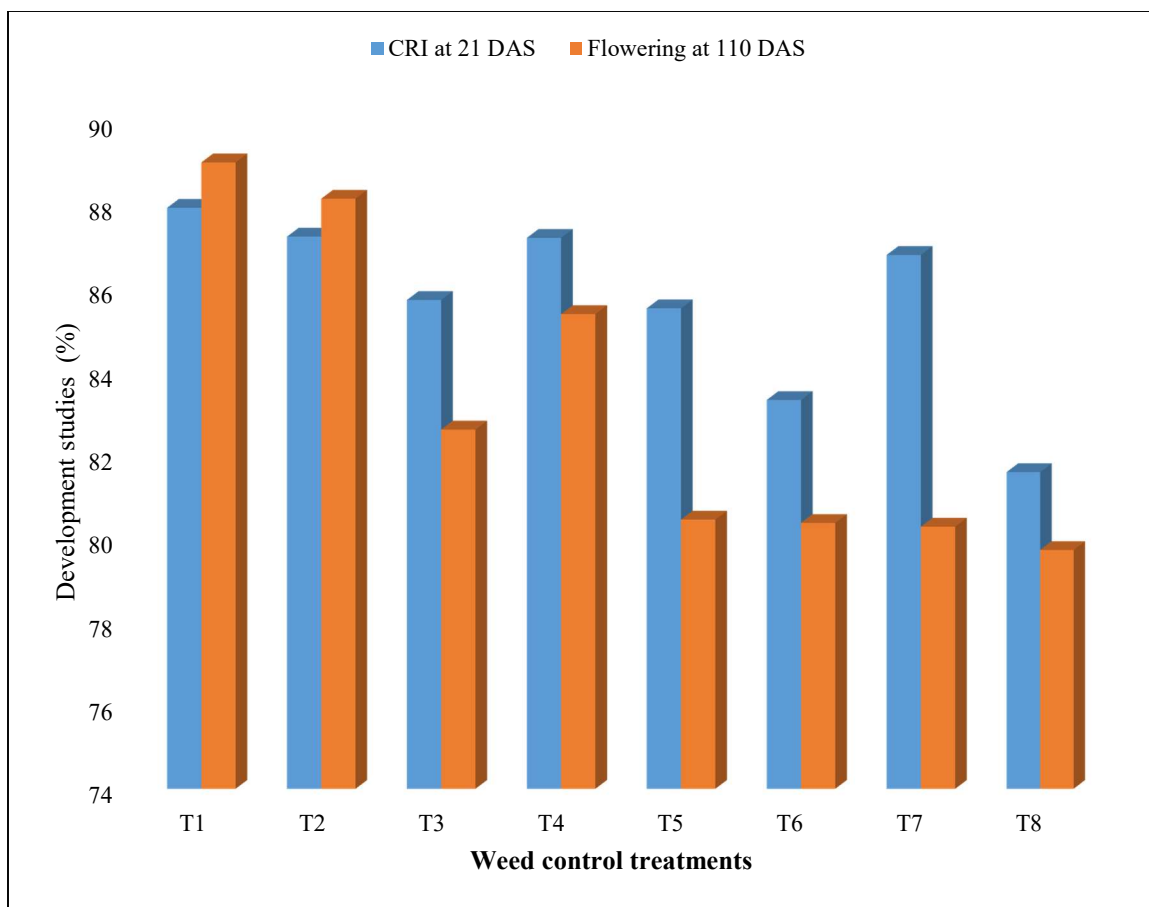
SE m (±): Standard Error of mean, CD: Critical Difference and DAS: Days after sowing

Treatments: T₁: Pyroxasulfone @ 120 g ha⁻¹ (PE) + Pendimethalin @ 850 g ha⁻¹ (PE), T₂: Pyroxasulfone @ 110 g ha⁻¹ (PE) Pendimethalin @ 800 g ha⁻¹ (PE), T₃: Sulfosulfuron + Metsulfuron @ 40 g ha⁻¹ (PE), T₄: Two hand weeding (30 and 60 DAS), T₅: Sulfosulfuron + Metsulfuron @ 35 g ha⁻¹ (PoE), T₆: Clodinafop-propargyl @ 400 g ha⁻¹ (PoE) + one hand weeding (60 DAS), T₇: 2, 4-D Na @ 750 g ha⁻¹ (PoE) + one hand weeding (60 DAS) and T₈: Weedy check (Control).

4.3.7 Development studies

The data presented in table 4.36 indicated that significant differences were not observed in days to 50 per cent flowering due to weed management

In the years 2020-21 and 2021-22 on weed control treatments considerably enhance development studies demonstrated over weedy check in Table 4.36. Compared to PoE herbicidal treatments, PE herbicidal treatments showed a maximum 50% crown root initiation at 21 DAS. The highest percentage of crown root initiation observed while using pyroxasulfone is 120 g PE in combination with 850 g PE of pendimethalin, and the next highest percentage is 110 g PE in combination with 800 g PE of pendimethalin and HW (30 and 60 DAS). At 21 DAS, 50% of the crown root initiation was seen while using clodinafop-propargyl 400 g PoE in combination with HW (60 DAS). This was followed by the combination of 35 g PoE and 40 g PoE of sulfosulfuron combined with metsulfuron. Treatments with clodinafop-propargyl 400 g PoE coupled with HW (60 DAS) showed at least 50% flowering on 110 DAS. These treatments were followed by sulfosulfuron combined with metsulfuron 35 g PoE and sulfosulfuron combined with metsulfuron 40 g PoE. The treatment with pyroxasulfone 120 g PE mixed with pendimethalin 850 g PE produced the maximum 50% blooming on 110 DAS. This was followed by PoE 2, 4-D Na 0.75 kg combined with HW (60 DAS) over weedy check.



Graph 4.34 Influence of different herbicide treatments on development studies (%) in wheat (Pooled data of 2020-2021 and 2021-2022).

Table 4.37 Influence of different herbicide treatments on yield attributes and yield in wheat (2020-2021 and 2021-2022).

Treat ment	No. of spikes per m ² (2020-21)	No. of spikes per m ² (2021- 22)	Pool data	No. of spikelet per spike (2020-21)	No. of spikelet per spike (2021- 22)	Pool data	Spike length (cm) (2020- 21)	Spike length (cm) (2021- 22)	Pool data	No. of grains per spike (2020- 21)	No. of grains per spike (2021- 22)	Pool data	Test wt. (g) (2020- 21)	Test wt. (g) (2021- 22)	Pool data
T ₁	217.14	243.22	230.18	23.10	23.47	23.29	11.47	11.49	11.48	32.42	32.76	32.59	38.79	38.95	38.87
T ₂	213.12	234.26	223.69	22.20	22.47	22.34	11.39	11.46	11.43	32.10	32.17	32.14	38.42	38.96	38.69
T ₃	200.10	222.20	211.15	20.90	20.96	20.93	11.17	11.23	11.20	31.59	31.65	31.62	36.10	36.49	36.30
T ₄	205.18	229.18	217.18	21.40	21.48	21.44	11.33	11.41	11.37	31.80	31.94	31.87	36.39	36.37	36.38
T ₅	197.15	207.17	202.16	20.45	20.50	20.48	11.11	11.20	11.16	31.50	31.59	31.55	35.96	36.11	36.04
T ₆	201.99	218.37	210.18	21.10	21.46	21.28	11.20	11.28	11.24	31.70	31.77	31.74	36.15	36.21	36.18
T ₇	209.17	229.89	219.53	23.42	23.60	23.51	11.50	11.59	11.55	32.42	32.48	32.45	37.60	37.77	37.69
T ₈	185.16	205.20	195.18	19.86	18.45	19.16	10.30	11.24	10.77	30.22	30.13	30.18	34.44	35.12	34.78
SE m (±)	1.35	1.19	1.27	0.50	0.45	0.48	0.69	0.43	0.56	0.45	0.41	0.43	0.41	0.33	0.37
CD (p = 0.05)	4.05	3.57	3.91	1.51	1.36	1.44	2.08	1.29	1.69	1.38	1.25	1.32	1.24	0.99	1.12

SE m (±): Standard Error of mean, CD: Critical Difference and DAS: Days after sowing

Treatments: T₁: Pyroxasulfone @ 120 g ha⁻¹ (PE) + Pendimethalin @ 850 g ha⁻¹ (PE), T₂: Pyroxasulfone @ 110 g ha⁻¹ (PE) Pendimethalin @ 800 g ha⁻¹ (PE), T₃: Sulfosulfuron + Metsulfuron @ 40 g ha⁻¹ (PE), T₄: Two hand weeding (30 and 60 DAS), T₅: Sulfosulfuron + Metsulfuron @ 35 g ha⁻¹ (PoE), T₆: Clodinafop-propargyl @ 400 g ha⁻¹ (PoE) + one hand weeding (60 DAS), T₇: 2, 4-D Na @ 750 g ha⁻¹ (PoE) + one hand weeding (60 DAS) and T₈: Weedy check (Control).

4.3.8 Yield attributes

The data on yield attributes are expressively impacted by weed control treatments in Table 4.37 and graph 4.35.

4.3.8.1 Number of spikes per m²

Data presented in table 4.37 and in fig 4.35 revealed that significant improvement in number of spikes per meter square due to weed management practices.

The yield characteristics for the years 2020-2021 and 2021-2022 are shown on Table 4.37 The number of spikes per meter rises with 7 weed control treatments compared to weedy check. The usage of pyroxasulfone 120 g PE paired with pendimethalin 850 g PE was shown to produce the most number of spikes per meter, after pyroxasulfone 110 g PE mixed with pendimethalin 800 g PE and PoE 2, 4-D Na 0.75 kg combined with HW (60 DAS). Treatment with sulfosulfuron combined with metsulfuron 35 g PoE and sulfosulfuron combined with metsulfuron 40 g PoE over weedy check resulted in fewer spikes per meter. Amare *et al.* (2016), Kaur and Kaur (2019), and Bayat *et al.* (2020) reported similar findings.

4.3.8.2 Spikelets per spike

Data presented in table 4.37 and in graph 4.35 revealed that significant improvement in number of spikelet per spike due to weed management practices. The usage of pyroxasulfone 120 g PE combined with pendimethalin 850 g PE, pyroxasulfone 110 g PE mixed with pendimethalin 800 g PE, and PoE 2, 4-D Na 0.75 kg paired with HW (60 DAS) resulted in the maximum number of spikelets per spike. Chandra *et al.* (2018) and Kaur *et al.* (2019) reported similar results. While compared to the weedy control, the reduced spikelets per spike were seen while using sulfosulfuron combined with metsulfuron 35 g PoE and sulfosulfuron combined with metsulfuron 40 g PoE

4.3.8.3 Spike length (cm)

Data presented in table 4.37 and in graph 4.35 revealed that significant improvement in number of spike length due to weed management practices compared to weedy check. When using pyroxasulfone 120 g PE paired with pendimethalin 850 g PE,

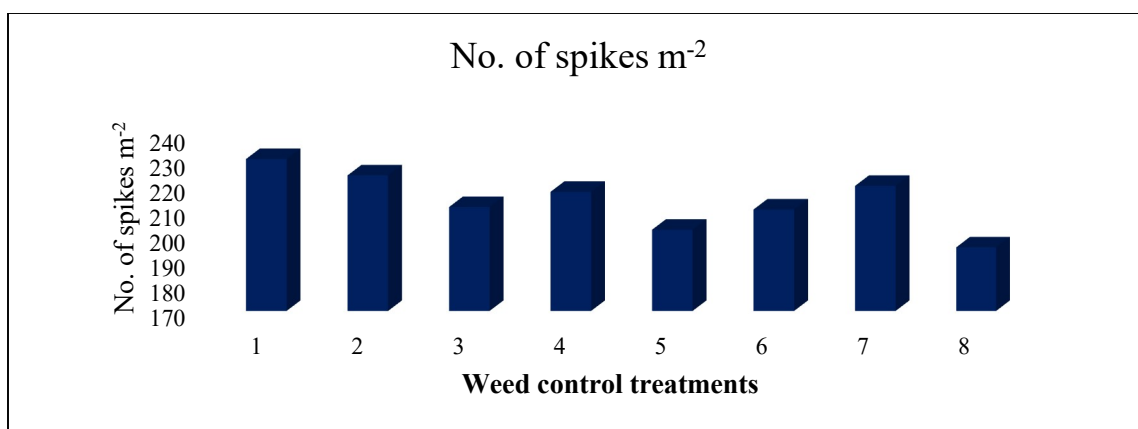
higher spike lengths (measured in centimetres) were seen. This was followed by pyroxasulfone 110 g PE mixed with pendimethalin 800 g PE, and finally PoE 2, 4-D Na 0.75 kg combined with HW (60 DAS). In comparison to the weedy check, the reduced spike length (in centimetres) were seen in sulfosulfuron combined with metsulfuron 35 g PoE and sulfosulfuron combined with metsulfuron 40 g PoE. Preston *et al.* 2014; Amare *et al.* 2016; and Kaur *et al.* 2019 have all noticed these results.

4.3.8.4 Number of grains per spike

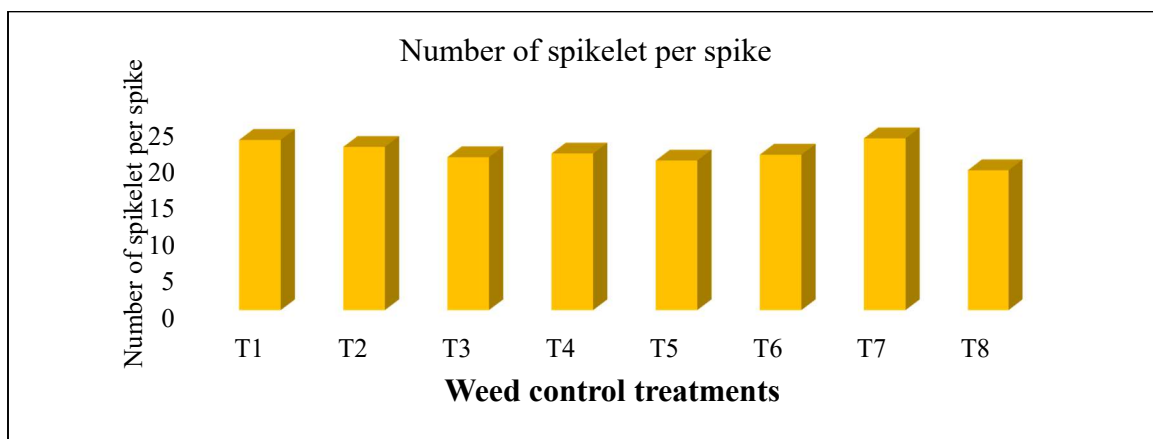
Data presented in table 4.37 and in fig 4.35 revealed that significant improvement in number of grains per spike due to weed management practices compared to weedy check. The usage of pyroxasulfone 120 g PE combined with pendimethalin 850 g PE, pyroxasulfone 110 g PE mixed with pendimethalin 800 g PE, and PoE 2, 4-D Na 0.75 kg paired with HW (60 DAS) resulted in the maximum number of grains per spike. Comparable results were reported by Bayat *et al.* (2020) and Johnson *et al.* (2018). Treatments with sulfosulfuron combined with metsulfuron 35 g PoE and sulfosulfuron combined with metsulfuron 40 g PoE showed a decrease in the number of grains per spike.

4.3.8.5 Test weight (g)

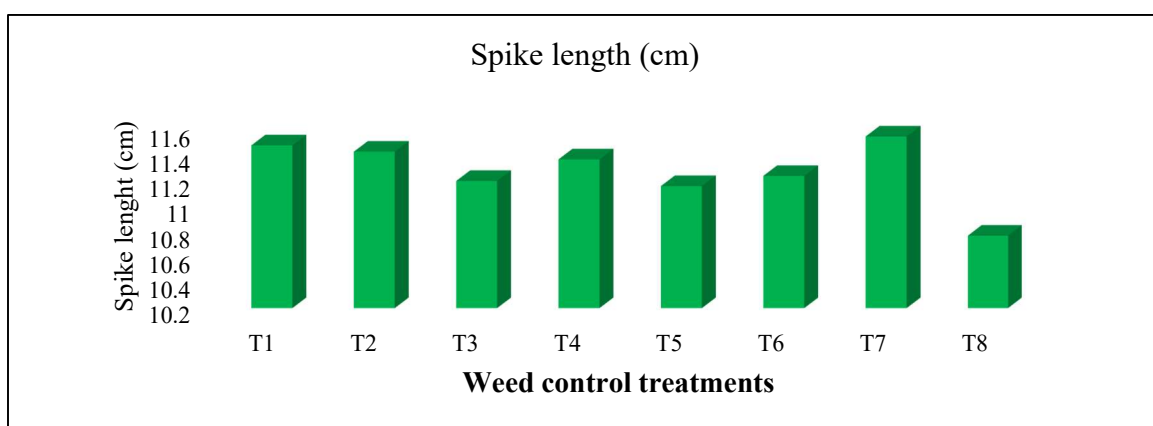
Data presented in table 4.37 and in fig 4.35 revealed that significant improvement in number of test weight due to weed management practices compared to weedy check. The use of pyroxasulfone 120 g PE combined with pendimethalin 850 g PE and PoE 2, 4-D Na 0.75 kg combined with HW (60 DAS) and lower in sulfosulfuron combined with metsulfuron 35 g PoE and sulfosulfuron combined with metsulfuron 40 g PoE likened to weedy check resulted in the maximum weight of 1000 seeds being noted. Johnson *et al.* 2018 and Amare *et al.* 2016 both workers reported the same results.



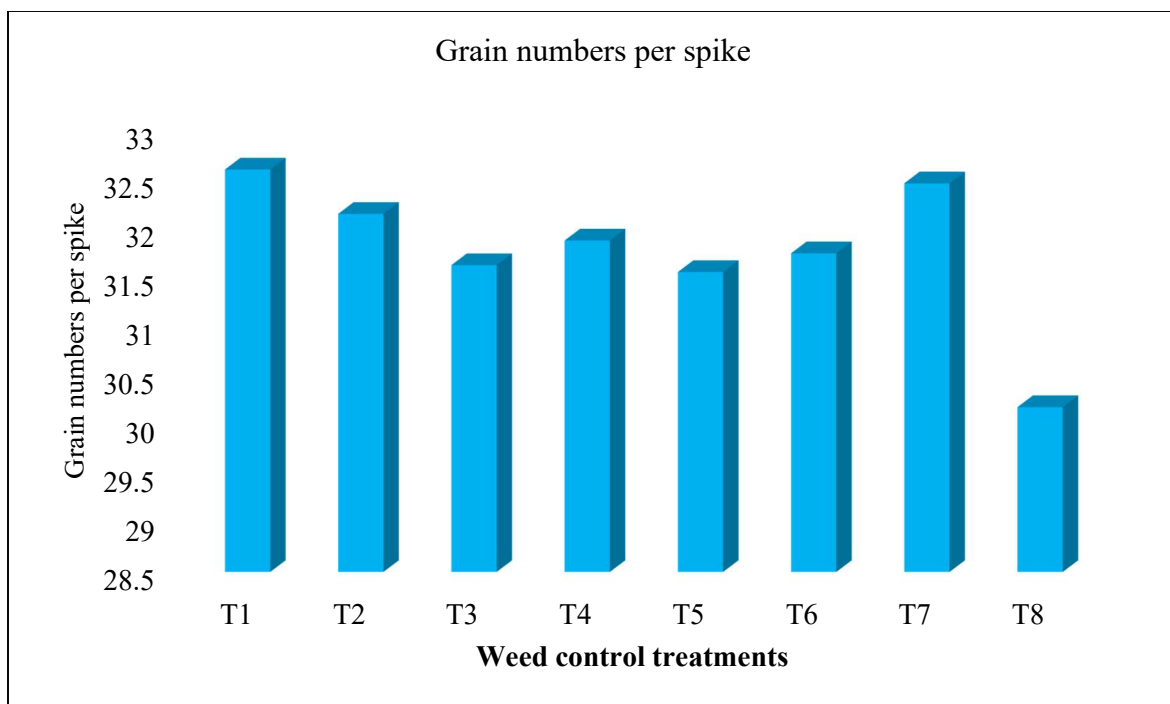
Graph 4.35a Influence of different herbicide treatments on number of spikes (m^{-2}) in wheat (Pooled data of 2020-2021 and 2021-2022).



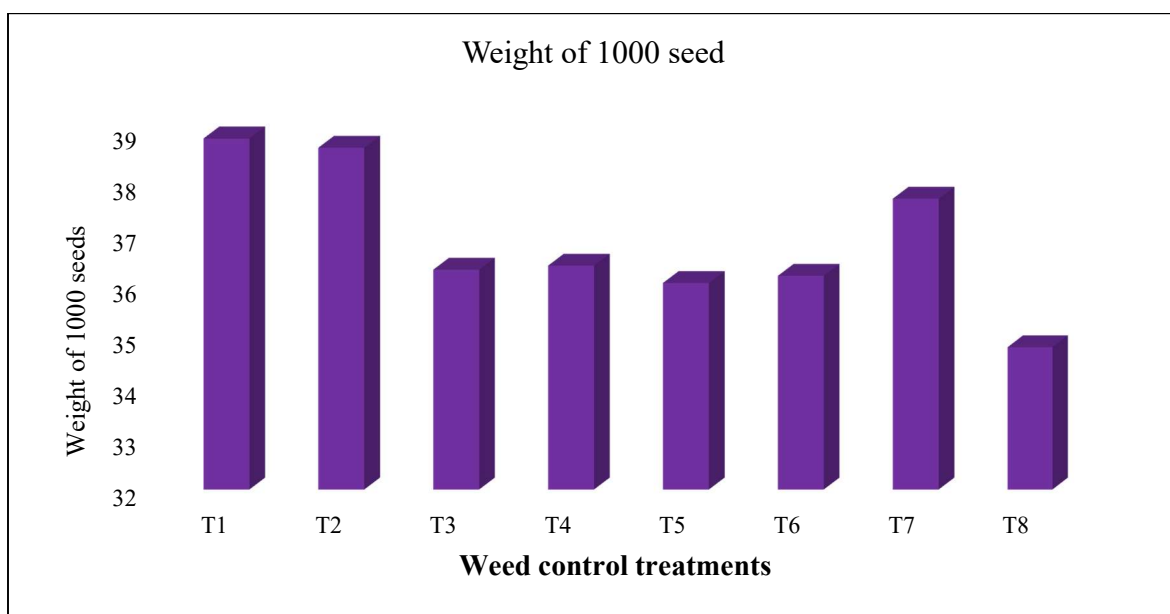
Graph 4.35b Influence of different herbicide treatments on number of spikelet per spike in wheat (Pooled data of 2020-2021 and 2021-2022).



Graph 4.35c Influence of different herbicide treatments on spike length (cm) in wheat (Pooled data of 2020-2021 and 2021-2022).



Graph 4.35d Influence of different herbicide treatments on number of grains per spike in wheat (Pooled data of 2020-2021 and 2021-2022).



Graph 4.35e Influence of different herbicide treatments on test weight (g) in wheat (Pooled data of 2020-2021 and 2021-2022).

Table 4.38 Influence of different herbicide treatments on yield character, harvest Index and weed Index in wheat (2020-2021 and 2021-2022).

Treatment	Seed yield (t ha ⁻¹) (2020-21)	Seed yield (t ha ⁻¹) (21-2022)	Pool data	Straw yield (t ha ⁻¹) (2020-21)	Straw yield (t ha ⁻¹) (2021-22)	Pool data	HI (%) (2020-21))	HI (%) (2021-22)	Pool data	WI (%) (2020-21)	WI (2021-22)	Pool data
T ₁	4.38	4.52	4.45	4.73	5.22	4.98	48.06	46.38	47.22	0.00	0.00	0.00
T ₂	4.21	4.50	4.35	4.68	4.97	4.83	47.35	47.48	47.41	3.88	0.44	2.16
T ₃	3.71	3.86	3.78	4.21	4.39	4.30	46.86	46.83	46.84	15.25	14.47	14.86
T ₄	3.98	4.25	4.12	4.48	4.71	4.60	47.07	47.42	47.24	8.95	5.93	7.44
T ₅	3.42	3.65	3.53	3.85	4.22	4.03	47.04	46.38	46.71	21.92	19.20	20.56
T ₆	3.83	4.03	3.93	4.31	4.64	4.48	47.08	46.48	46.78	12.44	10.69	11.56
T ₇	4.20	4.30	4.25	4.63	7.76	4.70	47.54	35.64	41.59	4.11	4.87	4.49
T ₈	1.92	2.08	2.00	2.30	2.70	2.50	45.50	43.51	44.51	56.16	53.98	55.07
SE m (±)	0.10	0.14	0.12	0.16	0.18	0.17	0.73	0.87	0.80	0.56	0.41	0.49
CD (p = 0.05)	0.30	0.42	0.36	0.48	0.54	0.53	2.22	2.65	2.44	1.69	1.24	1.47

SE m (±): Standard Error of mean, CD: Critical Difference and DAS: Days after sowing

Treatments: T₁: Pyroxasulfone @ 120 g ha⁻¹ (PE) + Pendimethalin @ 850 g ha⁻¹ (PE), T₂: Pyroxasulfone @ 110 g ha⁻¹ (PE) Pendimethalin @ 800 g ha⁻¹ (PE), T₃: Sulfosulfuron + Metsulfuron @ 40 g ha⁻¹ (PE), T₄: Two hand weeding (30 and 60 DAS), T₅: Sulfosulfuron + Metsulfuron @ 35 g ha⁻¹ (PoE), T₆: Clodinafop-propargyl @ 400 g ha⁻¹ (PoE) + one hand weeding (60 DAS), T₇: 2, 4-D Na @ 750 g ha⁻¹ (PoE) + one hand weeding (60 DAS) and T₈: Weedy check (Control).

4.3.8 Yield character, harvest index and weed index

Yield character is expressively effect of weed control treatments shown in Table 4.38 c and graph 4.36.

4.3.8.1 Seed yield (t ha⁻¹)

Data presented in table 4.38 revealed that significant improvement in seed yield due to weed management practices compared to weedy check. Weed management treatments increase wheat seed output (t ha⁻¹) in 2020-2021 and 2021-2022, similar to weedy check. When pyroxasulfone 120 g PE combined with pendimethalin 850 g PE and PoE 2, 4-D Na 0.75 kg combined with HW (60 DAS) was used, the seed yield (t per ha) increased, and when sulfosulfuron combined with metsulfuron 35 g PoE and sulfosulfuron combined with metsulfuron 40 g PoE were used, the seed yield (t per ha) decreased and was compared to weedy check. Johnson *et al.* 2018 and Amare *et al.* 2016 both reported the same results.

4.3.8.2 Straw yield (t ha⁻¹)

Data presented in table 4.38 revealed that significant improvement in straw yield due to weed management practices compared to weedy check. The wheat character in the years 2020-21 and 2021-22 indicates that the weed control treatments increase straw production (t per ha) in comparison to weedy check. Pyroxasulfone 120 g PE combined with pendimethalin 850 g PE and pyroxasulfone 110 g PE combined with pendimethalin 800 g PE and PoE 2, 4- D Na 0.75 kg combined with HW (60 DAS) and lower sulfosulfuron combined with metsulfuron 35 g PoE and sulfosulfuron combined with metsulfuron 40 g PoE associated with weedy check were found to yield the highest yield of straw. Johnson *et al.* 2018 and Amare *et al.* 2016 both made confidential conclusions.

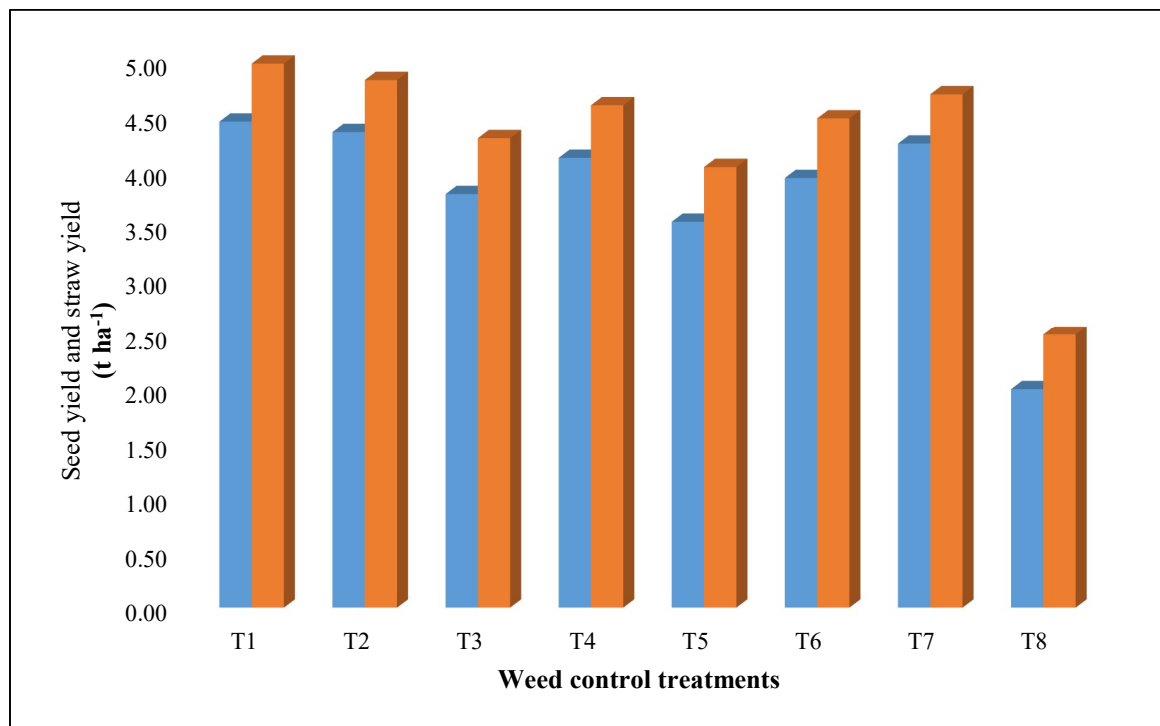
4.3.8.4 Harvest index (%)

Data presented in table 4.38 revealed that significant improvement in harvest index due to weed management practices compared to weedy check. Table 4.38 displays the yield character of wheat for the 2020-21 and 2021-22 growing seasons, with the increase in the harvest index (%) in wheat for weed control treatments compared to weedy check. The use

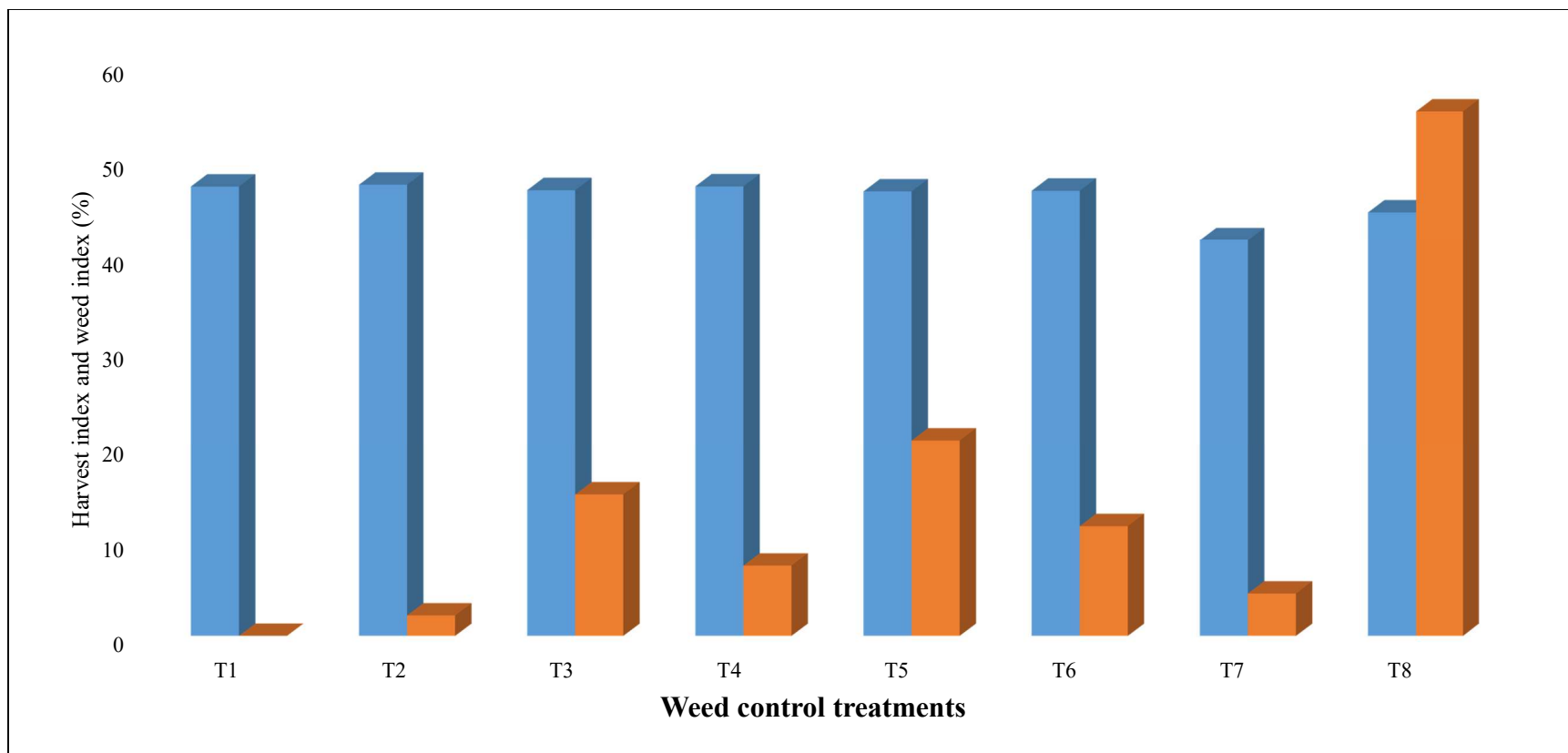
of sulfosulfuron combined with metsulfuron 35 g PoE and sulfosulfuron combined with metsulfuron 40 g PoE resulted in the highest harvest index (%), whereas the use of pyroxasulfone 120 g PE combined with pendimethalin 850 g PE and PoE 2, 4-D Na 0.75 kg combined with HW (60 DAS) yielded the lowest harvest index (%).

4.3.8.5 Weed index (%)

When compared to a weedy check, the data in table 4.38 showed a considerable weed index caused by weed control techniques. Data on yield character in Table 4.38 weed control treatments growth of weed index (%) in wheat compared to weedy check in 2020-21 and 2021-22. The combinations of pyroxasulfone 120 g PE and pendimethalin 850 g PE and pyroxasulfone 110 g PE and pendimethalin 800 g PE and PoE 2, 4-D Na 0.75 kg combined with HW (60 DAS) showed the lowest weed index (%), while the combinations of sulfosulfuron combined with metsulfuron 35 g PoE and sulfosulfuron combined with metsulfuron 40 g PoE showed the highest weed percentage when compared to weedy checks. Dixit *et al.* 2014; Bhoir *et al.* 2016; and Bayat *et al.* 2020 virtually stated these results.



Graph 4.36a Influence of different herbicide treatments on seed yield and straw yield (t ha⁻¹) in wheat (Pooled data of 2020-2021 and 2021-2022).



Graph 4.36b Influence of different herbicide treatments on harvest index and weed index (%) in wheat (Pooled data of 2020-2021 and 2021-2022).

Table 4.39 Influence of different herbicide treatments on crop growth rate ($\text{g m}^{-2} \text{ day}^{-1}$) in wheat at monthly intervals (2020-2021 and 2021-2022) (CGR X 10).

Treatment	30-60 DAS (2020-21)	30-60 DAS (2021- 22)	Pool data	60-90 DAS (2020-21)	60-90 DAS (2021-22)	Pool data	90-120 DAS (2020-21)	90-120 DAS (2021-22)	Pool data
T ₁	0.17	0.17	0.17	0.21	0.23	0.22	0.15	0.13	0.14
T ₂	0.16	0.16	0.16	0.21	0.22	0.22	0.14	0.13	0.14
T ₃	0.15	0.17	0.16	0.18	0.18	0.18	0.17	0.17	0.17
T ₄	0.16	0.15	0.16	0.18	0.19	0.18	0.18	0.17	0.18
T ₅	0.16	0.16	0.16	0.14	0.13	0.14	0.16	0.16	0.16
T ₆	0.15	0.16	0.16	0.18	0.18	0.18	0.17	0.17	0.17
T ₇	0.16	0.17	0.17	0.21	0.21	0.21	0.14	0.14	0.14
T ₈	0.13	0.13	0.13	0.14	0.16	0.15	0.10	0.08	0.09
SE m ($\pm$)	0.02	0.03	0.03	0.05	0.04	0.05	0.07	0.08	0.08
CD (p = 0.05)	0.05	0.07	0.06	0.14	0.13	0.14	0.20	0.23	0.22

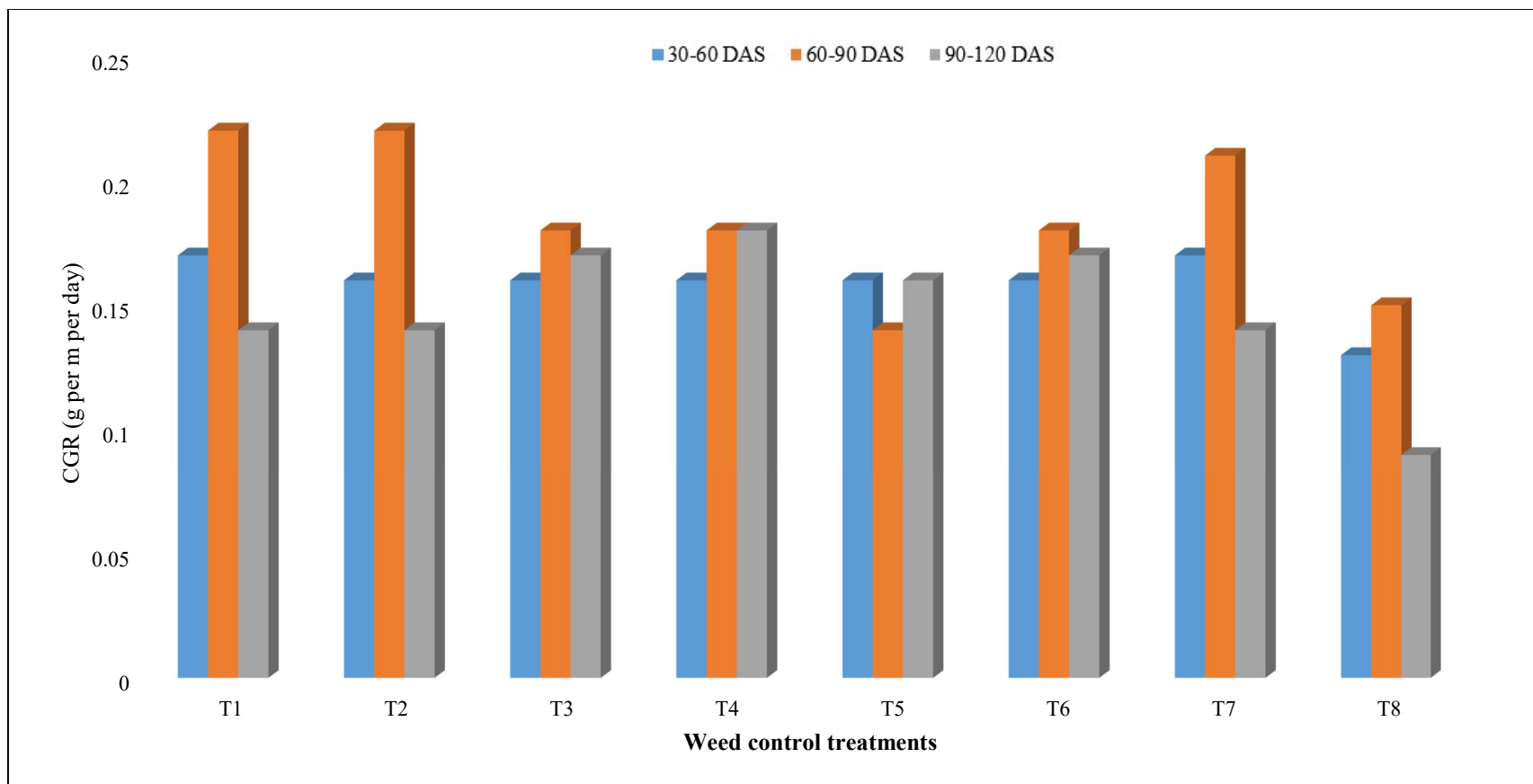
SE m ($\pm$): Standard Error of mean, CD: Critical Difference and DAS: Days after sowing

Treatments: T₁: Pyroxasulfone @ 120 g ha⁻¹ (PE) + Pendimethalin @ 850 g ha⁻¹ (PE), T₂: Pyroxasulfone @ 110 g ha⁻¹ (PE) + Pendimethalin @ 800 g ha⁻¹ (PE), T₃: Sulfosulfuron + Metsulfuron @ 40 g ha⁻¹ (PE), T₄: Two hand weeding (30 and 60 DAS), T₅: Sulfosulfuron + Metsulfuron @ 35 g ha⁻¹ (PoE), T₆: Clodinafop-propargyl @ 400 g ha⁻¹ (PoE) + one hand weeding (60 DAS), T₇: 2, 4-D Na @ 750 g ha⁻¹ (PoE) + one hand weeding (60 DAS) and T₈: Weedy check (Control).

4.3.10 Crop growth rate ($\text{g m}^{-2} \text{ day}^{-1}$)

The information about CGR effect of weed control treatments shown in Table 4.39 and graph 4.37.

Data presented in table 4.39 revealed that significant improvement in CGR due to weed management practices compared to weedy check. According to data from 2020-21 and 2021-22, weed control treatments increase wheat CGR when compared to weedy check. Using pyroxasulfone 110 g PE combined with pendimethalin 800 g PE, HW (30 and 60 DAS), PoE 2, 4-D Na 0.75 kg combined with HW (60 DAS), and sulfosulfuron combined with metsulfuron 40 g PoE, clodinafop-propargyl 400 g PoE combined with HW (60 DAS), and pyroxasulfone 120 g PE combined with pendimethalin 850 g PE likened to weedy check all showed higher CGR on 30-60 DAS. Lower CGR were observed at 60-90 DAS in the use of extreme pyroxasulfone 120 g PE combined with pendimethalin 850 g PE followed by PoE 2, 4-D Na 0.75 kg combined with HW (60 DAS), and pyroxasulfone 110 g PE combined with pendimethalin 800 g PE. Sulfosulfuron combined with metsulfuron 35 g PoE was used first, then HW (30 and 60 DAS). PoE 2, 4-D Na 0.75 kg combined with HW (60 DAS) was lower than pyroxasulfone 110 g PE combined with pendimethalin 800 g PE and pyroxasulfone 120 g PE. On 90-120 DAS, supreme CGR were noted in the use of sulfosulfuron combined with metsulfuron 35 g PoE followed by HW (60 DAS) and clodinafop-propargyl 400 g PoE combined with HW (60 DAS).



Graph 4.37 Influence of different herbicide treatments on crop growth rate ($\text{g m}^{-2} \text{ day}^{-1}$) in wheat at monthly intervals (Pooled data of 2020-2021 and 2021-2022).

Table 4.40 Influence of different herbicide treatments on relative growth rate ($\text{g g}^{-1} \text{ day}^{-1}$) in wheat at monthly intervals (2020-2021 and 2021-2022) (RGR X 10).

Treatment	30-60 DAS (2020-21)	30-60 DAS (2021-22)	Pool data	60-90 DAS (2020-21)	60-90 DAS (2021-22)	Pool data	90-120 DAS (2020-21)	90-120 DAS (2021-22)	Pool data
T₁	0.37	0.33	0.35	0.20	0.21	0.20	0.09	0.08	0.08
T₂	0.36	0.34	0.35	0.20	0.21	0.21	0.09	0.08	0.09
T₃	0.47	0.48	0.47	0.21	0.19	0.20	0.12	0.12	0.12
T₄	0.40	0.33	0.37	0.19	0.20	0.19	0.12	0.11	0.12
T₅	0.54	0.44	0.49	0.18	0.16	0.17	0.13	0.13	0.13
T₆	0.42	0.39	0.41	0.21	0.19	0.20	0.12	0.12	0.12
T₇	0.38	0.37	0.37	0.21	0.21	0.21	0.09	0.09	0.09
T₈	0.52	0.50	0.51	0.21	0.23	0.22	0.09	0.08	0.08
SE m ($\pm$)	0.05	0.04	0.05	0.07	0.07	0.07	0.09	0.10	0.10
CD (p = 0.05)	0.15	0.13	0.14	0.21	0.24	0.23	0.30	0.31	0.31

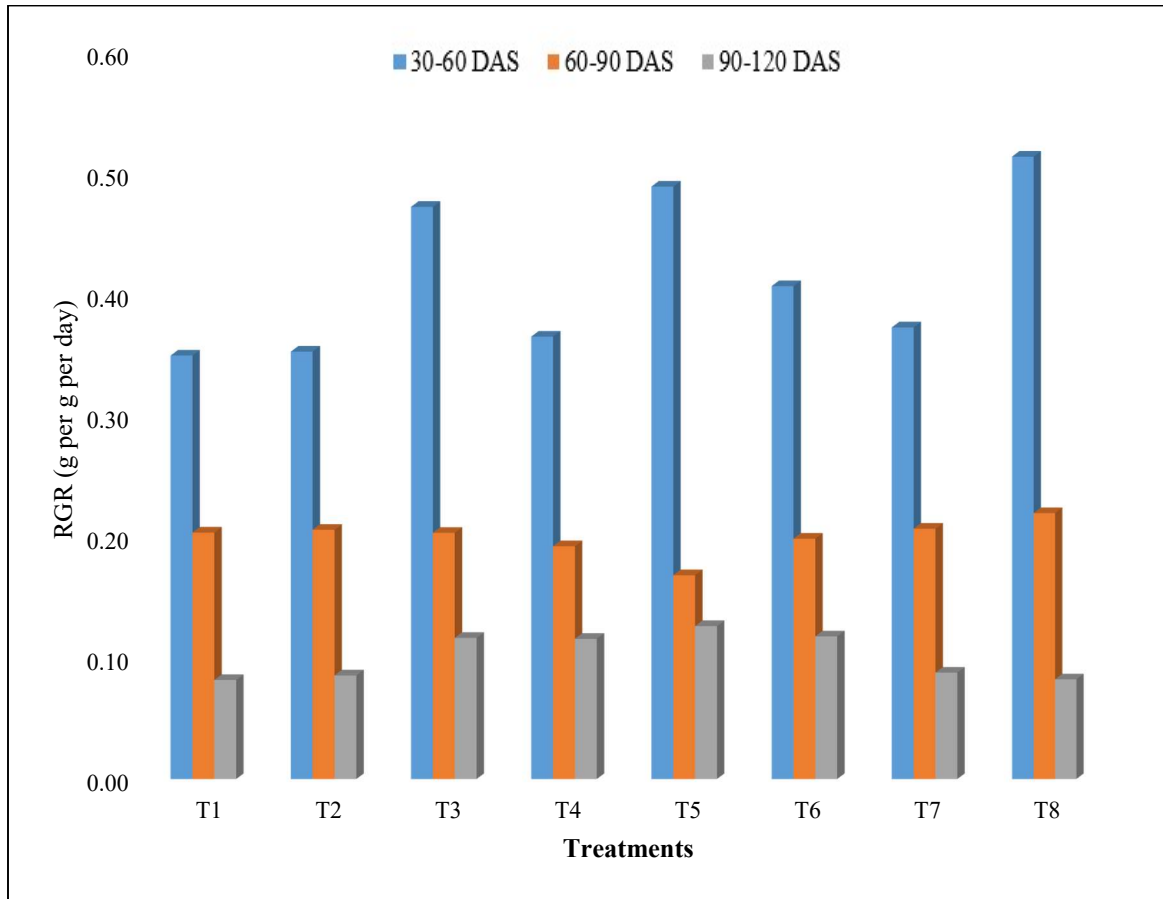
SE m ($\pm$): Standard Error of mean, CD: Critical Difference and DAS: Days after sowing

Treatments: T₁: Pyroxasulfone @ 120 g ha⁻¹ (PE) + Pendimethalin @ 850 g ha⁻¹ (PE), T₂: Pyroxasulfone @ 110 g ha⁻¹ (PE) Pendimethalin @ 800 g ha⁻¹ (PE), T₃: Sulfosulfuron + Metsulfuron @ 40 g ha⁻¹ (PE), T₄: Two hand weeding (30 and 60 DAS), T₅: Sulfosulfuron + Metsulfuron @ 35 g ha⁻¹ (PoE), T₆: Clodinafop-propargyl @ 400 g ha⁻¹ (PoE) + one hand weeding (60 DAS), T₇: 2, 4-D Na @ 750 g ha⁻¹ (PoE) + one hand weeding (60 DAS) and T₈: Weedy check (Control).

4.3.11 Relative growth rate ($\text{g g}^{-1} \text{ day}^{-1}$)

The data about the RGR impact of weed management strategies displayed in Table 4.40 and Graph 4.38 every month till harvest

The RGR in Table 4.40 indicates that weed control treatments increase RGR in wheat when compared to weedy check, based on data from 2020-21 and 2021-22. Higher RGR were noted on 30-60 DAS in the combination of sulfosulfuron combined with metsulfuron 35 g PoE, which was followed by sulfosulfuron combined with metsulfuron 40 g PoE and clodinafop-propargyl 400 g PoE combined with HW (60 DAS). Lower RGR were noted in the combination of pyroxasulfone 120 g PE and pendimethalin 850 g PE, pyroxasulfone 110 g PE and PoE 2, 4-D Na 0.75 kg combined with HW (60 DAS). RGR were seen at 60-90 DAS in the usage of sulfosulfuron combined with metsulfuron 40 g PoE and sulfosulfuron plus metsulfuron 35 g PoE, respectively. Pyroxasulfone 120 g PE coupled with pendimethalin 850 g PE, and clodinafop-propargyl 400 g PoE paired with HW (60 DAS) and lower HW (60 DAS). When using pyroxasulfone 120 g PE combined with pendimethalin 850 g PE and pyroxasulfone 110 g PE combined with pendimethalin 800 g PE, on 90-120 DAS, lower RGR were observed. This was especially true when using sulfosulfuron combined with metsulfuron 35 g PoE, clodinafop-propargyl 400 g PoE combined with HW (60 DAS) and HW (60 DAS), which was compared to weedy check.



Graph 4.38 Influence of different herbicide treatments on relative growth rate ($\text{g g}^{-1} \text{day}^{-1}$) in wheat at monthly periods (Pooled data of 2020-2021 and 2021-2022).

Table 4.41 Influence of different herbicide treatments on economics in wheat (2020-2021 and 2021-2022).

Treatments	Gross return (₹ ha ⁻¹) (2020-21)	Gross return (₹ ha ⁻¹) (2021-22)	Pool	Cost of cultivation (₹ ha ⁻¹) (2020-21)	Cost of cultivation (₹ ha ⁻¹) (2021-22)	Pool	Net return (₹ ha ⁻¹) (2020-21)	Net return (₹ ha ⁻¹) (2021-22)	Pool	B:C ratio (2020-21)	B:C ratio (2021-22)	Pool
T ₁	94695	102245	98470	33770	33770	33770	60925	68475	64700	1.80	2.04	1.92
T ₂	91440	102650	97045	33383	33383	33383	58057	69267	63662	1.74	2.08	1.91
T ₃	80515	83585	82050	31062	31062	31062	49454	52524	50989	1.59	1.87	1.73
T ₄	86320	92280	89300	36865	36865	36865	49455	55415	52435	1.34	1.86	1.60
T ₅	74175	79115	76645	30938	30938	30938	43237	48177	45707	1.40	1.66	1.53
T ₆	83065	87575	85320	32128	32128	32128	50937	55447	53192	1.59	1.69	1.64
T ₇	90945	93155	92050	31803	31803	31803	59142	61352	60247	1.86	1.82	1.84
T ₈	41850	45650	43750	29002	29002	29002	12848	16648	14748	0.44	0.66	0.55

Treatments: T₁: Pyroxasulfone @ 120 g ha⁻¹ (PE) + Pendimethalin @ 850 g ha⁻¹ (PE), T₂: Pyroxasulfone @ 110 g ha⁻¹ (PE) Pendimethalin @ 800 g ha⁻¹ (PE), T₃: Sulfosulfuron + Metsulfuron @ 40 g ha⁻¹ (PE), T₄: Two hand weeding (30 and 60 DAS), T₅: Sulfosulfuron + Metsulfuron @ 35 g ha⁻¹ (PoE), T₆: Clodinafop-propargyl @ 400 g ha⁻¹ (PoE) + one hand weeding (60 DAS), T₇: 2, 4-D Na @ 750 g ha⁻¹ (PoE) + one hand weeding (60 DAS) and T₈: Weedy check (Control).

4.3.12 Economics studies in wheat

4.3.12.1 Cost of cultivation

The most costly HW reported cost of cultivation was discovered in 2020-21, followed by 2020-22 data on the cost of cultivation displayed in Table 4.41 and graph 4.39; the weedy check revealed the lowest cost of culture. Because more personnel are involved in tending the plot to keep weeds in check, HW has the highest cultivation costs.

4.3.12.2 Total and net return

The data on total and net return are impacted with different weed control treatments, shown in Table 4.41.

In the years 2020-2021 and 2021-2022, HW (30 and 60 DAS) had the greatest total and net return, followed by pyroxasulfone 120 g PE combined with pendimethalin 850 g PE and pyroxasulfone 110 g PE combined with pendimethalin 800 g PE, while the remaining treatments showed lower total and net return. The weedy check indicated the lowest total then net returns.

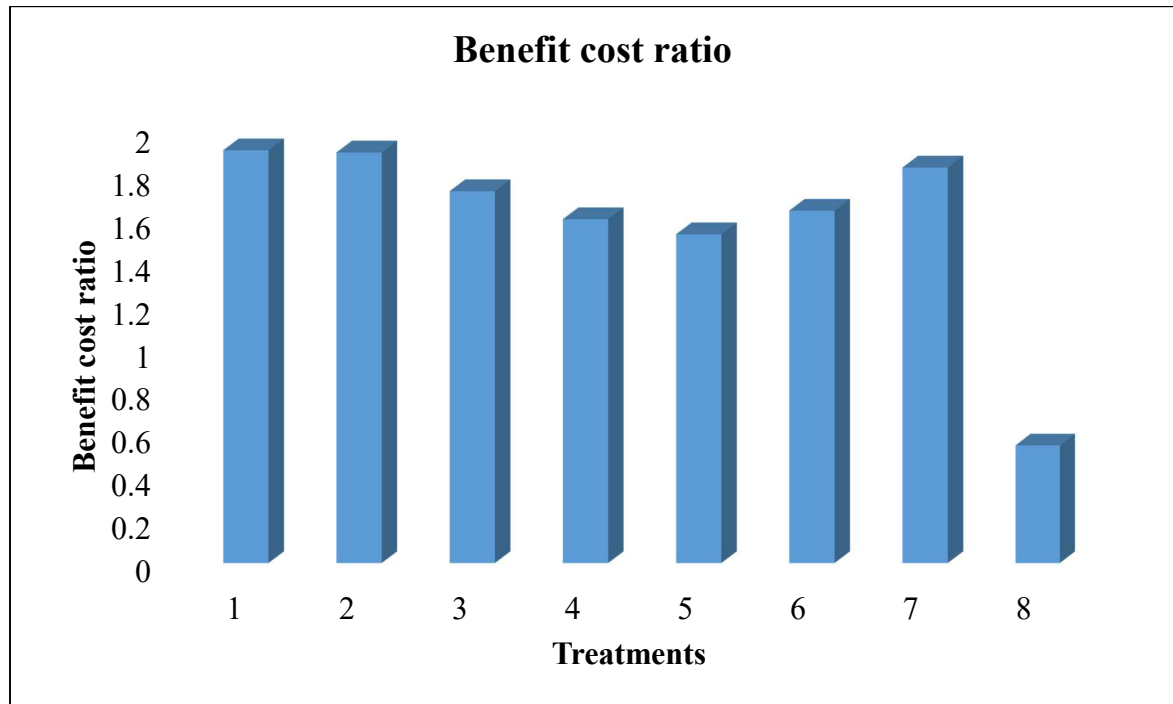
The cumulative data from 2020-2021 and 2020-2022 that was included in weedy checks indicated that their total and net return were higher than those of other treatments. HW (30 and 60 DAS) had the greatest net returns, followed by pyroxasulfone 120 g PE and pendimethalin 850 g PE and pyroxasulfone 110 g PE and pendimethalin 800 g PE.

4.3.12.3 Benefit cost ratio

The benefit cost ratio data is influenced by the different weed control techniques displayed in Table 4.41 and Graph 4.39.

Benefit cost ratio over weedy check with weed control treatments in the years 2020-2021 and 2021-2022 is shown in Table 4.41. The treatments with the greatest documented benefit-to-cost ratios were pyroxasulfone 120 g PE coupled with pendimethalin 850 g PE and pyroxasulfone 110 g PE combined with pendimethalin 800 g PE and HW (60 DAS). In the weedy check, the lowest benefit-to-cost ratio was noted. Amare *et al.* (2016) and Kaur *et al.* (2019) reported results that were almost identical. The unweeded minimum benefit cost ratio was seen in Table 4.41 and Graph 4.39, which provide cumulative data

for the years 2020-2021 and 2021-2022. When compared to the other treatments, the usage of pyrooxasulfone 120 g PE combined with pendimethalin 850 g PE had the greatest benefit-cost ratio, followed by pyrooxasulfone 110 g PE combined with pendimethalin 800 g PE and HW (30 and 60 DAS).



Graph 4.39 Influence of different herbicide treatments on benefit cost ratio in wheat (Pooled data of 2020-2021 and 2021-2022).

4.4 Studies of weeds

4.4.1 Weed observed in testing site

Dicot weeds as well as monocot weeds majority were observed in study sites. Dicot and monocot were present on area. The weed classes is specified on Table 4.42. and 4.43.

Table 4.42 Weeds detected at study site

Sr. No.	Common Name	Botanical Name	Family
A	Monocot		
1.	Tropical spiderwort	<i>Commelina benghalensis</i> L.	Commelinaceae
2.	Large crab grass	<i>Digitaria sanguinalis</i> L. (Scop.)	Poaceae
B	Sedges		
3.	Purple nutsedge	<i>Cyperus rotundus</i> L.	Cyperaceae
C	Dicot		
4.	Sicklepod	<i>Cassia tora</i> L. (Roxb.)	Fabaceae
5.	Cock's comb	<i>Celosia argentea</i> L.	Amaranthaceae

Table 4.43 Weed flora observed in green gram crop in weedy check (Control) (2021 and 2022)

Sr. No.	Weed species	20	40	60	Harvest
1.	<i>Commelina benghalensis</i>	✓	✓	✓	✓
2.	<i>Digitaria sanguinalis</i>	✓	✓	✓	✓
3.	<i>Cyperus rotundus</i>	✓	✓	✓	✓
4.	<i>Cassia tora</i>	✓	✓	✓	✓
5.	<i>Celosia argentea</i>	✓	✓	✓	✓

✓ Represents presence of weed

Table 4.44 Influence of different herbicide treatments on count (No. m⁻²) of *Commelina benghalensis* L. in green gram at 20 days intervals (2021 and 2022).

Treatment	20 DAS (2021)	20 DAS (2022)	Pool data	40 DAS (2021)	40 DAS (2022)	Pool data	60 DAS (2021)	60 DAS (2022)	Pool data	Harvest (2021)	Harvest (2022)	Pool data
T ₁	1.41** (2.0)*	1.44 (2.07)	1.43 (2.035)	1.48 (2.3)	1.53 (2.35)	1.53 (2.35)	1.58 (2.5)	1.59 (2.54)	1.58 (2.52)	1.56 (2.44)	1.58 (2.52)	1.57 (2.48)
T ₂	1.0 (1.00)	1.02 (1.04)	1.01 (1.020)	1.34 (1.8)	1.33 (1.84)	1.36 (1.84)	1.39 (1.94)	2.41 (1.99)	1.40 (1.97)	1.38 (1.94)	1.40 (1.96)	1.40 (1.95)
T ₃	1.10 (1.2)	1.11 (1.23)	1.10 (1.215)	1.22 (1.5)	1.26 (1.59)	1.21 (1.59)	1.14 (1.33)	1.18 (1.40)	1.17 (1.37)	1.14 (1.30)	1.15 (1.32)	1.14 (1.31)
T ₄	2.24 (5.0)	1.26 (5.12)	2.25 (5.060)	1.0 (1.00)	1.03 (1.06)	1.03 (1.06)	1.09 (1.2)	1.14 (1.29)	2.12 (1.25)	1.04 (1.1)	1.06 (1.13)	1.06 (1.12)
T ₅	2.45 (6.0)	1.46 (6.07)	2.46 (6.035)	1.55 (2.4)	1.57 (2.45)	1.57 (2.45)	1.45 (2.1)	1.48 (2.18)	1.46 (2.14)	1.41 (2.00)	1.45 (2.09)	1.43 (2.05)
T ₆	2.49 (6.2)	1.52 (6.26)	2.50 (6.230)	1.57 (2.55)	1.64 (2.69)	1.64 (2.69)	1.56 (2.44)	1.57 (2.48)	1.57 (2.46)	1.55 (2.42)	1.57 (2.45)	1.56 (2.44)
T ₇	2.41 (5.8)	2.42 (5.87)	2.42 (5.835)	1.49 (2.22)	1.51 (2.28)	1.51 (2.28)	1.41 (2.00)	1.45 (2.09)	1.43 (2.05)	1.41 (2.00)	1.44 (2.06)	1.42 (2.03)
T ₈	2.61 (7.0)	2.69 (7.21)	2.67 (7.105)	3.11 (10.0)	3.19 (10.16)	3.19 (10.16)	3.19 (10.20)	3.20 (10.30)	3.20 (10.25)	3.17 (10.07)	3.19 (10.23)	3.18 (10.15)
SE m (±)	0.10	0.06	0.08	0.16	0.08	0.12	0.18	0.10	0.14	0.14	0.09	0.12
CD (p = 0.05)	0.31	0.18	0.25	0.48	0.25	0.37	0.55	0.30	0.43	0.42	0.26	0.34

*Values given in parenthesis are the mean of original values. **Data subjected to ($\sqrt{x+0.5}$) square root transformation, SE m (±): Standard error of mean, CD: Critical Difference and DAS: Days after sowing

Treatments: T₁: Imazethapyr @ 60 g ha⁻¹ (PE), T₂: Pendimethalin 1 @ kg ha⁻¹ (PE), T₃: Pendimethalin 1 @ kg ha⁻¹ (PE) combined with Imazethapyr @ 50 g ha⁻¹ (PoE), T₄: Hand weeding twice (20 and 40 DAS), T₅: Quizalofop-p-ethyl @ 75 g ha⁻¹ (PoE), T₆: Imazethapyr + Imazamax @ 75 g ha⁻¹ (PoE), T₇: Sodium Aciflourfen and Clodinafop-propargyl @ 180 g ha⁻¹ (PoE) and T₈: Unweeded check (Control).

I. Green gram

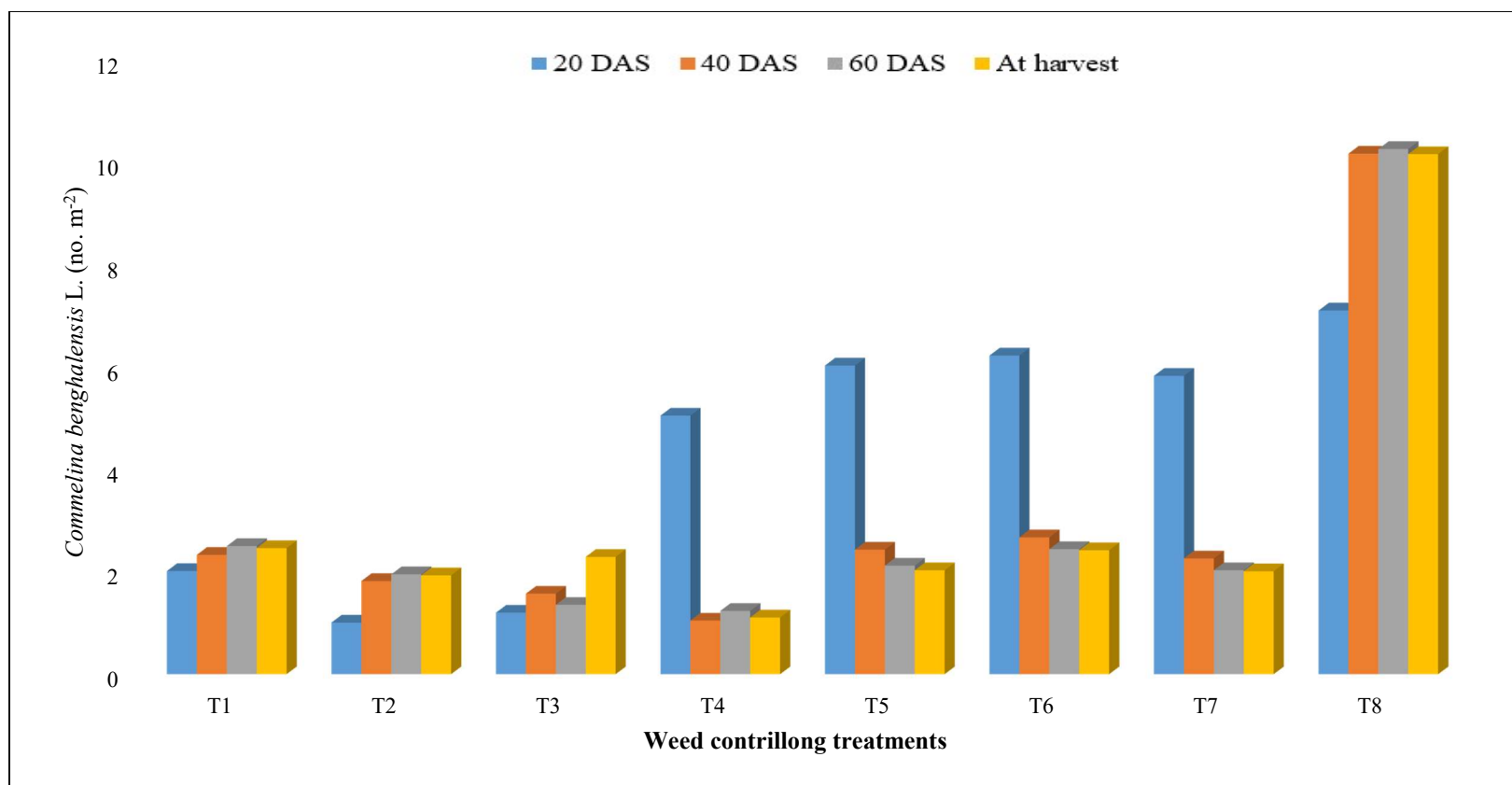
4.2.2 Species- wise and total species of weeds

Species-wise and total species of weeds were recorded at 20 day intervals to harvest.

4.4.2.1 *Commelina benghalensis* L.

Table 4.44 and Graph 40 present data on the population of *Commelina benghalensis* L. in 2021 and 2022 as a function of weed control interventions at 20 days prior to harvest. *Commelina benghalensis* L. data from 2021 and 2022 demonstrated that all weed control techniques significantly decreased this weed's population over the weedy check. The lowest population on *Commelina benghalensis* L. was successively control by 1000 g of PE pendimethalin and 50 g of PoE imazethapyr, with comparable HW (20 and 40 DAS). In the following phase of the investigation, HW were likewise equivalent to the imazethapyr 60 g PE. The combination of 1000 g of PE pendimethalin and 50 g of PoE imazethapyr, a control for *Commelina benghalensis* L., over a weedy check resulted in an increase in the species population during each observing period. T. Ramesh *et al.* 2020 expressed the same results.

The combined data presented in Table 4.44 and Graph 4.40 indicates that the most effective herbicide at 20 DAS for weedy check is PE pendimethalin 1000 g in combined with PoE imazethapyr 50 g. This treatment has demonstrated exceptional control of *Commelina benghalensis* L. in both years. Using PE pendimethalin 1000 g in combination with PoE imazethapyr 50 g over weedy check resulted in reduced counts on 40 DAS. Later in the observation, the weed was successfully controlled by combining 1000 g of PE pendimethalin with 50 g of PoE imazethapyr. PE pendimethalin 1000 g and *Commelina benghalensis* L. were under better control after two HW (20 and 40 DAS).



Graph 4.40 Influence of different herbicide treatments on count (No. m⁻²) of *Commelina benghalensis* L. in in green gram at 20 days intervals (Pool data of 2021 and 2022).

Table 4.45 Influence of different herbicide treatments on count of (No. m⁻²) of *Digitaria sanguinalis* L. in green gram at 20 days intervals (2021 and 2022).

Treatment	20 DAS (2021)	20 DAS (2022)	Pool data	40 DAS (2021)	40 DAS (2022)	Pool data	60 DAS (2021)	60 DAS (2022)	Pool data	Harvest (2021)	Harvest (2022)	Pool data
T ₁	1.73** (3.0)*	1.75 (3.08)	1.74 (3.04)	1.79 (3.2)	1.81 (3.26)	1.80 (3.23)	1.71 (3.5)	1.89 (3.56)	1.87 (3.53)	1.84 (3.42)	1.88 (3.54)	1.86 (3.48)
T ₂	1.45 (2.2)	1.50 (2.24)	1.49 (2.22)	1.58 (2.5)	1.60 (2.57)	1.59 (2.53)	1.64 (2.7)	1.66 (2.76)	1.64 (2.73)	1.61 (2.62)	1.64 (2.70)	1.63 (2.66)
T ₃	1.41 (2.0)	1.44 (2.07)	1.43 (2.03)	1.30 (1.7)	1.32 (1.75)	1.31 (1.72)	1.22 (1.5)	1.26 (1.59)	1.24 (1.54)	1.21 (1.47)	1.25 (1.57)	1.23 (1.52)
T ₄	2.83 (8.0)	2.85 (8.12)	2.84 (8.06)	1.04 (1.1)	1.09 (1.18)	1.07 (1.14)	1.09 (1.2)	1.10 (1.21)	1.09 (1.2)	1.04 (1.09)	1.07 (1.15)	1.05 (1.12)
T ₅	3.07 (9.4)	3.08 (9.49)	3.07 (9.44)	1.79 (3.2)	1.80 (3.23)	1.79 (3.21)	1.81 (3.28)	1.82 (3.32)	1.81 (3.30)	1.77 (3.16)	1.81 (3.28)	1.79 (3.22)
T ₆	3.32 (11.0)	3.33 (11.06)	3.32 (11.03)	1.58 (2.5)	1.61 (2.58)	1.69 (2.54)	1.45 (2.1)	1.46 (2.12)	1.45 (2.11)	1.40 (1.97)	1.45 (2.13)	1.43 (2.05)
T ₇	3.11 (9.7)	3.12 (9.74)	3.12 (9.72)	1.67 (2.8)	1.69 (2.84)	1.68 (2.82)	1.54 (2.4)	1.57 (2.48)	1.56 (2.46)	1.53 (2.37)	1.55 (2.43)	1.54 (2.40)
T ₈	3.23 (10.5)	3.25 (10.58)	3.25 (10.54)	3.26 (11.0)	3.33 (11.06)	3.32 (11.03)	3.30 (10.95)	3.32 (11.03)	3.31 (10.99)	3.30 (10.9)	3.31 (10.96)	3.30 (10.91)
SE m (±)	0.09	0.05	0.07	0.17	0.07	0.12	0.19	0.08	0.14	0.15	0.11	0.13
CD (p = 0.05)	0.28	0.16	0.22	0.51	0.22	0.32	0.58	0.25	0.42	0.44	0.34	0.39

*Values given in parenthesis are the mean of original values. **Data subjected to ($\sqrt{x+0.5}$) square root transformation, SE m (±): Standard error of mean, CD: Critical Difference and DAS: Days after sowing

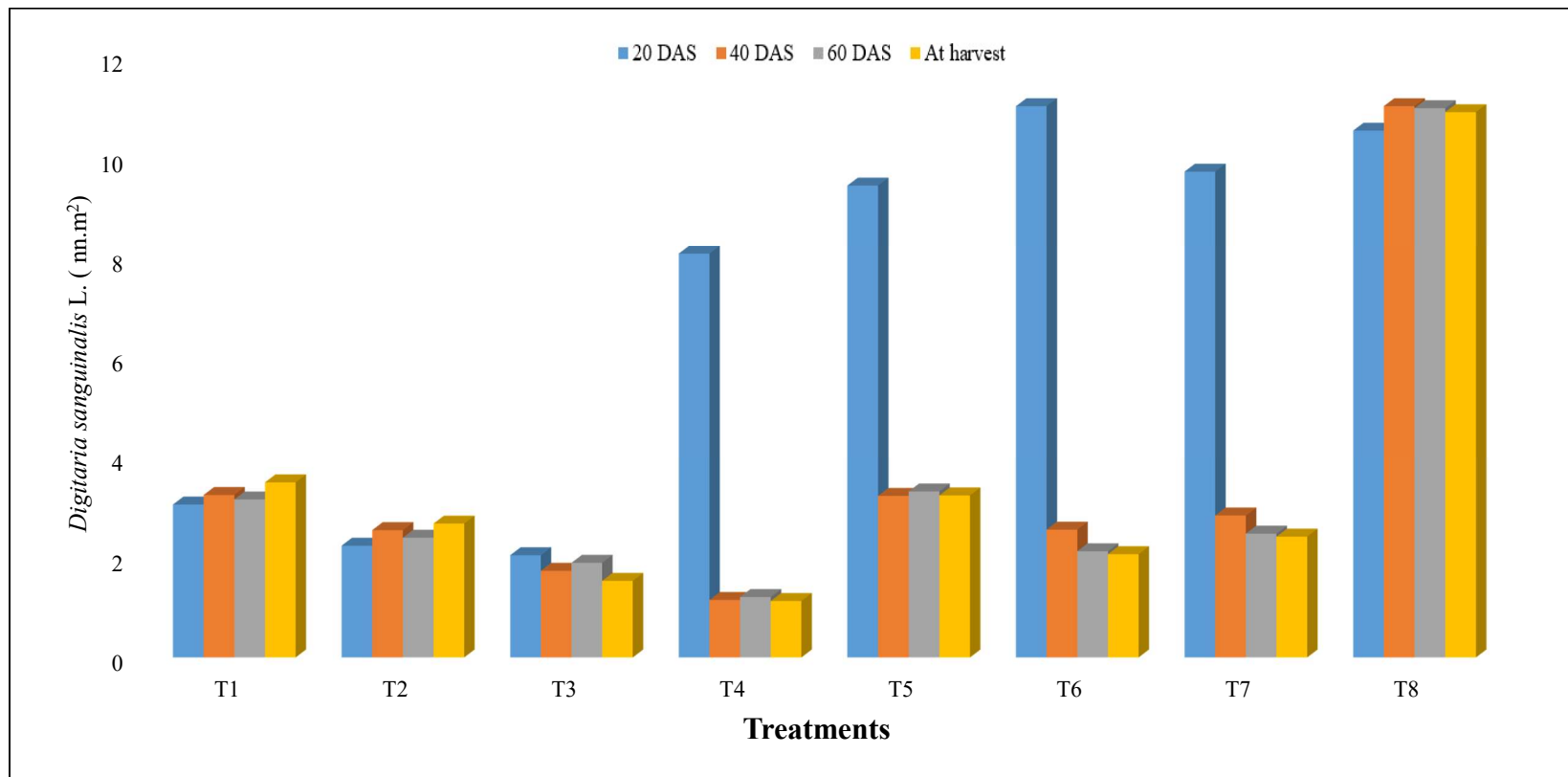
Treatments: T₁: Imazethapyr @ 60 g ha⁻¹ (PE), T₂: Pendimethalin 1 @ kg ha⁻¹ (PE), T₃: Pendimethalin 1 @ kg ha⁻¹ (PE) combined with Imazethapyr @ 50 g ha⁻¹ (PoE), T₄: Hand weeding twice (20 and 40 DAS), T₅: Quizalofop-p-ethyl @ 75 g ha⁻¹ (PoE), T₆: Imazethapyr + Imazamax @ 75 g ha⁻¹ (PoE), T₇: Sodium Aciflourfen and Clodinafop-propargyl @ 180 g ha⁻¹ (PoE) and T₈: Unweeded check (Control).

4.4.2.2 *Digitaria sanguinalis* L. (Scop.)

Data on the population of *Digitaria sanguinalis* L. in the years 2021 and 2022 was shown in graph 4.41 and Table 4.45, which illustrates the impact of weed controller measures at 20 days before to harvest.

Data from 2021 and 2022 on the use of PE pendimethalin 1000 g combined with imazethapyr 50 g successfully control *Digitaria sanguinalis* L., followed by PE pendimethalin 1000 g and imazethapyr 60 g PE as associated with weedy check at 20 days after grown, indicate that the total population of *Digitaria sanguinalis* L. was control by all weed management treatments over weedy check. Data on 40 DAS effectively manage the usage of PE pendimethalin 1000 g in combined with with imazethapyr 50 g to control *Digitaria sanguinalis* L. However, HW were statistically comparable to imazethapyr 60 g PE at 60. Despite this, the population of *Digitaria sanguinalis* L. rose over the whole observation period due to the weedy checks.

The cumulative data are displayed on graph 4.41 and in Table 4.45. *Digitaria sanguinalis* L. is controlled during both cropping seasons by using 1000 g of PE pendimethalin combined with 50 g of PoE imazethapyr at 20 DAS to keep weeds. In comparison to the weedy check, there were thereafter less counts of *Digitaria sanguinalis* L. using PE pendimethalin 1000 g in combination with PoE imazethapyr 50 g adjacent to HW (twice 20, and 40) and imazethapyr 60 g PE.



Graph 4.41 Influence of different herbicide treatments on count of (No. m⁻²) of *Digitaria sanguinalis* L. in green gram at 20 days intervals (Pool data of 2021 and 2022).

Table 4.46 Influence of different herbicide treatments on count (No. m⁻²) of *Cyperus rotundus* L. in green gram at 20 days intervals (2021 and 2022).

Treatment	20 DAS (2021)	20 DAS (2022)	Pool data	40 DAS (2021)	40 DAS (2022)	Pool data	60 DAS (2021)	60 DAS (2022)	Pool data	Harvest (2021)	Harvest (2022)	Pool data
T ₁	2.07** (4.3)*	2.10 (4.39)	2.08 (4.35)	2.39 (5.8)	2.42 (5.86)	2.41 (5.83)	2.38 (5.65)	2.40 (5.75)	2.39 (5.70)	2.20 (4.86)	2.24 (5.00)	2.22 (4.93)
T ₂	1.70 (2.9)	1.72 (2.96)	1.71 (2.93)	1.82 (3.4)	1.85 (3.43)	1.85 (3.42)	1.77 (3.12)	1.79 (3.22)	1.78 (3.17)	1.72 (2.95)	1.75 (3.05)	1.73 (3.00)
T ₃	1.22 (1.5)	1.25 (1.57)	1.24 (1.54)	1.07 (1.15)	1.09 (1.19)	1.08 (1.17)	0.99 (1.00)	1.02 (1.04)	1.01 (1.02)	0.94 (0.89)	1.00 (1.01)	0.97 (0.95)
T ₄	3.60 (13.0)	3.62 (13.07)	3.61 (13.04)	1.86 (3.50)	1.89 (3.56)	1.88 (3.53)	1.80 (3.23)	1.82 (3.33)	1.81 (3.28)	1.76 (3.11)	1.79 (3.19)	1.77 (3.15)
T ₅	3.87 (15.0)	3.88 (15.06)	3.88 (15.03)	3.66 (13.50)	3.68 (13.57)	3.68 (13.54)	3.65 (13.33)	3.68 (13.51)	3.66 (13.42)	3.40 (13.28)	3.66 (13.36)	3.63 (13.32)
T ₆	3.53 (12.5)	3.94 (15.54)	3.74 (14.02)	3.38 (11.50)	3.40 (11.59)	3.40 (11.55)	3.38 (11.44)	3.40 (11.56)	3.39 (11.50)	4.00 (11.36)	3.38 (11.44)	3.38 (11.40)
T ₇	4.10 (16.8)	4.11 (16.89)	4.10 (16.85)	3.29 (11.00)	3.33 (11.06)	3.32 (11.03)	3.29 (10.82)	3.31 (10.94)	3.30 (10.88)	4.00 (10.68)	3.29 (10.82)	3.28 (10.75)
T ₈	4.46 (20.0)	4.48 (20.04)	4.47 (20.02)	4.65 (22.00)	4.70 (22.09)	4.70 (22.05)	4.58 (20.96)	4.59 (21.10)	4.59 (21.03)	4.00 (20.75)	4.58 (20.95)	4.57 (20.85)
SE m (±)	0.14	0.08	0.11	0.19	0.09	0.14	0.22	0.10	0.16	0.18	0.10	0.14
CD (p = 0.05)	0.41	0.25	0.33	0.56	0.26	0.41	0.67	0.32	0.50	0.55	0.29	0.42

*Values given in parenthesis are the mean of original values. **Data subjected to ($\sqrt{x+0.5}$) square root transformation, SE m (±): Standard error of mean, CD: Critical Difference and DAS: Days after sowing

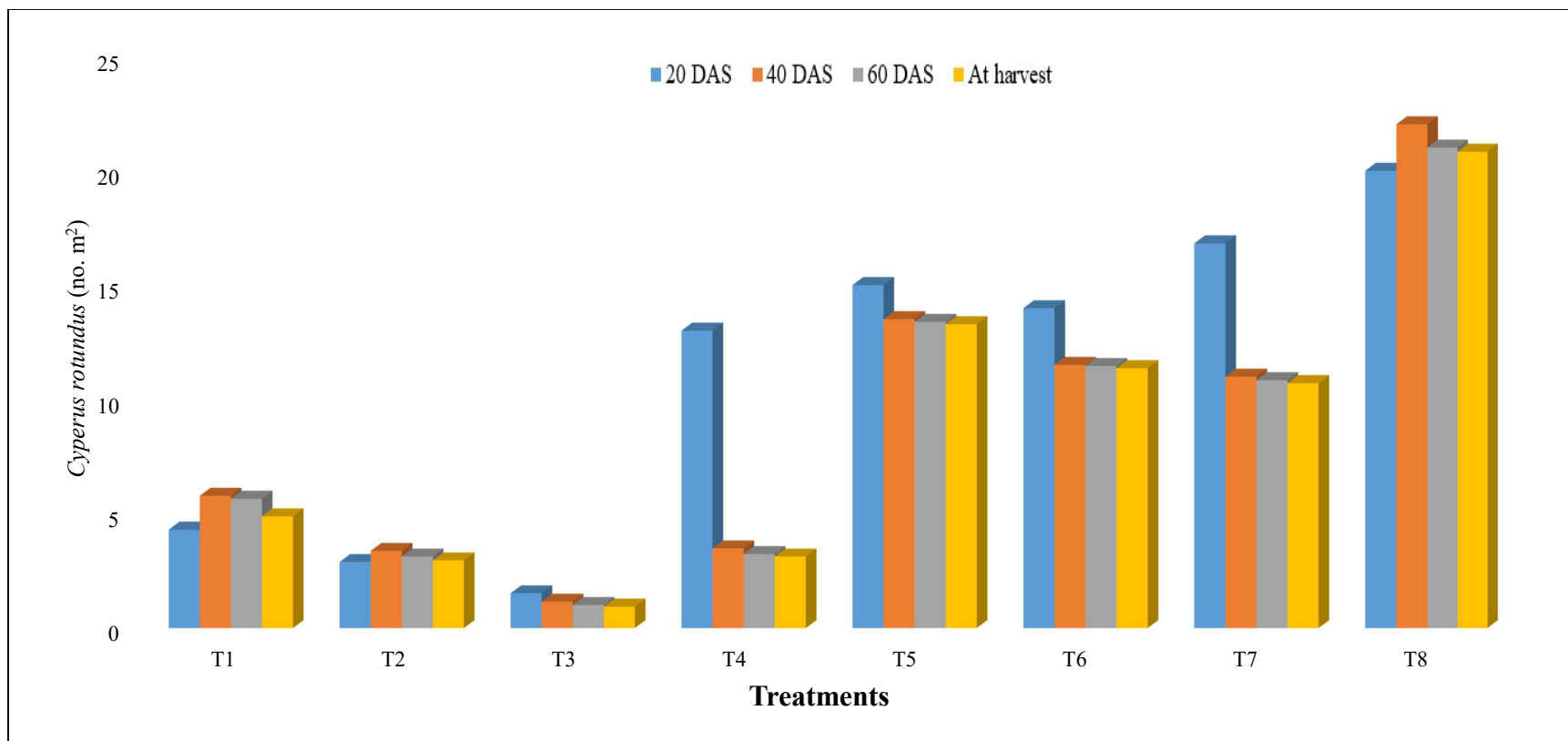
Treatments: T₁: Imazethapyr @ 60 g ha⁻¹ (PE), T₂: Pendimethalin 1 @ kg ha⁻¹ (PE), T₃: Pendimethalin 1 @ kg ha⁻¹ (PE) combined with Imazethapyr @ 50 g ha⁻¹ (PoE), T₄: Hand weeding twice (20 and 40 DAS), T₅: Quizalofop-p-ethyl @ 75 g ha⁻¹ (PoE), T₆: Imazethapyr + Imazamax @ 75 g ha⁻¹ (PoE), T₇: Sodium Aciflourfen and Clodinafop-propargyl @ 180 g ha⁻¹ (PoE) and T₈: Unweeded check (Control).

4.4.2.3 *Cyperus rotundus* L.

Data on the population of *Cyperus rotundus* L. in the years 2021 and 2022 was represented by graph 4.42 and Table 4.46, which shown the effect of weed control treatments at 20-day intervals up until harvest.

In years 2021 and 2022 statistics showing in Table 4.46 use of PE pendimethalin 1000 g with combination of imazethapyr 50 g PoE affected lowest count of *Cyperus rotundus* L. followed by PE pendimethalin 1000 g and imazethapyr 60 g PE. Data taken on 20 and 40 DAS higher count of *Cyperus rotundus* L. in quizalofop p ethyl 75 g PoE and imazethapyr combined with imazamax 75 g PoE over remaining herbicide treatments. Data on 60 DAS and harvest emotionally regulate of *Cyperus rotundus* L. When use of PE pendimethalin 1000 g with the combination of imazethapyr 50 g PoE as associated to weedy check.

Sedges are successfully killed as an associate to weedy check, according to the cumulative data displayed on Table 4.46 and illustrated in graph 4.42 at 20 DAS PE pendimethalin 1000 g with combination of imazethapyr 50 g PoE. Information on the carefully controlled usage of quizalofop ethyl 75 g PoE and imazethapyr combo of imazamax 75 g PoE 40 days after seeding was compared to the other treatments. Despite this, Weedy check shows that *Cyperus rotundus* L. has the largest population during the whole observation period. When PE pendimethalin 1000 g was used in conjunction with imazethapyr 50 g PoE and HW (20 and 40 days after sowing), the least amount of weeds was found, which was linked to weedy check.



Graph 4.42 Influence of different herbicide treatments on count (No. m⁻²) of *Cyperus rotundus* L. in green gram at 20 days intervals (Pool data of 2021 and 2022).

Table 4.47 Influence of different herbicide treatments on count (No. m⁻²) of *Cassia tora* L. in green gram at 20 days intervals (2021 and 2022).

Treatment	20 DAS (2021)	20 DAS (2022)	Pool data	40 DAS (2021)	40 DAS (2022)	Pool data	60 DAS (2021)	60 DAS (2022)	Pool data	Harvest (2021)	Harvest (2022)	Pool data
T ₁	1.13** (1.3)*	1.15 (1.32)	1.14 (1.31)	1.15 (1.35)	1.18 (1.39)	1.17 (1.37)	1.22 (1.50)	1.26 (1.58)	1.24 (1.54)	1.22 (1.49)	1.20 (1.50)	1.22 (1.50)
T ₂	1.04 (1.1)	1.09 (1.19)	1.07 (1.15)	1.11 (1.30)	1.15 (1.32)	1.14 (1.31)	1.18 (1.39)	1.19 (1.41)	1.18 (1.40)	1.14 (1.30)	1.18 (1.40)	1.16 (1.35)
T ₃	1.0 (1.0)	1.03 (1.07)	1.02 (1.04)	1.04 (1.10)	1.09 (1.19)	1.07 (1.15)	1.00 (1.00)	1.03 (1.06)	1.01 (1.03)	0.90 (0.81)	0.99 (0.99)	0.95 (0.90)
T ₄	1.57 (2.5)	1.61 (2.58)	1.59 (2.54)	1.08 (1.19)	1.10 (1.21)	1.10 (1.20)	1.05 (1.13)	1.07 (1.14)	1.07 (1.14)	1.03 (1.06)	1.07 (1.14)	1.07 (1.10)
T ₅	1.41 (2.0)	1.45 (2.09)	1.43 (2.05)	1.36 (1.90)	1.40 (1.96)	1.39 (1.93)	1.32 (1.80)	1.35 (1.81)	1.34 (1.81)	1.30 (1.70)	1.35 (1.82)	1.33 (1.76)
T ₆	2.0 (4.0)	2.00 (4.02)	2.00 (4.01)	1.64 (2.70)	1.66 (2.77)	1.65 (2.74)	1.37 (1.90)	1.39 (1.94)	1.39 (1.92)	1.33 (1.77)	1.37 (1.87)	1.35 (1.82)
T ₇	2.12 (4.8)	2.21 (4.89)	2.20 (4.85)	1.17 (1.40)	1.22 (1.49)	1.20 (1.45)	1.08 (1.19)	1.10 (1.20)	1.09 (1.20)	1.08 (1.6)	1.10 (1.24)	1.09 (1.15)
T ₈	2.52 (6.5)	2.57 (6.58)	2.56 (6.54)	2.80 (8.00)	2.86 (8.16)	2.84 (8.08)	2.82 (7.97)	2.87 (8.23)	2.85 (8.10)	2.77 (7.70)	2.85 (8.10)	2.81 (7.90)
SE m (±)	0.13	0.11	0.12	0.16	0.14	0.15	0.20	0.15	0.18	0.19	0.13	0.16
CD (p = 0.05)	0.39	0.34	0.37	0.48	0.42	0.45	0.61	0.45	0.53	0.56	0.39	0.48

*Values given in parenthesis are the mean of original values. **Data subjected to ($\sqrt{x+0.5}$) square root transformation, SE m (±): Standard error of mean, CD: Critical Difference and DAS: Days after sowing

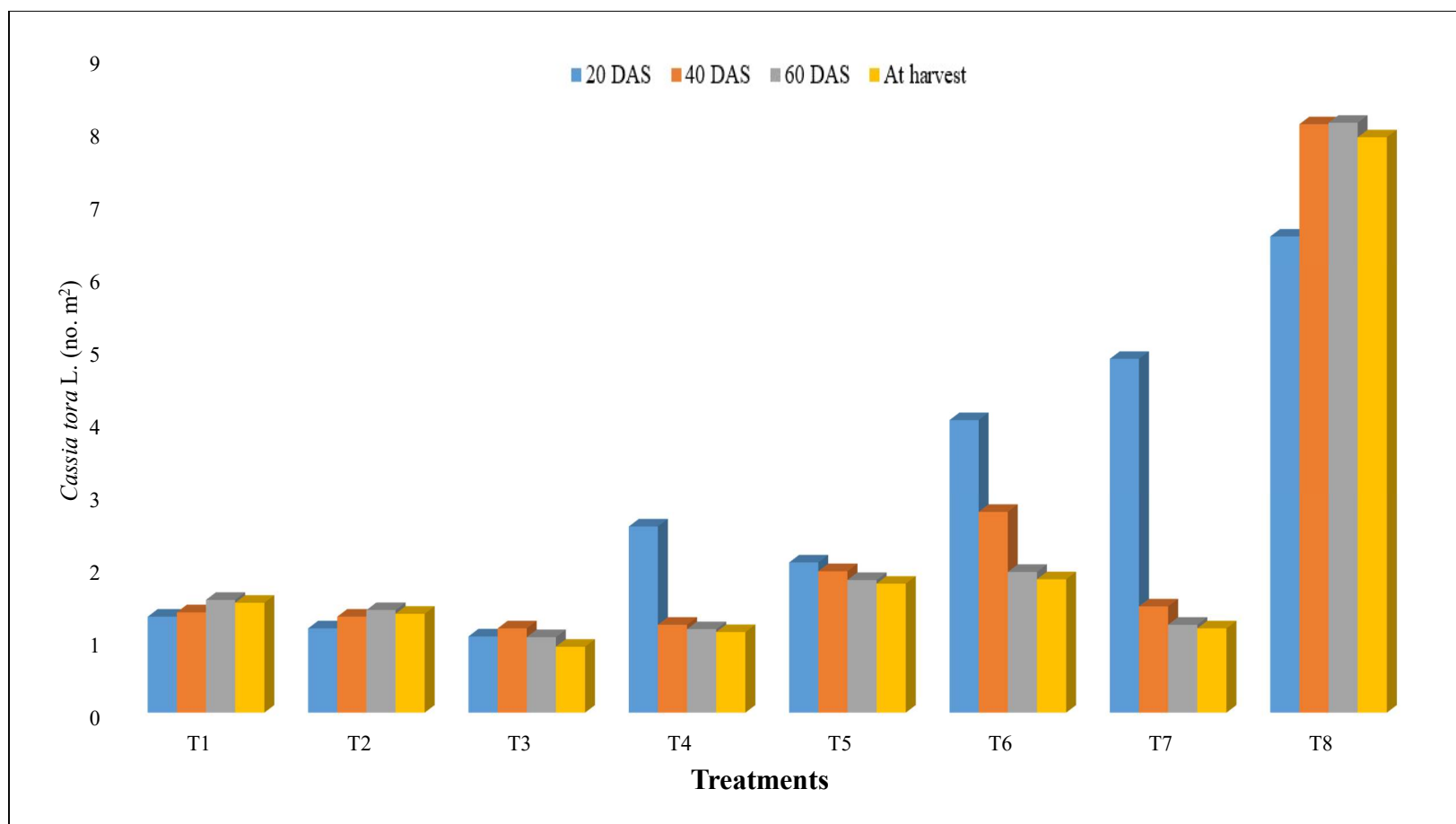
Treatments: T₁: Imazethapyr @ 60 g ha⁻¹ (PE), T₂: Pendimethalin 1 @ kg ha⁻¹ (PE), T₃: Pendimethalin 1 @ kg ha⁻¹ (PE) combined with Imazethapyr @ 50 g ha⁻¹ (PoE), T₄: Hand weeding twice (20 and 40 DAS), T₅: Quizalofop-p-ethyl @ 75 g ha⁻¹ (PoE), T₆: Imazethapyr + Imazamax @ 75 g ha⁻¹ (PoE), T₇: Sodium Aciflourfen and Clodinafop-propargyl @ 180 g ha⁻¹ (PoE) and T₈: Unweeded check (Control).

4.4.2.4 *Cassia tora* L.

Data on the effects of weed management treatments on the population of *Cassia tora* L. during all observational phases in 2021 and 2022 are displayed in Table 4.47 and graphically in graph 4.43.

In years 2021 and 2022 data shown in Table 4.47. PE pendimethalin 1000 g with combination of imazethapyr 50 g PoE caused minimum count of *Cassia tora* L. followed with PE pendimethalin 1000 g then imazethapyr 60 g PE. The PE herbicides used in experiment lower count of *Cassia tora* L. over weed control treatments. Data taken 40 DAS maximum count of *Cassia tora* L. were noted in usage of quizalofop p ethyl 75 g PoE and imazethapyr combined with imazamax 75 g PoE remaining treatment. Lowest count of *Cassia tora* L. were noted in treatment of PE pendimethalin 1000 g with combination of imazethapyr 50 g PoE followed by 2 HW (20 DAS) and PE pendimethalin 1000 g combined with imazethapyr 60 g PE associated to weedy check.

The combined findings on 20 days of PE pendimethalin 1000 g with the addition of imazethapyr 50 g PoE, as displayed in Table 4.47 and the graph 4.43, demonstrate the expressive control of *Cassia tora* L. over weedy check. Imazethapyr 60 g PE and PE pendimethalin 1000 g linked to weedy check were the next highest weed seen in the use of PE pendimethalin 1000 g with combination of imazethapyr 50 g PoE and HW (20 and 40 days after seed). When quizalofop p ethyl 75 g PoE was used, the highest concentration of *Cassia tora* L. was seen after a 40-day period. This was followed by imazethapyr mixed with imazamax 75 g PoE, which was compared to the other weed control treatments.



Graph 4.43 Influence of different herbicide treatments on count (No. m²) of *Cassia tora* L. in green gram at 20 days intervals (Pool data of 2021 and 2022).

Table 4.48 Influence of different herbicide treatments on count (No. m⁻²) of *Celosia argentea* L. in green gram at 20 days intervals (2021 and 2022).

Treatment	20 DAS (2021)	20 DAS (2022)	Pool data	40 DAS (2021)	40 DAS (2022)	Pool data	60 DAS (2021)	60 DAS (2022)	Pool data	Harvest (2021)	Harvest (2022)	Pool data
T ₁	1.18** (1.4)*	1.22 (1.49)	1.20 (1.45)	1.22 (1.5)	1.24 (1.53)	1.23 (1.52)	1.19 (1.42)	1.24 (1.54)	1.22 (1.48)	1.17 (1.37)	1.21 (1.47)	1.19 (1.42)
T ₂	1.0 (1.00)	1.04 (1.09)	1.02 (1.05)	1.04 (1.1)	1.06 (1.12)	1.05 (1.11)	1.13 (1.29)	1.14 (1.30)	1.16 (1.09)	0.94 (0.88)	1.01 (1.02)	0.97 (0.95)
T ₃	0.93 (0.89)	0.95 (0.91)	0.95 (0.90)	1.16 (1.23)	1.13 (1.27)	1.12 (1.25)	0.99 (1.00)	1.01 (1.02)	1.00 (1.01)	0.88 (0.77)	0.96 (0.93)	0.82 (0.85)
T ₄	2.0 (4.0)	2.01 (4.06)	2.01 (4.03)	1.41 (2.00)	1.44 (2.06)	1.42 (2.03)	0.99 (1.00)	1.03 (1.06)	1.01 (1.03)	0.97 (0.94)	1.03 (1.06)	1.00 (1.00)
T ₅	2.12 (4.5)	2.13 (4.54)	2.13 (4.52)	1.48 (2.20)	1.50 (2.26)	1.49 (2.23)	1.41 (2.00)	1.49 (2.23)	1.46 (2.12)	1.42 (1.91)	1.42 (2.09)	1.42 (2.00)
T ₆	1.95 (3.8)	1.96 (3.84)	1.95 (3.82)	1.76 (3.10)	1.78 (3.17)	1.77 (3.14)	1.53 (2.46)	1.57 (2.47)	1.39 (2.47)	1.53 (2.35)	1.57 (2.45)	1.55 (2.40)
T ₇	2.39 (5.7)	2.39 (5.71)	2.39 (5.71)	1.37 (1.90)	1.41 (1.98)	1.39 (1.94)	1.06 (1.12)	1.07 (1.14)	1.06 (1.13)	1.00 (1.00)	1.06 (1.12)	1.03 (1.06)
T ₈	2.42 (6.00)	2.49 (6.20)	2.47 (6.10)	2.69 (7.23)	2.79 (7.77)	3.74 (7.50)	2.71 (7.37)	2.74 (7.53)	2.73 (7.45)	2.71 (7.32)	2.73 (7.48)	2.72 (7.40)
SE m (±)	0.12	0.18	0.15	0.17	0.14	0.16	0.22	0.12	0.17	0.18	0.14	0.16
CD (p = 0.05)	0.37	0.45	0.41	0.51	0.43	0.47	0.66	0.35	0.51	0.55	0.43	0.49

*Values given in parenthesis are the mean of original values. **Data subjected to ($\sqrt{x+0.5}$) square root transformation, SE m (±): Standard error of mean, CD: Critical Difference and DAS: Days after sowing

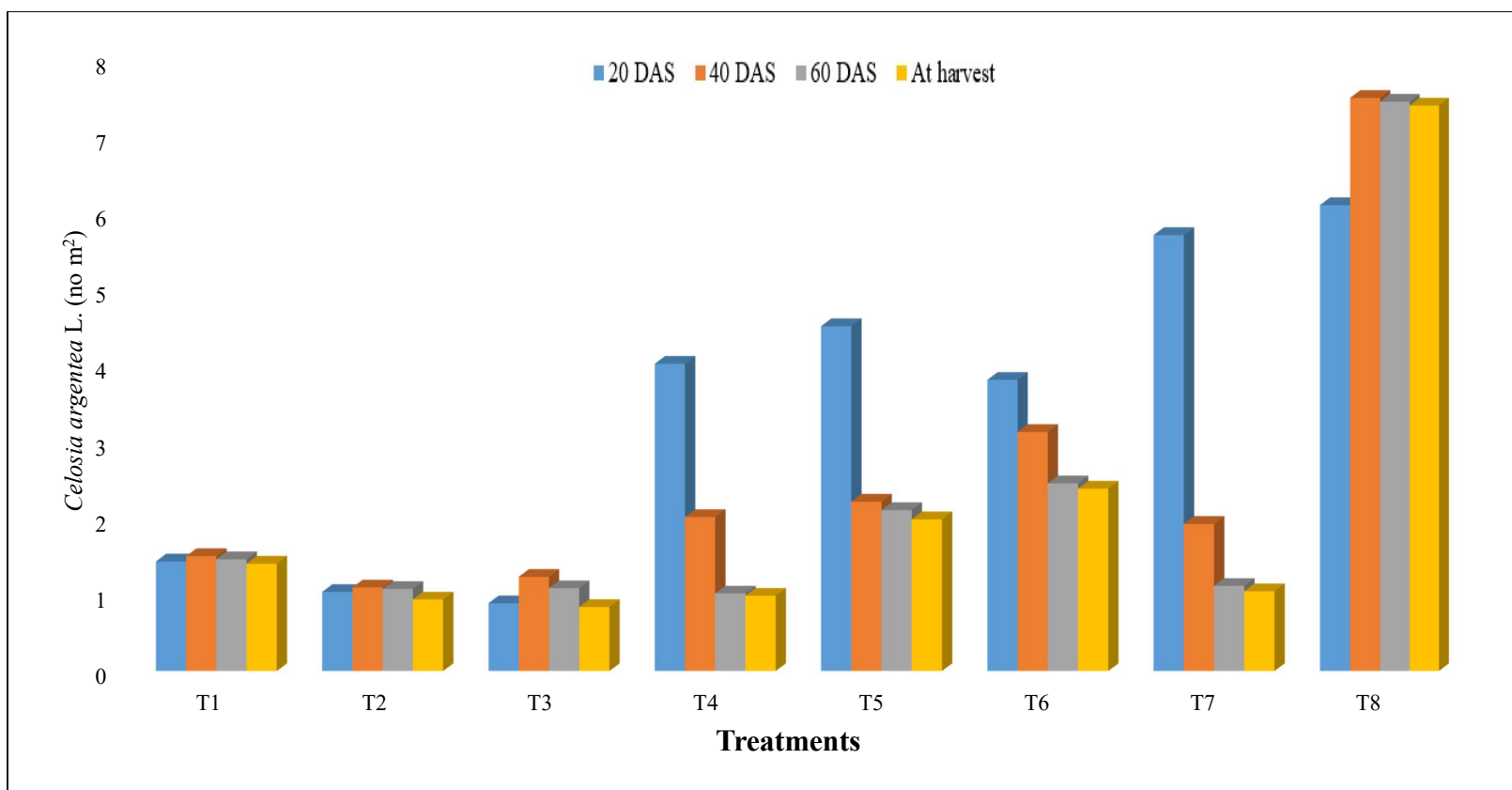
Treatments: T₁: Imazethapyr @ 60 g ha⁻¹ (PE), T₂: Pendimethalin 1 @ kg ha⁻¹ (PE), T₃: Pendimethalin 1 @ kg ha⁻¹ (PE) combined with Imazethapyr @ 50 g ha⁻¹ (PoE), T₄: Hand weeding twice (20 and 40 DAS), T₅: Quizalofop-p-ethyl @ 75 g ha⁻¹ (PoE), T₆: Imazethapyr + Imazamax @ 75 g ha⁻¹ (PoE), T₇: Sodium Aciflourfen and Clodinafop-propargyl @ 180 g ha⁻¹ (PoE) and T₈: Unweeded check (Control).

4.4.2.5 *Celosia argentea* L.

The information on the population impact of various weed management treatments on *Celosia argentea* L. throughout all observation phases in 2021 and 2022 is displayed in Table 4.48 and is depicted in graph 4.44.

In years 2021 and 2022 statistics shown on Table 4.48, PE pendimethalin 1000 g with combination of imazethapyr 50 g PoE arrest the growth of *Celosia argentea* L. followed by PE pendimethalin 1000 g and imazethapyr 60 g PE. The higher counting of *Celosia argentea* L. in PoE treatments at 20 DAS. Data taken on 40 DAS minimum count of *Celosia argentea* L. were noted in usage of PE pendimethalin 1000 g with the combination of imazethapyr 50 g PoE followed by HW twice (20 and 40 DAS) and PE pendimethalin 1000 g then imazethapyr 60 g PE. The use of quizalofop p ethyl 75 g PoE and imazethapyr combined with imazamax 75 g PoE noted highest count of *Celosia argentea* L. associated to other treatments. Highest weed population were noted under weedy check. Alike outcomes were stated by T. Muthuram *et al.* (2017) and Danga *et al.* (2020).

Cumulative statistics on 20 days lower count on *Celosia argentea* L. among PoE weedicide treatment and 2 HW (20 and 40 DAS) over weedy check are displayed in Table 4.48 and illustrated in Graph 4.44. HW (20 and 40 DAS), PE pendimethalin 1000 g, and imazethapyr 60 g PE weedy check were the next highest data points collected after 40 days. When compared to other treatments, the usage of Imazethapyr in combination with imazamax 75 g PoE and quizalofop p ethyl 75 g PoE resulted in the greatest count of *Celosia argentea* L.



Graph 4.44 Influence of different herbicide treatments on count (No. m²) of *Celosia argentea* L. in green gram at 20 days intervals (Pool data of 2021 and 2022).

Table 4.49 Influence of different herbicide treatments on count (No. m⁻²) of total weeds in green gram at 20 days intervals (2021 and 2022).

Treatment	20 DAS (2021)	20 DAS (2022)	Pool data	40 DAS (2021)	40 DAS (2022)	Pool data	60 DAS (2021)	60 DAS (2022)	Pool data	Harvest (2021)	Harvest (2022)	Pool data
T ₁	4.23** (17.90)*	3.51 (12.35)	3.89 (15.13)	4.21 (17.75)	3.79 (14.39)	4.01 (16.07)	3.87 (15.10)	3.90 (15.24)	3.89 (15.17)	3.83 (14.65)	3.86 (14.87)	3.84 (14.76)
T ₂	3.72 (13.81)	2.92 (8.52)	3.34 (11.17)	3.87 (15.00)	3.21 (10.28)	3.56 (12.64)	3.29 (10.84)	3.29 (10.84)	3.29 (10.84)	3.24 (10.49)	3.26 (10.61)	3.25 (10.55)
T ₃	3.51 (12.09)	2.62 (6.85)	3.08 (9.47)	2.63 (06.93)	2.64 (6.99)	2.64 (6.96)	2.40 (05.82)	2.42 (5.85)	2.42 (5.84)	2.30 (5.29)	2.33 (5.41)	2.31 (5.35)
T ₄	4.37 (32.50)	5.74 (32.95)	5.72 (32.73)	2.96 (08.79)	3.00 (9.00)	2.98 (8.90)	2.72 (7.42)	2.72 (7.39)	2.72 (7.41)	2.69 (7.25)	2.71 (7.35)	2.70 (7.30)
T ₅	6.07 (36.90)	6.10 (37.25)	6.09 (37.08)	4.82 (23.20)	4.63 (21.47)	4.73 (22.34)	4.54 (20.81)	4.49 (20.15)	4.53 (20.48)	4.42 (19.58)	4.44 (19.74)	4.43 (19.66)
T ₆	6.12 (37.50)	6.38 (40.72)	6.25 (39.11)	4.72 (22.35)	4.56 (20.80)	4.64 (21.58)	4.26 (18.32)	4.29 (18.41)	4.29 (18.37)	4.21 (18.71)	4.22 (17.85)	4.22 (17.78)
T ₇	6.33 (40.10)	6.55 (42.90)	6.44 (41.50)	4.39 (19.30)	4.43 (19.66)	4.41 (19.48)	3.87 (15.00)	3.89 (15.12)	3.88 (15.06)	3.76 (14.13)	3.78 (14.31)	3.77 (14.22)
T ₈	7.06 (50.00)	7.07 (50.00)	7.07 (50.00)	7.94 (63.20)	7.98 (63.70)	7.97 (63.45)	7.81 (60.93)	7.95 (63.27)	7.88 (62.10)	7.80 (60.86)	7.82 (81.14)	7.81 (61.00)
SE (m±)	0.49	0.08	0.29	0.12	0.09	0.11	0.18	0.12	0.15	0.23	0.13	0.18
CD (p = 0.05)	1.48	0.23	0.86	0.36	0.27	0.32	0.56	0.36	0.46	0.71	0.39	0.55

*Values given in parenthesis are the mean of original values. **Data subjected to ($\sqrt{x+0.5}$) square root transformation, SE m (±): Standard error of mean, CD: Critical Difference and DAS: Days after sowing

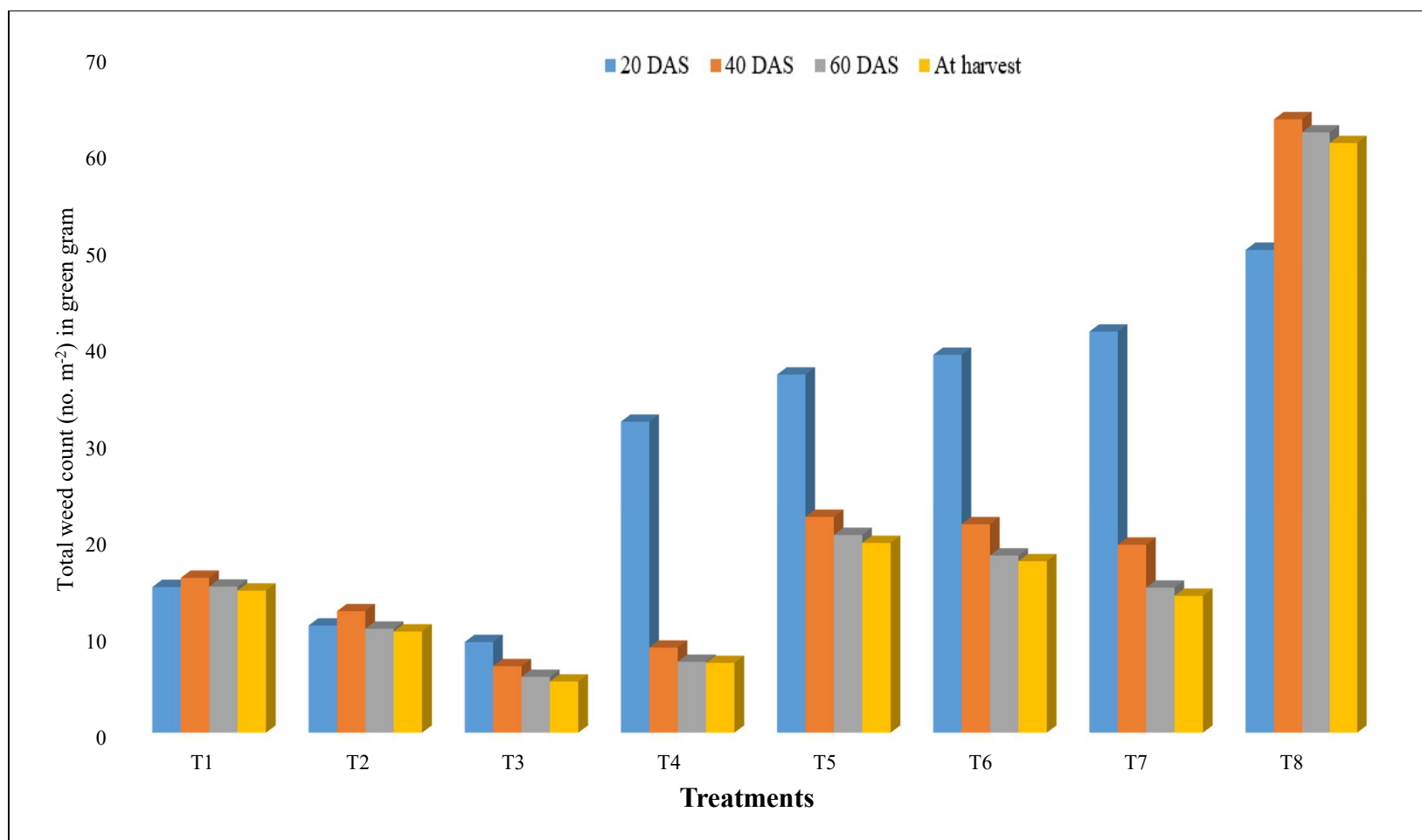
Treatments: T₁: Imazethapyr @ 60 g ha⁻¹ (PE), T₂: Pendimethalin 1 @ kg ha⁻¹ (PE), T₃: Pendimethalin 1 @ kg ha⁻¹ (PE) combined with Imazethapyr @ 50 g ha⁻¹ (PoE), T₄: Hand weeding twice (20 and 40 DAS), T₅: Quizalofop-p-ethyl @ 75 g ha⁻¹ (PoE), T₆: Imazethapyr + Imazamax @ 75 g ha⁻¹ (PoE), T₇: Sodium Aciflourfen and Clodinafop-propargyl @ 180 g ha⁻¹ (PoE) and T₈: Unweeded check (Control).

4.4.2.6 Total population of weeds (No. m⁻²)

Data from Table 4.49 and graph 4.45 regarding the total number of weed species impacted by different weed control treatments at every observational stage in the years 2021 and 2022.

The data shown in Table 4.49 for the years 2021 and 2022 indicates that the lowest count of all weeds was achieved by PE pendimethalin 1000 g in combination with imazethapyr 50 g PoE, followed by PE pendimethalin 1000 g and imazethapyr 60 g PE. Twenty days of data showed that, with the exception of PE, all treatments had the largest population of weed. The lowest amount of weeds overall were seen 40 days after sowing in both years when PE pendimethalin 1000 g was used in conjunction with imazethapyr 50 g PoE. Commencing with HW (20 and 40 DAS), comparable outcomes were seen, succeeded by PE pendimethalin 1000 g and imazethapyr 60 g PE. Quizalofop p ethyl 75 g PoE and imazethapyr coupled with imazamax 75 g PoE had the largest total population of weeds, followed by PoE sodium Aciflurofen mixed with clodinafop propargyl 180 g. The weedy check had the largest overall number of weeds. Singh and Yadav (2015), T. Muthuram *et al.* (2017), and T. Ramesh *et al.* (2020) have reported same results.

Cumulative statistics are displayed in graph 4.45 and Table 4.49. With the exception of PoE, less weeds were found in PE at 20 DAS. Imazethapyr 50 g PoE combined with PE pendimethalin 1000 g and Imazethapyr 60 g PE resulted in the lowest population of weeds ever seen. Sodium aciflurofen paired with clodinafop- propargyl 180 g PoE and imazethapyr combined with imazamax 75 g PoE were shown to have the maximum population of weed on 40 DAS. When PE pendimethalin 1000 g was used in conjunction with imazethapyr 50 g PoE, HW (20 and 40 DAS) and PE pendimethalin 1000 g were observed to have the lowest overall population of weeds in both years.



Graph 4.45 Influence of different herbicide treatments on count (No. m⁻²) of total weeds population in green gram at 20 days intervals (Pool data of 2021 and 2022).

Table 4.50 Influence of different herbicide treatments on dry weight (g m⁻²) of *Commelina benghalensis* L. in green gram at 20 days intervals (2021 and 2022).

Treatment	20 DAS (2021)	20 DAS (2022)	Pool data	40 DAS (2021)	40 DAS (2022)	Pool data	60 DAS (2021)	60 DAS (2022)	Pool data	Harvest (2021)	Harvest (2022)	Pool data
T ₁	0.20** (0.04)*	0.22 (0.047)	0.21 (0.044)	0.35 (0.12)	0.36 (0.12)	0.35 (0.12)	0.50 (0.25)	0.50 (0.25)	0.50 (0.25)	0.52 (0.28)	0.51 (0.24)	0.50 (0.26)
T ₂	0.17 (0.03)	0.19 (0.035)	0.18 (0.033)	0.28 (0.08)	0.29 (0.086)	0.29 (0.08)	0.41 (0.17)	0.43 (0.17)	0.42 (0.17)	0.47 (0.23)	0.43 (0.19)	0.45 (0.21)
T ₃	0.14 (0.02)	0.15 (0.024)	0.15 (0.022)	0.24 (0.06)	0.26 (0.069)	0.25 (0.06)	0.37 (0.14)	0.38 (0.14)	0.38 (0.14)	0.46 (0.22)	0.40 (0.16)	0.43 (0.19)
T ₄	0.30 (0.09)	0.31 (0.094)	0.30 (0.092)	0.14 (0.021)	0.17 (0.029)	0.16 (0.02)	0.32 (0.10)	0.34 (0.11)	0.34 (0.11)	0.42 (0.18)	0.37 (0.14)	0.40 (0.16)
T ₅	0.32 (0.10)	0.40 (0.16)	0.36 (0.130)	0.39 (0.150)	0.40 (0.158)	0.39 (0.15)	0.49 (0.24)	0.50 (0.24)	0.50 (0.24)	0.53 (0.28)	0.54 (0.28)	0.54 (0.28)
T ₆	0.33 (0.11)	0.37 (0.14)	0.35 (0.125)	0.42 (0.180)	0.43 (0.184)	0.43 (0.18)	0.53 (0.28)	0.52 (0.28)	0.53 (0.28)	0.59 (0.35)	0.53 (0.29)	0.56 (0.32)
T ₇	0.30 (0.09)	0.31 (0.099)	0.31 (0.095)	0.34 (0.120)	0.35 (0.126)	0.35 (0.12)	0.49 (0.24)	0.51 (0.24)	0.49 (0.24)	0.51 (0.25)	0.52 (0.25)	0.52 (0.25)
T ₈	0.59 (0.35)	0.63 (0.40)	0.61 (0.375)	0.64 (0.410)	0.67 (0.45)	0.66 (0.43)	0.91 (0.84)	0.94 (0.89)	0.93 (0.86)	0.92 (0.85)	0.95 (0.90)	0.93 (0.90)
SE m (±)	0.01	0.02	0.02	0.01	0.03	0.02	0.03	0.02	0.03	0.02	0.03	0.03
CD (p = 0.05)	0.03	0.06	0.05	0.04	0.08	0.06	0.09	0.06	0.08	0.07	0.08	0.08

*Values given in parenthesis are the mean of original values. **Data subjected to ($\sqrt{x+0.5}$) square root transformation, SE m (±): Standard error of mean, CD: Critical Difference and DAS: Days after sowing

Treatments: T₁: Imazethapyr @ 60 g ha⁻¹ (PE), T₂: Pendimethalin 1 @ kg ha⁻¹ (PE), T₃: Pendimethalin 1 @ kg ha⁻¹ (PE) combined with Imazethapyr @ 50 g ha⁻¹ (PoE), T₄: Hand weeding twice (20 and 40 DAS), T₅: Quizalofop-p-ethyl @ 75 g ha⁻¹ (PoE), T₆: Imazethapyr + Imazamax @ 75 g ha⁻¹ (PoE), T₇: Sodium Aciflourfen and Clodinafop-propargyl @ 180 g ha⁻¹ (PoE) and T₈: Unweeded check (Control).

4.4.3 Dry matter accumulation of species-wised and total

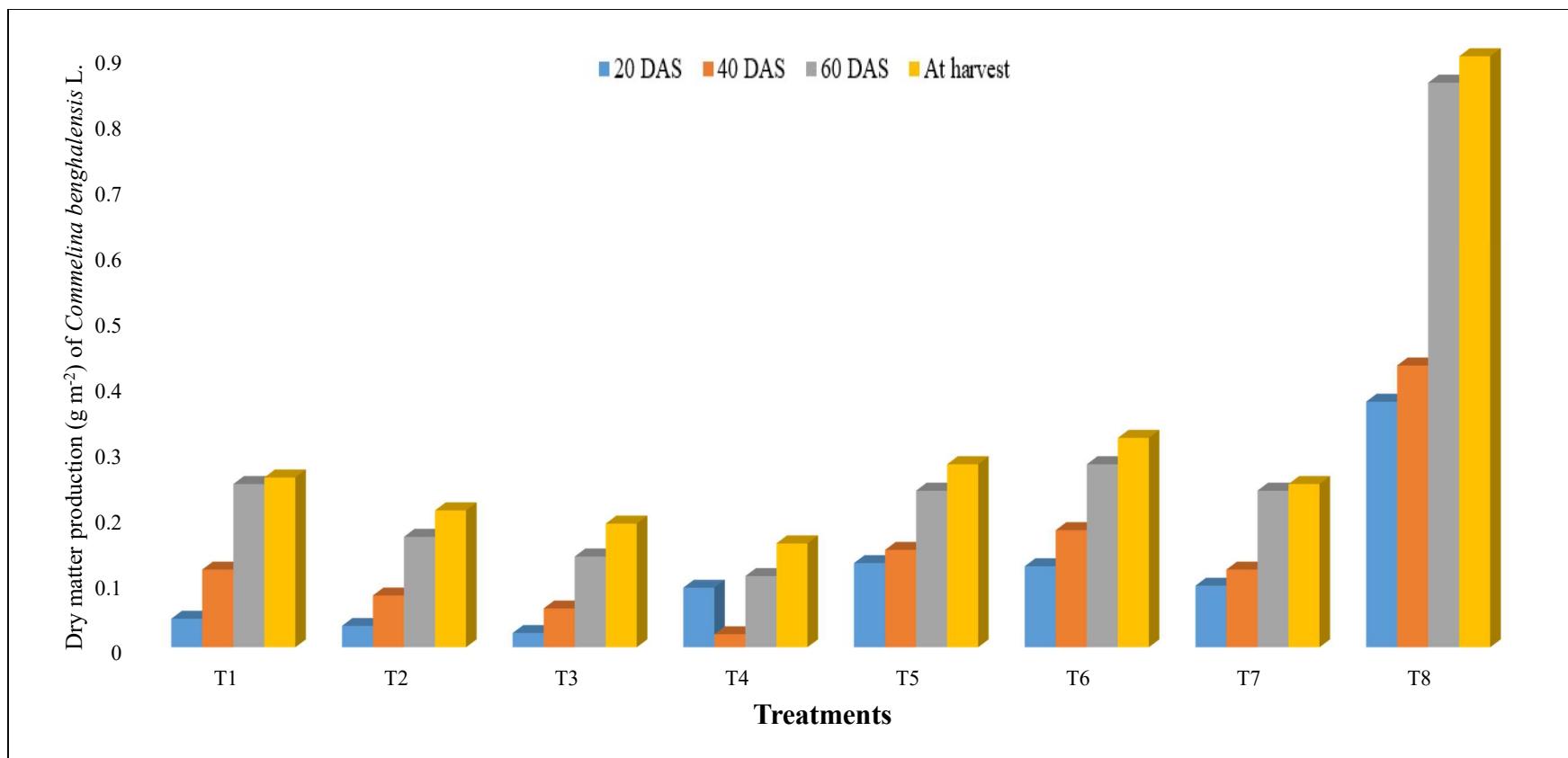
Up to harvest, the dry weight total and species-specific output of weeds was observed every 20 days.

4.4.3.1 *Commelina benghalensis* L.

The data on *Commelina benghalensis* L. dry weight impacted by various weed management treatments at all observational phases in 2021 and 2022, as displayed in Table 4.50 and depicted in graph 4.46.

When comparing the minimum dry weight of PE pendimethalin 1000 g with the combination of imazethapyr 50 g PoE to HW (20 and 40 DAS), PE pendimethalin 1000 g and imazethapyr 60 g PE, data from the years 2021 and 2022 are displayed in Table 4.50. *Commelina benghalensis* L. minimum dry weight was recorded in PE treatment, with the exception of PoE treatment. A minimum of forty days were required for the weed dry weight to be recorded in HW (20 and 40 DAS). The results were comparable to the weedy check connected with PE pendimethalin 1000 g, imazethapyr 60 g, and quizalofop p ethyl 75 g PoE. Data collected on a 40-day period revealed that *Commelina benghalensis* L. was used at a reduced dry weight. At data 60 DAS, increased dry weights of *Commelina benghalensis* L. were seen in imazethapyr mixed with imazamax 75 g PoE, quizalofop ethyl 75 g PoE, and imazethapyr 60 g PE. *Commelina benghalensis* L. minimum dry weight was noted when HW (20 and 40 DAS, PE pendimethalin 1000 g, and imazethapyr 60 g PE) were used over weedy check.

Cumulative data on the 20 DAS minimum dry weight of *Commelina benghalensis* L. were noticed in favour of PE herbicidal treatment over PE treatment, as indicated in Table 4.50 and depicted in graph 4.46. In comparison to HW (20 and 40 DAS) and PE pendimethalin 1000 g, imazethapyr 60 g PE linked to Weedy check, a lower dry weight was seen in the treatment of PE pendimethalin 1000 g with combination of imazethapyr 50 g PoE.



Graph 4.46 Influence of different herbicide treatments on dry weight (g m⁻²) of *Commelina benghalensis* L. in green gram at 20 days intervals (Pool data of 2021 and 2022).

Table 4.51 Influence of different herbicide treatments on dry weight (g m⁻²) of *Digitaria sanguinalis* L. (Scop.) in green gram at 20 days intervals (2021 and 2022).

Treatment	20 DAS (2021)	20 DAS (2022)	Pool data	40 DAS (2021)	40 DAS (2022)	Pool data	60 DAS (2021)	60 DAS (2022)	Pool data	Harvest (2021)	Harvest (2022)	Pool data
T ₁	0.24** (0.06)*	0.26 (0.06)	0.25 (0.064)	0.26 (0.066)	0.26 (0.070)	0.026 (0.068)	0.31 (0.095)	0.31 (0.099)	0.25 (0.097)	1.00 (0.102)	0.99 (0.098)	1.00 (0.10)
T ₂	0.22 (0.05)	0.23 (0.05)	0.22 (0.052)	0.26 (0.07)	0.27 (0.076)	0.027 (0.073)	0.28 (0.08)	0.30 (0.087)	0.26 (0.084)	0.30 (0.092)	0.29 (0.086)	0.29 (0.089)
T ₃	0.18 (0.034)	0.20 (0.03)	0.19 (0.037)	0.22 (0.05)	0.24 (0.058)	0.23 (0.054)	0.26 (0.07)	0.28 (0.078)	0.27 (0.074)	0.26 (0.07)	0.28 (0.079)	0.29 (0.075)
T ₄	0.19 (0.036)	0.21 (0.03)	0.18 (0.033)	0.17 (0.02)	0.16 (0.026)	0.15 (0.023)	0.23 (0.055)	0.24 (0.059)	0.24 (0.057)	0.25 (0.065)	0.24 (0.059)	0.24 (0.062)
T ₅	0.33 (0.11)	0.34 (0.12)	0.033 (0.11)	0.23 (0.055)	0.24 (0.057)	0.24 (0.056)	0.30 (0.091)	0.31 (0.096)	0.31 (0.094)	0.30 (0.092)	0.31 (0.098)	0.30 (0.095)
T ₆	0.36 (0.13)	0.36 (0.13)	0.036 (0.13)	0.24 (0.058)	0.25 (0.062)	0.25 (0.060)	0.30 (0.088)	0.30 (0.093)	0.30 (0.091)	0.31 (0.098)	0.30 (0.095)	0.30 (0.096)
T ₇	0.32 (0.10)	0.34 (0.11)	0.034 (0.105)	0.25 (0.061)	0.26 (0.067)	0.25 (0.064)	0.25 (0.064)	0.27 (0.070)	0.26 (0.067)	0.25 (0.065)	0.27 (0.071)	0.27 (0.068)
T ₈	0.44 (0.19)	0.48 (0.20)	0.44 (0.195)	0.46 (0.22)	0.55 (0.30)	0.51 (0.260)	0.54 (0.30)	0.60 (0.36)	0.47 (0.330)	0.57 (0.32)	0.60 (0.36)	0.58 (0.34)
SE m (±)	0.01	0.02	0.02	0.02	0.01	0.02	0.02	0.01	0.02	0.02	0.02	0.02
CD (p = 0.05)	0.04	0.05	0.05	0.06	0.03	0.05	0.05	0.04	0.05	0.05	0.05	0.05

*Values given in parenthesis are the mean of original values. **Data subjected to ($\sqrt{x+0.5}$) square root transformation, SE m (±): Standard error of mean, CD: Critical Difference and DAS: Days after sowing

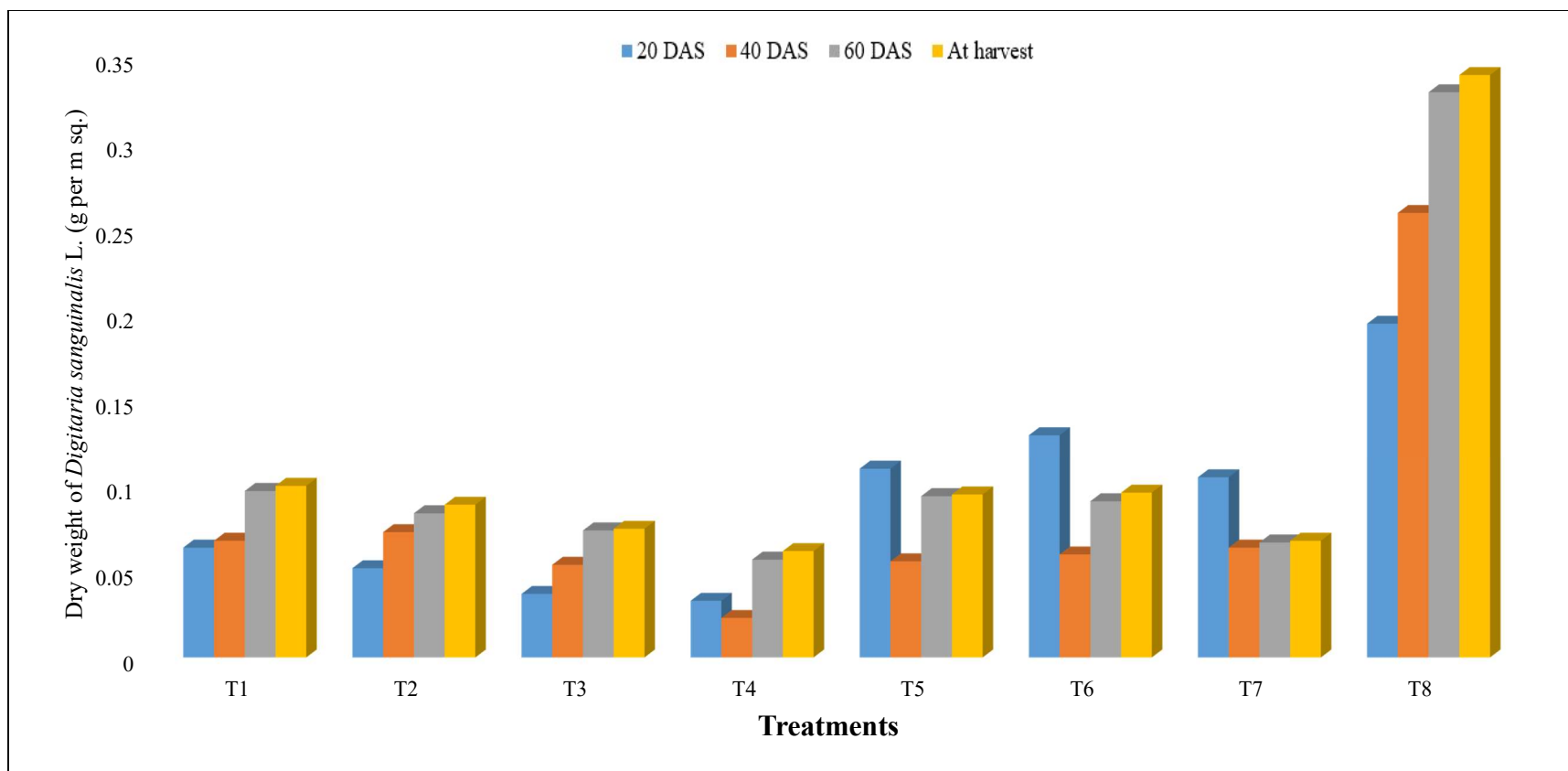
Treatments: T₁: Imazethapyr @ 60 g ha⁻¹ (PE), T₂: Pendimethalin 1 @ kg ha⁻¹ (PE), T₃: Pendimethalin 1 @ kg ha⁻¹ (PE) combined with Imazethapyr @ 50 g ha⁻¹ (PoE), T₄: Hand weeding twice (20 and 40 DAS), T₅: Quizalofop-p-ethyl @ 75 g ha⁻¹ (PoE), T₆: Imazethapyr + Imazamax @ 75 g ha⁻¹ (PoE), T₇: Sodium Aciflourfen and Clodinafop-propargyl @ 180 g ha⁻¹ (PoE) and T₈: Unweeded check (Control).

4.4.3.2. *Digitaria sanguinalis* L.

Data on *Digitaria sanguinalis* L. dry weight as a function of weed management treatments all observational phases in 2021 and 2022 are displayed in Table 4.51 and are represented in graph 4.47.

Data on *Digitaria sanguinalis* L. minimum dry weight observed in HW (20 and 40 DAS) and PE pendimethalin 1000 g with combination PoE imazethapyr 50 g for the years 2021 and 2022 are displayed in Table 4.51. When using imazamax 75 g PoE and quizalofop p ethyl 75 g PoE in conjunction with Imazethapyr, the highest dry weight of *Digitaria sanguinalis* L. was observed, and this was linked to weedy check. Imazethapyr 60 g PE and PoE sodium aciflurofen mixed with clodinafop propargyl 180 g showed data on 40 days greater dry weight on *Digitaria sanguinalis* L., with the lowest value in HW (20 and 40 DAS) and PE pendimethalin 1000 g with combination of imazethapyr 50 g PoE over weedy check. At 60 DAS and harvest minimum in HW (20 and 40 DAS) followed by PE pendimethalin 1000 g with combination of imazethapyr 50 g PoE and maximum dry weight of *Digitaria sanguinalis* L. were in weedy check.

The cumulative statistics on the 20 DAS maximum dry weight of *Digitaria sanguinalis* L. found in PoE treatment linked to PE are displayed in Table 4.51 and are depicted in graph 4.47. The lowest dry weight of *Digitaria sanguinalis* L. was observed in HW (20 and 40 DAS), while the highest dry weight of *Digitaria sanguinalis* L. was reported in comparison to herbicidal treatments. PE pendimethalin 1000 g and combination PoE imazethapyr 50 g came next.



Graph 4.47 Influence of different herbicide treatments on dry weight (g m^{-2}) of *Digitaria sanguinalis* L. in green gram at 20 days intervals (Pool data of 2021 and 2022).

Table 4.52 Influence of different herbicide treatments on dry weight (g m⁻²) of *Cyperus rotundus* L. in green gram at 20 days intervals (2021 and 2022).

Treatment	20 DAS (2021)	20 DAS (2022)	Pool data	40 DAS (2021)	40 DAS (2022)	Pool data	60 DAS (2021)	60 DAS (2022)	Pool data	Harvest (2021)	Harvest (2022)	Pool data
T ₁	0.29** (0.086)*	0.30 (0.090)	0.30 (0.088)	0.34 (0.115)	0.34 (0.120)	0.34 (0.157)	0.37 (0.14)	0.38 (0.141)	0.37 (0.141)	0.37 (0.18)	0.38 (0.14)	0.38 (0.16)
T ₂	0.27 (0.075)	0.29 (0.077)	0.28 (0.076)	0.27 (0.085)	0.30 (0.090)	0.29 (0.087)	0.33 (0.11)	0.35 (0.12)	0.33 (0.115)	0.35 (0.12)	0.35 (0.124)	0.40 (0.12)
T ₃	0.21 (0.044)	0.23 (0.049)	0.22 (0.0465)	0.23 (0.055)	0.24 (0.060)	0.24 (0.057)	0.21 (0.043)	0.24 (0.050)	0.21 (0.047)	0.25 (0.065)	0.23 (0.057)	0.24 (0.061)
T ₄	0.32 (0.105)	0.33 (0.11)	0.32 (0.1075)	0.31 (0.096)	0.32 (0.10)	0.31 (0.098)	0.34 (0.115)	0.35 (0.119)	0.34 (0.117)	0.37 (0.14)	0.33 (0.11)	0.36 (0.13)
T ₅	0.35 (0.120)	0.36 (0.127)	0.36 (0.1235)	0.35 (0.122)	0.36 (0.129)	0.35 (0.125)	0.38 (0.145)	0.39 (0.150)	0.37 (0.148)	0.41 (0.17)	0.38 (0.15)	0.40 (0.16)
T ₆	0.31 (0.100)	0.33 (0.109)	0.33 (0.1045)	0.31 (0.095)	0.32 (0.099)	0.32 (0.097)	0.31 (0.098)	0.31 (0.10)	0.31 (0.099)	0.36 (0.13)	0.33 (0.11)	0.34 (0.12)
T ₇	0.37 (0.140)	0.39 (0.15)	0.38 (0.145)	0.30 (0.091)	0.32 (0.098)	0.30 (0.094)	0.33 (0.111)	0.33 (0.113)	0.33 (0.112)	0.37 (0.14)	0.34 (0.12)	0.36 (0.13)
T ₈	0.53 (0.280)	0.55 (0.29)	0.54 (0.285)	0.58 (0.35)	0.60 (0.36)	0.59 (0.355)	0.63 (0.43)	0.67 (0.45)	0.66 (0.440)	0.69 (0.48)	0.66 (0.44)	0.67 (0.46)
SE m (±)	0.02	0.02	0.02	0.03	0.03	0.03	0.04	0.03	0.04	0.03	0.02	0.03
CD (p = 0.05)	0.05	0.06	0.06	0.09	0.06	0.08	0.13	0.06	0.10	0.10	0.05	0.08

*Values given in parenthesis are the mean of original values. **Data subjected to ($\sqrt{x+0.5}$) square root transformation, SE m (±): Standard error of mean, CD: Critical Difference and DAS: Days after sowing

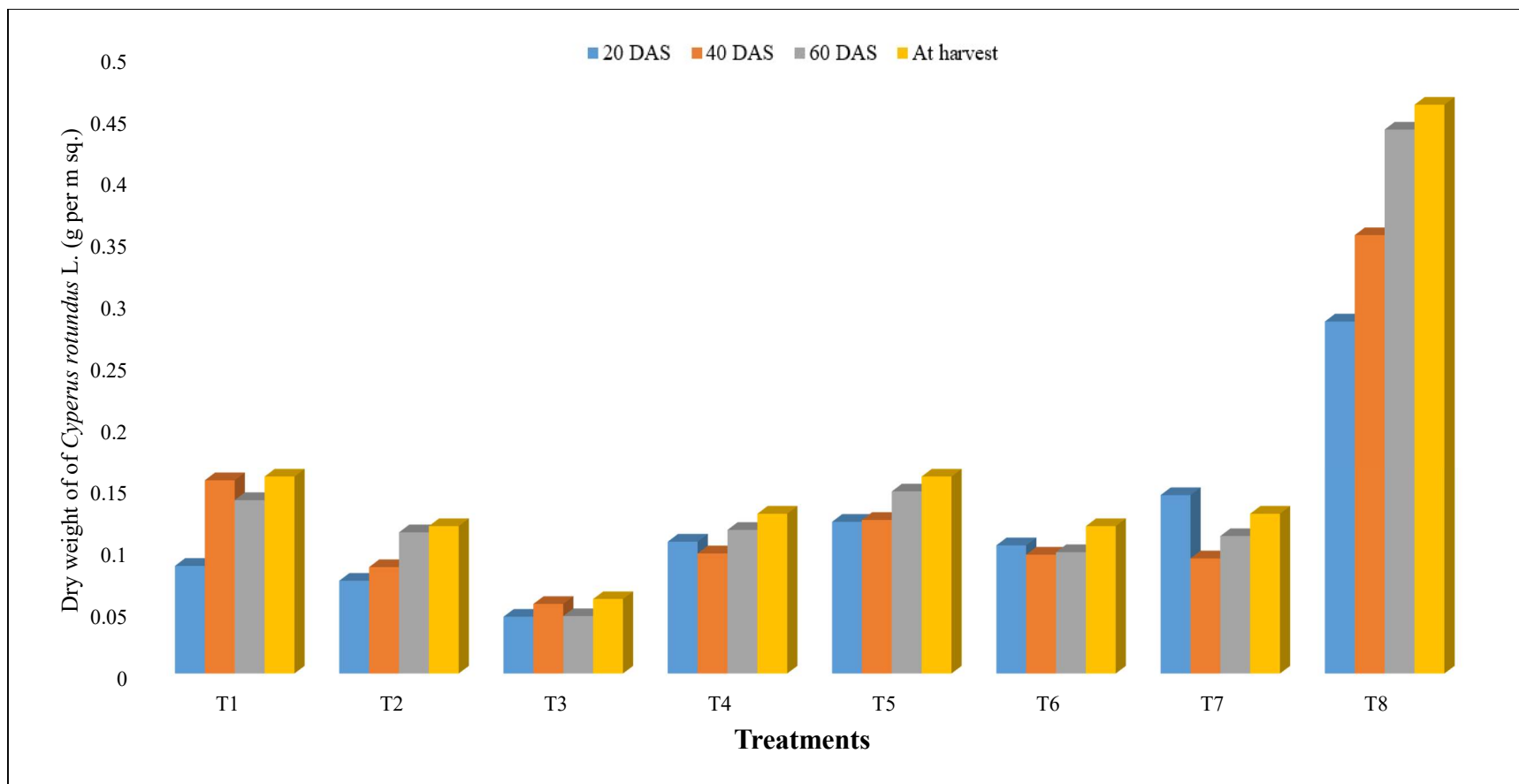
Treatments: T₁: Imazethapyr @ 60 g ha⁻¹ (PE), T₂: Pendimethalin 1 @ kg ha⁻¹ (PE), T₃: Pendimethalin 1 @ kg ha⁻¹ (PE) combined with Imazethapyr @ 50 g ha⁻¹ (PoE), T₄: Hand weeding twice (20 and 40 DAS), T₅: Quizalofop-p-ethyl @ 75 g ha⁻¹ (PoE), T₆: Imazethapyr + Imazamax @ 75 g ha⁻¹ (PoE), T₇: Sodium Aciflourfen and Clodinafop-propargyl @ 180 g ha⁻¹ (PoE) and T₈: Unweeded check (Control).

4.4.3.3. *Cyperus rotundus* L.

The data on *Cyperus rotundus* L. dry weight was Influence of herbicides at all points during observations in the years 2021 and 2022, as shown in Table 4.52 and represents in the graph. 4.48.

Data on 20 DAS reduced dry weight on *Cyperus rotundus* L. in usage on PE pendimethalin 1000 g in combination with PoE imazethapyr 50 g and PE pendimethalin 1000 g and higher in PoE sodium aciflourfen and clodinafop propargyl 180 g and PoE quizalofop p ethyl 75 g are shown in Table 4.52 for the years 2021 and 2022. Using PE pendimethalin 1000 g combined with PoE imazethapyr 50 g and lower in PE pendimethalin 1000 g combine with PoE imazethapyr 50 g over Weedy check, the maximum dry weight on *Cyperus rotundus* L. was observed at 40 and 60 DAS. At harvest minimum dry weight on *Cyperus rotundus* L. in use of PE pendimethalin 1000 g combine with PoE imazethapyr 50 g followed by imazethapyr combined with imazamax 75 g PoE and maximum in imazethapyr 60 g PE followed by PE pendimethalin 1000 g associated to weedy check.

Cumulative statistics shown on Table 4.52 and represented in graph 4.48 on data 20 days PE control of *Cyperus rotundus* L. on initial periods of crop growth compared to PoE. At 40 days minimum dry weight on *Cyperus rotundus* L. in use of PE pendimethalin 1000 g combine with PoE imazethapyr 50 g then PE pendimethalin 1000 g, higher in PE imazethapyr 60 g and PoE quizalofop p ethyl 75 g associated to weedy check.



Graph 4.48 Influence of different herbicide treatments on dry weight (g m⁻²) of *Cyperus rotundus* L. in green gram at 20 days period (Pool data of 2021 and 2022).

Table 4.53 Influence of different herbicide treatments on dry weight (g m⁻²) of *Cassia tora* L. in green gram at 20 days intervals (2021 and 2022).

Treatment	20 DAS (2021)	20 DAS (2022)	Pool data	40 DAS (2021)	40 DAS (2022)	Pool data	60 DAS (2021)	60 DAS (2022)	Pool data	Harvest (2021)	Harvest (2022)	Pool data
T ₁	0.27** (0.071)*	0.28 (0.077)	0.30 (0.074)	0.084 (0.29)	0.30 (0.090)	0.30 (0.087)	0.144 (0.38)	0.39 (0.15)	0.39 (0.147)	0.40 (0.16)	0.41 (0.168)	0.40 (0.164)
T ₂	0.23 (0.053)	0.23 (0.055)	0.27 (0.054)	0.26 (0.068)	0.26 (0.070)	0.29 (0.069)	0.12 (0.35)	0.36 (0.13)	0.36 (0.125)	0.13 (0.36)	0.36 (0.134)	0.34 (0.132)
T ₃	0.21 (0.045)	0.22 (0.050)	0.21 (0.0475)	0.22 (0.049)	0.23 (0.055)	0.23 (0.052)	0.30 (0.09)	0.30 (0.10)	0.31 (0.095)	0.31 (0.10)	0.32 (0.106)	0.20 (0.103)
T ₄	0.25 (0.061)	0.26 (0.069)	0.25 (0.065)	0.26 (0.066)	0.26 (0.069)	0.26 (0.067)	0.32 (0.101)	0.31 (0.109)	0.30 (0.105)	0.33 (0.112)	0.34 (0.118)	0.33 (0.115)
T ₅	0.35 (0.12)	0.37 (0.134)	0.36 (0.073)	0.30 (0.091)	0.31 (0.099)	0.31 (0.095)	0.42 (0.18)	0.43 (0.190)	0.41 (0.185)	0.46 (0.21)	0.46 (0.212)	0.46 (0.211)
T ₆	0.36 (0.132)	0.38 (0.139)	0.35 (0.135)	0.29 (0.082)	0.29 (0.089)	0.29 (0.085)	0.41 (0.17)	0.42 (0.176)	0.42 (0.173)	0.43 (0.19)	0.43 (0.191)	0.38 (0.190)
T ₇	0.37 (0.139)	0.38 (0.146)	0.38 (0.142)	0.27 (0.074)	0.28 (0.080)	0.32 (0.077)	0.40 (0.16)	0.40 (0.166)	0.40 (0.163)	0.41 (0.17)	0.41 (0.172)	0.41 (0.171)
T ₈	0.53 (0.290)	0.55 (0.31)	0.53 (0.30)	0.62 (0.410)	0.67 (0.45)	0.69 (0.43)	0.93 (0.90)	0.98 (0.97)	0.96 (0.935)	1.08 (1.20)	1.14 (1.30)	1.11 (1.25)
SE m (±)	0.02	0.02	0.02	0.04	0.02	0.03	0.05	0.03	0.04	0.06	0.03	0.05
CD (p = 0.05)	0.07	0.05	0.06	0.12	0.06	0.09	0.14	0.10	0.12	0.17	0.09	0.13

*Values given in parenthesis are the mean of original values. **Data subjected to ($\sqrt{x+0.5}$) square root transformation, SE m (±): Standard error of mean, CD: Critical Difference and DAS: Days after sowing

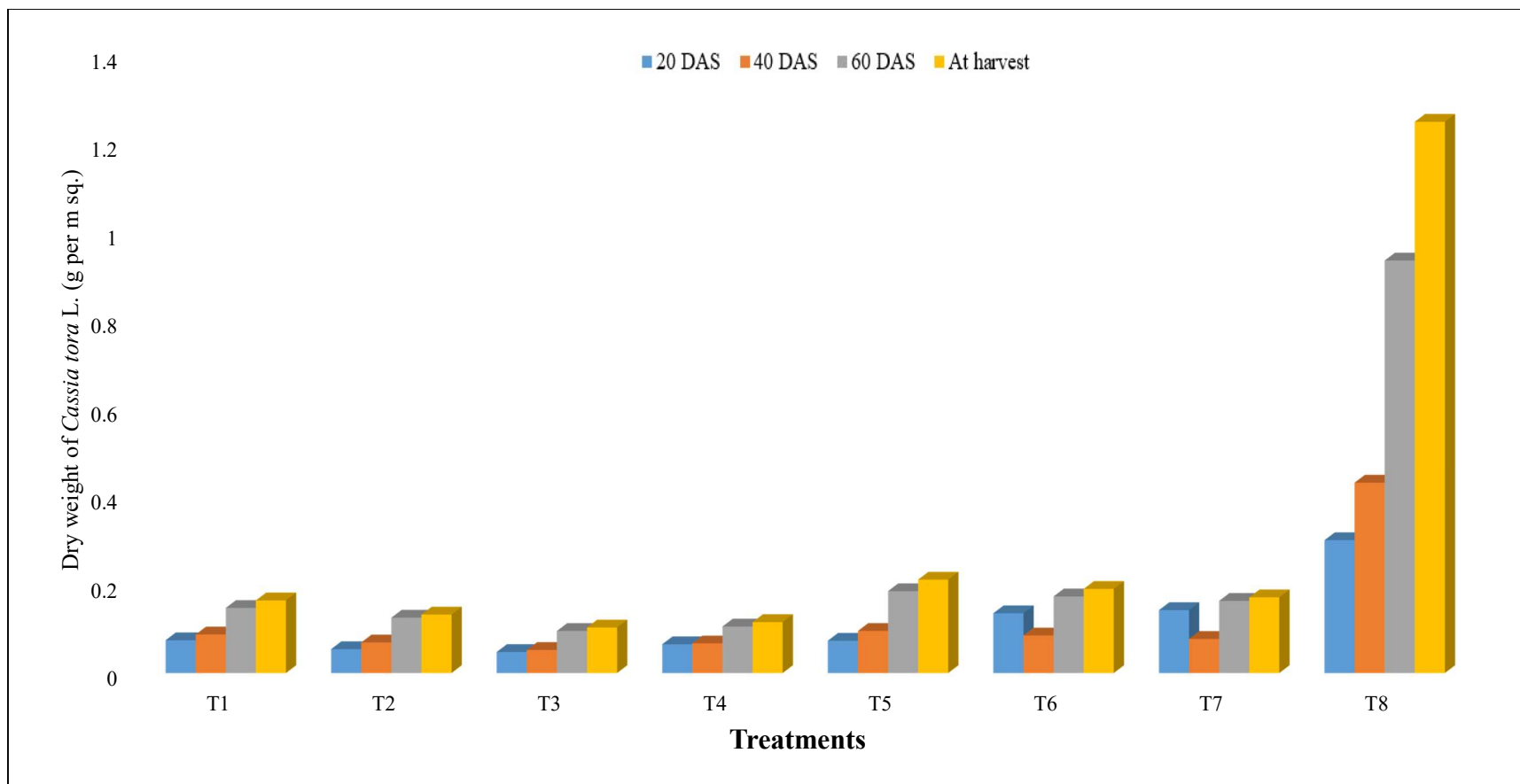
Treatments: T₁: Imazethapyr @ 60 g ha⁻¹ (PE), T₂: Pendimethalin 1 @ kg ha⁻¹ (PE), T₃: Pendimethalin 1 @ kg ha⁻¹ (PE) combined with Imazethapyr @ 50 g ha⁻¹ (PoE), T₄: Hand weeding twice (20 and 40 DAS), T₅: Quizalofop-p-ethyl @ 75 g ha⁻¹ (PoE), T₆: Imazethapyr + Imazamax @ 75 g ha⁻¹ (PoE), T₇: Sodium Aciflurofen and Clodinafop-propargyl @ 180 g ha⁻¹ (PoE) and T₈: Unweeded check (Control).

4.4.3.4. *Cassia tora* L.

The information on *Cassia tora* L. dry weight was influence of herbicides at 20 days interval up to harvest in the years 2021 and 2022, as shown in Table 4.53 and represented in the graph. 4.49.

In the 2021 and 2022 statistical years displayed in Table 4.53 minimum dry weight on *Cassia tora* L. at 20 days in PE pendimethalin 1000 g mixed with PoE imazethapyr 50 g after PE pendimethalin 1000 g; maximum in PoE sodium aciflourfen combined with clodinafop propargyl 180 g after PoE quizalofop p ethyl 75 g. At 40 days, the highest dry weight of *Cassia tora* L. was recorded in PoE quizalofop p ethyl 75 g, followed by imazethapyr 60 g PE, and the lowest in PE pendimethalin 1000 g combined with PoE imazethapyr 50 g on par with HW (20 and 40 DAS) above weedy check.

Cumulative statistics shown on Table 4.53 and represented graph 4.49 on 20 DAS maximum dry weight on *Cassia tora* L. were observed in PoE treatment since there is no use of herbicide on initial phases. At 20 days PE herbicide regulate weed properly minimum dry weight observed in treatments. At later stage of crop growth, maximum dry weight on *Cassia tora* L. were recorded in PoE quizalofop p ethyl 75 g then PE imazethapyr 60 g. The minimum dry weight on *Cassia tora* L. were noted in use of PE pendimethalin 1000g combine with PoE imazethapyr 50 g were par with HW (20 and 40 DAS) compared to weedy check.



Graph 4.49 Influence of herbicides on dry weight of *Cassia tora* L. in green gram at 20 days intervals (Pool data of 2021 and 2022).

Table 4.54 Influence of different herbicide treatments on dry weight (g m⁻²) of *Celosia argentea* L. in green gram at 20 days intervals (2021 and 2022).

Treatment	20 DAS (2021)	20 DAS (2022)	Pool data	40 DAS (2021)	40 DAS (2022)	Pool data	60 DAS (2021)	60 DAS (2022)	Pool data	Harvest (2021)	Harvest (2022)	Pool data
T ₁	0.15** (0.024)*	0.17 (0.030)	0.16 (0.027)	0.17 (0.029)	0.17 (0.031)	0.17 (0.03)	0.30 (0.09)	0.31 (0.098)	0.30 (0.094)	0.30 (0.09)	0.31 (0.10)	0.30 (0.095)
T ₂	0.13 (0.018)	0.14 (0.021)	0.14 (0.0195)	0.14 (0.021)	0.17 (0.029)	0.15 (0.025)	0.26 (0.07)	0.27 (0.076)	0.27 (0.073)	0.28 (0.08)	0.30 (0.09)	0.29 (0.085)
T ₃	0.12 (0.015)	0.13 (0.018)	0.12 (0.0165)	0.13 (0.018)	0.14 (0.022)	0.14 (0.02)	0.20 (0.04)	0.24 (0.060)	0.24 (0.05)	0.26 (0.072)	0.26 (0.068)	0.26 (0.070)
T ₄	0.15 (0.022)	0.15 (0.025)	0.15 (0.0235)	0.23 (0.051)	0.23 (0.057)	0.23 (0.054)	0.26 (0.06)	0.26 (0.070)	0.25 (0.065)	0.25 (0.065)	0.25 (0.067)	0.25 (0.066)
T ₅	0.28 (0.079)	0.29 (0.086)	0.28 (0.0825)	0.30 (0.088)	0.31 (0.091)	0.29 (0.089)	0.35 (0.12)	0.35 (0.129)	0.35 (0.124)	0.37 (0.14)	0.34 (0.12)	0.36 (0.13)
T ₆	0.26 (0.067)	0.27 (0.077)	0.27 (0.072)	0.30 (0.091)	0.30 (0.096)	0.30 (0.093)	0.34 (0.11)	0.34 (0.119)	0.34 (0.114)	0.34 (0.119)	0.34 (0.120)	0.34 (0.119)
T ₇	0.31 (0.096)	0.31 (0.100)	0.31 (0.098)	0.28 (0.076)	0.28 (0.080)	0.27 (0.078)	0.32 (0.10)	0.36 (0.13)	0.35 (0.115)	0.35 (0.12)	0.35 (0.123)	0.35 (0.121)
T ₈	0.35 (0.120)	0.35 (0.124)	0.34 (0.122)	0.56 (0.320)	0.58 (0.340)	0.57 (0.33)	0.83 (0.70)	0.92 (0.85)	0.88 (0.775)	0.91 (0.84)	0.87 (0.76)	0.89 (0.80)
SE m (±)	0.01	0.01	0.01	0.02	0.01	0.02	0.03	0.03	0.03	0.03	0.03	0.03
CD (p = 0.05)	0.02	0.04	0.03	0.05	0.04	0.05	0.08	0.09	0.09	0.10	0.09	0.10

*Values given in parenthesis are the mean of original values. **Data subjected to ($\sqrt{x+0.5}$) square root transformation, SE m (±): Standard error of mean, CD: Critical Difference and DAS: Days after sowing

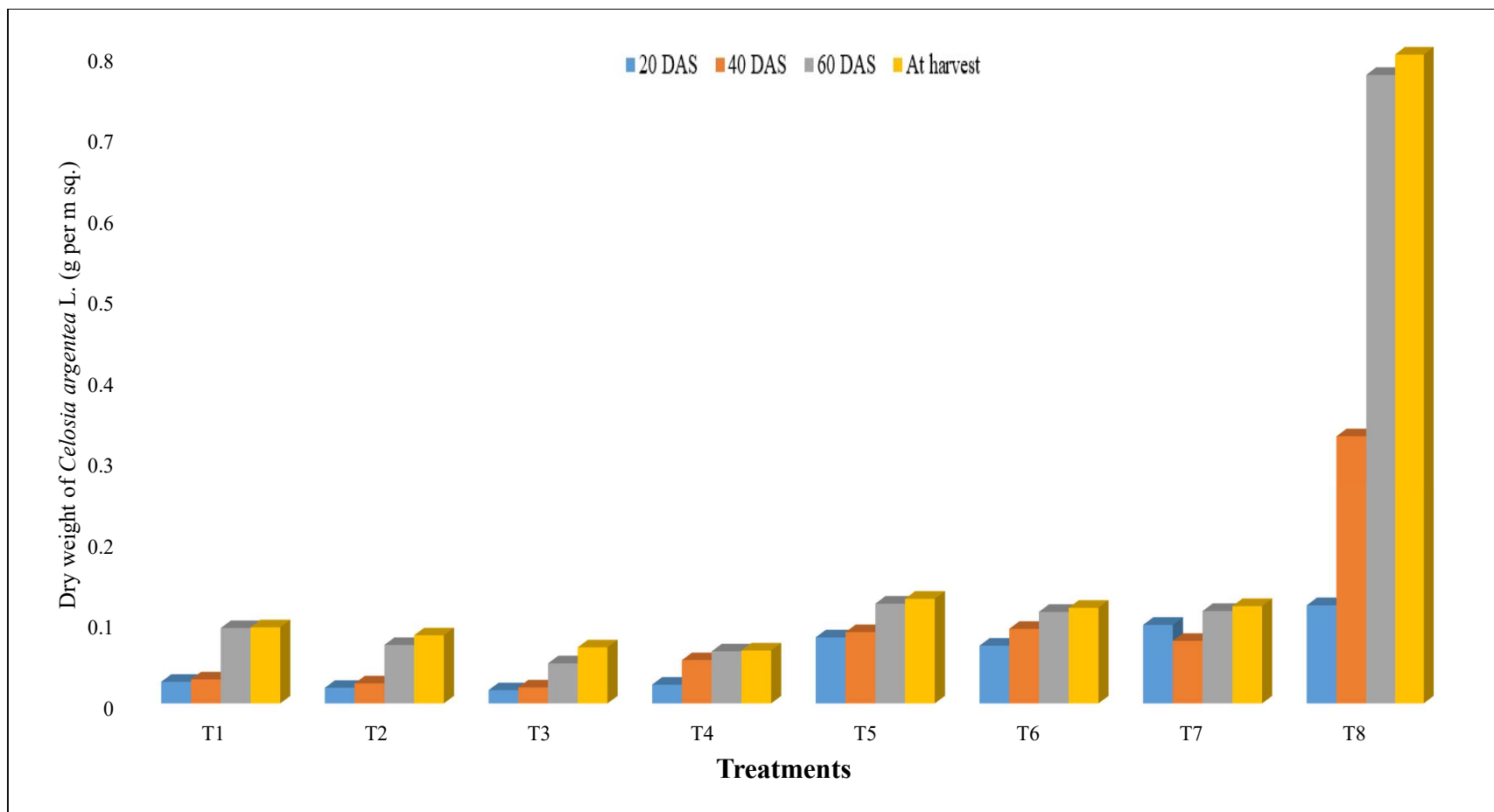
Treatments: T₁: Imazethapyr @ 60 g ha⁻¹ (PE), T₂: Pendimethalin 1 @ kg ha⁻¹ (PE), T₃: Pendimethalin 1 @ kg ha⁻¹ (PE) combined with Imazethapyr @ 50 g ha⁻¹ (PoE), T₄: Hand weeding twice (20 and 40 DAS), T₅: Quizalofop-p-ethyl @ 75 g ha⁻¹ (PoE), T₆: Imazethapyr + Imazamax @ 75 g ha⁻¹ (PoE), T₇: Sodium Aciflourfen and Clodinafop-propargyl @ 180 g ha⁻¹ (PoE) and T₈: Unweeded check (Control).

4.4.3.5. *Celosia argentea* L.

The information on *Celosia argentea* L. dry weight was influence of herbicides at 20 days intervals up to harvest in the years 2021 and 2022, as shown in Table 4.54 and represented in the graph. 4.50.

The data for 20 days maximum dry weight on *Celosia argentea* L. in use for PoE sodium aciflourfen coupled with clodinafop propargyl 180 g, PoE quizalofop p ethyl 75 g, and PoE imazethapyr mixed with imazamax 75 g for the years 2021 and 2022 are displayed in Table 4.54. PoE imazethapyr 50 g is mixed with the minimum dry weight of *Celosia argentea* L. used in combined with PE pendimethalin 1000 g. When using PE pendimethalin 1000 g in combination with PoE imazethapyr 50 g at 40 days, the minimum dry weight of *Celosia argentea* L. is used. Following PE pendimethalin 1000 g, PE imazethapyr 60 g, and the maximum amount of imazethapyr coupled with PoE imazamax 75 g, PoE quizalofop p ethyl 75 g. The identical treatment shows minimum dry weight of *Celosia argentea* L. during both years over weedy check. Alike outcomes were stated by Danga *et al.* 2020.

The cumulative data for the greatest dry weight on *Celosia argentea* L. 20 days after sowing were recorded in the PoE treatment linked to PE. These statistics are displayed in Table 4.54 and are depicted in graph 4.50. After 40 days, the lowest dry weight of *Celosia argentea* L. was measured in PE pendimethalin 1000 g combined with PoE imazethapyr 50 g, PE imazethapyr 60 g, and the highest dry weight was measured in imazethapyr combined with PoE imazamax 75 g following PoE quizalofop p ethyl 75 g and PoE sodium aciflourfen combined with clodinafop propargyl 180 g. Similar results start to appear after 60 days and are linked to weed control.



Graph 4.50 Influence of different herbicide treatments on dry weight (g m⁻²) of *Celosia argentea* L. in green gram at 20 days intervals (Pooled data of 2021 and 2022).

Table 4.55 Influence of different herbicide treatments on dry weight (g m⁻²) of total weed species in green gram at 20 days intervals (2021 and 2022).

Treatment	20 DAS (2021)	20 DAS (2022)	Pool data	40 DAS (2021)	40 DAS (2022)	Pool data	60 DAS (2021)	60 DAS (2022)	Pool data	Harvest (2021)	Harvest (2022)	Pool data
T ₁	0.53** (0.28)*	0.55 (0.31)	0.54 (0.29)	0.64 (0.41)	0.71 (0.51)	0.77 (0.60)	0.81 (0.65)	0.86 (0.74)	0.34 (0.69)	0.81 (0.65)	0.87 (0.76)	0.84 (0.70)
T ₂	0.46 (0.21)	0.49 (0.24)	0.47 (0.22)	0.57 (0.33)	0.59 (0.35)	0.58 (0.34)	0.77 (0.60)	0.76 (0.58)	0.77 (0.59)	0.79 (0.62)	0.77 (0.59)	0.77 (0.60)
T ₃	0.41 (0.16)	0.42 (0.18)	0.41 (0.17)	0.46 (0.20)	0.51 (0.26)	0.48 (0.23)	0.57 (0.32)	0.65 (0.43)	0.61 (0.37)	0.64 (0.41)	0.61 (0.38)	0.62 (0.39)
T ₄	0.55 (0.30)	0.48 (0.23)	0.52 (0.27)	0.50 (0.25)	0.50 (0.25)	0.50 (0.25)	0.57 (0.33)	0.69 (0.47)	0.63 (0.40)	0.68 (0.46)	0.64 (0.42)	0.66 (0.44)
T ₅	0.73 (0.52)	0.79 (0.62)	0.76 (0.57)	0.71 (0.50)	0.73 (0.53)	0.72 (0.52)	0.84 (0.70)	1.05 (1.01)	0.92 (0.85)	0.94 (0.89)	0.95 (0.91)	0.94 (0.90)
T ₆	0.73 (0.53)	0.77 (0.60)	0.75 (0.57)	0.71 (0.50)	0.72 (0.53)	0.72 (0.51)	0.83 (0.69)	0.88 (0.77)	0.85 (0.73)	0.84 (0.70)	0.94 (0.89)	0.89 (0.79)
T ₇	0.75 (0.56)	0.78 (0.60)	0.76 (0.58)	0.65 (0.42)	0.67 (0.45)	0.66 (0.43)	0.75 (0.56)	0.84 (0.72)	0.80 (0.64)	0.82 (0.68)	0.84 (0.72)	0.82 (0.70)
T ₈	1.10 (1.23)	1.51 (1.32)	1.13 (1.27)	1.28 (1.71)	1.37 (1.90)	1.34 (1.80)	1.58 (2.50)	1.87 (3.53)	1.73 (3.01)	1.82 (3.33)	1.81 (3.28)	1.81 (3.30)
SE m (±)	0.06	0.03	0.05	0.08	0.05	0.07	0.09	0.06	0.08	0.10	0.07	0.09
CD (p = 0.05)	0.20	0.08	0.14	0.28	0.14	0.21	0.23	0.17	0.20	0.32	0.22	0.27

*Values given in parenthesis are the mean of original values. **Data subjected to ($\sqrt{x+0.5}$) square root transformation, SE m (±): Standard error of mean, CD: Critical Difference and DAS: Days after sowing

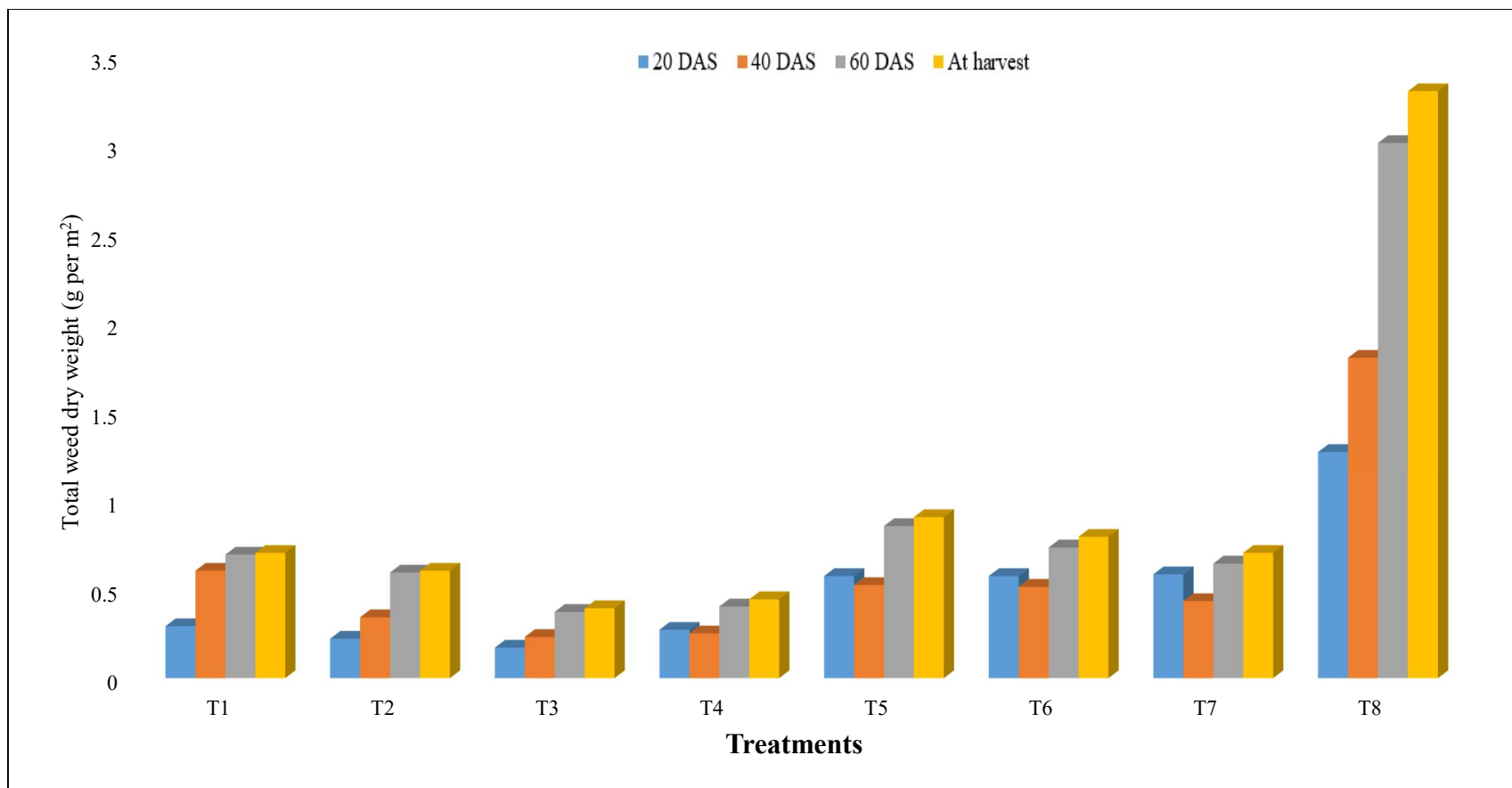
Treatments: T₁: Imazethapyr @ 60 g ha⁻¹ (PE), T₂: Pendimethalin 1 @ kg ha⁻¹ (PE), T₃: Pendimethalin 1 @ kg ha⁻¹ (PE) combined with Imazethapyr @ 50 g ha⁻¹ (PoE), T₄: Hand weeding twice (20 and 40 DAS), T₅: Quizalofop-p-ethyl @ 75 g ha⁻¹ (PoE), T₆: Imazethapyr + Imazamax @ 75 g ha⁻¹ (PoE), T₇: Sodium Aciflourfen and Clodinafop-propargyl @ 180 g ha⁻¹ (PoE) and T₈: Unweeded check (Control).

4.4.3.6. Dry weight of total weed species (g m⁻²)

The data on dry weight of the total weed population affected by weed control treatments at all observational stages in the years 2021 and 2022, as shown in Table 4.55 also represented in graph 4.51.

Statistics for 20 days of PE treatment in 2021 and 2022 are displayed in Table 4.55, which also records minimal dry weight in comparison to PoE and shows improved weed control. Minimum dry weight of all weeds in treatment HW (20 and 40 DAS) par with 1000 g of PE pendimethalin combined with 50 g of PoE imazethapyr and 1000 g of PE pendimethalin at 20 and 40 days. The highest dry weight of all weeds in PE was 60 g of imimazethapyr, then 75 g of PoE quizalofop p ethyl and 75 g of imazethapyr mixed with PoE imazamax. Similar effects are started on the crop's lateral phases 60 days before harvest in relation to weed control. A similar outcome were stated by Singh and Yadav, 2015, Kaur 2016, T. Muthuram 2017, Singh 2018, Osari 2019 and T. Ramesh *et al.* 2020.

Cumulative statistics on 2021 and 2022 shown on Table 4.55 and represented in graph 4.51 at 20 days minimum dry weight of total weeds observed in PE treatment associated with PoE treatments. At 40 days minimum dry weight of total weeds is observed in PE pendimethalin 1000 g combine with PoE imazethapyr 50 g and hand weeding (20 and 40 DAS) and PE pendimethalin 1000 g. Maximum dry weight of total weeds PE imazethapyr 60 g next to PoE quizalofop p ethyl 75 g and imazethapyr combined with PoE imazamax 75 g. On later period 60 DAS similar treatment shown higher performance during both years as compared to weedy check.



Graph 4.51 Influence of herbicides on dry weight of total weed species in green gram at 20 days intervals (Pool data of 2021 and 2022).

Table 4.56 Influence of different herbicide treatments on weed control efficiency (%) of *Commelina benghalensis* L. in green gram at 20 days intervals (2021 and 2022).

Treatment	20 DAS (2021)	20 DAS (2022)	Pool data	40 DAS (2021)	40 DAS (2022)	Pool data	60 DAS (2021)	60 DAS (2022)	Pool data	Harvest (2021)	Harvest (2022)	Pool data
T₁	88.57	88.25	88.41	70.73	76.90	73.81	70.24	71.91	71.08	67.06	73.33	70.20
T₂	91.42	91.25	91.33	80.48	80.88	80.68	79.76	80.90	80.33	72.94	78.89	75.92
T₃	94.28	94.00	94.14	85.36	84.66	85.01	83.33	84.27	83.80	74.12	82.22	78.17
T₄	74.28	76.50	75.39	94.81	93.55	94.18	86.90	87.64	87.27	78.82	84.44	81.63
T₅	71.14	60.00	65.57	63.41	64.88	64.14	71.43	73.03	72.23	67.06	68.89	67.98
T₆	68.57	65.00	66.78	56.09	59.11	57.60	66.67	68.54	67.61	58.82	67.78	63.30
T₇	74.28	75.25	74.76	70.73	72.00	71.36	71.43	73.03	72.23	70.59	72.22	71.41
T₈	-	-	-	-	-	-	-	-	-	-	-	-

Treatments: T₁: Imazethapyr @ 60 g ha⁻¹ (PE), T₂: Pendimethalin 1 @ kg ha⁻¹ (PE), T₃: Pendimethalin 1 @ kg ha⁻¹ (PE) combined with Imazethapyr @ 50 g ha⁻¹ (PoE), T₄: Hand weeding twice (20 and 40 DAS), T₅: Quizalofop-p-ethyl @ 75 g ha⁻¹ (PoE), T₆: Imazethapyr + Imazamax @ 75 g ha⁻¹ (PoE), T₇: Sodium Aciflourfen and Clodinafop-propargyl @ 180 g ha⁻¹ (PoE) and T₈: Unweeded check (Control).

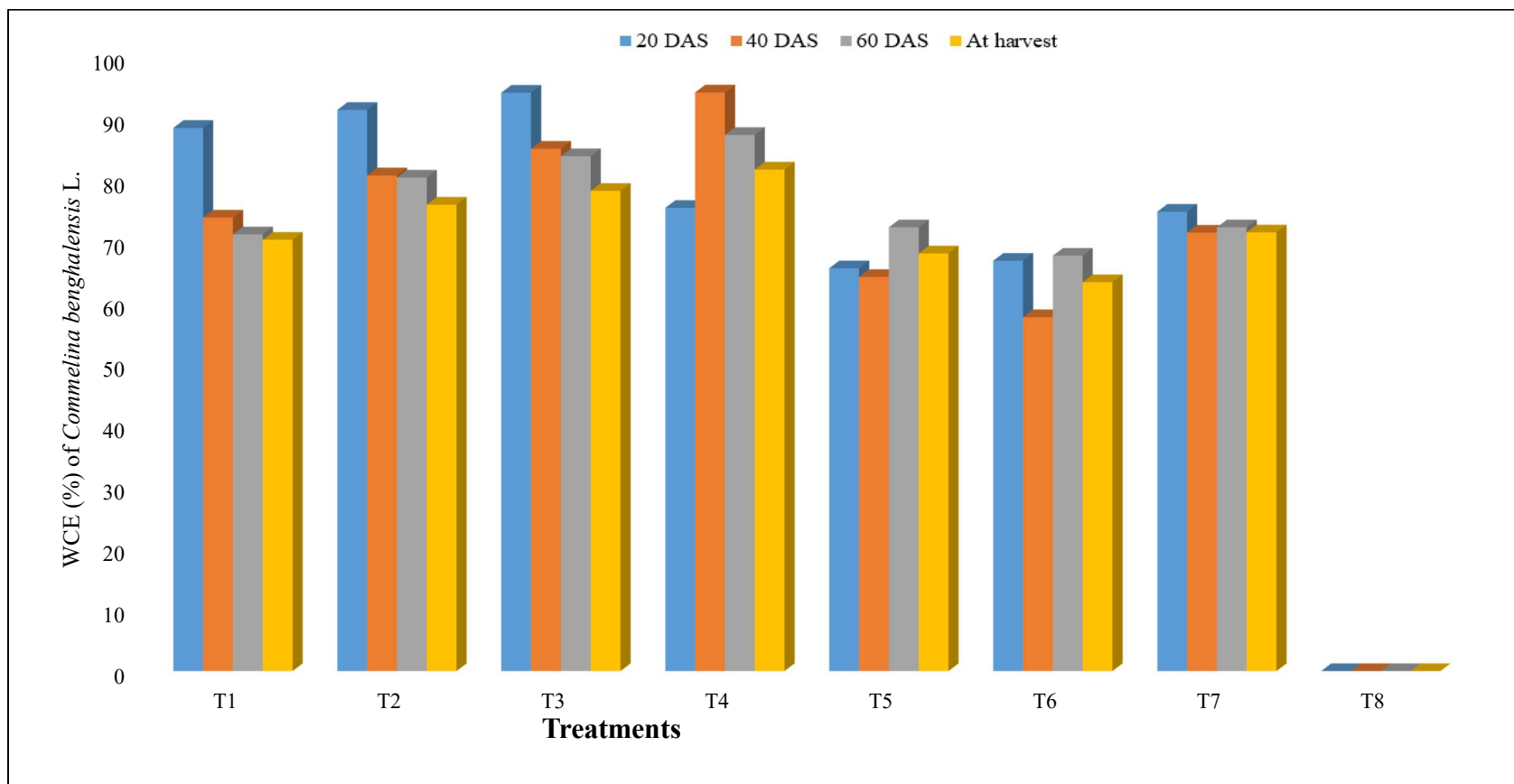
4.4.4 Weed Control Efficiency (%)

The species wise weed and total weed control efficiency were recorded 20 days interval upto harvest.

4.4.4.1 *Commelina benghalensis* L.

The data on *Commelina Spp* L. effect of weed control treatments on WCE at 20 days interval up to harvest in the years 2021 and 2022, as shown in Table 4.56 and represented in graph. 4.52.

The data from the years 2021 and 2022 are displayed in Table 4.56. For *Commelina benghalensis* L., the highest WCE was seen in PE pendimethalin 1000 g when combined with PoE imazethapyr 50 g and PE pendimethalin 1000 g and PE imazethapyr 60 g. The lowest WCE was seen in the (PoE) treatment. *Commelina benghalensis* L. were discovered to exhibit WCE at 40 days higher in HW (20 and 40 DAS) and PE pendimethalin 1000 g when combined with PoE imazethapyr 50 g. The combination of imazethapyr and PoE imazamax 75 g produced the maximum WCE on *Commelina benghalensis* L. followed by PoE quizalofop p ethyl 75 g and PoE sodium aciflurofen mixed with clodinafop propargyl 180 g. Data showed that, after 60 days, *Commelina benghalensis* L. showed the highest WCE when treated with HW (20 and 40 DAS), PE pendimethalin 1000 g in combination with PoE imazethapyr 50 g, PE pendimethalin 1000 g, and lower WCE when treated with imazethapyr in combination with PoE imazamax 75 g, PE imazethapyr 60 g, and PoE quizalofop p ethyl 75 g. The same treatment showed greater WCE at harvest for the whole record period spanning both years. The minimal performance required for treatments is weedy check forms. Osari *et al.* 2019 reported similar results.



Graph 4.52 Influence of different herbicide treatments on weed control efficiency (%) of *Commelina benghalensis* L. in green gram at 20 days intervals (Pool data of 2021 and 2022).

Table 4.57 Influence of different herbicide treatments on weed control efficiency (%) of *Digitaria sanguinalis* L. (Scop.) in green gram at 20 days intervals (2021 and 2022).

Treatment	20 DAS (2021)	20 DAS (2022)	Pool data	40 DAS (2021)	40 DAS (2022)	Pool data	60 DAS (2021)	60 DAS (2022)	Pool data	Harvest (2021)	Harvest (2022)	Pool data
T ₁	68.42	66.50	67.46	70.00	76.66	73.33	68.33	72.50	70.42	68.13	72.78	70.40
T ₂	73.68	73.00	73.34	68.18	74.66	71.42	66.66	75.33	71.00	65.15	73.12	69.13
T ₃	82.10	80.50	81.30	77.27	80.66	78.97	76.66	78.33	77.50	75.20	75.00	75.10
T ₄	81.05	81.00	81.03	90.90	91.33	91.12	81.66	83.61	82.64	79.69	83.61	81.65
T ₅	42.10	40.00	41.05	75.00	81.00	78.00	69.66	73.33	71.50	68.40	72.78	72.02
T ₆	31.57	32.00	31.79	73.00	79.33	76.17	70.66	73.33	72.00	69.28	73.61	71.45
T ₇	47.36	45.00	46.18	72.00	77.66	74.83	78.66	80.55	79.61	77.69	80.28	78.99
T ₈	-	-	-	-	-	-	-	-	-	-	-	-

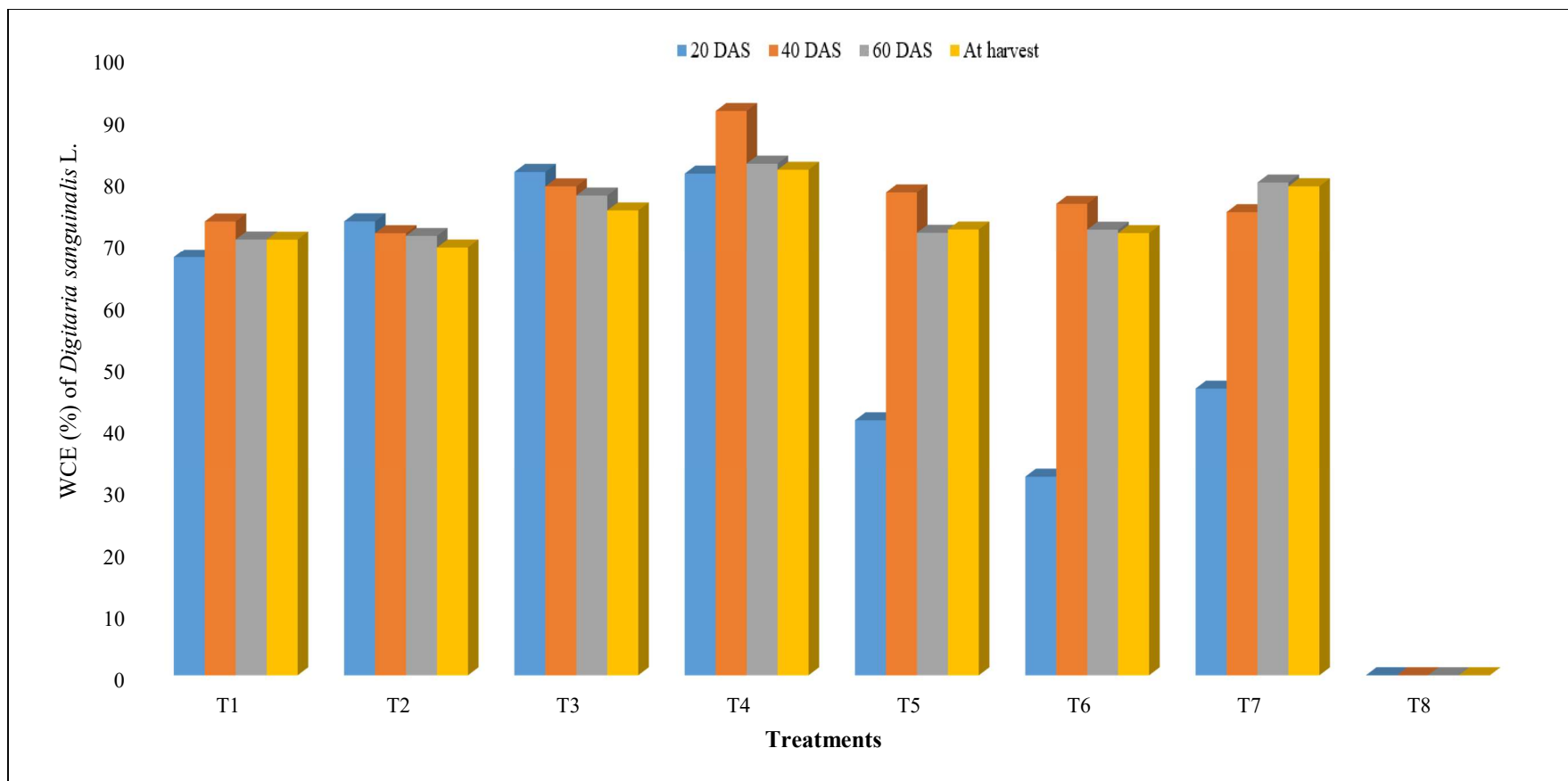
Treatments: T₁: Imazethapyr @ 60 g ha⁻¹ (PE), T₂: Pendimethalin 1 @ kg ha⁻¹ (PE), T₃: Pendimethalin 1 @ kg ha⁻¹ (PE) combined with Imazethapyr @ 50 g ha⁻¹ (PoE), T₄: Hand weeding twice (20 and 40 DAS), T₅: Quizalofop-p-ethyl @ 75 g ha⁻¹ (PoE), T₆: Imazethapyr + Imazamax @ 75 g ha⁻¹ (PoE), T₇: Sodium Aciflurofen and Clodinafop-propargyl @ 180 g ha⁻¹ (PoE) and T₈: Unweeded check (Control).

4.4.4.2 *Digitaria sanguinalis* L.

The data on *Digitaria sanguinalis* L. WCE effect of weed control treatments at all observational steps, as shown in Table 4.57 and represented in graph 4.53 in the years 2021 and 2022.

The data presented in Table 4.57 for the years 2021 and 2022 indicate that greater WCE on *Digitaria sanguinalis* L. were reported in PoE and lower WCE in PE usage were linked to weedy check. At 40 days, the combination of PoE Imazethapyr 50 g and PoE quizalofop p ethyl 75 g produced the greatest WCE in HW (20 and 40 DAS) and PE pendimethalin 1000 g. PE pendimethalin 1000 g had the lowest WCE, closely followed by PE imazethapyr 60 g. The same treatment creates minimal WCE on subsequent periods throughout both seasons connected with weedy check at 60 days and harvest. Osari *et al.* 2019 and Kumar *et al.* 2019 reported similar results.

The cumulative results for 2021 and 2022 are displayed in Table 4.57 and are depicted in graph 4.53 about the highest WCE performance of a 20-day PE treatment in comparison to a PoE treatment during the early stages of crop growth. Increased WCE over 40 days was seen in HW (20 and 40 DAS), PE pendimethalin 1000 g in combined with PoE imazethapyr 50 g, and decreased WCE over weedy check in Quizalofop p ethyl 75 g. A minimum WCE of 1000 g of PE pendimethalin was reported. HW (20 and 40 DAS) observed higher in WCE at 60 days and harvest. The combination of PoE sodium aciflourfen and 180 g of clodinafop propargyl showed the lowest WCE in comparison to the PE linked to the weedy check.



Graph 4.53 Influence of different herbicide treatments on weed control efficiency (%) of *Digitaria sanguinalis* L. (Scop.) in green gram at 20 days intervals (Pooled data of 2021 and 2022).

Table 4.58 Influence of different herbicide treatments on weed control efficiency (%) of *Cyperus rotundus* L. in green gram at 20 days intervals (2021 and 2022).

Treatment	20 DAS (2021)	20 DAS (2022)	Pool data	40 DAS (2021)	40 DAS (2022)	Pool data	60 DAS (2021)	60 DAS (2022)	Pool data	Harvest (2021)	Harvest (2022)	Pool data
T ₁	69.28	68.96	69.12	67.14	66.66	66.90	67.44	68.66	68.05	62.50	68.18	65.34
T ₂	73.21	73.44	73.33	75.71	75.00	75.36	74.41	73.33	73.87	75.00	71.82	73.41
T ₃	84.28	83.10	83.69	84.28	83.33	83.81	86.51	88.88	87.70	86.46	87.05	86.76
T ₄	62.50	62.00	62.25	72.57	72.22	72.40	73.25	73.55	73.40	70.83	75.00	72.92
T ₅	57.14	56.20	56.67	65.14	61.38	63.26	66.27	66.66	66.47	64.58	65.91	65.25
T ₆	64.28	62.41	63.35	72.75	72.50	72.63	72.98	77.77	75.38	72.92	75.00	73.96
T ₇	50.00	48.27	49.14	74.00	72.77	73.39	74.18	82.22	78.20	70.83	72.73	71.78
T ₈	-	-	-	-	-	-	-	-	-	-	-	-

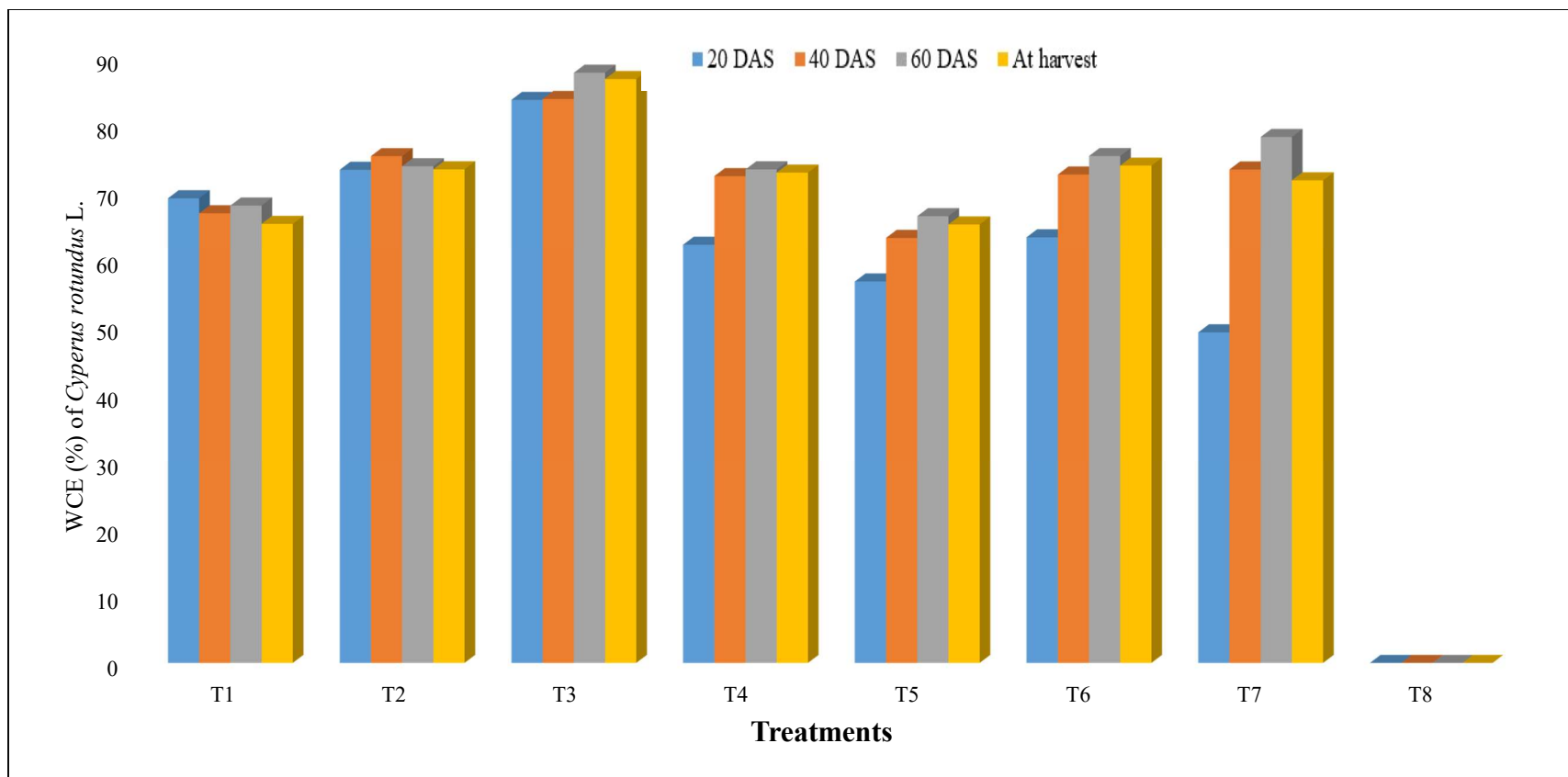
Treatments: T₁: Imazethapyr @ 60 g ha⁻¹ (PE), T₂: Pendimethalin 1 @ kg ha⁻¹ (PE), T₃: Pendimethalin 1 @ kg ha⁻¹ (PE) combined with Imazethapyr @ 50 g ha⁻¹ (PoE), T₄: Hand weeding twice (20 and 40 DAS), T₅: Quizalofop-p-ethyl @ 75 g ha⁻¹ (PoE), T₆: Imazethapyr + Imazamax @ 75 g ha⁻¹ (PoE), T₇: Sodium Aciflourfen and Clodinafop-propargyl @ 180 g ha⁻¹ (PoE) and T₈: Unweeded check (Control).

4.4.4.3 *Cyperus rotundus* L.

Data on the effects of weed control treatments on *Cyperus rotundus* L. WCE at 20 days before harvest, as displayed in Table 4.58 and depicted in graph 4.54 for the years 2021 and 2022.

The data on 20 days higher WCE on *Cyperus rotundus* L. recorded in PE treatment linked to PoE in the years 2021 and 2022 are displayed in Table 4.58. On *Cyperus rotundus* L., HW (double at 20-day intervals) showed the maximum WCE at 40 days. The treatment with the greatest WEC over the weedy check was PE pendimethalin 1000 g mixed with PoE imazethapyr 50 g. The lowest WCE was recorded in 60 g of PE imazethapyr and 75 g of PoE quizalofop p ethyl. After harvesting and 60 days, blend 1000 g of PE pendimethalin with 50 g of PoE imazethapyr and 1000 g of HW (20 and 40 DAS). Superior results are formed by equal treatment in relation to weedy check.

The cumulative statistics in 2021 then 2022 remain exposed on Table 4.58 and represented graph 4.54 on 20 days minimum WCE of *Cyperus rotundus* L. detected in PoE treatment associated to PE treatment. At 40 DAS PE pendimethalin 1000 g combine with PoE imazethapyr 50 g and PE pendimethalin 1000g achieved higher WCE compared to HW (double at 20 days periods). The minimum WCE observed in imazethapyr is 60 g PE. At 60 days and harvest PE pendimethalin 1000g combine with PoE imazethapyr 50 g recorded higher WCE likened to HW (20 and 40 DAS). The minimum WCE is noted in PE imazethapyr 60 g then PoE quizalofop p ethyl 75 g associated to weedy check.



Graph 4.54 Influence of different herbicide treatments on weed control efficiency (%) of *Cyperus rotundus* L. in green gram at 20 days intervals (2021 and 2022).

Table 4.59 Influence of different herbicide treatments on weed control efficiency (%) of *Cassia tora* L. in green gram at 20 days intervals (2021 and 2022).

Treatment	20 DAS (2021)	20 DAS (2022)	Pool data	40 DAS (2021)	40 DAS (2022)	Pool data	60 DAS (2021)	60 DAS (2022)	Pool data	Harvest (2021)	Harvest (2022)	Pool data
T ₁	75.12	75.16	75.14	79.51	80.00	79.76	84.00	84.53	84.27	86.66	87.68	87.17
T ₂	81.72	82.25	81.99	83.41	84.44	83.93	86.66	86.59	86.63	89.66	89.69	89.68
T ₃	84.48	83.87	84.18	88.04	87.77	87.91	90.00	89.69	89.85	91.66	91.84	91.75
T ₄	78.96	77.41	78.19	83.90	84.66	84.28	88.77	88.76	88.77	90.66	90.92	90.79
T ₅	58.62	56.77	57.70	77.80	78.00	77.90	80.00	80.41	80.21	82.50	83.69	83.10
T ₆	54.48	55.16	54.82	80.00	80.22	80.11	81.11	81.85	81.48	84.16	85.30	84.73
T ₇	52.06	52.90	52.48	81.95	77.77	79.86	82.22	82.88	82.55	85.83	86.76	86.30
T ₈	-	-	-	-	-	-	-	-	-	-	-	-

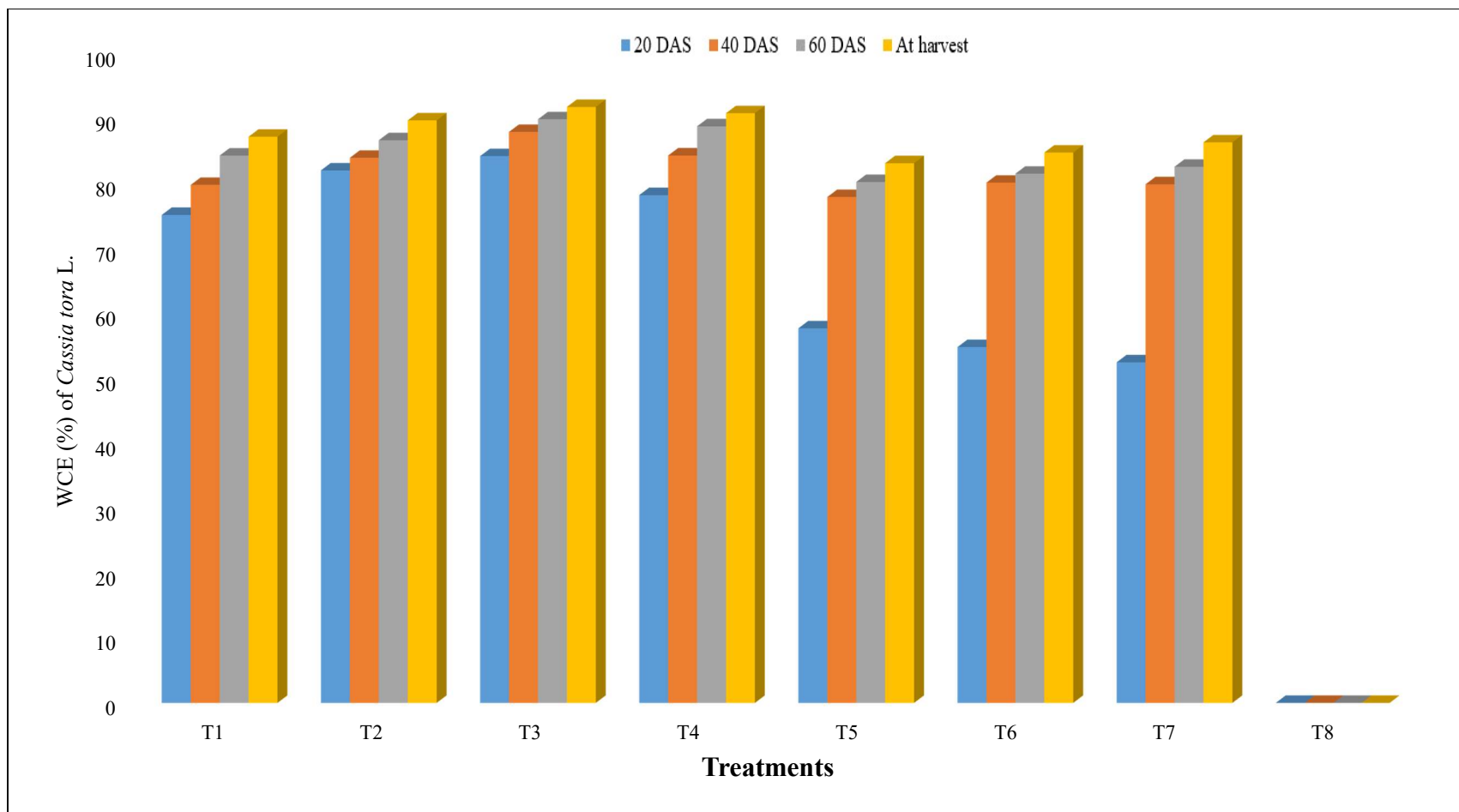
Treatments: T₁: Imazethapyr @ 60 g ha⁻¹ (PE), T₂: Pendimethalin 1 @ kg ha⁻¹ (PE), T₃: Pendimethalin 1 @ kg ha⁻¹ (PE) combined with Imazethapyr @ 50 g ha⁻¹ (PoE), T₄: Hand weeding twice (20 and 40 DAS), T₅: Quizalofop-p-ethyl @ 75 g ha⁻¹ (PoE), T₆: Imazethapyr + Imazamax @ 75 g ha⁻¹ (PoE), T₇: Sodium Aciflurofen and Clodinafop-propargyl @ 180 g ha⁻¹ (PoE) and T₈: Unweeded check (Control).

4.4.4.4 *Cassia tora* L.

Statistics on the WCE of *Cassia tora* L. affected by weed control treatments in all observational phases for the years 2021 and 2022 are displayed in Table 4.59 and are depicted in graph 4.55.

The data on 20 days of PE treatment in 2021 and 2022, as presented in Table 4.59, indicated increased WCE in comparison to PoE application of herbicides. WCE were compared to manual weeding at 40 days after the addition of 1000 g of PE pendimethalin and 50 g of PoE imazethapyr. PoE quizalofop p ethyl 75 g had the lowest WCE after PE imazethapyr 60 g. When PE pendimethalin 1000 g was combined with PoE imazapethapyr 50 g and HW (20 and 40 DAS), the maximum WCE was seen after 60 days and harvest. PoE imazethapyr paired with imazamax 75 g has the lowest WCE, followed by PoE quizalofop p ethyl 75 g. In both years with the same treatment, herbicides performed better at later stages of crop growth.

The cumulative statistics on 2021 and 2022 remain shown on Table 4.59 and represented in graph 4.55 PoE treatment appearances minimum WCE causes no use of weedicide able to 20 days causing in extreme weeds. PE treatment arrests the growth of weed at early periods subsequent in higher WCE. At 40 days higher WCE were experiential in PE pendimethalin 1000 g combine with PoE imazethapyr 50 g and HW (20 and 40 DAS) and minimum in quizalofop p ethyl 75 g compared to further treatment. At 60 days and harvest the minimum WCE were experiential in use of PoE quizalofop p ethyl 75 g then imazethapyr combined with PoE imazamax 75 g and higher in PE pendimethalin 1000 g combine with PoE imazethapyr 50 g over weedy check.



Graph 4.55 Influence of different herbicide treatments on weed control efficiency (%) of *Cassia tora* L. in green gram at 20 days intervals (Pooled data of 2021 and 2022).

Table 4.60 Influence of different herbicide treatments on weed control efficiency (%) of *Celosia argentea* L. in green gram at 20 days intervals (2021 and 2022).

Treatment	20 DAS (2021)	20 DAS (2022)	Pool data	40 DAS (2021)	40 DAS (2022)	Pool data	60 DAS (2021)	60 DAS (2022)	Pool data	Harvest (2021)	Harvest (2022)	Pool data
T ₁	80.21	75.80	78.01	90.93	90.88	90.91	88.57	88.47	88.52	87.73	86.84	87.29
T ₂	85.00	83.06	84.03	93.43	91.47	92.45	90.27	91.05	90.66	90.48	88.16	89.32
T ₃	87.50	85.48	86.49	94.37	93.52	93.95	94.44	92.94	93.69	91.43	91.05	91.25
T ₄	80.00	79.83	79.92	86.25	83.23	84.74	90.83	91.76	91.30	91.21	91.18	91.20
T ₅	34.16	30.64	32.40	84.06	73.23	78.65	83.19	84.82	84.01	83.33	84.21	83.75
T ₆	44.16	37.90	41.03	72.50	71.76	72.13	83.61	86.00	84.81	83.91	84.21	84.06
T ₇	20.00	19.35	19.68	71.56	76.47	74.02	86.11	84.70	85.41	83.78	83.81	83.80
T ₈	-	-	-	-	-	-	-	-	-	-	-	-

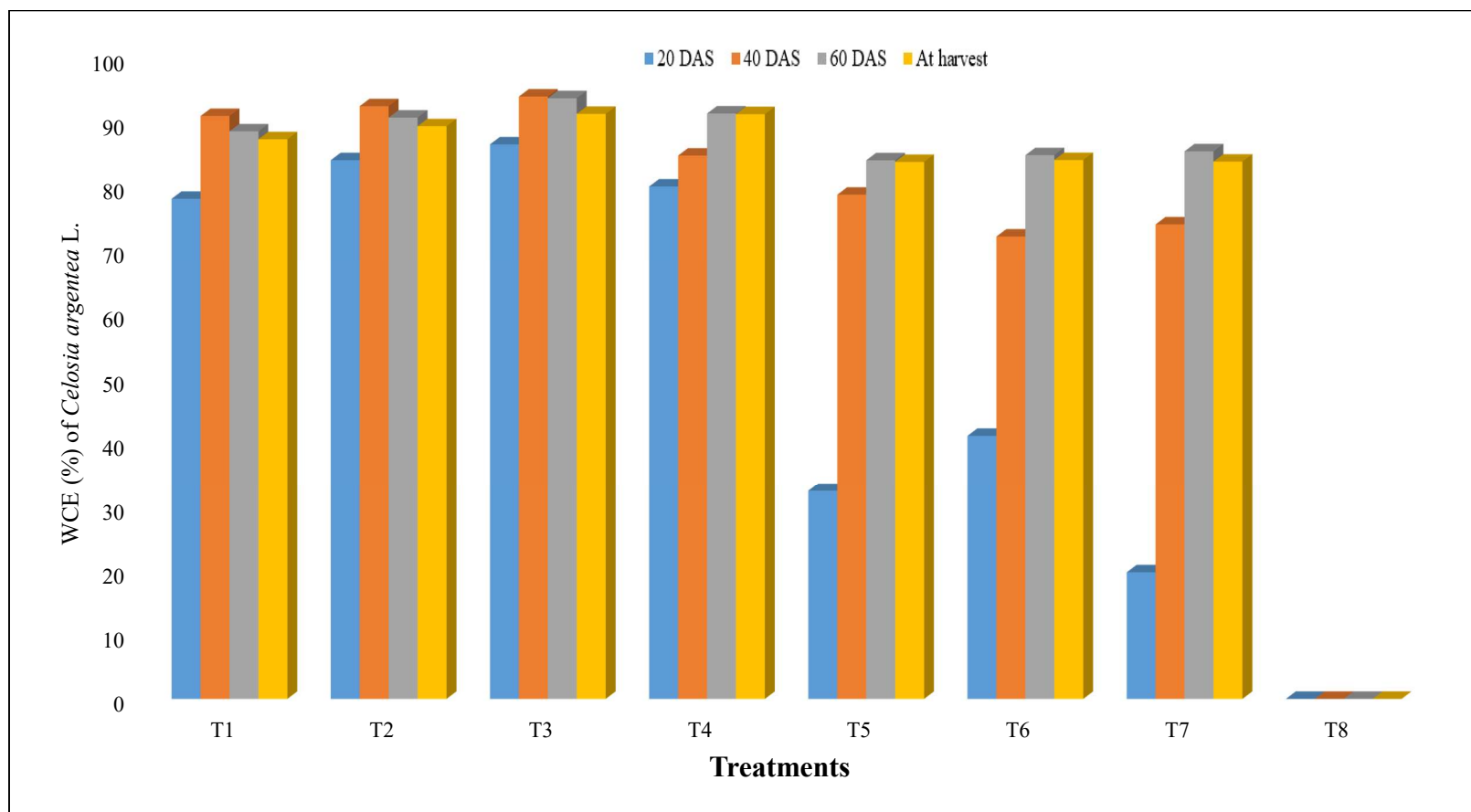
Treatments: T₁: Imazethapyr @ 60 g ha⁻¹ (PE), T₂: Pendimethalin 1 @ kg ha⁻¹ (PE), T₃: Pendimethalin 1 @ kg ha⁻¹ (PE) combined with Imazethapyr @ 50 g ha⁻¹ (PoE), T₄: Hand weeding twice (20 and 40 DAS), T₅: Quizalofop-p-ethyl @ 75 g ha⁻¹ (PoE), T₆: Imazethapyr + Imazamax @ 75 g ha⁻¹ (PoE), T₇: Sodium Aciflourfen and Clodinafop-propargyl @ 180 g ha⁻¹ (PoE) and T₈: Unweeded check (Control).

4.4.4.5 *Celosia argentea* L.

In the years of 2021 and 2022 statistics on WCE of *Celosia argentea* L. impacted by weed control treatments at all observational phases, as shown in Table 4.60 also represented in graph 4.56.

Table 4.60 presents information on 20 days increased WCE seen in PE treatment compared to PoE treatment for the years 2021 and 2022. In PE pendimethalin 1000 g combined with PoE imazethapyr 50 g and HW (20 and 40 DAS) similar to HW, excessive WCE were seen at 40 days. The PoE sodium aciflurofen and clodinafop propargyl lowest weight measured was 180 g, which was in close proximity to the PoE imazethapyr with imazamox 75 g. The combination of 1000 g of PE pendimethalin and 50 g of PoE imazethapyr produced the maximum WCE at harvest and 60 days, followed by HW twice (20 and 40 DAS) and PE pendimethalin 1000 g compared to HW. 75 g above weedy was the lowest WCE found in PoE quizalofop p ethyl.

The 20-day minimum WCE obtained in PoE treatment compared to PE treatment is shown in graph 4.56 and the cumulative statistics for 2021 and 2022 are also displayed in Table 4.60. The largest WCE relative to HW was seen at 40 days when PE pendimethalin 1000 g and PE imazethapyr 60 g were used to arrest weed for longer durations of time. PoE imazethapyr plus imazamox had a lower WCE of 75 g, but PoE sodium aciflurofen plus clodinafop propargyl had a lower WCE of 180 g. When it comes to the least amount of weeds present during the lateral stages of crop growth, complete treatments outperform weedy check.



Graph 4.56 Influence of different herbicide treatments on weed control efficiency (%) of *Celosia argentea* L. in green gram at 20 days intervals (Pooled data of 2021 and 2022).

Table 4.61 Influence of different herbicide treatments on weed control efficiency (%) of total weed population in green gram at 20 days intervals (2021 and 2022).

Treatment	20 DAS (2021)	20 DAS (2022)	Pool data	40 DAS (2021)	40 DAS (2022)	Pool data	60 DAS (2021)	60 DAS (2022)	Pool data	Harvest (2021)	Harvest (2022)	Pool data
T ₁	77.15	76.43	76.79	75.78	69.47	72.63	70.00	78.98	74.49	80.48	76.83	78.66
T ₂	82.43	81.66	82.05	80.58	81.21	80.90	76.00	83.31	79.66	81.38	82.01	81.70
T ₃	86.26	91.66	88.96	87.77	86.10	86.94	87.20	87.81	87.51	87.69	88.41	88.05
T ₄	75.04	82.08	78.56	85.32	86.73	86.03	86.80	86.51	86.66	86.19	87.20	86.70
T ₅	56.99	52.50	54.75	70.40	77.15	73.78	72.00	71.38	71.69	73.27	72.26	72.77
T ₆	56.17	54.46	55.32	70.40	72.10	71.25	72.40	78.07	75.24	78.98	72.87	75.93
T ₇	54.06	54.126	54.09	75.32	76.26	75.79	77.60	79.51	78.56	79.58	78.05	78.82
T ₈	-	-	-	-	-	-	-	-	-	-	-	-

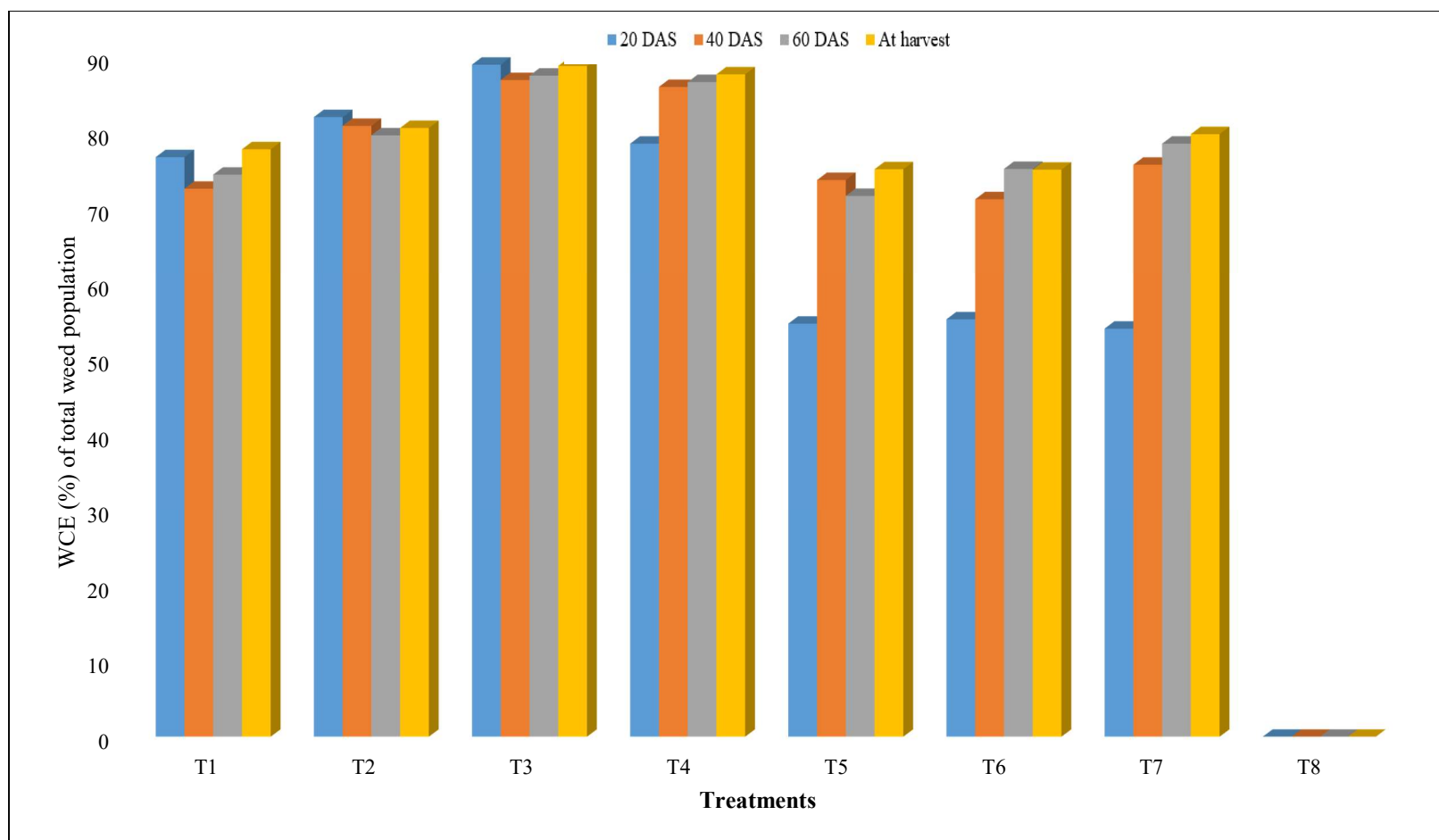
Treatments: T₁: Imazethapyr @ 60 g ha⁻¹ (PE), T₂: Pendimethalin 1 @ kg ha⁻¹ (PE), T₃: Pendimethalin 1 @ kg ha⁻¹ (PE) combined with Imazethapyr @ 50 g ha⁻¹ (PoE), T₄: Hand weeding twice (20 and 40 DAS), T₅: Quizalofop-p-ethyl @ 75 g ha⁻¹ (PoE), T₆: Imazethapyr + Imazamax @ 75 g ha⁻¹ (PoE), T₇: Sodium Aciflourfen and Clodinafop-propargyl @ 180 g ha⁻¹ (PoE) and T₈: Unweeded check (Control).

4.4.4.6 Weed control efficiency (%) of total weed population.

The information on WCE for the total weed population affected by various weed control treatments at all phases of observation in the years 2021 and 2022, as shown in Table 4.61 along with represented in graph 4.57.

Table 4.61 presents the statistics for 20 days highest WCE total weeds observed in PE, followed by lowest in PoE treatment, for the years 2021 and 2022. Following PoE quizalofop p ethyl 75 g and PoE imazethapyr mixed with imazamax 75 g, the maximum WCE total weeds were detected at 40 days in PE pendimethalin 1000 g combined with PoE imazethapyr 50 g and HW (20 and 40 DAS), and the lowest in PoE sodium aciflurofen and clodinafop propargyl 180 g. The highest WCE in relation to HW was recorded 60 days following the harvest of 1000 g of PE pendimethalin and 50 g of PoE imazethapyr. Equal treatment was seen to have a greater WCE at harvest than in subsequent treatments. PoE quizalofop p ethyl 75 g was found to have the lowest WCE, followed by PoE imazethapyr coupled with imazamax 75 g. Similar results were reported by Choudhary *et al.* (2016), Mishra *et al.* (2017), T. Laxman *et al.* (2015), and T. Ramesh *et al.* (2020).

The combined data for 2021 and 2022 are still visible in Table 4.61 and are shown in Graph 4.57 in the PoE treatment, where unchecked weed growth results in little WCE compared to PE treatment. Peak WCE is shown in PE pendimethalin 1000 g combined with PoE imazethapyr 50 g at 40 days, which is comparable to HW (20 and 40 DAS). When PoE imazethapyr and imazamax were mixed, the minimum WCE experienced was 75 g. The same treatment generates the greatest WCE on the lateral growth stages of the crop over weedy check at 60 days and harvest.



Graph 4.57 Influence of different herbicide treatments on weed control efficiency (%) of total weed population in green gram at 20 days intervals (Pooled data of 2021 and 2022).

Table 4.62 Residual effect of different herbicide treatments on germination percentage of cucumber at monthly intervals (2021 and 2022).

Treatment	30 (2021)	30 (2022)	Pool data	60 (2021)	60 (2022)	Pool data	Harvest (2021)	Harvest (2022)	Pool data
T ₁	46.23	47.52	46.88	61.56	62.47	62.02	77.45	78.21	77.83
T ₂	47.51	49.41	48.46	63.12	64.16	63.64	78.16	79.74	78.95
T ₃	48.57	50.33	49.45	65.20	66.23	65.72	73.21	75.24	74.23
T ₄	82.23	83.18	82.71	84.18	85.20	84.69	84.25	86.31	85.28
T ₅	81.44	82.26	81.85	48.17	50.52	49.35	65.23	67.13	66.18
T ₆	82.10	83.89	83.00	46.14	48.37	47.26	64.75	66.41	65.58
T ₇	80.20	81.30	80.75	47.45	53.16	50.31	69.22	72.27	70.75
T ₈	83.24	84.16	83.70	85.20	85.89	85.55	86.00	87.18	86.59
SE m (±)	0.59	0.60	0.60	0.86	0.72	0.79	0.93	1.42	1.18
CD (p = 0.05)	1.78	1.81	1.80	2.60	2.19	2.40	2.82	4.31	3.57

SE m (±): Standard error of mean, CD: Critical Difference and DAS: Days after sowing

Treatments: T₁: Imazethapyr @ 60 g ha⁻¹ (PE), T₂: Pendimethalin 1 @ kg ha⁻¹ (PE), T₃: Pendimethalin 1 @ kg ha⁻¹ (PE) combined with Imazethapyr @ 50 g ha⁻¹ (PoE), T₄: Hand weeding twice (20 and 40 DAS), T₅: Quizalofop-p-ethyl @ 75 g ha⁻¹ (PoE), T₆: Imazethapyr + Imazamax @ 75 g ha⁻¹ (PoE), T₇: Sodium Aciflourfen and Clodinafop-propargyl @ 180 g ha⁻¹ (PoE) and T₈: Unweeded check (Control).

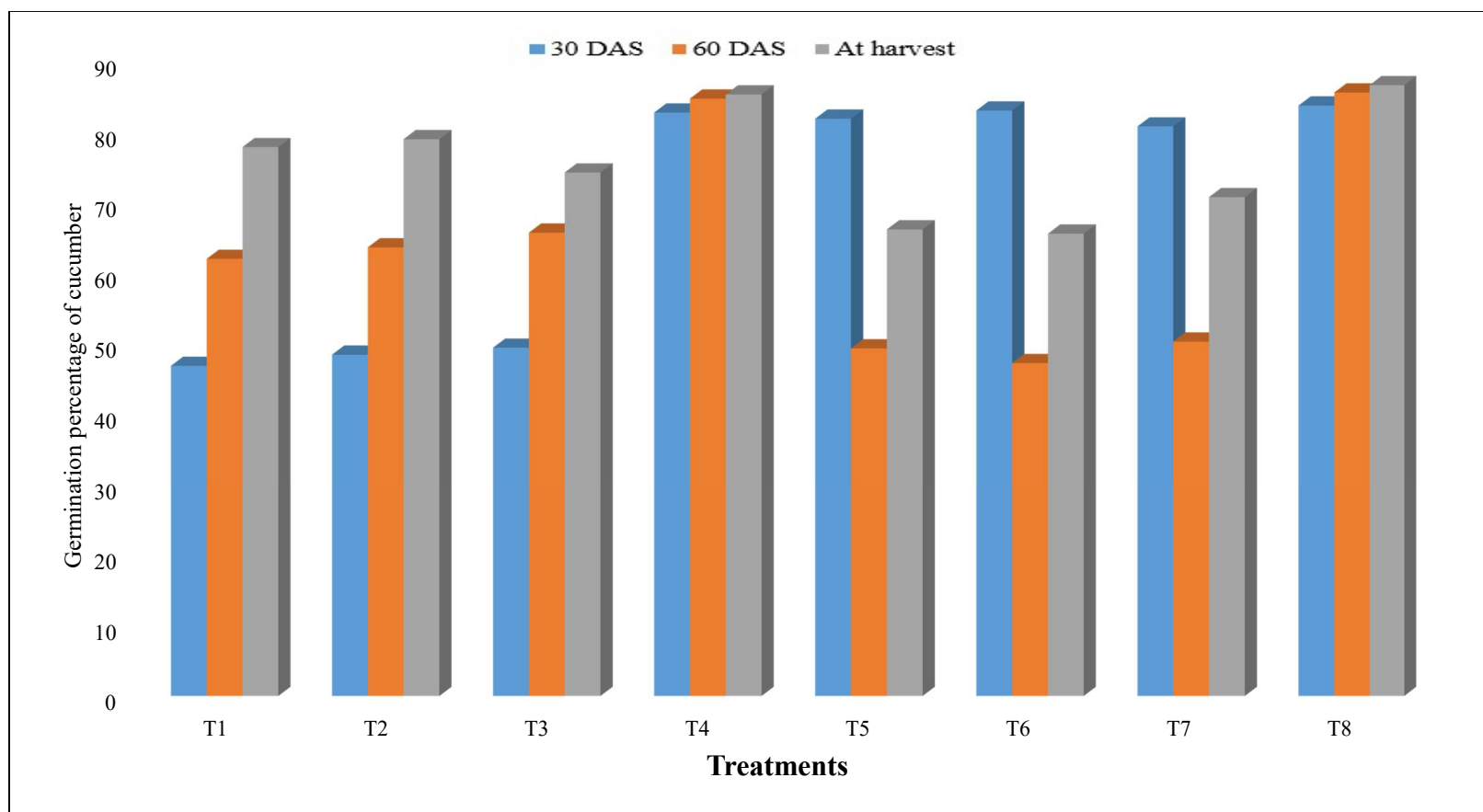
4.5 Herbicide Persistence studies (Bioassay)

4.5.1 Effect of herbicide residues on germination percentage of cucumber

Various weed control treatments at different phases of growth have a significant influence on the data on herbicide residues on cucumber germination %, as seen in Table 4.62 and graph 4.58 in the monthly interval till harvest.

In years 2021 and 2022 statistics shown on Table 4.62 on monthly expressively lower germination percentage of cucumber seed were in PE pendimethalin 1000 g combine with PoE imazethapyr 50 g after PE pendimethalin 1000 g and imazethapyr 60 g PE. At 60 days highest germination percentage were with in HW (20 and 40 DAS) likened to further herbicidal treatments. Minimum germination percentage observed PoE imazethapyr combined with imazamax 75 g and PoE sodium aciflourfen and clodinafop propargyl 180 g then PoE quizalofop p ethyl 75 g because it is applied at PoE. At harvest lower, residual effect were with in PE pendimethalin 1000 g combine with PoE imazethapyr 50 g followed by PE pendimethalin 1000g then PE imazethapyr 60 g, caused extreme germination percentage of cucumber seed liken to further herbicidal treatment. The similar results recorded by Joseph, 1996 and Rashid and Sharma, 2001.

The cumulative statistics for 2021 and 2022 are displayed in Table 4.62 and graph 4.58. These statistics indicate that, one month after seeding, a lower germination percentage was observed in the combination of 1000 g of PE pendimethalin and 50 g of PoE imazethapyr after the 1000 g of PE pendimethalin and 60 g of PE imazethapyr because the herbicide has a longer half-life in the soil. Similar herbicides were used for 60 days, during which time cucumber seeds showed signs of active development and decreased activity in the soil. Because of the PoE treatment's higher active content in the soil than that of HW, there was less germination. All herbicidal treatments showed an expressively high germination % upon data collection, with the exception of PoE, wherein 75 g in Imazethapyr combination with imazamax was compared to weedy check.



Graph 4.58 Residual effect of different herbicide treatments on germination percentage of cucumber at monthly intervals (Pooled data of 2021 and 2022).

Table 4.63 Residual effect of different herbicide treatments on root length (cm) of Cucumber at 10 DAS at monthly intervals (2021 and 2022).

Treatment	30 DAT (2021)	30 DAT (2022)	Pool data	60 DAT (2021)	60 DAT (2022)	Pool data	Harvest (2021)	Harvest (2022)	Pool data
T₁	3.12	3.40	3.26	4.12	4.17	4.15	5.12	5.16	5.14
T₂	3.19	3.47	3.33	4.71	4.77	4.74	5.22	5.20	5.21
T₃	3.26	3.29	3.28	3.86	3.89	3.88	5.34	5.34	5.34
T₄	5.40	5.44	5.42	5.81	5.83	5.82	5.89	5.91	5.90
T₅	5.32	5.37	5.35	3.46	3.48	3.47	4.55	4.57	4.56
T₆	5.53	5.60	5.57	3.51	3.55	3.53	4.66	4.67	4.67
T₇	5.70	5.76	5.73	3.76	3.77	3.77	4.77	4.79	4.78
T₈	5.84	5.89	5.87	5.89	5.88	5.89	5.95	5.90	5.93
SE m (±)	0.45	0.29	0.37	0.53	0.55	0.54	0.61	0.55	0.58
CD (p = 0.05)	1.36	0.87	1.12	1.60	1.67	1.64	1.86	1.68	1.77

SE m (±): Standard error of mean, CD: Critical Difference and DAS: Days after sowing

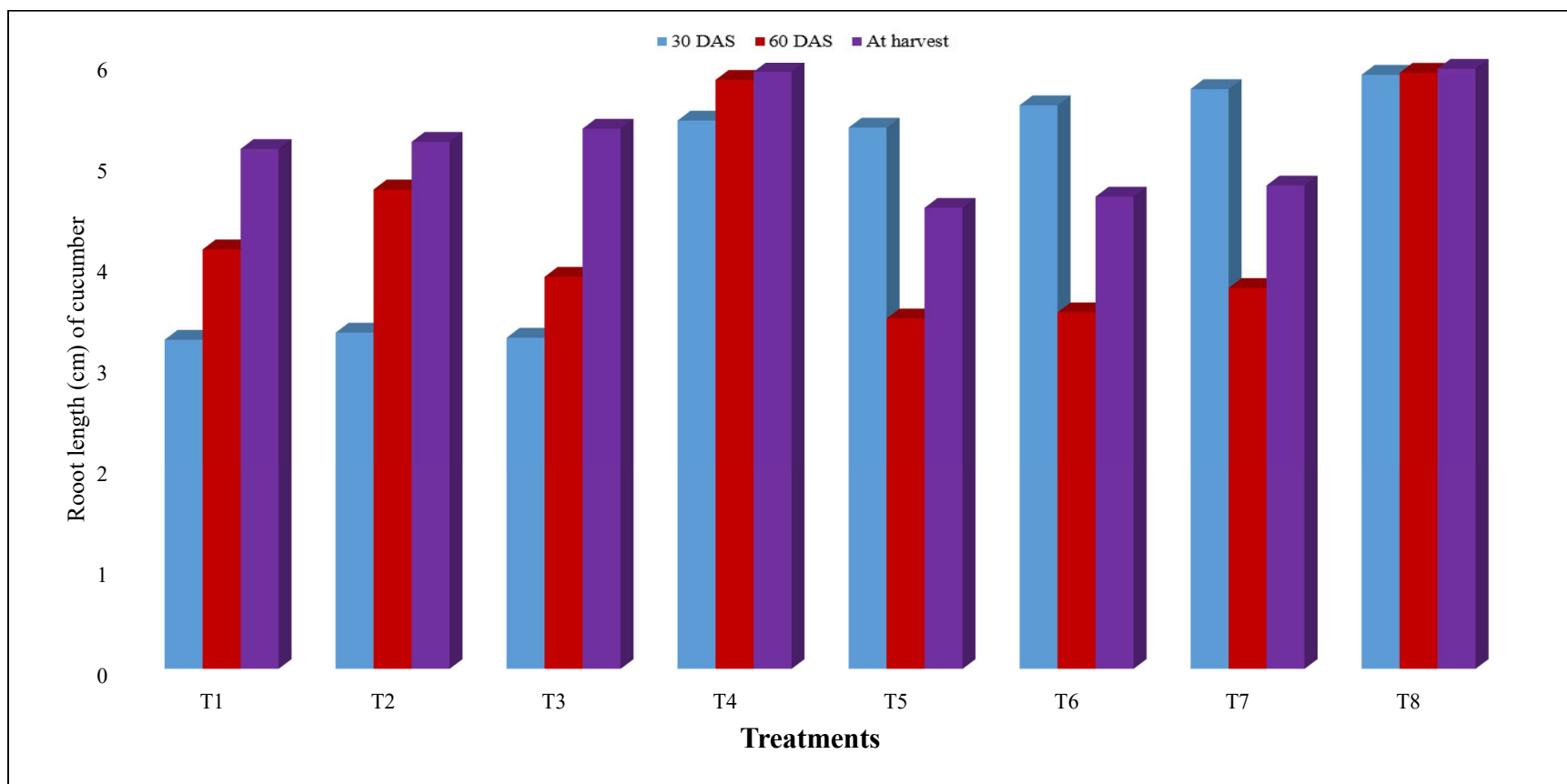
Treatments: T₁: Imazethapyr @ 60 g ha⁻¹ (PE), T₂: Pendimethalin 1 @ kg ha⁻¹ (PE), T₃: Pendimethalin 1 @ kg ha⁻¹ (PE) combined with Imazethapyr @ 50 g ha⁻¹ (PoE), T₄: Hand weeding twice (20 and 40 DAS), T₅: Quizalofop-p-ethyl @ 75 g ha⁻¹ (PoE), T₆: Imazethapyr + Imazamax @ 75 g ha⁻¹ (PoE), T₇: Sodium Aciflourfen and Clodinafop-propargyl @ 180 g ha⁻¹ (PoE) and T₈: Unweeded check (Control).

4.5.2 Effect of herbicide residues on root length (cm) of cucumber

The data on herbicide residues on root length on cucumber is expressively impacted by various weed control treatments at development stages that shown on Table 4.63 and graph 4.59 in monthly interval until harvest.

In year 2021 and 2022 statistics shown in Table 4.63 on monthly expressively lower root length of cucumber seed were with in PE pendimethalin 1000 g combine with PoE imazethapyr 50 g after PE pendimethalin 1000 g and PE imazethapyr 60 g. At 60 days highest root length were with in HW (20 and 40 DAS) likened to further herbicidal treatments. Minimum root length noted in PoE imazethapyr combined with imazamax 75 g after PoE sodium aciflourfen and clodinafop propargyl 180 g then PoE quizalofop p ethyl 75 g because realistic on PoE. On harvest lower residual effect were with in PE pendimethalin 1000 g combine with PoE imazethapyr 50g after PE pendimethalin 1000 g then PE imazethapyr 60 g, caused extreme root length of cucumber seed liken to further herbicidal treatment. The results are in near stated by Joseph *et al.* 1996 and Rashid and Sharma, 2001.

Table 4.63 and graph 4.59 present cumulative statistics for 2021 and 2022 on the month following significantly reduced root length experienced in PE pendimethalin 1000 g in combination with PoE imazethapyr 50 g after PE pendimethalin 1000 g, followed by PE imazethapyr 60 g, due to the herbicide's greater persistence in soil for up to one month. After 60 days, similar herbicides showed that the cucumber seeds were actively growing and were becoming less active in the soil. Because of their active concentration in the soil compared to HW, the PoE treatment resulted in shorter root lengths. With the exception of PoE imazethapyr coupled with imazamax 75 g, all herbicidal treatments showed a noticeably longer root length at data harvesting as compared to the weedy control.



Graph 4.59 Residual effect of different herbicide treatments on root length (cm) of cucumber at 10 DAS at monthly intervals (Pooled data of 2021 and 2022).

Table 4.64 Residual effect of different herbicide treatments on shoot length (cm) of cucumber at 10 DAS at monthly intervals (2021 and 2022).

Treatment	30 (2021)	30 (2022)	Pool data	60 (2021)	60 (2022)	Pool data	Harvest (2021)	Harvest (2022)	Pool data
T₁	2.89	2.87	2.88	4.14	4.17	4.16	4.58	4.60	4.59
T₂	2.76	2.78	2.77	4.39	4.41	4.40	4.64	4.65	4.65
T₃	2.84	2.85	2.85	4.36	4.38	4.37	4.68	4.70	4.69
T₄	4.39	4.40	4.40	4.86	4.85	4.86	4.79	4.81	4.80
T₅	4.85	4.87	4.86	2.76	2.78	2.77	3.87	3.89	3.88
T₆	4.79	4.80	4.80	2.91	2.92	2.92	3.92	3.95	3.94
T₇	4.80	4.84	4.82	2.88	2.90	2.89	3.99	4.07	4.03
T₈	4.96	4.95	4.96	4.77	4.78	4.78	4.80	4.84	4.82
SE m (±)	0.45	0.49	0.47	0.50	0.36	0.43	0.53	0.43	0.48
CD (p = 0.05)	1.36	1.47	1.42	1.51	1.08	1.30	1.62	1.31	1.47

SE m (±): Standard error of mean, CD: Critical Difference and DAS: Days after sowing

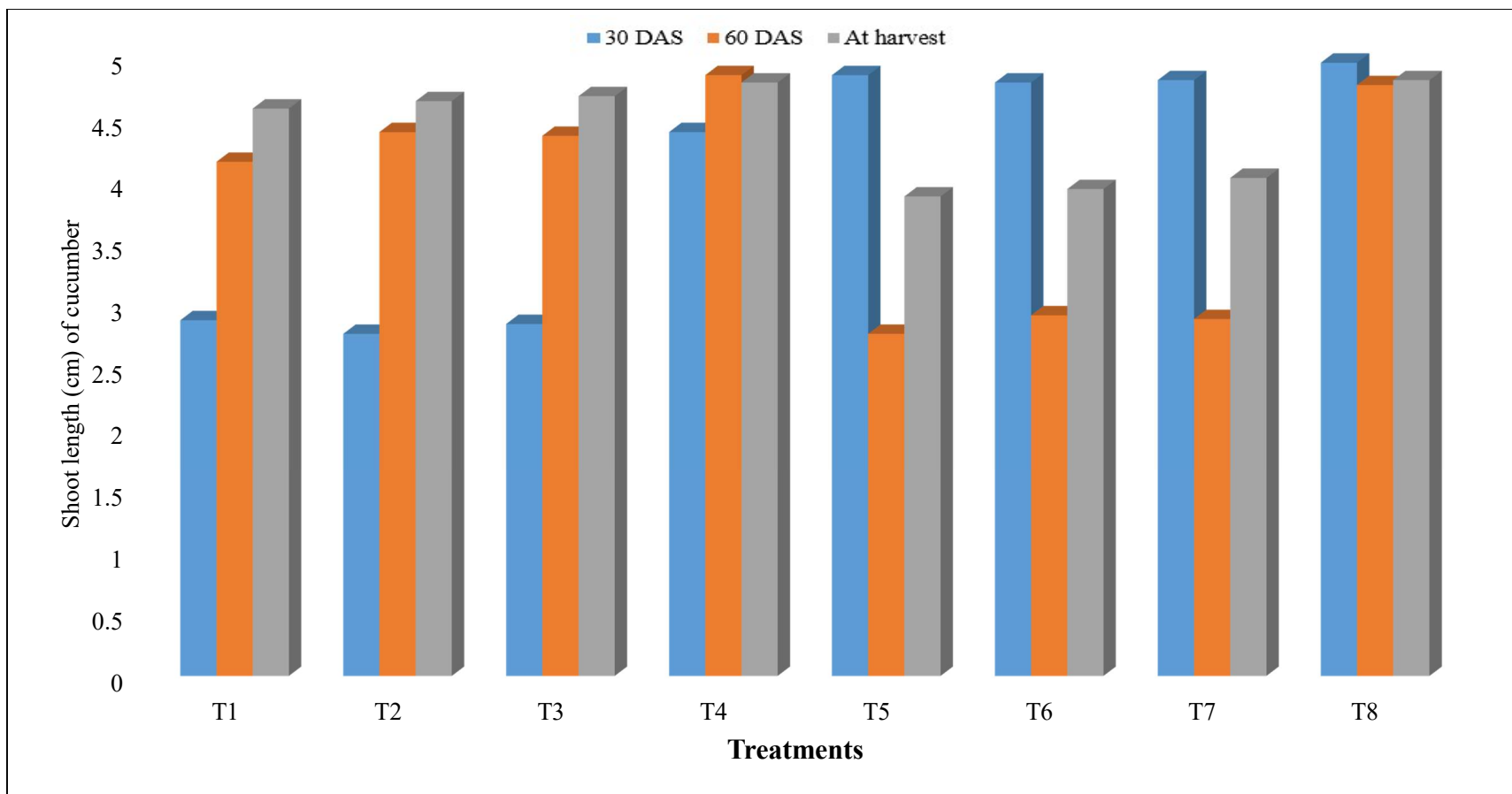
Treatments: T₁: Imazethapyr @ 60 g ha⁻¹ (PE), T₂: Pendimethalin 1 @ kg ha⁻¹ (PE), T₃: Pendimethalin 1 @ kg ha⁻¹ (PE) combined with Imazethapyr @ 50 g ha⁻¹ (PoE), T₄: Hand weeding twice (20 and 40 DAS), T₅: Quizalofop-p-ethyl @ 75 g ha⁻¹ (PoE), T₆: Imazethapyr + Imazamax @ 75 g ha⁻¹ (PoE), T₇: Sodium Aciflourfen and Clodinafop-propargyl @ 180 g ha⁻¹ (PoE) and T₈: Unweeded check (Control).

4.5.3 Effect of herbicide residues on shoot length (cm) of cucumber

Statistics on herbicide residues on shoot length on cucumber is expressively impacted by various weed control treatments at development stages that provided on Table 4.64 and graph 4.60 in monthly interval until harvest.

In the years of 2021 and 2022 statistics shown on Table 4.64 on monthly expressively lower shoot length on cucumber were in PE pendimethalin 1000 g combine with PoE imazethapyr 50 g after PE pendimethalin 1000 g and PE imazethapyr 60 g. At 60 days highest shoot length were with in HW (20 and 40 DAS) compared to further herbicidal treatments. Minimum shoot length experiential in PoE imazethapyr combined with imazamax 75 g after PoE sodium aciflourfen then clodinafop propargyl 180 g then PoE quizalofop p ethyl 75 g because it is applied at PoE. At harvest lower, residual effect were with in PE pendimethalin 1000 g combine with PoE imazethapyr 50g after PE pendimethalin 1000 g then imazethapyr 60 g PE, caused maximum shoot length of cucumber seed liken to further herbicidal treatment. The results are near noted by Joseph *et al.* 1996 and Rashid and Sharma. 2001.

The cumulative statistics on 2021 and 2022 shown on Table 4.64 and graph 4.60 specified on month after expressively lower shoot length in PE pendimethalin 1000 g combine with PoE imazethapyr 50 g and PE pendimethalin 1000 g then PE imazethapyr 60 g because this herbicide more persistence in soil up to month. At 60 days identical herbicides noted active growth of cucumber seed causing them to decrease their activities in soil. The minimum shoot length were with in PoE treatment because of their active concentration in the soil compared to HW. Data at harvest, entirely herbicidal treatments noted an expressively lower shoot length except imazethapyr combined with imazamax 75 g PoE likened to weedy check.



Graph 4.60 Residual effect of different herbicide treatments on shoot length (cm) of cucumber at 10 DAS at monthly intervals (Pooled data of 2021 and 2022).

4.6 Study on green gram

4.6.1 Plant Population

Table 4.65 and graph 4.61 shown various weed management treatments on 20 DAS have an expressive influence on plant population statistics.

Weed control treatments significantly increase plant population over weedy check in the years 2021 and 2022, as indicated by the plant population in Table 4.21. When comparing PE herbicidal treatments to PoE herbicidal treatments, the maximum plant population was observed. Singh *et al.* (2015), Patel *et al.* (2016), Leva *et al.* (2018), and Patel *et al.* (2019) all reported the same results.

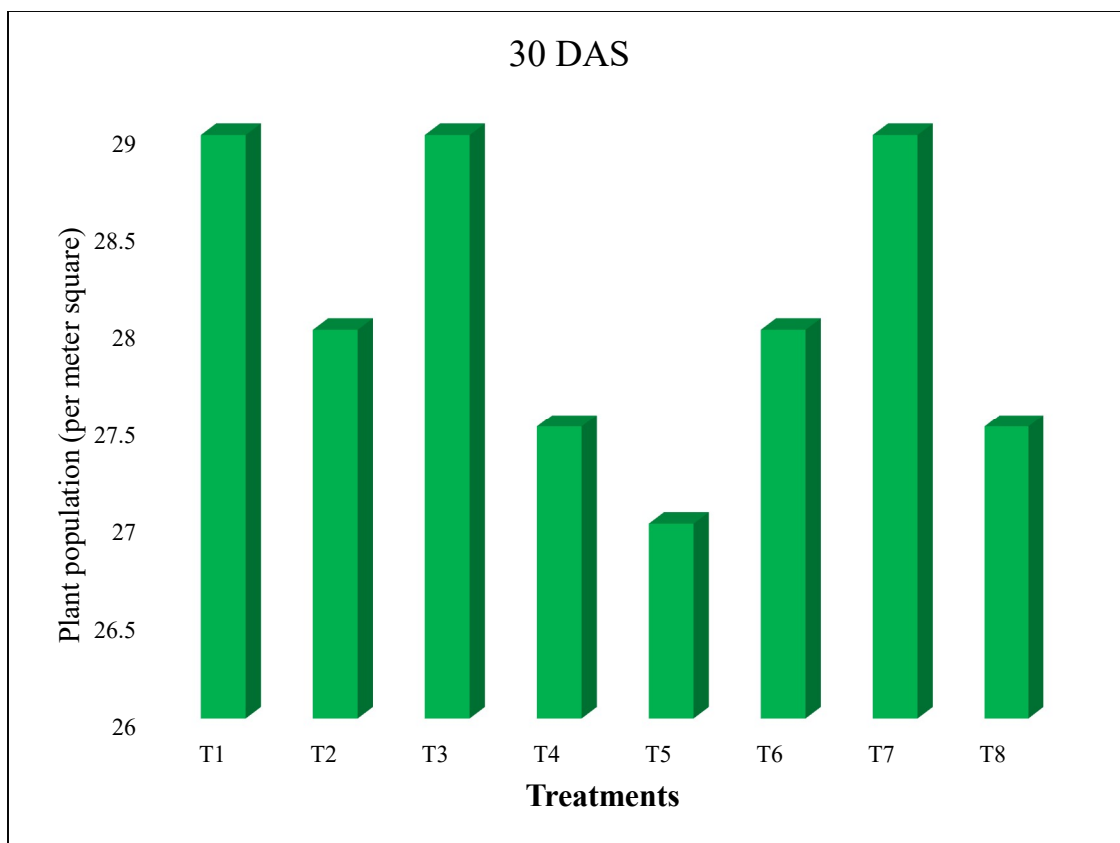
The maximum plant population reported in the PE treatment for the years 2021 and 2022 is displayed cumulatively on Table 4.65 and graph 4.61. This is because stopping weed development at an early stage is similar to using PoE herbicide over weedy check.

Table 4.65 Influence of different herbicide treatments on plant population (No. m⁻²) in green gram at 20 DAS (2021 and 2022).

Treatment	20 DAS	20 DAS	Pool data
T ₁	29 ^a	29	29.0
T ₂	29 ^a	28	28.0
T ₃	29 ^a	29	29.0
T ₄	27	28	27.5
T ₅	27	27	27.0
T ₆	28 ^b	28	28.0
T ₇	28 ^b	29	29.0
T ₈	27	28	27.5
SE m (±)	0.26	0.72	0.49
CD (p = 0.05)	0.78	2.19	1.49

SE m (±): Standard error of mean, CD: Critical Difference and DAS: Days after sowing

Treatments: T₁: Imazethapyr @ 60 g ha⁻¹ (PE), T₂: Pendimethalin 1 @ kg ha⁻¹ (PE), T₃: Pendimethalin 1 @ kg ha⁻¹ (PE) combined with Imazethapyr @ 50 g ha⁻¹ (PoE), T₄: Hand weeding twice (20 and 40 DAS), T₅: Quizalofop-p-ethyl @ 75 g ha⁻¹ (PoE), T₆: Imazethapyr + Imazamax @ 75 g ha⁻¹ (PoE), T₇: Sodium Aciflurofen and Clodinafop-propargyl @ 180 g ha⁻¹ (PoE) and T₈: Unweeded check (Control).



Graph 4.61 Influence of different herbicide treatments on plant population (No. m⁻²) in green gram at 20 DAS (2021 and 2022).

Table 4.66 Influence of different herbicide treatments on plant height (cm) in green gram at 20 days intervals (2021 and 2022).

Treatment	20 DAS (2021)	20 DAS (2022)	Pool data	40 DAS (2021)	40 DAS (2022)	Pool data	60 DAS (2021)	60 DAS (2022)	Pool data	Harvest (2021)	Harvest (2022)	Pool data
T₁	21.90	21.96	21.93	30.07	30.17	30.12	39.11	39.39	39.25	39.18	39.26	39.22
T₂	22.18	22.21	22.195	31.24	31.48	31.36	39.78	39.92	39.85	39.81	39.85	39.83
T₃	22.40	22.47	22.435	32.50	32.74	32.62	40.22	40.88	40.55	40.52	40.56	40.54
T₄	21.60	21.64	21.62	30.98	31.22	31.10	38.18	38.30	38.24	38.21	38.25	38.23
T₅	19.45	19.48	19.465	26.18	26.40	26.29	32.48	32.70	32.59	32.55	32.61	32.58
T₆	20.66	20.69	20.675	26.95	27.35	27.15	33.96	34.28	34.12	34.06	34.16	34.11
T₇	21.44	21.50	21.47	28.96	29.36	29.16	36.11	36.39	36.25	36.20	36.26	36.23
T₈	19.00	19.46	19.23	24.20	26.50	25.35	36.77	28.86	29.46	29.34	29.46	29.40
SE m (±)	0.44	0.84	0.64	0.68	0.85	0.77	0.91	0.67	0.79	0.98	0.79	0.89
CD (p = 0.05)	1.33	2.55	1.94	2.07	2.59	2.33	2.75	2.03	2.39	2.96	2.39	2.68

SE m (±): Standard error of mean, CD: Critical Difference and DAS: Days after sowing

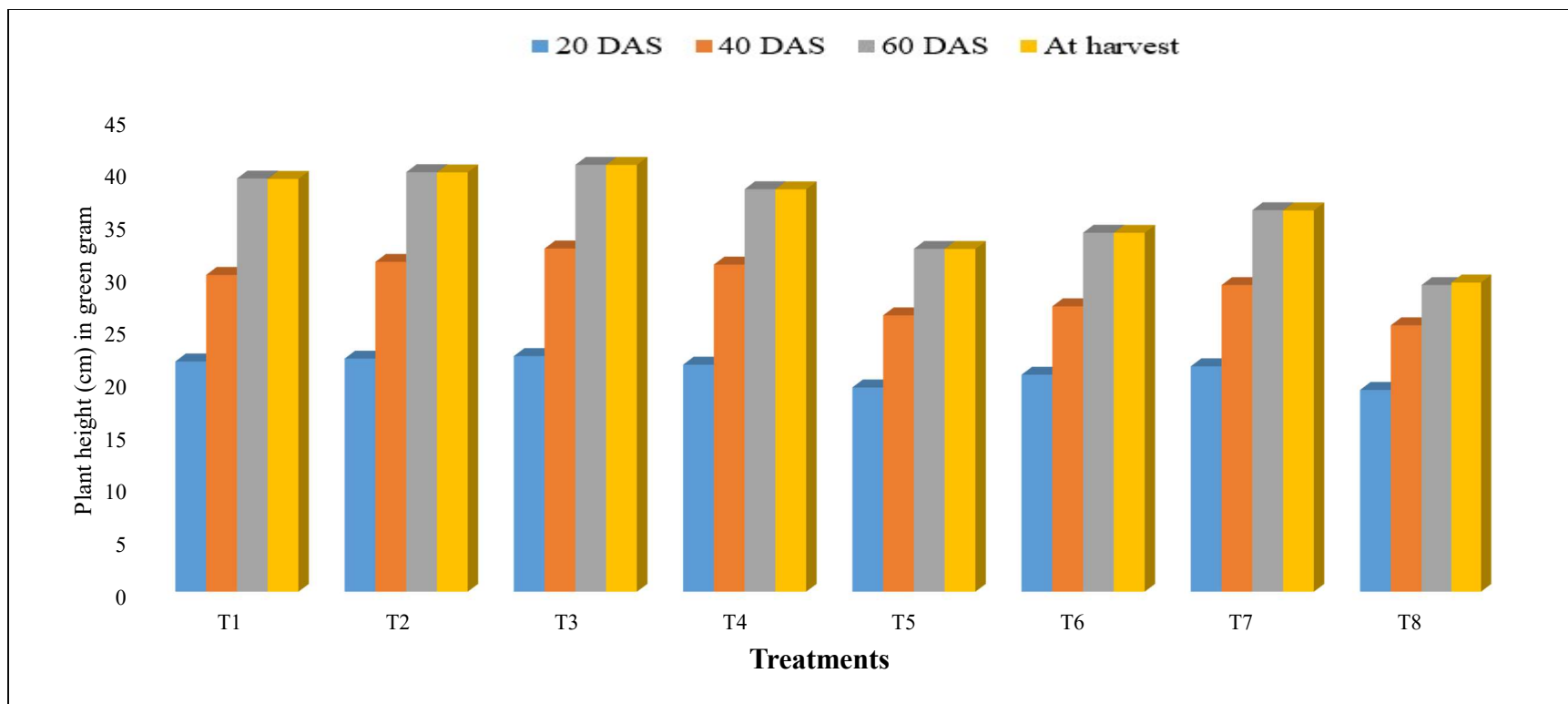
Treatments: T₁: Imazethapyr @ 60 g ha⁻¹ (PE), T₂: Pendimethalin 1 @ kg ha⁻¹ (PE), T₃: Pendimethalin 1 @ kg ha⁻¹ (PE) combined with Imazethapyr @ 50 g ha⁻¹ (PoE), T₄: Hand weeding twice (20 and 40 DAS), T₅: Quizalofop-p-ethyl @ 75 g ha⁻¹ (PoE), T₆: Imazethapyr + Imazamax @ 75 g ha⁻¹ (PoE), T₇: Sodium Aciflourfen and Clodinafop-propargyl @ 180 g ha⁻¹ (PoE) and T₈: Unweeded check (Control).

4.6.2 Plant height (cm)

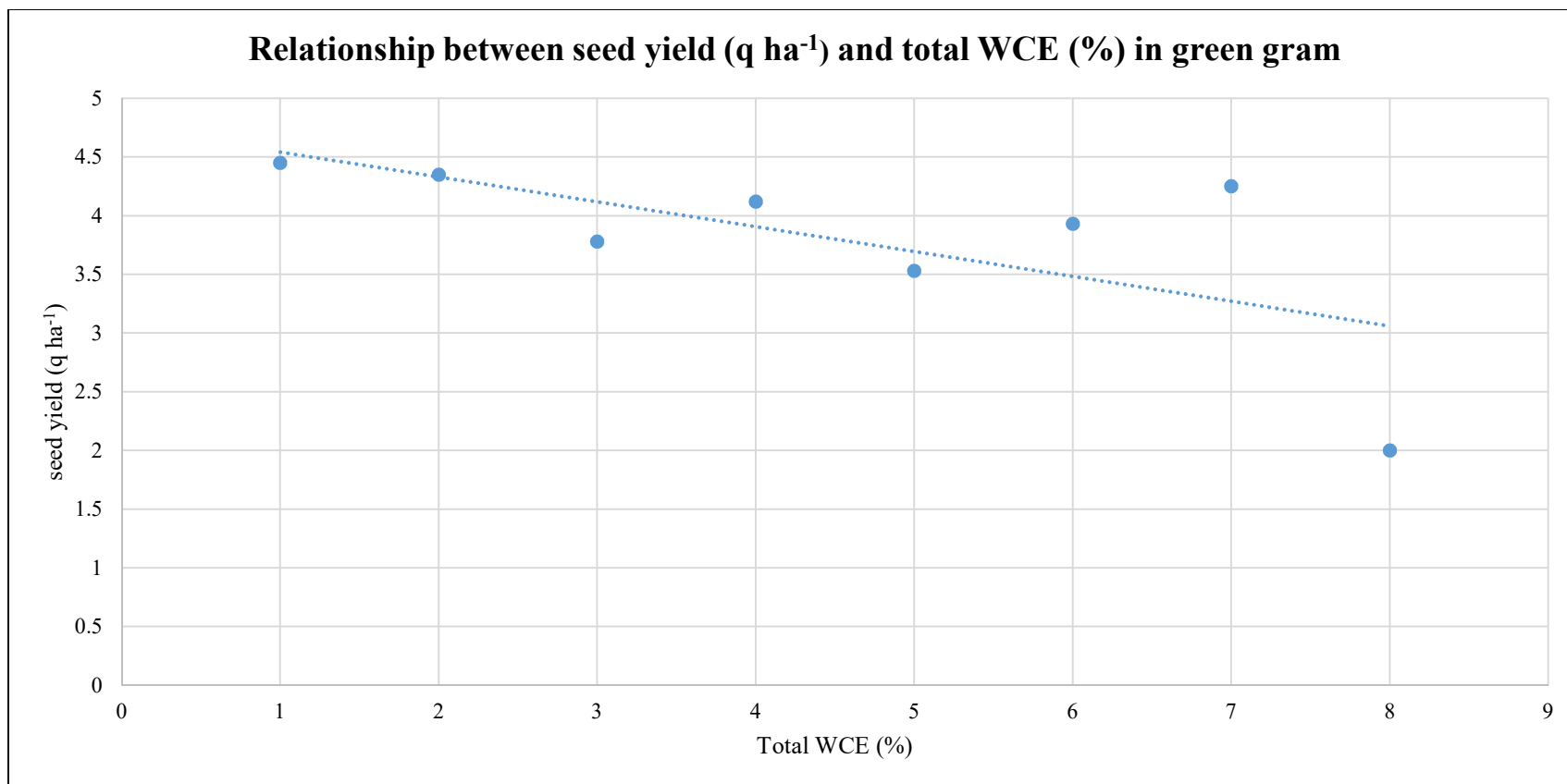
Different weed management treatments had an expressive influence on the plant height data at 20-day intervals leading up to harvest, as seen in Table 4.66 and graph 4.62.

Table 4.66 presents the weed control methods for the years 2021 and 2022, which clearly increase plant height above weedy check. In comparison to PoE treatment, findings showed that 20 DAS plant populations were seen in PE treatment. According to statistics, the maximum plant heights on DAS 40 were obtained with 1000 g of PE pendimethalin combined with 50 g of PoE imazethapyr, and then 1000 g of PE pendimethalin in comparison to HW. PoE quizalofop p ethyl 75 g had the lowest plant height, followed by PoE imazethapyr with imazamax 75 g, PoE sodium aciflurofen, and finally clodinafop propargyl 180 g over a weedy check. The maximum plant height was observed at 60 DAS and harvest with PE pendimethalin 1000 g combined with PoE imazethapyr 50 g, whereas the lowest plant height was recorded by PoE quizalofop p ethyl 75 g when compared to weedy check. According to Kumar *et al.* 2019, Singh *et al.* 2019, Patel *et al.* 2020, and Jyoti *et al.* 2020, these results are still essentially in accord.

Data for the years 2021 and 2022 combined are shown in Table 4.66 and graph 4.62. All treatments performed better when compared to weedy check. According to data 40 DAS, the combination of 1000 g of PE pendimethalin and 50 g of PoE imazethapyr closely resulted in the highest plant heights. PoE quizalofop p ethyl 75 g and PoE imazethapyr coupled with imazamax 75 g showed the lowest plant heights. data at 60 DAS and harvest, with the minimum plant height recorded in PoE quizalofop p ethyl 75 g and imazethapyr mixed with PoE imazamax 75 g over weedy check, and the highest plant height recorded in PE pendimethalin 1000 g combined with PoE imazethapyr 50 g. PE pendimethalin 1 kg in combination with PoE imazethapyr 50 g performs best when it comes to reducing weed growth, which is a major step towards weed crop rivalry and crop receiving weed limited environment for physiological growth in green gram.



Graph 4.62a Influence of different herbicide treatments on plant height (cm) in green gram at 20 days intervals (Pooled data of 2021 and 2022).



$r = 0.20$

Graph.4.62b Relationship between seed yield (q ha^{-1}) and total WCE (%) in green gram at harvest (Pooled data of 2021 and 2022).

Table 4.67 Influence of different herbicide treatments on leaf area index in green gram at 20 days intervals (2021 and 2022).

Treatment	20 DAS (2021)	20 DAS (2022)	Pool data	40 DAS (2021)	40 DAS (2022)	Pool data	60 DAS (2021)	60 DAS (2022)	Pool data	Harvest (2021)	Harvest (2022)	Pool data
T₁	0.77	0.81	0.79	1.19	1.27	1.23	1.32	1.40	1.36	1.18	1.26	1.22
T₂	0.78	0.84	0.81	1.22	1.26	1.24	1.28	1.38	1.33	1.19	1.27	1.23
T₃	0.85	0.93	0.89	1.24	1.28	1.26	1.32	1.38	1.35	1.22	1.26	1.24
T₄	0.74	0.80	0.77	1.19	1.21	1.20	1.26	1.40	1.32	1.15	1.21	1.18
T₅	0.67	0.69	0.68	1.10	1.13	1.12	1.21	1.31	1.26	1.08	1.12	1.10
T₆	0.72	0.80	0.76	1.13	1.17	1.15	1.20	1.28	1.24	1.10	1.14	1.12
T₇	0.69	0.75	0.72	1.15	1.21	1.18	1.23	1.35	1.29	1.15	1.17	1.16
T₈	0.55	0.63	0.59	0.98	1.04	1.02	1.05	1.13	1.09	0.95	1.05	1.00
SE m (±)	0.44	0.68	0.56	0.68	0.74	0.71	0.91	0.63	0.77	0.98	0.79	0.89
CD (p = 0.05)	1.33	2.07	1.70	2.07	2.24	2.16	2.75	1.91	2.33	2.96	2.38	2.67

SE m (±): Standard error of mean, CD: Critical Difference and DAS: Days after sowing

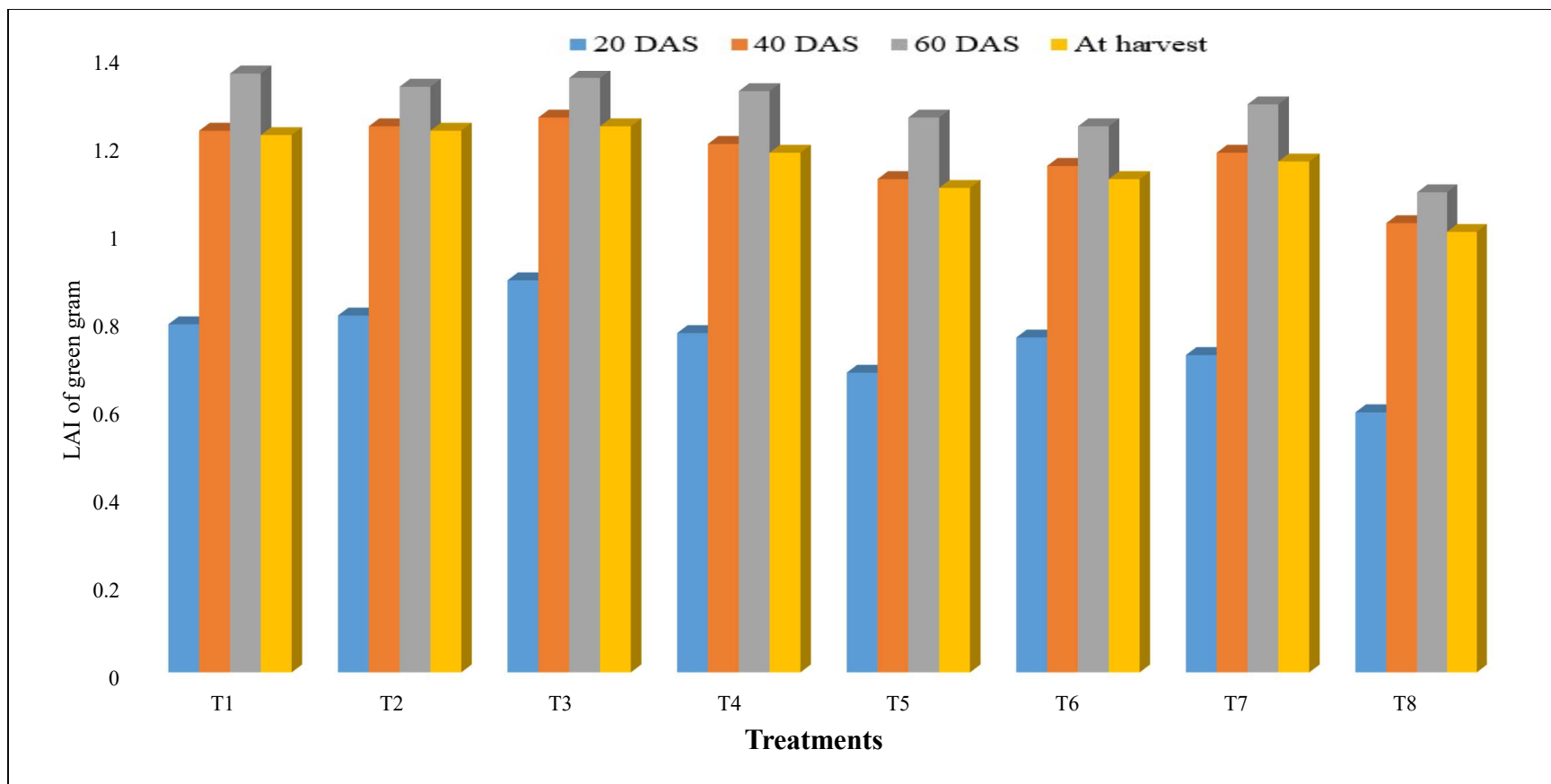
Treatments: T₁: Imazethapyr @ 60 g ha⁻¹ (PE), T₂: Pendimethalin 1 @ kg ha⁻¹ (PE), T₃: Pendimethalin 1 @ kg ha⁻¹ (PE) combined with Imazethapyr @ 50 g ha⁻¹ (PoE), T₄: Hand weeding twice (20 and 40 DAS), T₅: Quizalofop-p-ethyl @ 75 g ha⁻¹ (PoE), T₆: Imazethapyr + Imazamax @ 75 g ha⁻¹ (PoE), T₇: Sodium Aciflurofen and Clodinafop-propargyl @ 180 g ha⁻¹ (PoE) and T₈: Unweeded check (Control).

4.6.3 Leaf Area Index

The influence of various weed management treatments on LAI statistics is seen in Table 4.67 and graph 4.63 at 20 days leading up to the last.

In year 2021 and 2022 presented in Table 4.67 in 20 DAS lower LAI were recorded in PoE treatment as likened to PE herbicides. On data 40 DAS higher LAI in PE pendimethalin 1000 g combine with PoE imazethapyr 50 g and PE pendimethalin 1000 g and lower PoE quizalofop p ethyl 75 g followed by PoE imazethapyr combined with imazamax 75 g as likened to weedy check. At 60 DAS and harvest highest LAI were recorded PE pendimethalin 1000 g combine with PoE imazethapyr 50 g after PE pendimethalin 1000 g likened to HW. The lower leaf area index PoE were recorded in quizalofop p ethyl 75 g and PoE imazethapyr combined with imazamax 75 g as likened to weedy check.

The cumulative results for 2021 and 2022, as shown in Table 4.67 and graph 4.63, indicate that at 20 DAS in the PoE treatment lower LAI were starting to show higher weed infestation throughout the crop's early development stage. The PE treatment started with the maximal LAI. According to data, PE pendimethalin 1000 g was used in conjunction with PoE imazethapyr 50 g and PE pendimethalin 1000 g before PE imazethapyr 60 g as compared to HW. This was done for 40 DAS greater LAI. Following PoE imazethapyr mixed with Imazamax 75 g and PoE sodium aciflourfen and clodinafop propargyl 180 g, the reduced LAI was seen in PoE quizalofop p ethyl 75 g. The same treatment was documented as excessive, the data showed a 60-day LAI index, and harvest was compared to weedy check.



Graph 4.63 Influence of different herbicide treatments on leaf area index in green gram at 20 days intervals (Pooled data of 2021 and 2022).

Table 4.68 Influence of different herbicide treatments on branches per plant in green gram at 20 days intervals (2021 and 2022).

Treatment	20 DAS (2021)	20 DAS (2022)	Pool data	40 DAS (2021)	40 DAS (2022)	Pool data	60 DAS (2021)	60 DAS (2022)	Pool data	Harvest (2021)	Harvest (2022)	Pool data
T₁	1.70	1.74	1.72	2.90	2.99	2.95	2.96	3.03	3.00	2.96	2.98	2.97
T₂	1.90	1.92	1.91	3.00	3.10	3.05	3.13	3.17	3.15	3.14	3.17	3.16
T₃	2.00	2.07	2.04	3.10	3.14	3.12	3.15	3.20	3.18	3.15	3.19	3.17
T₄	1.50	1.57	1.54	2.80	2.87	2.84	2.85	2.89	2.87	2.84	2.83	2.84
T₅	1.25	2.29	1.77	2.62	2.69	2.66	2.67	2.71	2.69	2.65	2.68	2.67
T₆	1.30	1.35	1.33	2.70	2.76	2.73	2.76	2.80	2.78	2.73	2.74	2.74
T₇	1.45	1.49	1.47	2.79	2.85	2.82	2.83	2.87	2.85	2.83	2.85	2.84
T₈	1.11	1.13	1.12	2.50	2.57	2.54	2.53	2.60	2.57	2.50	2.71	2.61
SE m (±)	0.15	0.14	0.15	0.21	0.25	0.23	0.24	0.20	0.22	0.23	0.27	0.25
CD (p = 0.05)	0.45	0.44	0.45	0.63	0.74	0.69	0.73	0.61	0.67	0.69	0.82	0.76

SE m (±): Standard error of mean, CD: Critical Difference and DAS: Days after sowing

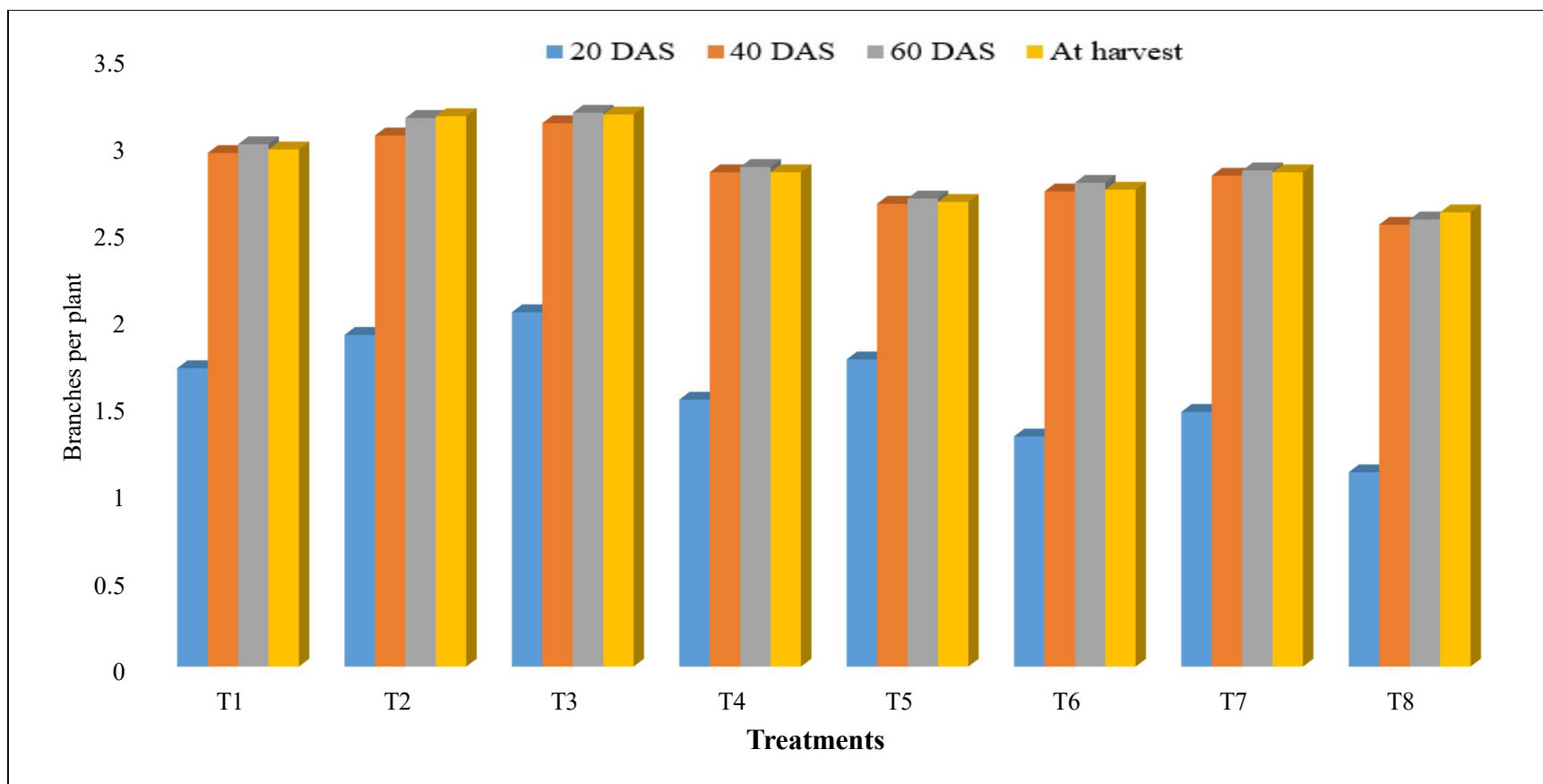
Treatments: T₁: Imazethapyr @ 60 g ha⁻¹ (PE), T₂: Pendimethalin 1 @ kg ha⁻¹ (PE), T₃: Pendimethalin 1 @ kg ha⁻¹ (PE) combined with Imazethapyr @ 50 g ha⁻¹ (PoE), T₄: Hand weeding twice (20 and 40 DAS), T₅: Quizalofop-p-ethyl @ 75 g ha⁻¹ (PoE), T₆: Imazethapyr + Imazamax @ 75 g ha⁻¹ (PoE), T₇: Sodium Aciflurofen and Clodinafop-propargyl @ 180 g ha⁻¹ (PoE) and T₈: Unweeded check (Control).

4.6.4 Branches per plant

Table 4.68 and graph 4.64 show how the various weed control treatments affected the statistics on the number of branches per plant 20 days before harvest.

Table 4.68 displays the number of higher branches per plant in PE treatment compared to PoE use for the years 2021 and 2022. PE pendimethalin 1000 g combined with PoE imazethapyr 50 g and PE pendimethalin 1000 g and PE imazethapyr 60 g as compared to HW, based on data, with a maximum of 40 DAS branches per plant. PoE quizalofop p ethyl 75 g, PoE imazethapyr together with imazamax 75 g, and PoE sodium aciflurofen and clodinafop propargyl 180 g all had reduced branches per plant that are comparable to weedy check. Higher and reduced branching per plant was seen on data 60 DAS and harvest, respectively, compared to a weedy check.

Cumulative data in 2021 and 2022 presented on Table 4.68 and graph 4.64 on 20 DAS lower branches per plant due to uncontrolled weed growth up to 20 DAS. PE higher branches per plant due to weed-free environment. At 40 DAS higher branches per plant in PE pendimethalin 1000 g combine with PoE imazethapyr 50 g and PE pendimethalin 1000 g and PE imazethapyr 60 g over HW. The lower branches per plant were observed in PoE quizalofop p ethyl 75 g and PoE imazethapyr combined with imazamax 75 g. At 60 DAS and at harvest similar treatment recorded maximum branches per plant at entirely periods of observation because it switch weed very efficiently then offers proper space to crop.



Graph 4.64 Influence of different herbicide treatments on branches per plant in green gram at 20 days intervals (Pooled data of 2021 and 2022).

Table 4.69 Influence of different herbicide treatments on root nodules per plant in green gram at 20 days intervals (2021 and 2022).

Treatment	20 DAS (2021)	20 DAS (2022)	Pool data	40 DAS (2021)	40 DAS (2022)	Pool data
T ₁	8.21	8.24	8.23	13	13.20	13.10
T ₂	8.50	8.53	8.52	13	13.59	13.30
T ₃	9.00	9.04	9.02	14	14.12	14.06
T ₄	8.00	8.02	8.01	11	11.29	11.15
T ₅	7.12	7.16	7.14	10	10.12	10.06
T ₆	7.33	7.29	7.31	09	9.21	9.11
T ₇	7.51	7.54	7.53	12	12.05	12.03
T ₈	6.50	6.13	6.32	07	8.13	7.57
SE m ($\pm$)	0.24	0.30	0.27	0.36	0.41	0.39
CD (p = 0.05)	0.72	0.92	0.82	1.08	1.36	1.22

SE m ($\pm$): Standard error of mean, CD: Critical Difference and DAS: Days after sowing

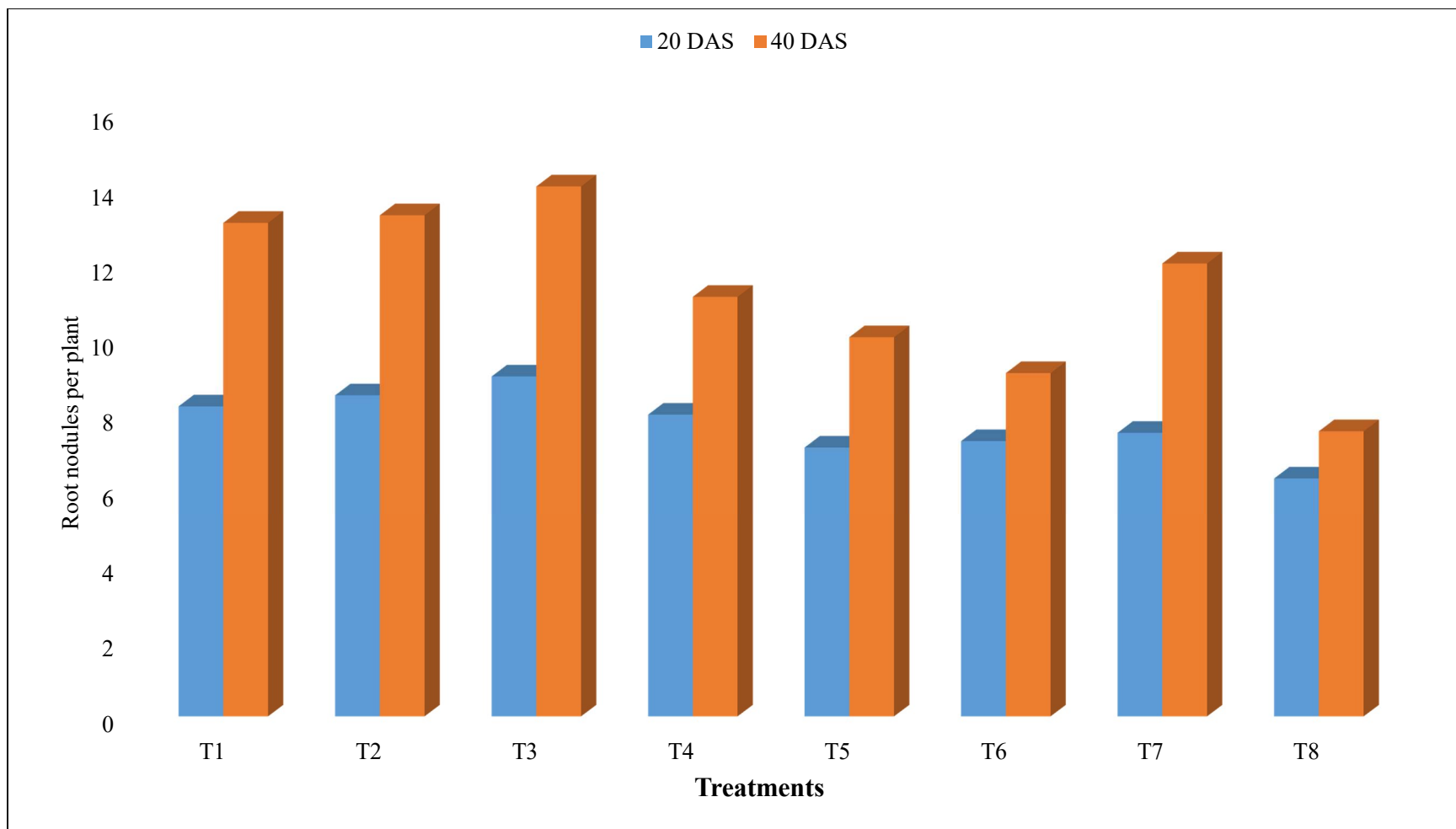
Treatments: T₁: Imazethapyr @ 60 g ha⁻¹ (PE), T₂: Pendimethalin 1 @ kg ha⁻¹ (PE), T₃: Pendimethalin 1 @ kg ha⁻¹ (PE) combined with Imazethapyr @ 50 g ha⁻¹ (PoE), T₄: Hand weeding twice (20 and 40 DAS), T₅: Quizalofop-p-ethyl @ 75 g ha⁻¹ (PoE), T₆: Imazethapyr + Imazamax @ 75 g ha⁻¹ (PoE), T₇: Sodium Aciflurofen and Clodinafop-propargyl @ 180 g ha⁻¹ (PoE) and T₈: Unweeded check (Control).

4.6.5 Root nodules per plant

As shown in Table 4.69 and graph 4.65, the statistics on root nodules per plant were significantly altered by various weed control treatments at 20 and 40 DAS.

PE treatment was compared to PoE treatment in the years 2021 and 2022, as shown in Table 4.69 per plant at 20 DAS maximum root nodules per plant. Maximum root nodules per plant were recorded on data 40 DAS PE usage of pendimethalin 1000 g in cobined with PoE imazethapyr 50 g, and PE pendimethalin 1000 g was followed by PE imazethapyr 60 g as compared to HW. Comparing PoE imazethapyr with imazamax 75 g and PoE quizalofop p ethyl 75 g to weedy check, fewer root nodules per plant were observed. The same results were reported by Choudhary *et al.* (2016) and Singh *et al.* (2015).

Cumulative data on 2021 and 2022 presented in Table 4.69 and graph 4.65 on data 20 DAS highest root nodules per plant in use of PE pendimethalin 1000 g combine with PoE imazethapyr 50 g then PE pendimethalin 1000 g liken to HW. At 40 DAS lowest root nodules per plant were recorded in PoE imazethapyr combined with imazamax 75 g and higher in PE pendimethalin 1000 g combine with PoE imazethapyr 50 g likened to weedy check.



Graph 4.65 Influence of different herbicide treatments on root nodules per plant on green gram at 20 days intervals (Pooled data of 2021 and 2022).

Table 4.70 Influence of different herbicide treatments on development studies (%) in green gram (2021 and 2022).

Treatment	50 % Flowering 35 DAS (2021)	50 % Flowering 35 DAS (2022)	Pool data	50 % Maturity 55 DAS (2021)	50 % Maturity 55 DAS (2022)	Pool data
T₁	84.11	84.16	84.14	86.00	86.07	86.04
T₂	85.84	85.90	85.87	87.13	87.18	87.16
T₃	86.11	86.19	86.15	87.36	87.40	87.38
T₄	84.00	84.21	84.11	85.58	85.62	85.60
T₅	80.52	80.60	80.56	81.47	81.50	81.49
T₆	82.00	82.12	82.06	82.23	82.28	82.26
T₇	82.89	82.90	82.90	83.26	83.30	83.28
T₈	79.00	79.27	79.14	80.21	80.32	80.27
SE m (±)	0.53	0.48	0.51	0.91	0.98	0.95
CD (p = 0.05)	1.61	1.45	1.53	2.75	2.96	2.86

SE m (±): Standard error of mean, CD: Critical Difference and DAS: Days after sowing

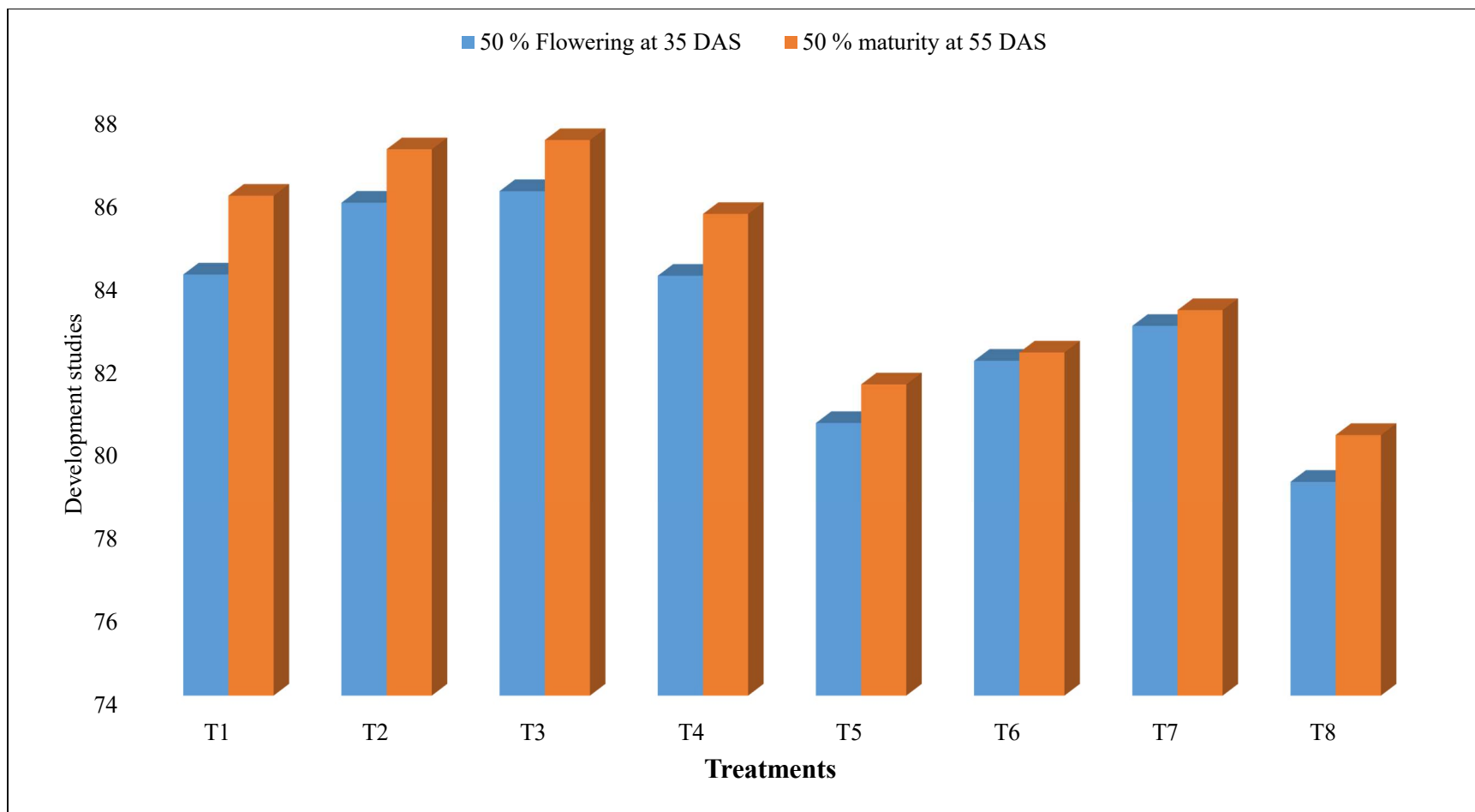
Treatments: T₁: Imazethapyr @ 60 g ha⁻¹ (PE), T₂: Pendimethalin 1 @ kg ha⁻¹ (PE), T₃: Pendimethalin 1 @ kg ha⁻¹ (PE) combined with Imazethapyr @ 50 g ha⁻¹ (PoE), T₄: Hand weeding twice (20 and 40 DAS), T₅: Quizalofop-p-ethyl @ 75 g ha⁻¹ (PoE), T₆: Imazethapyr + Imazamax @ 75 g ha⁻¹ (PoE), T₇: Sodium Aciflurofen and Clodinafop-propargyl @ 180 g ha⁻¹ (PoE) and T₈: Unweeded check (Control).

4.6.6 Developmental studies

The data on developmental studies expressively impacted by different weed controller treatments on different growth period shown on Table 4.70 and graph 4.66 on developmental studies on flowering and maturity period of observation.

The weed control treatments in Table 4.70 in the years 2021 and 2022 increased crop blooming by 50% above weedy check. When combined with PoE imazethapyr 50 g and PE pendimethalin 1000 g, the maximum blooming in PE was comparable to the PoE treatment above weedy control. Lower PoE quizalofop p ethyl 75 g and PoE imazethapyr mixed with imazamax 75 g over a weedy check, and PE pendimethalin 1000 g combined with PoE imazethapyr 50 g near with PE pendimethalin 1000 g likened to HW over weedy check, were noticed to have the maximum 50% maturity on 55 days.

The cumulative data in 2021 and 2022 shown in Table 4.70 and graph 4.66 appearance at 35 days maximum flowering noted in use of PE pendimethalin 1000 g combined with imazethapyr 50 g and lower in PoE quizalofop p ethyl 75 g. Maximum 50 % maturity at 50 days were recorded in PE pendimethalin 1000 g combined with imazethapyr 50 g and lower in use of PoE quizalofop p ethyl 75 g over a weedy check.



Graph 4.66 Influence of different herbicide treatments on development studies (%) in green gram at different growth stages (Pooled data of 2021 and 2022).

Table 4.71 Influence of different herbicide treatments on fresh weight (g plant⁻¹) in green gram at 20 days intervals (2021-2022).

Treatment	20 DAS (2021)	20 DAS (2022)	Pool data	40 DAS (2021)	40 DAS (2022)	Pool data	60 DAS (2021)	60 DAS (2022)	Pool data	Harvest (2021)	Harvest (2022)	Pool data
T₁	2.20	2.28	2.24	3.76	3.82	3.79	5.16	5.24	5.20	5.06	5.14	5.10
T₂	2.27	2.33	2.3	3.82	3.86	3.84	5.30	5.36	5.33	5.24	5.30	5.27
T₃	2.31	2.39	2.35	3.83	3.89	3.86	5.44	5.52	5.48	5.36	5.44	5.40
T₄	2.18	2.24	2.21	3.68	3.76	3.72	4.86	4.96	4.91	4.86	4.92	4.89
T₅	2.08	2.12	2.10	3.52	3.62	3.57	4.48	4.54	4.51	4.45	4.51	4.48
T₆	2.10	2.14	2.12	3.58	3.64	3.61	4.74	4.80	4.77	4.70	4.74	4.72
T₇	2.11	2.19	2.15	3.63	3.69	3.66	4.78	4.94	4.86	4.80	4.88	4.84
T₈	1.86	1.94	1.90	2.30	2.40	2.35	2.82	2.98	2.90	2.82	2.96	2.89
SE m (±)	0.64	0.45	0.55	0.81	0.71	0.76	1.08	0.46	0.77	1.17	0.72	0.95
CD (p = 0.05)	1.94	1.31	1.63	2.64	2.17	2.41	3.28	1.40	2.34	3.55	2.18	2.87

SE m (±): Standard error of mean, CD: Critical Difference and DAS: Days after sowing

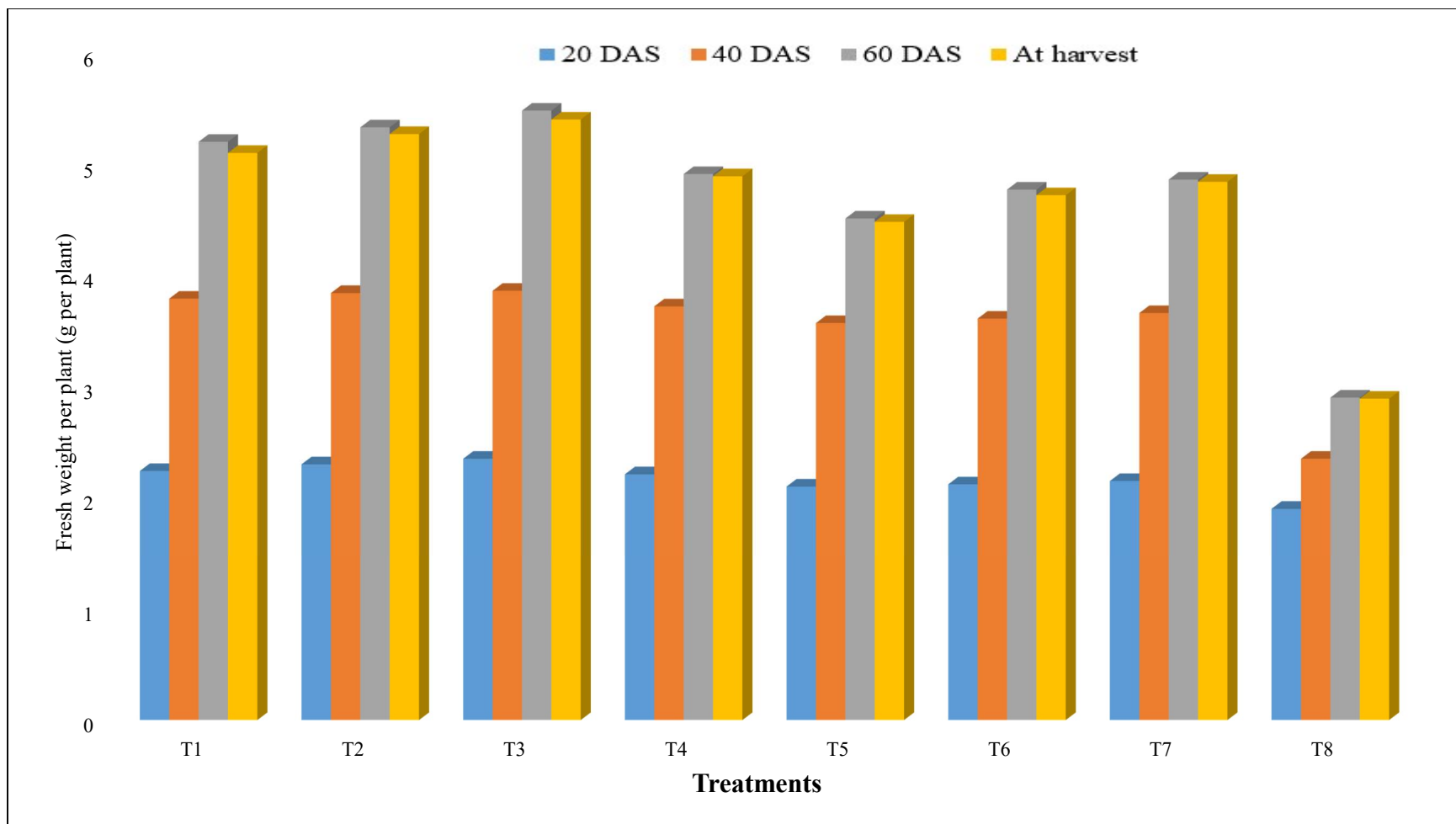
Treatments: T₁: Imazethapyr @ 60 g ha⁻¹ (PE), T₂: Pendimethalin 1 @ kg ha⁻¹ (PE), T₃: Pendimethalin 1 @ kg ha⁻¹ (PE) combined with Imazethapyr @ 50 g ha⁻¹ (PoE), T₄: Hand weeding twice (20 and 40 DAS), T₅: Quizalofop-p-ethyl @ 75 g ha⁻¹ (PoE), T₆: Imazethapyr + Imazamax @ 75 g ha⁻¹ (PoE), T₇: Sodium Aciflourfen and Clodinafop-propargyl @ 180 g ha⁻¹ (PoE) and T₈: Unweeded check (Control).

4.6.7 Fresh weight per plant (g plant⁻¹)

Data on how various weed management strategies affected fresh weight 20 days before harvest are displayed in Table 4.71 and graph 4.67.

In years 2021 and 2022 data presented in Table 4.71 at 20 DAS in entirely weed control treatments noticed increased fresh weight per plant likened to weedy check. The higher fresh weight per plant is recorded in PE treatment as likened to PoE treatment over a weedy check. At 40 days expressively higher fresh weight per plant recorded in treatment PE pendimethalin 1000 g combine with PoE imazethapyr 50 g followed by PE pendimethalin 1000 g and PE imazethapyr 60 g. Lower fresh weight per plant recorded in PoE quizalofop p ethyl 75 g and PoE imazethapyr combined with imazamax 75 g over weedy check. On data 60 days and harvest expressively highest fresh weight were recorded in use of PE pendimethalin 1000 g combine with PoE imazethapyr 50 g and PE pendimethalin 1000 g as likened to HW. The lower fresh weight per plant is recorded in PoE quizalofop p ethyl 75 g and PoE imazethapyr combined with imazamax 75 g until harvest over weedy check. An alike outcome were stated by Lava *et al.* 2018, Patel *et al.* 2020 and T. Ramesh *et al.* 2020.

The cumulative data in 2021 and 2022 presented in Table 4.71 and graph 4.67 on 20 days higher fresh weight per plant in PE treatment causes lower growth of weed at initial periods in growth of crop. The lower fresh weight per plant in PoE treatment weeds makes rivalry with a crop at initial growth periods. At 40 DAS PE pendimethalin 1000 g combine with PoE imazethapyr 50 g arrests weed progress affecting higher fresh weight per plant and PE pendimethalin 1000 g and lowest in PoE quizalofop p ethyl 75 g and PoE imazethapyr combined with imazamax 75 g as liken to HW over a weedy check. At 60 days and harvest similar treatment recorded extreme and lower fresh weight of plant over a weedy check.



Graph 4.67 Influence of different herbicide treatments on fresh weight (g plant⁻¹) in green gram at 20 days intervals (Pooled data of 2021 and 2022).

Table 4.72 Influence of different herbicide treatments on dry weight (g plant⁻¹) in green gram at 20 days intervals (2021 and 2022).

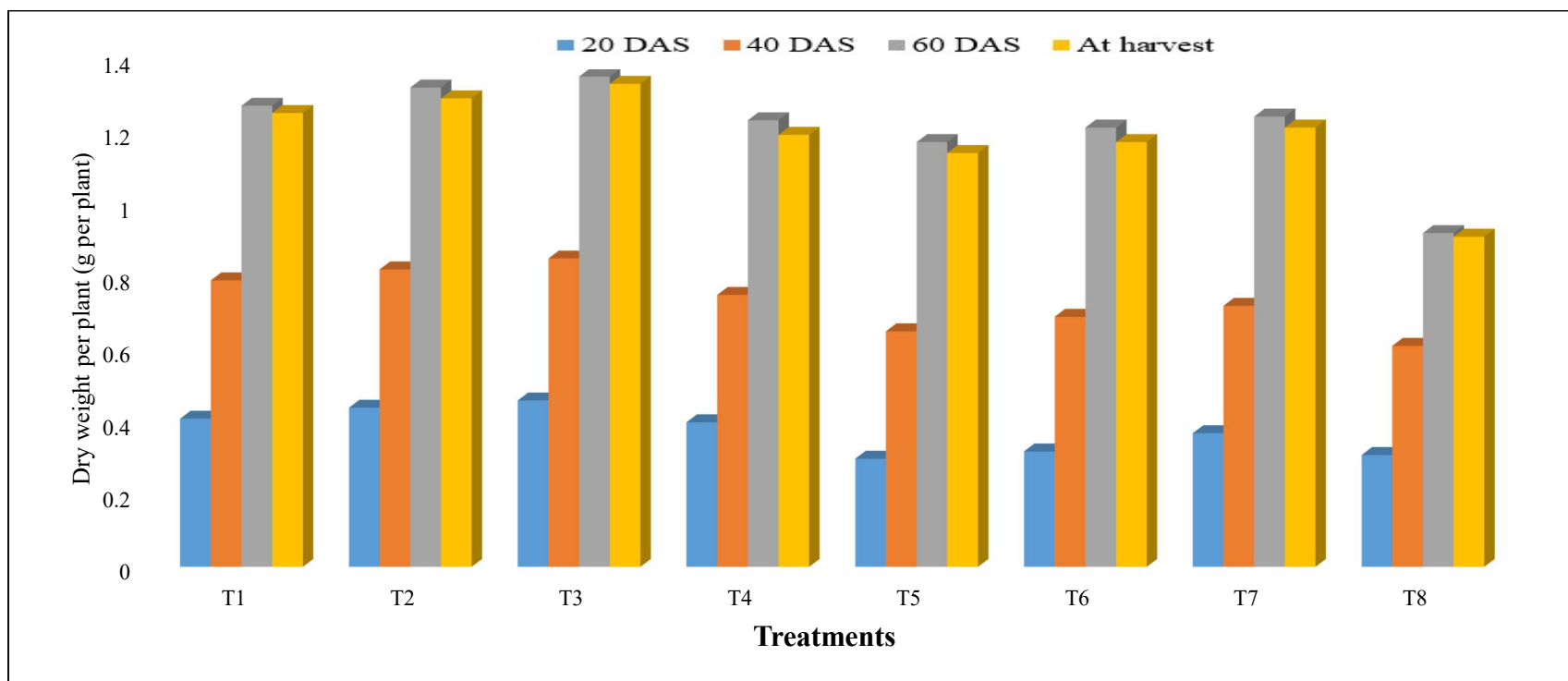
Treatment	20 DAS (2021)	20 DAS (2022)	Pool data	40 DAS (2021)	40 DAS (2022)	Pool data	60 DAS (2021)	60 DAS (2022)	Pool data	Harvest (2021)	Harvest (2022)	Pool data
T₁	0.39	0.43	0.41	0.75	0.83	0.79	1.23	1.31	1.27	1.23	1.27	1.25
T₂	0.41	0.47	0.44	0.80	0.84	0.82	1.29	1.35	1.32	1.25	1.33	1.29
T₃	0.44	0.48	0.46	0.81	0.89	0.85	1.31	1.39	1.35	1.29	1.37	1.33
T₄	0.37	0.43	0.40	0.70	0.80	0.75	1.18	1.28	1.23	1.15	1.23	1.19
T₅	0.27	0.33	0.30	0.62	0.68	0.65	1.13	1.21	1.17	1.10	1.18	1.14
T₆	0.26	0.38	0.32	0.66	0.72	0.69	1.15	1.27	1.21	1.12	1.22	1.17
T₇	0.32	0.42	0.37	0.68	0.76	0.72	1.16	1.32	1.24	1.19	1.23	1.21
T₈	0.24	0.38	0.31	0.57	0.65	0.61	0.86	0.98	0.92	0.85	0.97	0.91
SE m (±)	0.32	0.27	0.30	0.39	0.41	0.40	0.56	0.45	0.51	0.74	0.53	0.64
CD (p = 0.05)	0.97	0.81	0.89	1.18	1.23	1.21	1.70	1.36	1.53	2.25	1.61	1.53

4.6.8 Dry weight per plant (g plant⁻¹)

Data on dry weight at 20 days before to harvest are presented in Table 4.72 and graph 4.68, shown the significant effects of various weed management treatments.

In years 2021 and 2022 data shown in Table 4.72 at 20 DAS entirely weed control treatments noticed higher dry weight per plant likened to weedy check. The higher dry weight per plant is recorded in PE treatment as likened to PoE treatment over a weedy check. At 40 DAS higher dry weight per plant recorded in use of PE pendimethalin 1000 g combine with PoE imazethapyr 50g followed by PE pendimethalin 1000 g and PE imazethapyr 60 g. Lower dry weight per plant recorded in PoE quizalofop p ethyl 75 g and PoE imazethapyr combined with imazamax 75 g over weedy check. PE pendimethalin 1000 g in combination with PoE imazethapyr 50 g and PE pendimethalin 1000 g similar to HW at 60 DAS and harvest greater dry weight were reported. Up to harvest over weedy check, the lower dry weight per plant is recorded in PoE quizalofop p ethyl 75 g and imazethapyr mixed with imazamax 75 g PoE. Lava *et al.* 2018, Patel *et al.* 2020, and T. Ramesh *et al.* 2020 all reported similar results.

The cumulative data in 2021 and 2022 shown in Table 4.71 and graph 4.67 on 20 days higher dry weight per plant in PE treatment causes lower growth of weed at initial periods in growth of crop. The lower dry weight per plant in PoE treatment weeds makes rivalry with a crop at initial growth periods. At 40 DAS PE pendimethalin 1000 g combine with PoE imazethapyr 50 g arrests weed progress affecting higher dry weight per plant after PE pendimethalin 1000 g followed by lowest in PoE quizalofop p ethyl 75 g and PoE imazethapyr combined with imazamax 75 g as liken to HW over a weedy check. At 60 DAS and harvest identical treatment recorded higher and lower dry weight of plant over a weedy check.



Graph 4.68 Influence of different herbicide treatments on dry weight (g plant⁻¹) in green gram at 20 days intervals (Pooled data of 2021 and 2022).

Table 4.73 Influence of different herbicide treatments on crop growth rate ($\text{g m}^{-2} \text{ day}^{-1}$) in green gram at 20 days intervals (2021 and 2022) (CGR X 10).

Treatment	20-40 DAS (2021)	20-40 DAS (2022)	Pool data	40-60 DAS (2021)	40-60 DAS (2022)	Pool data
T₁	0.18	0.20	0.19	0.20	0.24	0.22
T₂	0.20	0.19	0.19	0.19	0.26	0.22
T₃	0.19	0.21	0.20	0.21	0.25	0.23
T₄	0.17	0.19	0.18	0.19	0.24	0.21
T₅	0.18	0.18	0.18	0.18	0.27	0.22
T₆	0.20	0.17	0.19	0.17	0.28	0.22
T₇	0.18	0.17	0.18	0.17	0.28	0.23
T₈	0.17	0.14	0.15	0.14	0.17	0.15
SE m ($\pm$)	0.12	0.13	0.13	0.04	0.03	0.04
CD (p = 0.05)	0.37	0.38	0.39	0.12	0.08	0.10

SE m ($\pm$): Standard error of mean, CD: Critical Difference and DAS: Days after sowing

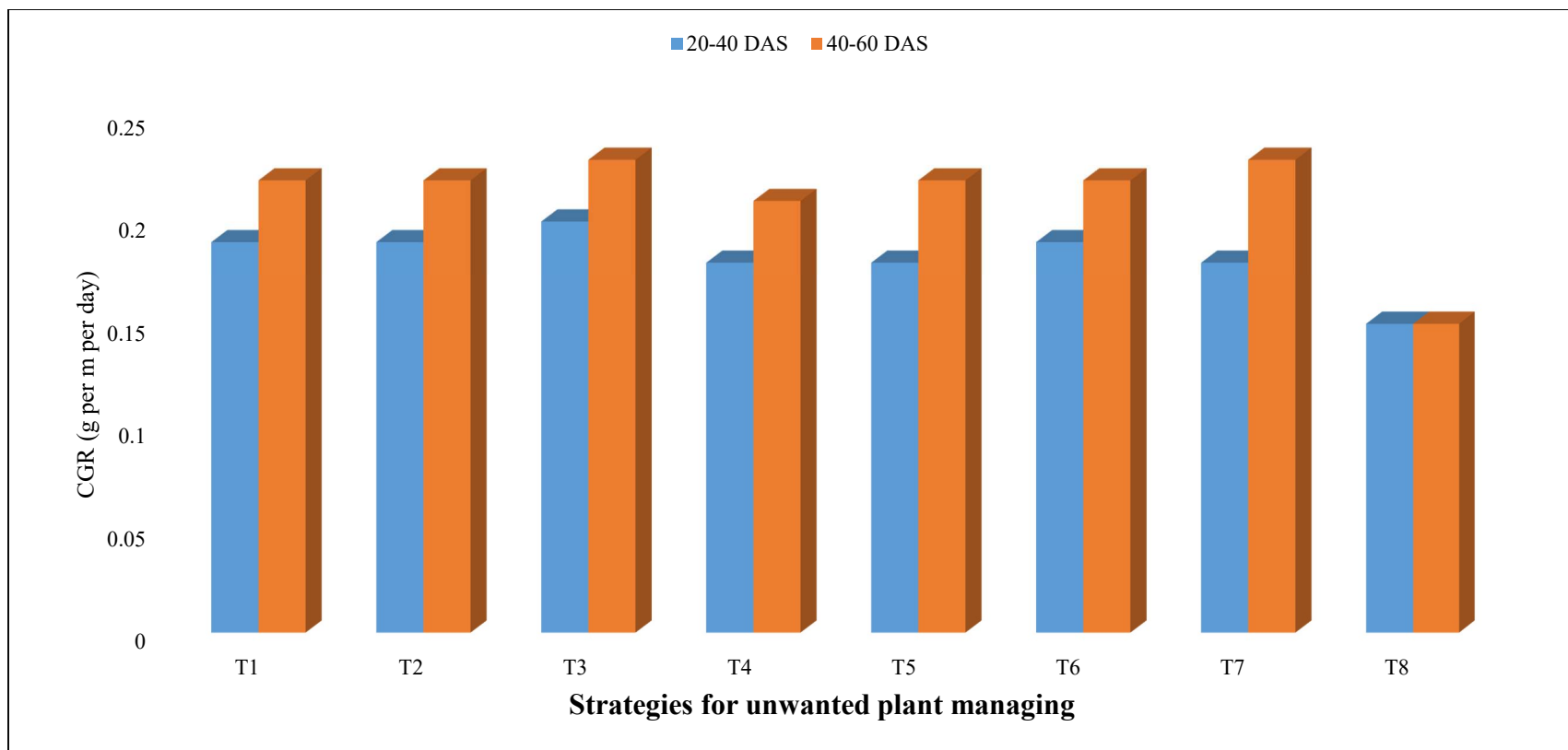
Treatments: T₁: Imazethapyr @ 60 g ha⁻¹ (PE), T₂: Pendimethalin 1 @ kg ha⁻¹ (PE), T₃: Pendimethalin 1 @ kg ha⁻¹ (PE) combined with Imazethapyr @ 50 g ha⁻¹ (PoE), T₄: Hand weeding twice (20 and 40 DAS), T₅: Quizalofop-p-ethyl @ 75 g ha⁻¹ (PoE), T₆: Imazethapyr + Imazamax @ 75 g ha⁻¹ (PoE), T₇: Sodium Aciflurofen and Clodinafop-propargyl @ 180 g ha⁻¹ (PoE) and T₈: Unweeded check (Control).

4.6.9 Crop growth rate ($\text{g m}^{-2} \text{ day}^{-1}$)

The data on CGR expressively impacted by different weed control treatments in different growth period obtainable in Table 4.73 and graph 4.69 at 20 days intervals up to harvest.

As compared to PoE treatment over a weedy check, the years 2021 and 2022 indicated in Table 4.73 in data 20-40 DAS completely PE weed controller treatments increase CGR. According to statistics, PE pendimethalin 1000 g combined with PoE imazethapyr 50 g and CGR was 40-60 DAS greater than HW. The PoE usage of quizalofop p ethyl 75 g and PoE sodium aciflourfen and clodinafop propargyl 180 g was associated with a reduced CGR.

The cumulative data in 2021 and 2022 presented in Table 4.73 and graph 4.69 on 20-40 DAS recorded higher CGR in use of PE pendimethalin 1000 g combine with PoE imazethapyr 50g and PE pendimethalin 1000 g likened to weedy check. Among herbicidal treatments, PoE quizalofop p ethyl 75 g showed the lowest crop growth rate at 40-60 DAS, followed by PoE sodium aciflourfen and clodinafop propargyl 180 g throughout the whole observation period, the CGR values for PE pendimethalin 1000 g in combination with PoE Imazethapyr 50 g were higher than those for other herbicides.



Graph 4.69 Influence of different herbicide treatments on crop growth rate ($\text{g m}^{-2} \text{ day}^{-1}$) in green gram at 20 days intervals (Pooled data of 2021 and 2022).

Table 4.74 Influence of different herbicide treatments on relative growth rate ($\text{g g}^{-1} \text{ day}^{-1}$) in green gram at 20 days intervals (2021 and 2022).

Treatment	20-40 DAS (2021)	20-40 DAS (2022)	Pool data	40-60 DAS (2021)	40-60 DAS (2022)	Pool data
T₁	0.22	0.22	0.22	0.16	0.15	0.16
T₂	0.22	0.19	0.21	0.16	0.16	0.16
T₃	0.20	0.21	0.20	0.16	0.15	0.15
T₄	0.21	0.21	0.21	0.17	0.16	0.17
T₅	0.28	0.24	0.26	0.20	0.19	0.20
T₆	0.31	0.21	0.26	0.19	0.19	0.19
T₇	0.25	0.20	0.22	0.18	0.18	0.18
T₈	0.29	0.18	0.23	0.14	0.14	0.14
SE m ($\pm$)	0.08	0.09	0.09	0.10	0.11	0.11
CD (p = 0.05)	0.23	0.26	0.27	0.30	0.32	0.33

SE m ($\pm$): Standard error of mean, CD: Critical Difference and DAS: Days after sowing

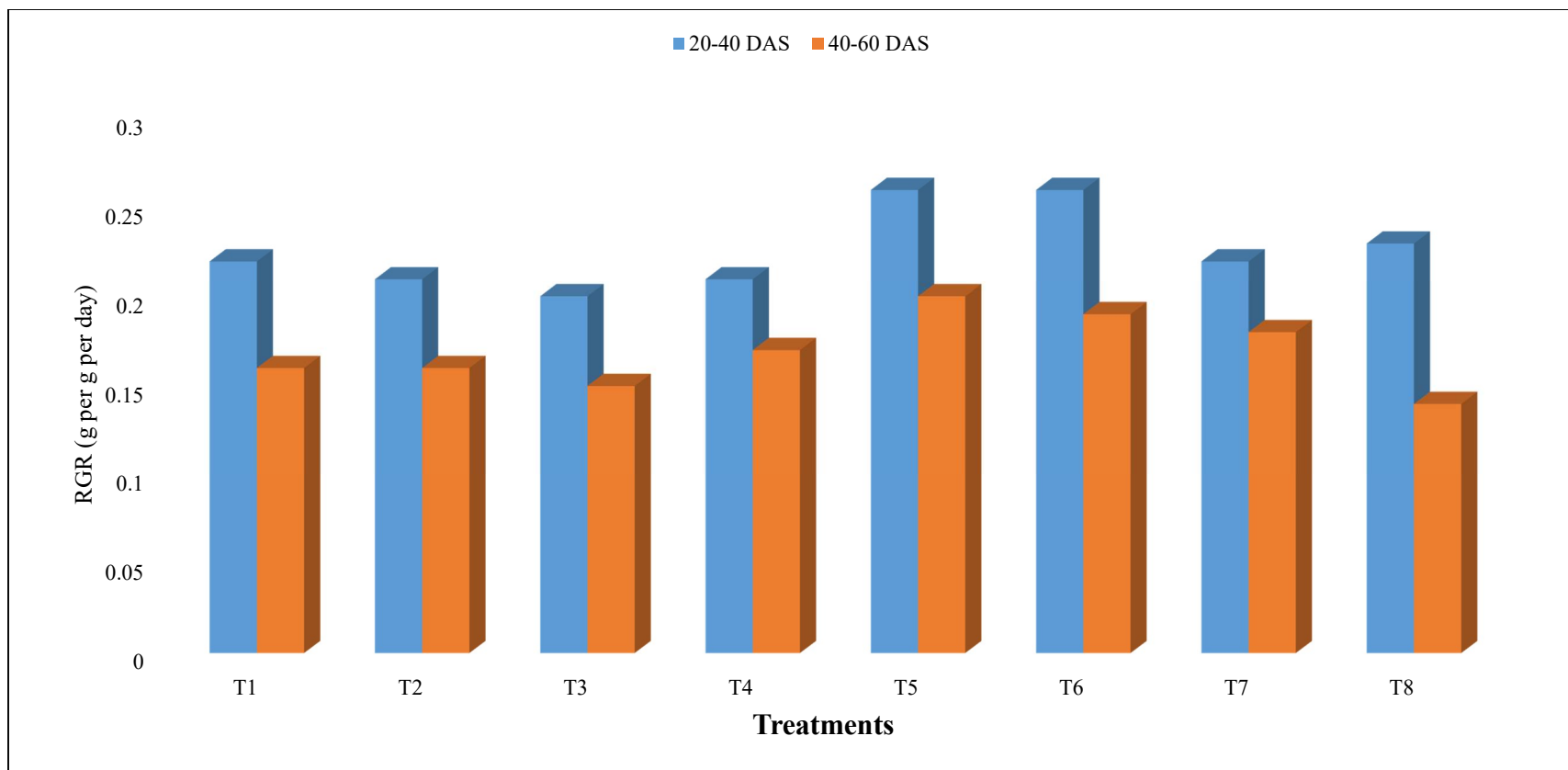
Treatments: T₁: Imazethapyr @ 60 g ha⁻¹ (PE), T₂: Pendimethalin 1 @ kg ha⁻¹ (PE), T₃: Pendimethalin 1 @ kg ha⁻¹ (PE) combined with Imazethapyr @ 50 g ha⁻¹ (PoE), T₄: Hand weeding twice (20 and 40 DAS), T₅: Quizalofop-p-ethyl @ 75 g ha⁻¹ (PoE), T₆: Imazethapyr + Imazamax @ 75 g ha⁻¹ (PoE), T₇: Sodium Aciflurofen and Clodinafop-propargyl @ 180 g ha⁻¹ (PoE) and T₈: Unweeded check (Control).

4.6.9 Relative growth rate ($\text{g g}^{-1} \text{ day}^{-1}$)

The data on RGR expressively impacted by different weed control treatments on different growth period obtainable in Table 4.74 and graph 4.70.

In years 2021 and 2022 presented on Table 4.74 in 20-40 DAS entirely PE weed switch treatments rise RGR likened PoE treatment over weedy check. On 40-60 DAS maximum RGR were recorded in PE pendimethalin 1000 g combine with PoE imazethapyr 50 g followed by PE imazethapyr 60g and PE pendimethalin 1000 g liken to HW. The lower RGR in use of sodium aciflourfen and PoE clodinafop propargyl is 180 g likened over weedy check.

The cumulative data on 2021 and 2022 shown in Table 4.74 and graph 4.70 on data 20-40 DAS recorded lower RGR in PoE treatment as likened to PE treatment over weedy check. At 40-60 DAS maximum RGR in green gram were recorded in PE pendimethalin 1000 g combine with PoE imazethapyr 50 g and PE imazethapyr 60 g and better over other herbicides liken to HW over a weedy check.



Graph 4.70 Influence of different herbicide treatments on relative growth rate ($\text{g g}^{-1} \text{ day}^{-1}$) in green gram at 20 days intervals (Pooled data of 2021 and 2022).

Table 4.75 Influence of different herbicide treatments on yield attributes in green gram (2021 and 2022).

Treatment	No. of Pods Per Plant (2021)	No. of Pods Per Plant (2022)	Pool data	No. of grains Per Pod (2021)	No. of grains Per Pod (2022)	Pool data	Length of Pods (cm) (2021)	Length of Pods (cm) (2022)	Pool data	Test weight (g) (2021)	Test weight (g) (2022)	Pool data
T₁	20.10	20.19	20.15	10.44	10.50	10.47	11.77	11.81	11.79	31.86	31.90	31.88
T₂	20.96	21.03	21.00	11.33	11.39	11.36	12.56	12.60	12.58	32.69	32.60	32.65
T₃	21.22	21.30	21.26	11.94	12.04	11.99	13.27	13.32	13.30	32.84	32.87	32.86
T₄	15.71	15.80	15.76	09.71	09.79	09.75	11.10	11.16	11.13	30.94	31.04	30.99
T₅	15.96	15.99	15.98	08.22	08.30	08.26	09.94	10.04	09.99	28.77	28.81	28.79
T₆	16.31	16.39	16.35	08.74	08.79	08.77	10.22	10.30	10.26	29.44	29.51	29.48
T₇	18.91	19.00	18.96	09.54	09.60	09.57	10.88	10.96	10.92	30.39	30.52	30.46
T₈	14.30	14.40	14.35	07.71	07.80	07.76	9.00	9.30	9.15	26.52	26.67	26.60
SE m (±)	0.57	0.50	0.54	0.66	0.34	0.50	0.70	0.43	0.57	1.03	0.63	0.83
CD (p = 0.05)	1.73	1.53	1.63	2.01	1.03	1.52	2.11	1.31	1.71	3.12	1.92	2.52

SE m (±): Standard error of mean, CD: Critical Difference and DAS: Days after sowing

Treatments: T₁: Imazethapyr @ 60 g ha⁻¹ (PE), T₂: Pendimethalin 1 @ kg ha⁻¹ (PE), T₃: Pendimethalin 1 @ kg ha⁻¹ (PE) combined with Imazethapyr @ 50 g ha⁻¹ (PoE), T₄: Hand weeding twice (20 and 40 DAS), T₅: Quizalofop-p-ethyl @ 75 g ha⁻¹ (PoE), T₆: Imazethapyr + Imazamax @ 75 g ha⁻¹ (PoE), T₇: Sodium Aciflurofen and Clodinafop-propargyl @ 180 g ha⁻¹ (PoE) and T₈: Unweeded check (Control).

4.6.10 Yield attributes

Table 4.75 and graph 4.71 present statistics on yield attributes that are expressively changed by various weed management techniques.

4.6.10.1 Pods per plant

The findings presented in Table 4.75 and graph 4.71a for the years 2021 and 2022 indicate that all weed control treatments saw higher pod counts per plant in comparison to weedy check. When PE pendimethalin 1000 g was combined with PoE imazethapyr 50 g and PE pendimethalin 1000 g, more pods per plant were observed. In comparison to other herbicides, PE pendimethalin 1000 g coupled with imazethapyr 50 g produced more pods per plant. Weedy check was used to note the bottom pods on each plant. The findings of Choudhary *et al.* (2016), Singh *et al.* (2017), Jyoti *et al.* (2020), and Singh *et al.* (2015) are still in accord.

The combined results for 2021 and 2022 is shown in Table 4.75 and graph 4.71a, where all weed control methods significantly increased the number of pods per plant compared to weedy check. Weedy check was used to note the bottom pods on each plant. When PE pendimethalin 1000 g was combined with PoE imazethapyr 50 g and PE pendimethalin 1000 g, significantly more pods per plant were seen than when additional herbicide was used.

4.6.10.2 Seeds per pod

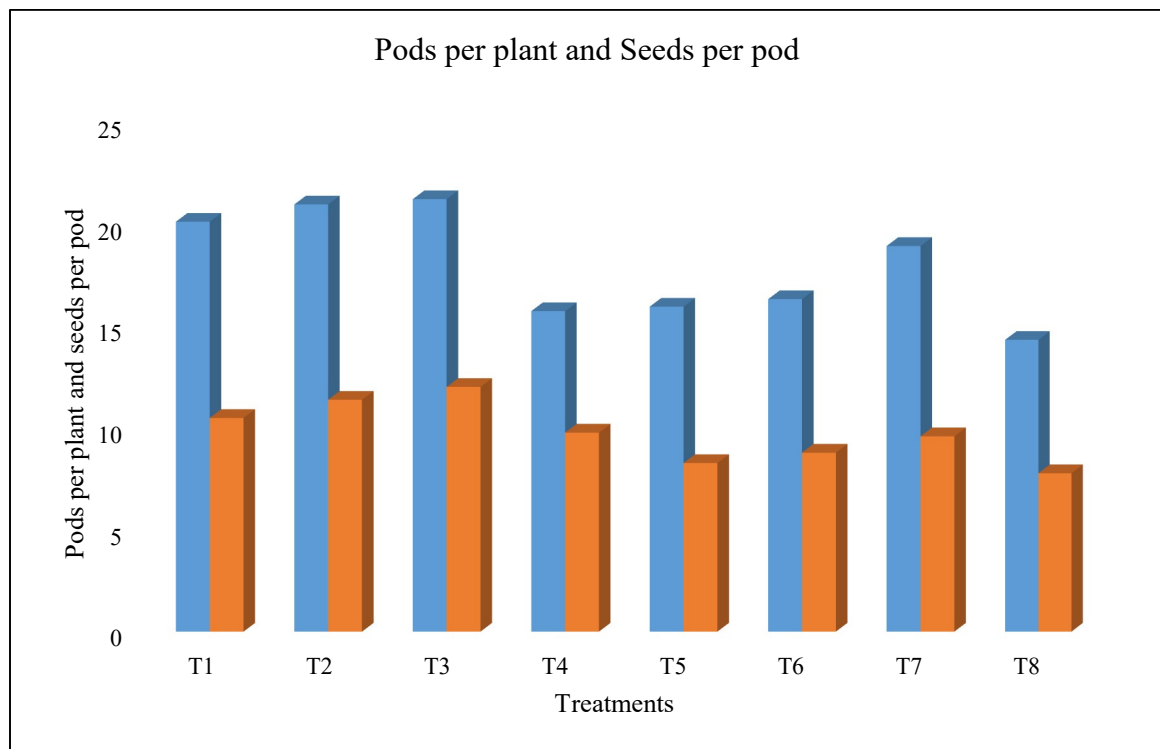
The total weed control treatments in the years 2021 and 2022, as shown on Table 4.75 and graph 4.71a, clearly produced more seeds per pod as compared to weedy check. When PE pendimethalin 1000 g was combined with PoE imazethapyr 50 g and PE pendimethalin 1000 g, significantly more seeds per pod were seen. In the weedy check, the number of seeds per pod was greater. Similar conclusions are still made in relation to Leva *et al.* (2018) and Kumar *et al.* (2019).

4.6.10.3 Length of pods (cm)

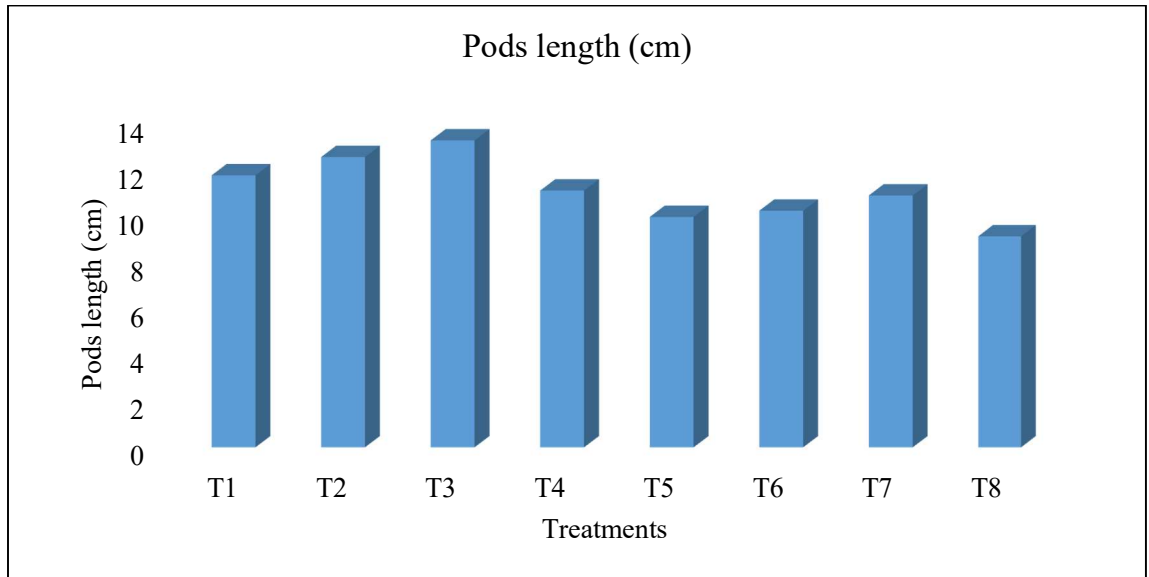
The results for 2021 and 2022 are shown in Table 4.75 and graph 4.71b, which show the maximum length of pods compared to weedy check for all weed management methods. In combination with 50g of PoE imazethapyr and 1000 g of PE pendimethalin, significantly longer pods were seen. The weedy check had the shortest pod lengths on record. The findings of Kumar *et al.* (2019) and Patel *et al.* (2020) are still almost same.

4.6.10.4 Test weight (g)

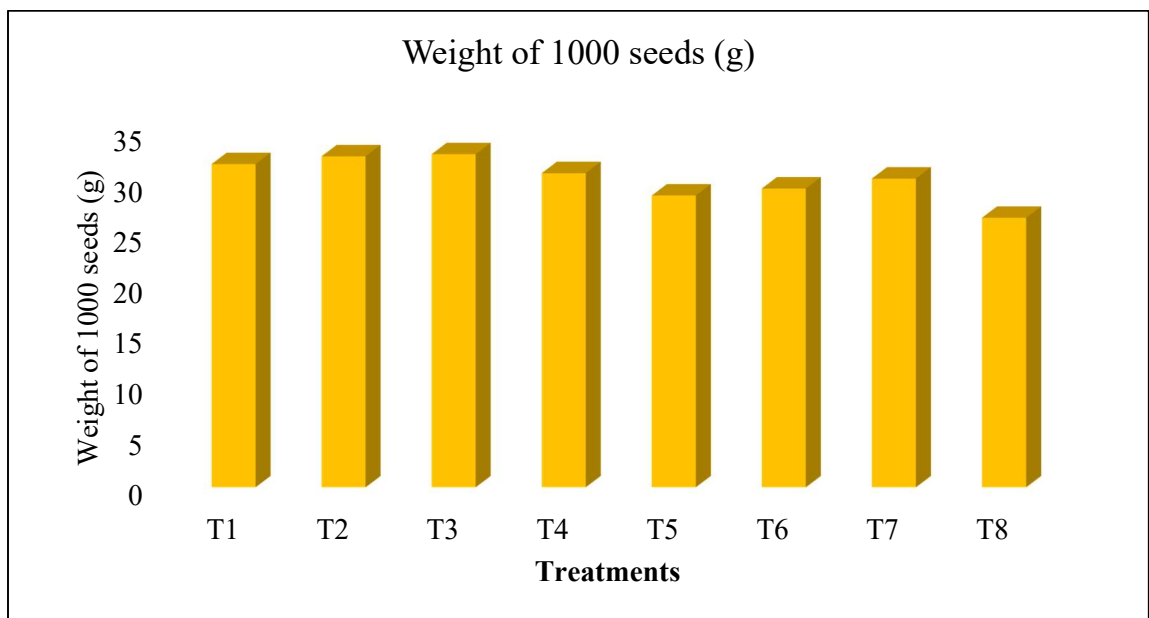
The results from the years 2021 and 2022 are displayed in Table 4.75 and graph 4.71c, where all weed control treatments are clearly compared to weedy checks in terms of maximum test weight. In combination with PoE imazethapyr 50 g and PE pendimethalin 1000 g, the expressly mixed maximum test weight was recorded. Weedy check has the lowest test weight recorded. Singh *et al.*, 2019, T. Ramesh *et al.* 2020, and Jyoti *et al.* 2020 all reported similar results.



Graph 4.71a Influence of different herbicide treatments on pods per plant and seeds per pod in green gram (Pooled data of 2021 and 2022).



Graph 4.71b Influence of different herbicide treatments on pod length (cm) in green gram (Pooled data of 2021 and 2022).



Graph 4.71c Influence of different herbicide treatments on weight of 1000 seeds in green gram (Pooled data of 2021 and 2022).

Table 4.76 Influence of different herbicide treatments on yield character, harvest index and weed index in green gram (2021 and 2022).

Treatment	Seed yield (q ha ⁻¹) (2021)	Seed yield (q ha ⁻¹) (2022)	Pool data	Straw yield (q ha ⁻¹) (2021)	Straw yield (q ha ⁻¹) (2022)	Pool data	HI (%) (2021)	HI (%) (2022)	Pool data	WI (%) (2021)	WI (%) (2022)	Pool data
T ₁	6.70	6.85	6.78	22.50	23.04	22.77	23.49	23.52	23.51	06.94	06.03	06.49
T ₂	6.91	7.10	7.00	23.55	23.88	23.72	23.27	22.91	23.09	04.02	03.70	03.86
T ₃	7.20	7.29	7.25	24.30	24.66	24.48	23.91	24.69	24.30	00.00	00.00	00.00
T ₄	6.50	6.61	7.00	21.93	22.26	23.66	22.20	22.91	22.56	09.72	09.32	03.45
T ₅	5.65	5.72	5.69	20.34	20.67	20.51	21.10	21.39	21.25	21.52	21.53	21.53
T ₆	5.91	6.01	5.96	20.67	20.82	20.75	21.60	21.90	21.75	17.91	17.55	17.73
T ₇	6.23	6.35	6.29	21.00	21.36	21.18	22.59	23.03	22.81	13.47	12.89	13.18
T ₈	3.40	3.54	3.47	12.00	12.43	12.22	19.45	19.79	19.62	52.77	51.44	52.11
SE m (±)	0.14	0.16	0.15	0.45	0.49	0.47	0.50	0.60	0.55	0.57	0.51	0.54
CD (p = 0.05)	0.42	0.48	0.46	1.35	1.47	1.40	1.50	1.83	1.67	1.72	1.54	1.63

SE m (±): Standard error of mean, CD: Critical Difference and DAS: Days after sowing

Treatments: T₁: Imazethapyr @ 60 g ha⁻¹ (PE), T₂: Pendimethalin 1 @ kg ha⁻¹ (PE), T₃: Pendimethalin 1 @ kg ha⁻¹ (PE) combined with Imazethapyr @ 50 g ha⁻¹ (PoE), T₄: Hand weeding twice (20 and 40 DAS), T₅: Quizalofop-p-ethyl @ 75 g ha⁻¹ (PoE), T₆: Imazethapyr + Imazamax @ 75 g ha⁻¹ (PoE), T₇: Sodium Aciflurofen and Clodinafop-propargyl @ 180 g ha⁻¹ (PoE) and T₈: Unweeded check (Control).

4.6.11 Yield character, harvest index and weed index

Table 4.76 and graph 4.72 present the statistical data on yield character that were significantly changed by the various weed control techniques.

4.6.11.1 Seed yield and straw yield (q ha⁻¹)

The results from the years 2021 and 2022 are shown in Table 4.76, graphs 4.72a and 4.72b, and all weed control treatments that effectively compare maximum seed production and straw yield to weedy check. Comparing PE pendimethalin 1000 g with PoE imazethapyr 50 g to PE pendimethalin 1000 g and PE imazethapyr 60 g, a significantly greater seed production was observed. PoE quizalofop p ethyl 75 g and PoE imazethapyr coupled with imazamax 75 g showed lower seed yields. Comparing HW lower straw yield recorded in PoE quizalofop p ethyl 75 g and PoE imazethapyr combined with imazamax 75 g over weedy check, higher straw yield were recorded in the use of PE pendimethalin 1000 g combine with PoE imazethapyr 50 g, followed by PE pendimethalin 1000 g and PE imazethapyr 60 g. Singh *et al.* (2015), Patel *et al.* (2016), Verma and Kushwaha (2018), and T. Ramesh *et al.* (2020) all reported the same results..

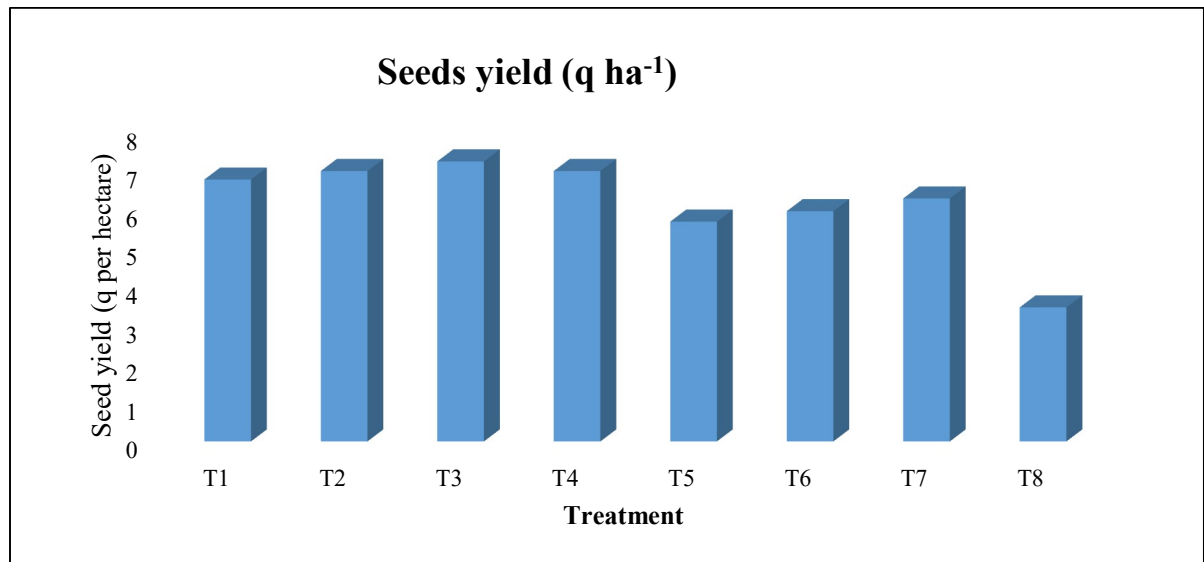
4.6.11.2 Harvest index (%)

The maximum harvest index were recorded in Table 4.76 use of PE pendimethalin 1000 g combine with PoE imazethapyr 50 g and PE pendimethalin 1000 g and PE imazethapyr 60 g liken to HW. The lower harvest index were recorded in PoE quizalofop p ethyl 75 g and PoE imazethapyr combined with imazamax 75 g as likened to weedy check. Identical outcomes were stated by Singh *et al.* 2017, Kumar *et al.* 2019 and Patel *et al.* 2020.

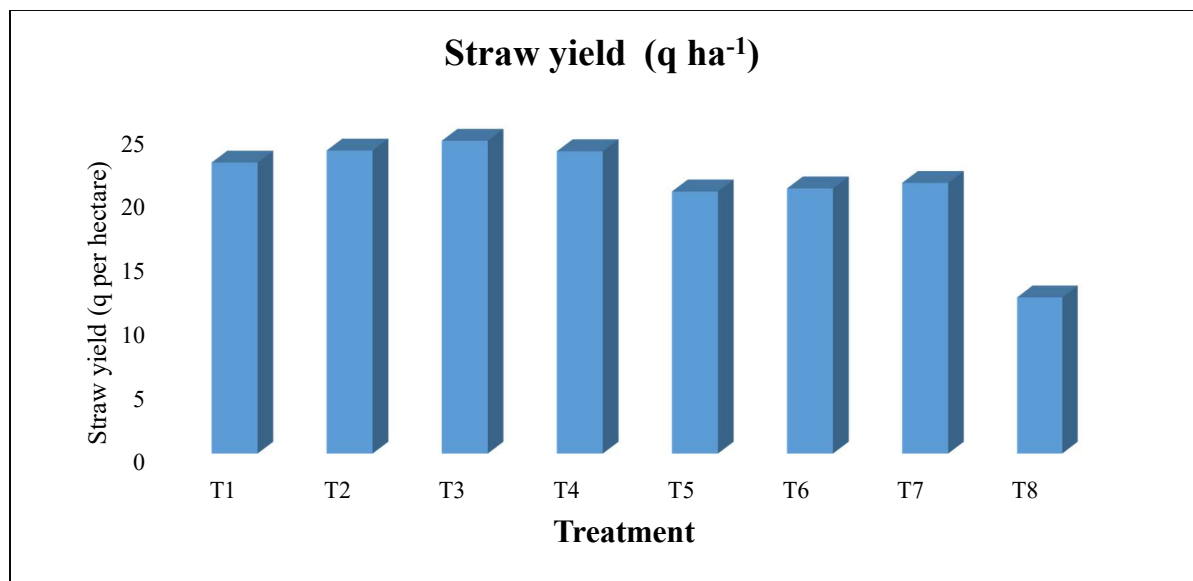
4.6.11.3 Weed index (%)

Lowest weed index were recorded in Table 4.76 use of PE pendimethalin 1000 g combine with PoE imazethapyr 50 g followed by PE pendimethalin 1000 g and PE imazethapyr 60 g likened to HW. The higher weed index were recorded in PoE quizalofop p ethyl 75 g and PoE imazethapyr combined with imazamax 75 g as likened to weedy

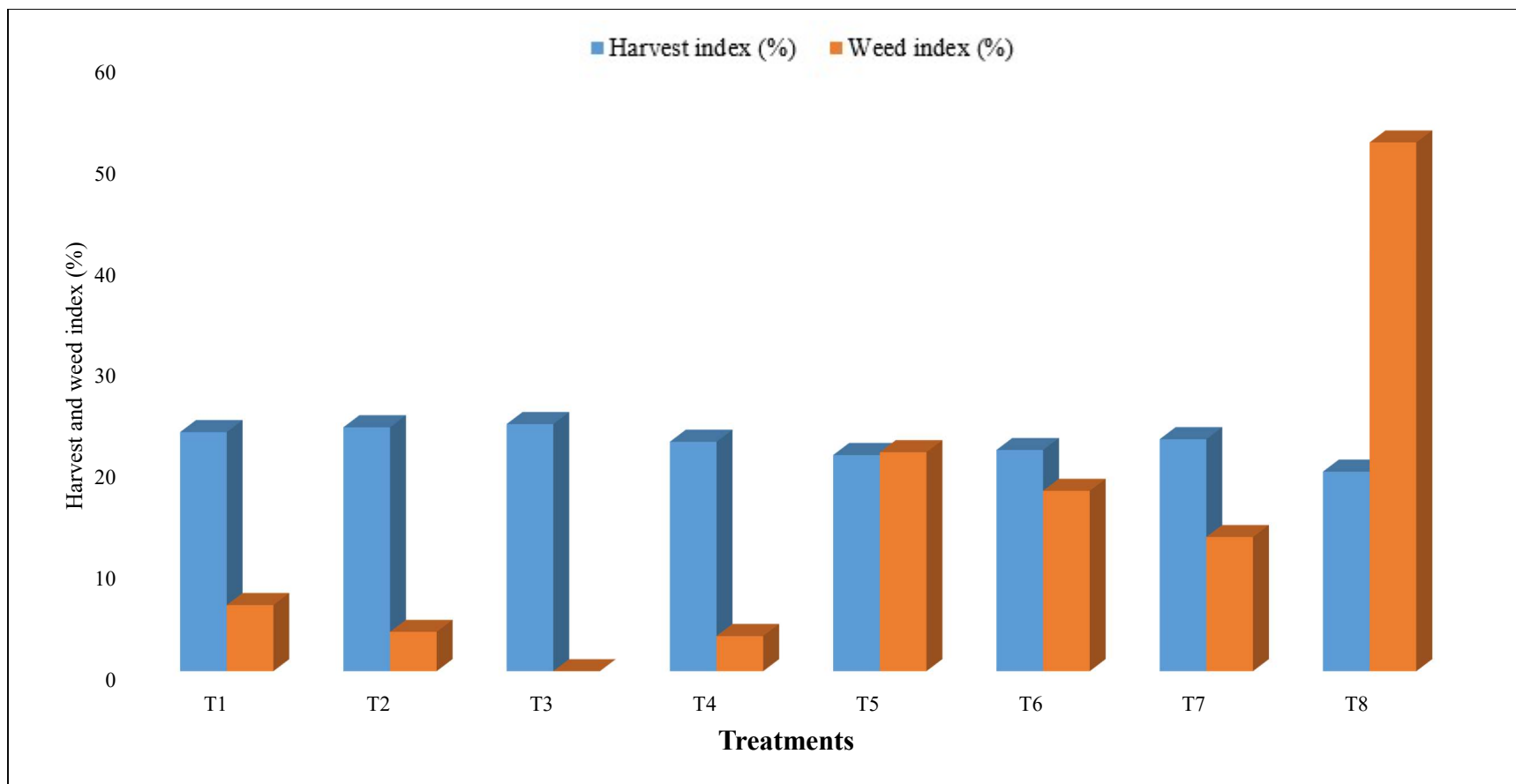
check. Identical outcomes were stated by Kumar *et al.* 2019, Singh and T. Ramesh *et al.* 2020.



Graph 4.72a Influence of different herbicide treatments on seed yield (q ha⁻¹) in green gram (Pooled data of 2021 and 2022).



Graph 4.72b Influence of different herbicide treatments on straw yield (q ha⁻¹) in green gram (Pooled data of 2021 and 2022).



Graph 4.72c Influence of different herbicide treatments on harvest index and weed index (%) in green gram (Pooled data of 2021 and 2022).

Table 4.77 Influence of different herbicide treatments economics in green gram (2021 and 2022).

Treatments	Gross return (₹ ha ⁻¹) (2020-21)	Gross return (₹ ha ⁻¹) (2021-22)	Pool data	Cost of cultivation (₹ ha ⁻¹) (2020-21)	Cost of cultivation (₹ ha ⁻¹) (2021-22)	Pool data	Net return (₹ ha ⁻¹) (2020-21)	Net return (₹ ha ⁻¹) (2021-22)	Pool data	B:C ratio (2020-21)	B:C ratio (2021-22)	Pool data
T ₁	51400	52628	52014	17890	17890	17890	33510	34738	34124	1.87	1.95	1.91
T ₂	53080	54412	53746	18482	18482	18482	34598	35930	35264	1.87	1.95	1.91
T ₃	55260	56032	55646	18515	18515	18515	36745	37517	37131	1.98	2.04	2.01
T ₄	49886	57578	53732	21008	21008	21008	28878	36570	32724	1.37	1.75	1.56
T ₅	43618	44246	43932	17998	17998	17998	25620	26248	25934	1.42	1.46	1.44
T ₆	45504	46236	45870	18008	18008	18008	27496	28228	27862	1.53	1.57	1.55
T ₇	47810	48722	48266	18276	18276	18276	29534	30446	29990	1.62	1.66	1.64
T ₈	26200	27268	26734	16797	16797	16797	9403	10471	9937	0.56	0.62	0.59

Treatments: T₁: Imazethapyr @ 60 g ha⁻¹ (PE), T₂: Pendimethalin 1 @ kg ha⁻¹ (PE), T₃: Pendimethalin 1 @ kg ha⁻¹ (PE) combined with Imazethapyr @ 50 g ha⁻¹ (PoE), T₄: Hand weeding twice (20 and 40 DAS), T₅: Quizalofop-p-ethyl @ 75 g ha⁻¹ (PoE), T₆: Imazethapyr + Imazamax @ 75 g ha⁻¹ (PoE), T₇: Sodium Aciflurofen and Clodinafop-propargyl @ 180 g ha⁻¹ (PoE) and T₈: Unweeded check (Control).

4.6.12 Economics studies in green gram

4.6.12.1 Cost of cultivation (₹ ha⁻¹)

Herbicide usage was reported at higher cultivation costs in the years 2021 and 2022, as indicated by the statistics on cultivation costs found in Table 4.77. The weedy check has the lowest documented cultivation costs. The highest cultivation fee received from HW is charged for extra labour to weed the plot and maintain it free of weeds.

The cumulative data on 2021 and 2022 the lower cultivation of cost were recorded in weedy checks. The maximum cultivation of cost were recorded in PE pendimethalin 1000 g combine with PoE imazethapyr 50 g after HW (20 and 40 DAS) and PE pendimethalin 1000 g further treatments.

4.6.12.2 Total and net return (₹ ha⁻¹)

As shown, various weed management strategies in statistics on total and net return on Table 4.77.

In the years 2021 and 2022 total and net return higher were recorded in PE pendimethalin 1000 g combine with PoE imazethapyr 50 g and HW twice (20 and 40 DAS) and PE pendimethalin 1000 g on respite of treatments. The lowermost total and net return were recorded in weedy check.

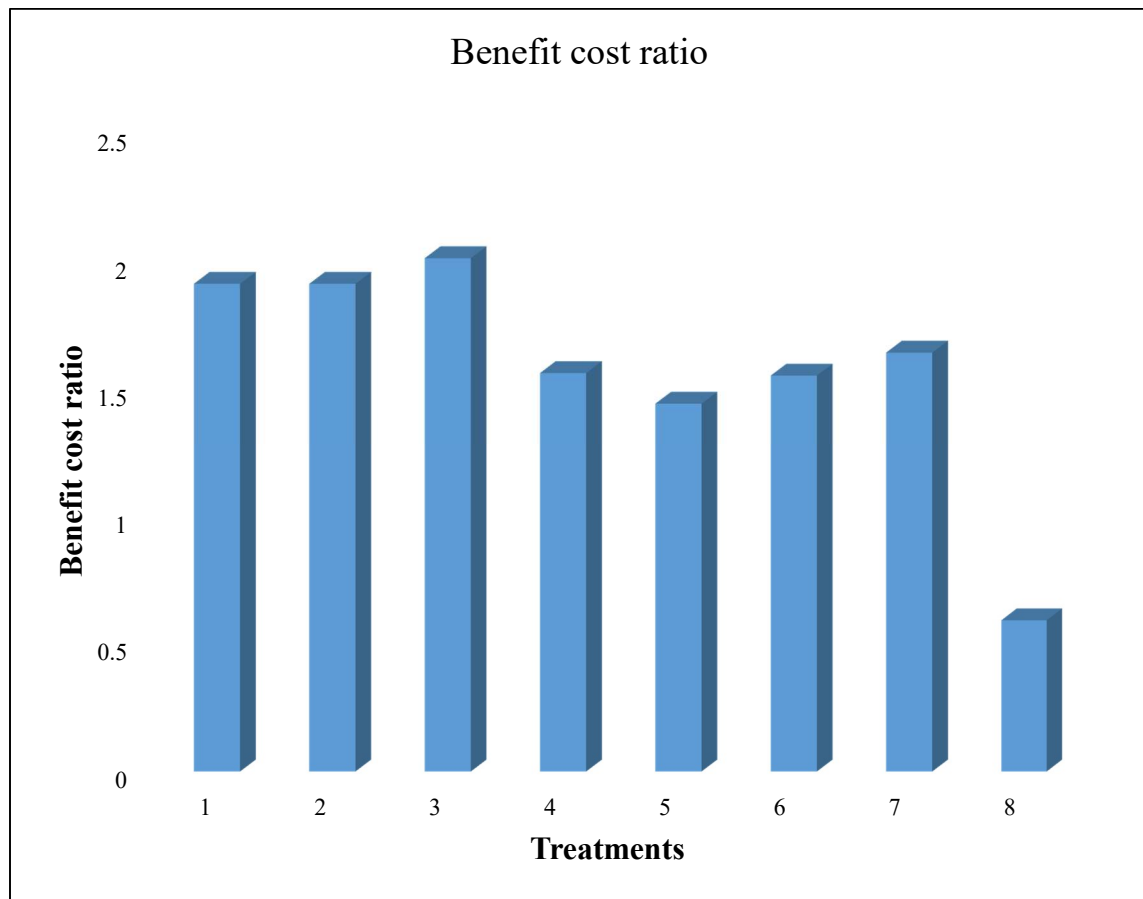
The cumulative data on 2021 and 2022 lower total and net returns were recorded in weedy check likened treatments. The higher total and net return were recorded in PE pendimethalin 1000 g combine with PoE imazethapyr 50 g followed by HW (20 and 40 DAS) and PE pendimethalin 1000 g on respite of treatments.

4.6.12.3 Benefit cost ratio

The data on the benefit cost ratio is expressively various weed management strategies on data ratio of benefit cost ratio on Table 4.77 and graph 4.73.

In years 2021 and 2022 data shown on Table 4.77 expressively different weed management treatments on statistics in benefit cost relation. The higher benefit cost ratio were recorded in PE pendimethalin 1000 g combine with PoE imazethapyr 50 g followed by PE pendimethalin 1000 g and imazethapyr 60 g PE on rest of treatments. The lowermost benefit cost ratio were recorded in weedy check. Alike outcomes were stated by Osari *et al.* 2019 and Patel *et al.* 2020.

The cumulative data on 2021 and 2022 on Table 4.77 and graph 4.73 lesser benefit cost ratio were recorded in weedy check on rest of treatments. The higher benefit cost ratio were recorded in PE pendimethalin 1000 g combine with PoE imazethapyr 50 g followed by HW (20 and 40 days later seeding) and PE pendimethalin 1000 g on rest of treatments.



Graph 4.73 Influence of different herbicide treatments benefit cost ratio in green gram (Pooled data of 2021 and 2022).

Table 4.78 Influence of different herbicide treatments economics of wheat-green gram (2020-2021 and 2021-2022).

Treatments	Gross return (₹ ha ⁻¹) 2020-21 and 2021-2022 of Wheat	Gross return (₹ ha ⁻¹) 2020-21 and 2021-2022 of Green gram	Pool data	Cost of Cultivation (₹ ha ⁻¹) 2020-21 and 2021-2022 of Wheat	Cost of Cultivation (₹ ha ⁻¹) 2020-21 and 2021-2022 of Green gram	Pool data	Net return (₹ hectare ⁻¹) 2020-21 and 2021-2022 of Wheat	Net return (₹ ha ⁻¹) 2020-21 and 2021-2022 of Green gram	Pool data	B: C ratio (2020-21 and 2021-2022) of Wheat	B: C ratio (2020-21 and 2021-2022) of Green gram	Pool data
T ₁	98470	52014	75242	33770	17890	75242	64700	34124	49412	1.92	1.91	1.92
T ₂	97045	53746	75396	33383	18482	75396	63662	35264	49463	1.91	1.91	1.91
T ₃	82050	55646	68848	31062	18515	68848	50989	37131	44060	1.73	2.01	1.87
T ₄	89300	53732	71516	36865	21008	71516	52435	32724	42580	1.60	1.56	1.58
T ₅	76645	43932	60289	30938	17998	60289	45707	25934	35821	1.53	1.44	1.49
T ₆	85320	45870	65595	32128	18008	65595	53192	27862	40527	1.64	1.55	1.60
T ₇	92050	48266	70158	31803	18276	70158	60247	29990	45119	1.84	1.64	1.74
T ₈	43750	26734	35242	29002	16797	35242	14748	9937	12343	0.55	0.59	0.57

4.6.13 Economics studies in wheat-green gram cropping system

4.6.13.1 Cost of cultivation (₹ ha⁻¹)

The statistics on cultivation of cost remain impacted by weed control treatments, as shown in Table 4.78.

Table 4.78 and graph 4.74, which present the cumulative data on cultivation costs for 2020-21 and 2021-22, indicate that greater cultivation costs were seen in weedy check. The weedy check has the lowest documented cultivation costs. Extra labour are required in weedings is the biggest cultivation expense.

4.6.13.2 Total and net return (₹ ha⁻¹)

The statistics on total then net return remain impacted by weed control treatments, as exposed in Table 4.78.

The cumulative statistics on 2020-21 and 2021-22 total and net return is expressively effect of weed control treatments in Table 4.78 and graph 4.74 on wheat-green gram cropping sytem.

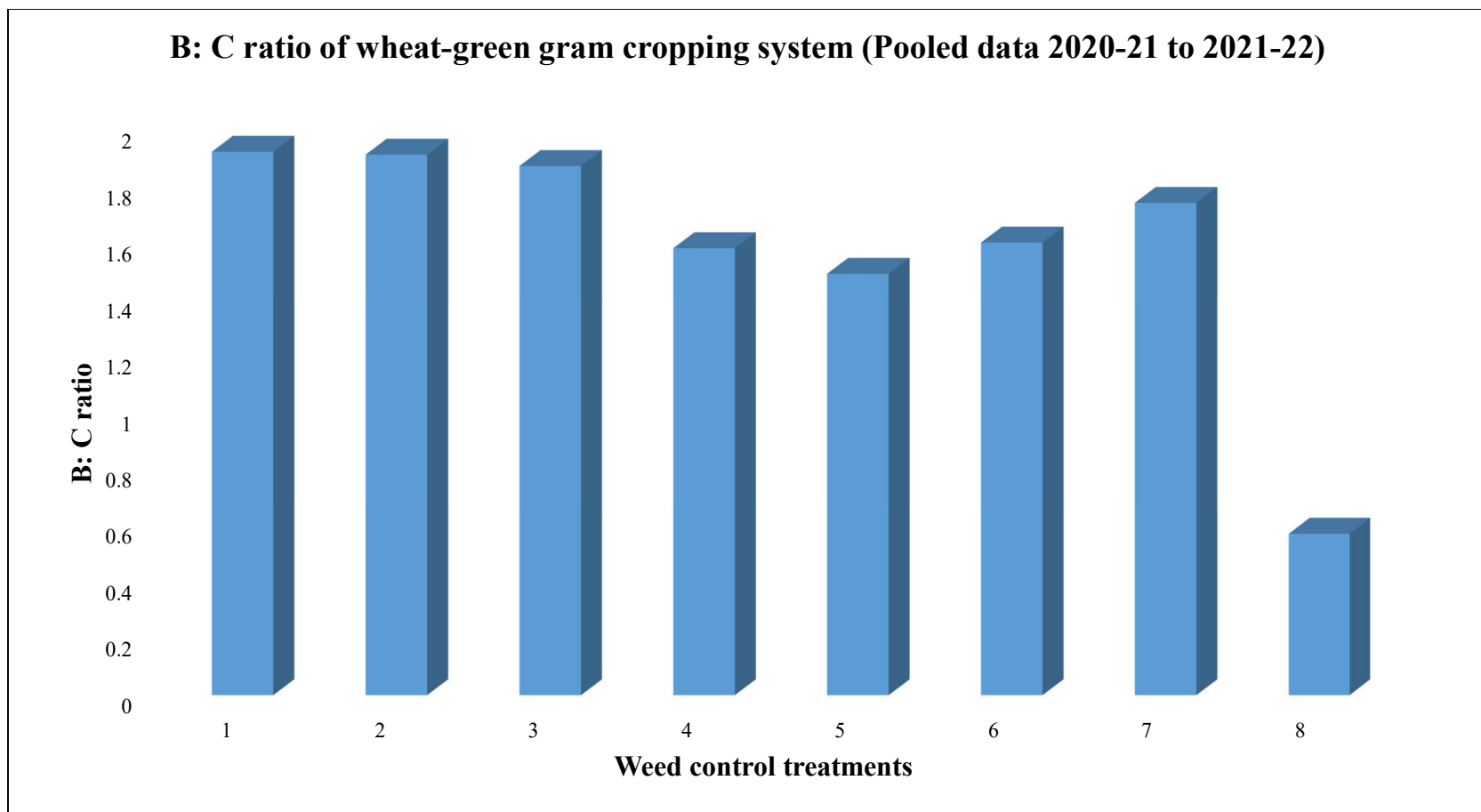
In cumulative data on 2020-21 and 2021-22 the wheat-green gram cropping system the total and net return (₹ 75, 242) and (₹ 49,412) were recorded treatment (T₁) by PE pyroxasulfone 120 g combined with pendimethalin 850 g PE in wheat and PE imazethapyr 60 g under green gram.

4.6.13.3 Benefit cost ratio

The statistics on benefit cost ratio is expressively impacted by different weed control treatments, as exposed Table 4.78 and graph 4.74.

The cumulative data on 2020-21 and 2021-22 benefit cost ratio is expressively impacted by different weed control treatment in Table 4.78 and graph 4.74 on wheat-green gram cropping sytem.

In cumulative data on 2020-21 and 2022 wheat-green gram cropping system the highest benefit cost ratio (1.92) were recorded treatment (T₁) with PE pyroxasulfone 120 g combined with PE pendimethalin 850 g in wheat and PE imazethapyr 60 g under green gram.



Graph 4.74 Influence of different herbicide treatments on benefit cost ratio in wheat-green gram (Pooled data of 2020-21 and 2021-22).

V-SUMMARY AND CONCLUSION

Study led on topic **Efficacy of pre-emergence and post-emergence herbicides on weed Control in Wheat-Green gram cropping system under Trans-gangetic plains of Punjab** continued to be held at Lovely Professional University, Punjab. *Rabi*, 2020-2021 and 2021-2022, and *Kharif*, 2021 and *Kharif*, 2022. The primary goals for the study continued towards study weed flora then weed controlling treatments on weed growth then WCE, learning response of weed controller treatments on green gram and wheat in terms of growth then yield, then study most cost-effective weed control treatment in Wheat-Green gram Cropping System.

A) Wheat

In order to assess their impact of weed control treatments in weeds, eight weed suppression strategies in wheat were used in the field study. These tests continued pyroxasulfone 120 g PE combined with pendimethalin 850 g PE, pyroxasulfone 110 g PE combined with pendimethalin 800 g PE, sulfosulfuron combined with metsulfuron 40 g PoE, two hands weeding (30 and 60 DAS), sulfosulfuron combined with metsulfuron 35 g PoE, clodinafop propargyl 400 g PoE combined with HW (60 DAS), PoE 2, 4- D Na 0.75 kg combined with HW (60 DAS) then weedy check. Following is a summary of the outcomes from the area experiment that have been included within this chapter:

1. Lower count in *Phalaris minor Retz* were recorded in HW (30 and 60 DAS) followed by pyroxasulfone 120 g PE combined with pendimethalin 850 g PE and PoE 2, 4- D Na 0.75 kg combined with HW (60 DAS) on entirely period.
2. Application of pyroxasulfone 120 g PE combined with pendimethalin 850 g PE followed by PoE 2, 4- D Na 0.75 kg combined with HW (60 DAS) and HW (30 and 60 DAS) on entirely period were recorded minim count of *Cynodon dactylon* L.
3. Lower count in *Cyperus rotundus* L. were recorded in pyroxasulfone 120 g PE combined with pendimethalin 850 g PE followed by pyroxasulfone 110 g PE combined with pendimethalin 800 g PE and PoE 2, 4- D Na 0.75 kg combined with HW (60 DAS) on entirely period.

4. Minimum population of *Cannabis sativa* L. were noted in use of pyroxasulfone 120 g PE combined with pendimethalin 850 g PE followed by pyroxasulfone 110 g PE combined with pendimethalin 800 g PE and PoE 2, 4- D Na 0.75 kg combined with HW (60 DAS) on completely growing period.
5. Use of 2, 4- D Na 0.75 kg combined with HW (60 DAS) followed by HW (60 DAS) and pyroxasulfone 120 g PE combined with pendimethalin 850 g PE reduced plant population of *Chenopodium album* L. at monthly interval up to harvest.
6. Lower count in *Medicago denticulate* Willd. were recorded in pyroxasulfone 120 g PE combined with pendimethalin 850 g PE followed by PoE 2, 4- D Na 0.75 kg combined with HW (60 DAS) and HW (30 and 60 DAS) on completely period.
7. Lower population of *Parthenium hysterophorus* L. were recorded in pyroxasulfone 120 g PE combined with pendimethalin 850 g PE followed by PoE 2, 4- D Na 0.75 kg combined with HW (60 DAS) and HW (30 and 60 DAS) in completely growing period.
8. Post-emergence use of 2, 4- D Na 0.75 kg combined with HW (60 DAS) followed by two hand weeding (60 DAS) and clodinafop propargyl 400 g PoE combined with HW (60 DAS) were recorded lower total weed population at different days intervals upto harvest.
9. Minimum dry weight in *Phalaris minor* Retz. recorded in pyroxasulfone 120 g PE combined with pendimethalin 850 g PE followed by pyroxasulfone 110 g PE combined with pendimethalin 800 g PE HW (60 DAS), PoE 2, 4- D Na 0.75 kg combined with HW (60 DAS) and HW (30 and 60 DAS) .
10. Lower dry weight in *Cynodon dactylon* L. noted in pyroxasulfone 120 g PE combined with pendimethalin 850 g PE followed by pyroxasulfone 110 g PE combined with pendimethalin 800 g PE, two hand weeding (30 and 60 DAS) at initial period and harvest, PoE 2, 4- D Na 0.75 kg combined with HW (60 DAS) and HW (30 and 60 DAS).
11. Application of pyroxasulfone 120 g PE combined with pendimethalin 850 g PE followed by PoE 2, 4- D Na 0.75 kg combined with HW (60 DAS) and HW (30 and 60 DAS) minimum dry weight were recorded in *Cyperus rotundus* L.

12. Least dry weight in *Cannabis sativa* L. noted in PoE 2, 4- D Na 0.75 kg combined with HW (60 DAS) and HW (30 and 60 DAS).
13. Minimum dry weight on *Chenopodium album* L. noted in PoE 2, 4- D Na 0.75 kg combined with HW (60 DAS) after HW (60 DAS) then pyroxasulfone 120 g PE combined with pendimethalin 850 g PE at harvest.
14. Lower dry weight in *Medicago denticulate* Willd noted in PoE 2, 4- D Na 0.75 kg combined with HW (60 DAS) followed by HW (60 DAS) and clodinafop propargyl 400 g PoE combined with HW (60 DAS) on harvest.
15. Minimum dry weight in *Parthenium hysterophorus* L. noted in pyroxasulfone 120 g PE combined with pendimethalin 850 g PE followed by after PoE 2, 4- D Na 0.75 kg combined with HW (60 DAS) and two hand weeding (60 DAS) at harvest.
16. Post emergence application of 2, 4- D Na 0.75 kg combined with HW (60 DAS) followed by HW (60 DAS) and clodinafop propargyl 400 g PoE combined with HW (60 DAS) recorded lowest total weed dry matter production total weed population at 120 DAS.
17. Maximum WCE in *Phalaris minor* Retz. noted in HW (30 and 60 DAS) followed by pyroxasulfone 120 g PE combined with pendimethalin 850 g PE, pyroxasulfone 110 g PE combined with pendimethalin 800 g PE on initial period then harvest PoE 2, 4- D Na 0.75 kg combined with HW (60 DAS).
18. Highest WCE in *Cynodon dactylon* L. noted in PoE 2, 4- D Na 0.75 kg combined with HW (60 DAS) and HW (60 DAS) at harvest.
19. Use of pyroxasulfone 120 g PE combined with pendimethalin 850 g PE after PoE 2, 4- D Na 0.75 kg combined with HW (60 DAS) and HW (30 and 60 DAS) at harvest recorded lower WCE in *Cyperus rotundus* L.
20. Maximum WCE in *Cannabis sativa* L. noted in PoE 2, 4- D Na 0.75 kg combined with HW (60 DAS) and HW (60 DAS) on harvest.
21. Higher WCE recorded in PoE use of 2, 4- D Na 0.75 kg combined with HW (60 DAS) followed by HW (30 and 60 DAS) and pyroxasulfone 120 g PE combined with pendimethalin 850 g PE in *Chenopodium album* L. at harvest.

22. Higher WCE in *Medicago denticulate* Willd noted in PoE 2, 4- D Na 0.75 kg combined with HW (60 DAS) followed by HW (30 and 60 DAS) and clodinafop propargyl 400 g PoE combined with HW (60 DAS) at harvest.
23. Use of pyroxasulfone 120 g PE combined with pendimethalin 850 g PE followed by PoE 2, 4- D Na 0.75 kg combined with HW (60 DAS) and two hand weeding (60 DAS) noted higher WCE in *Parthenium hysterophorus* L. at harvest.
24. Maximum WCE on total population of weed were noted in PoE 2, 4- D Na 0.75 kg combined with HW (60 DAS) followed by HW (60 DAS) and clodinafop propargyl 400 g PoE combined with HW (60 DAS) on harvest.
25. The minimum residual effect observed in pyroxasulfone 120 g PE combined with pendimethalin 850 g PE and pyroxasulfone 110 g PE combined with pendimethalin 800 g PE, caused in an observed maximum germination percentage of oat seed as likened to further herbicidal treatments on harvest.
26. Effect of herbicide residues on minimum root and shoot length of oat were observed in pyroxasulfone 120 g PE combined with pendimethalin 850 g PE and pyroxasulfone 110 g PE combined with pendimethalin 800 g PE at the initial periods and until harvest all herbicidal treatments noted maximum root and shoot length.
27. Higher plant population were noted in pyroxasulfone 120 g PE combined with pendimethalin 850 g PE followed by pyroxasulfone 110 g PE combined with pendimethalin 800 g PE and PoE 2, 4- D Na 0.75 kg combined with HW (60 DAS) over a weedy check.
28. Application of pyroxasulfone 120 g PE combined with pendimethalin 850 g PE followed by pyroxasulfone 110 g PE combined with pendimethalin 800 g PE and PoE 2, 4- D Na 0.75 kg combined with HW (60 DAS) were recorded highest plant height upto harvest.
29. Maximum tillers per meter square were noted in pyroxasulfone 120 g PE combined with pendimethalin 850 g PE followed by pyroxasulfone 110 g PE combined with pendimethalin 800 g PE and PoE 2, 4- D Na 0.75 kg combined with HW (60 DAS) at harvest.

30. Higher LAI were noted in pyroxasulfone 120 g PE combined with pendimethalin 850 g PE followed by pyroxasulfone 110 g PE combined with pendimethalin 800 g PE and PoE 2, 4- D Na 0.75 kg combined with combined with HW (60 DAS) until harvest.
31. Use of pyroxasulfone 120 g PE combined with pendimethalin 850 g PE followed by pyroxasulfone 110 g PE combined with pendimethalin 800 g PE and PoE 2, 4- D Na 0.75 kg and HW (30 and 60 DAS) were noted highest fresh and dry weights (g plant^{-1}) upto harvest.
32. Maximum 50 % crown root initiation and 50 % flowering were noted in pyroxasulfone 120 g PE combined with pendimethalin 850 g PE followed by pyroxasulfone 110 g PE combined with pendimethalin 800 g PE and HW (60 DAS) as likened to weedy check.
33. Highest spikes per meter square, spikelets per spike, spike length and grains per spike were noted in the use of pyroxasulfone 120 g PE combined with pendimethalin 850 g PE followed by pyroxasulfone 110 g PE combined with pendimethalin 800 g PE and PoE 2, 4- D Na 0.75 kg combined with HW (30 and 60 DAS).
34. Application of pyroxasulfone 120 g PE combined with pendimethalin 850 g PE combined with pendimethalin 850 g PE followed by pyroxasulfone 110 g PE combined with pendimethalin 800 g PE and PoE 2, 4- D Na 0.75 kg combined with HW (30 and 60 DAS) were noted higher 1000 seeds weight.
35. Extreme seed yield and straw yield (kg per hectare) were noted in pyroxasulfone 120 g PE combined with pendimethalin 850 g PE and pyroxasulfone 110 g PE combined with pendimethalin 800 g PE as likened to weedy check.
36. Lower harvest index weed and weed index were noted in pyroxasulfone 120 g PE combined with pendimethalin 850 g PE followed by pyroxasulfone 110 g PE combined with pendimethalin 800 g PE and PoE 2, 4- D Na 0.75 kg combined with HW (60 days later sedding).
37. Use of pyroxasulfone 120 g PE combined with pendimethalin 850 g PE followed by HW (30 and 60 DAS) , PoE 2, 4- D Na 0.75 kg combined with combined with

HW (60 DAS) and pyroxasulfone 110 g PE combined with pendimethalin 800 g PE were recorded maximum CGR.

38. Higher RGR were noted in sulfosulfuron combined with metsulfuron 35 g PoE followed by clodinafop propargyl 400 g PoE combined with combined with HW (60 DAS), HW (30 and 60 DAS) and lower RGR were noted in pyroxasulfone 120 g PE combined with pendimethalin 850 g PE and pyroxasulfone 110 g PE combined with pendimethalin 800 g PE as likened to weedy check.
39. Pre-emergence Application of pyroxasulfone 120 g combined with pendimethalin 850 g PE and pyroxasulfone 110 g PE combined with pendimethalin 800 g PE as likened to weedy check were noted maximum total, net earnings then benefit cost ratio.

B) Green gram

In order to assess their impact of weed control treatments in weeds, eight weed suppression strategies in green gram were used in field study. These tests continued imazethapyr 60 g PE, PE pendimethalin 1000 g, PE pendimethalin 1000 g combine with PoE imazethapyr 50 g, HW (20 and 40 days after sowing), quizalofop p ethyl 75 g PoE, imazethapyr combined with imazamax 75 g PoE, sodium aciflourfen then clodinafop propargyl 180 g PoE and weedy check. Following summary of the outcomes from the area of experiment that have been included within this chapter:

1. Minimum population of *Commelina benghalensis* L. were noted in PE pendimethalin 1000 g combine with PoE imazethapyr 50 g followed by HW (20 and 40 DAS) and PE pendimethalin 1000 g until harvest.
2. Pre-emergence use of pendimethalin 1000 g combine with PoE imazethapyr 50 g and HW (20 and 40 DAS) were noted lower count of *Digitaria sanguinalis* L. until harvest.
3. Minimum count in *Cyperus rotundus* L. were noted in PE pendimethalin 1000 g with the combination of imazethapyr 50 g PoE and HW (20 and 40 DAS) until harvest.
4. Lower count in *Cassia tora* L. were noted in use of PE pendimethalin 1000 g with the combination of imazethapyr 50 g PoE and HW (20 and 40 DAS) until harvest.
5. Least population of *Celosia argentea* L. were noted in PE pendimethalin 1000 g

- followed by imazethapyr 60 g PE which were near with HW (20 and 40 DAS) and Sodium aciflourfen and clodinafop propargyl 180 g PoE until harvest.
6. PE use of pendimethalin 1000 g with combination of imazethapyr 50 g PoE followed by HW (20 and 40 DAS) and PE pendimethalin 1000 g were noted minimum count of total population of weed up to harvest.
 7. Lower dry weight on *Commelina benghalensis* L. were noted in HW (20 and 40 DAS), sodium aciflourfen combined with clodinafop propargyl 180 g PoE, PE pendimethalin 1000 g and imazethapyr 60 g PE until harvest.
 8. HW (20 and 40 DAS) and PE pendimethalin 1000 g with combination of imazethapyr 50 g PoE were noted lower dry weight of *Digitaria sanguinalis* L. up to harvest.
 9. Minimum dry weight on *Cyperus rotundus* L. in use of PE pendimethalin 1000 g combine with PoE imazethapyr 50 g and PE pendimethalin 1000 g until harvest.
 10. Use of PE pendimethalin 1000 g combine with PoE imazethapyr 50 g near with HW (20 and 40 DAS) noted Lower dry weight of *Cassia tora* L. up to harvest.
 11. Minimum were with in PE application of pendimethalin 1000 g combine with PoE imazethapyr 50 g followed by PE pendimethalin 1000 g, imazethapyr 60 g PE were recorded lower dry weight of *Celosia argentea* L. at harvest.
 12. Lower dry weight on total species of weed is experiential in use of PE pendimethalin 1000 g combine with PoE imazethapyr 50 g followed by HW (20 and 40 DAS), PE pendimethalin 1000 g on harvest.
 13. Maximum WCE on *Commelina benghalensis* L. were noted in HW (20 and 40 DAS) followed by PE pendimethalin 1000 g with the combination of imazethapyr 50 g PoE and PE pendimethalin 1000 g.
 14. Higher WCE on *Digitaria sanguinalis* L. were noted in HW (20 and 40 DAS) and PE pendimethalin 1000 g with combination of imazethapyr 50 g PoE.
 15. Maximum WCE on *Cyperus rotundus* L. were noted in PE pendimethalin 1000 g combine with PoE imazethapyr 50 g and sodium aciflourfen combined with clodinafop propargyl 180 g PoE at harvest.
 16. Pre-emergence use of pendimethalin 1000 g combine with PoE imazethapyr 50 g and HW (20 and 40 DAS) were noted maximum WCE of *Cassia tora* L. up to

harvest.

17. Maximum WCE on *Celosia argentea* L. were noted in PE pendimethalin 1000 g and imazethapyr 60 g PE on completely crop growing period.
18. Higher WCE of total population of weed were noted in PE use of pendimethalin 1000 g combine with PoE imazethapyr 50 g and HW (20 and 40 DAS) at all growth phases.
19. Maximum germination percentage of cucumber were noted on harvest entirely herbicidal treatment maximum germination percentage except imazethapyr combined with imazamax 75 g PoE as likened to weedy check.
20. Extreme root and shoot length of cucumber were noted in pendimethalin 1000 g combined with imazethapyr 50 g PoE on harvest.
21. PE application of pendimethalin 1000 g combined with imazethapyr 60 g PE and PE pendimethalin 1000 g were noted higher plant population at 20 DAS.
22. Top plant height were noted in PE pendimethalin 1000 g combine with PoE imazethapyr 50 g on entirely period.
23. Higher LAI were noted in PE pendimethalin 1000 g combine with PoE imazethapyr 50 g followed by PE pendimethalin 1000 g and imazethapyr 60 g PE as liken to HW until harvest.
24. Maximum branches per plant were noted in PE pendimethalin 1000 g combine with PoE imazethapyr 50 g followed by PE pendimethalin 1000 g and imazethapyr 60 g PE.
25. Pre emergence use of pendimethalin 1000 g combine with PoE imazethapyr 50 g and PE pendimethalin 1000 g were noted higher root nodules at 20 and 40 DAS.
26. Maximum of 50 % flowering and 50 % maturity were noted in PE pendimethalin 1000 g combined with imazethapyr 50 g likened to weedy check.
27. Use of PE pendimethalin 1000 g combine with PoE imazethapyr 50 g arrests weed growth then causes highest fresh weight of plant after PE pendimethalin 1000 g.
28. Maximum dry weight of plant is noted that PE pendimethalin 1000 g combine with PoE imazethapyr 50 g and PE pendimethalin 1000 g on entirely period.
29. Higher CGR recorded in use of PE pendimethalin 1000 g combine with PoE imazethapyr 50 g and PE pendimethalin 1000 g.

30. PE use of pendimethalin 1000 g combine with PoE imazethapyr 50 g after imazethapyr 60 g PE were noted expressively higher RGR of green gram.
31. Maximum pods per plant, seeds per pod, Length of pods, and test weight were noted in PE pendimethalin 1000 g combine with PoE imazethapyr 50 g and PE pendimethalin 1000 g.
32. PE use of pendimethalin 1000 g combine with PoE imazethapyr 50 g followed by PE pendimethalin 1000 g and imazethapyr 60 g PE as liken to HW noted maximum harvest index.
33. Lower weed index were noted in use of PE pendimethalin 1000 g combine with PoE imazethapyr 50 g followed by PE pendimethalin 1000 g and imazethapyr 60 g PE liken to HW.
34. Higher seed yield and straw yield were noted in PE pendimethalin 1000 g followed by PoE imazethapyr 50 g and PE pendimethalin 1000 g.
35. Use of PE pendimethalin 1000 g combine with PoE imazethapyr 50 g were noted maximum total rearning, net earning and benefit cost ratio.

Conclusion

On wheat, use of pyroxasulfone 120 g PE combined with pendimethalin 850 g PE were comparable to pyroxasulfone 110 g PE combined with pendimethalin 800 g PE and PoE use of 2, 4-D Na 0.750 kg combined with HW (60 DAS) post-emergence, they were control all kinds of weeds (*Phalaris minor*, *Cynodon dactylon*, *Cyperus rotundus*, *Cannabis sativa*, *Chenopodium album*, *Medicago denticulate* and *Parthenium hysterophorus*) were control and upper seed yield (4.45 t ha⁻¹), net monetary benefits (₹ 64,700 ha⁻¹) and benefit cost ratio (1:92) were obtained. It may be advantageous to use premix herbicides for practical and ecologically responsible suppression of weeds in wheat crop.

It can be decided that all kinds of weeds (*Commelina benghalensis*, *Digitaria sanguinalis*, *Cyperus rotundus*, *Cassia tora* and *Celosia argentea*) in Kharif green gram were controlled with sequential use of PE pendimethalin 1000 g combined with imazethapyr 50 g PoE noted maximum seed yield (7.25 q ha⁻¹), net return (₹ 37,131 ha⁻¹) and benefit cost ratio (2.01) with enhanced WCE.

On data 2020-21 to 2021-22 wheat-green gram cropping system higher benefit cost ratio (1:92) and net return (₹ 49,412 ha⁻¹) were noted with pyroxasulfone 120 g PE combined with pendimethalin 850 g PE on wheat and imazethapyr 60 g PE under green gram.

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Self-Citation

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VII-Appendices

Appendix-A: Calculation of fixed cost of cultivation (₹ ha⁻¹) of Wheat (Pooled data 2020-21 to 2021-22)

S. No.	Particulars	Fixed cost of cultivation (₹ ha ⁻¹)		Total cost (₹ ha ⁻¹)
		Input	Price (Rs)	
1.	Land preparation			
a.	Ploughing	1 tractor (4hr) ha ⁻¹	700 Rs ha ⁻¹	2800
b.	Harrowing and planking	1 tractors (2 hrs) ha ⁻¹	800 Rs ha ⁻¹	1600
2.	Seeds and sowing			
a.	Cost of seed	100 kg ha ⁻¹	80 Rs kg ⁻¹	8000
b.	Seed treatment	1 laboure (1 hrs)	300 RS laboure ⁻¹	40
c.	Sowing and fertilizer application	1 tractor (1 hrs) ha ⁻¹	800 Rs hrs ⁻¹	800
3.	Irrigation	4 labourers	200 Rs laboure ⁻¹	800
4.	Fertilizer			
a.	Urea	260 kg ha ⁻¹	7 Rs kg ⁻¹	1820
b.	SSP	375 kg ha ⁻¹	10 Rs kg ⁻¹	3750
c.	MOP	67 kg ha ⁻¹	11.5 Rs kg ⁻¹	770.5
5.	Plant protection			
a.	Spraying (1) Cost of Chloropyriphos (20 % EC)	160 ml ha ⁻¹	457+600	1057
5.	Harvesting, Threshing and Winnowing	Multi crop thresher	5000 Rs ha ⁻¹	3791
A.	Common cost			25228
B.	Miscellaneous 10 % of common cost			2522
	Grand total			27750

Rs = Rupees, ha⁻¹ = Hectare, hrs⁻¹ = per hours, g = Gram, kg⁻¹ = per kilogram, % = Percent

Appendix-B: Variable cost (₹ ha⁻¹) of Wheat (Pooled data 2020-21 to 2021-22)

Weed management practices	Dose (g a. i. ha ⁻¹)	Variable cost (Rs ha ⁻¹)		
		Price (₹ ha ⁻¹)	Cost of application (₹ ha ⁻¹)	Total variable cost (₹ ha ⁻¹)
T ₁ : Pyroxasulfone 85 % WG + Pendimethalin 30 % EC	120 +850	4440	1000	4540
T ₂ : Pyroxasulfone 85 % WP+ Pendimethalin 30 % EC	110 + 800	4070	1000	4170
T ₃ : Sulfosulfuron 75 % + Metsulfuron 5% WG	40	950	1000	1950
T ₄ : Hand weeding at 30 and 60 DAS		7500		7500
T ₅ : Sulfosulfuron 75 % + Metsulfuron 5% WG	35	832	1000	1832
T ₆ : Clodinafop-propargyl 15 % WP + Hand weeding at 60 DAS	400	500 + 1500	1000	3000
T ₇ : 2, 4-D sodium salt 80 % WP + Hand weeding at 60 DAS	750	1071 + 600	1000	2671
T ₈ Unweeded check (Control)				

Hand weeding twice	= 25 labour ha ⁻¹ @ 300 Rs day ⁻¹ labour ⁻¹ ,
Pyroxasulfone 85 % WG (Awkira) + Pendimethalin 30 % EC (Bunker)	= 2250 Rs 60 gm ⁻¹ ,
Sulfosulfuron 75 % + Metsulfuron 5% WG (Total)	= 360 Rs 16 gm ⁻¹ ,
Clodinafop - propargyl 15 % WP (Zhataka) + Hand weeding at 60 DAS	= 1000 Rs kg ⁻¹ + 5 labour ha ⁻¹ (300 Rs day ⁻¹ labour ⁻¹)
2, 4-D sodium salt 80 % WP (Weedmar-80) + Hand weeding at 60 DAS	= 350 Rs kg ⁻¹ + 2 labour ha ⁻¹ (300 Rs day ⁻¹ labour ⁻¹)

Appendix-C: Total cost incurred of wheat by different weed management practices of wheat (Pooled data 2020-21 to 2021-22)

Sr. No.	Treatments	Weed Management cost (ha ⁻¹)	Cost of cultivation on (ha ⁻¹)	Interest on the column 3+4 @ (12%per annum for 4 months (ha ⁻¹))	Interest on the column 3+4 @ (10 % per annum for 4 months)	Total cost of cultivation 3+4+5+6 (ha ⁻¹)
1	2	3	4	5	6	7
1	T ₁	4540	27750	673	807	33770
2	T ₂	4170	27750	665	798	33383
3	T ₃	1950	27750	619	743	31062
4	T ₄	7500	27750	734	881	36865
5	T ₅	1832	27750	616	740	30938
6	T ₆	3000	27750	609	769	32128
7	T ₇	2671	27750	621	761	31803
8	T ₈		27750	558	694	29002

(D): SALES PRICE OUTPUT

Seed : ₹ 20 kg⁻¹

Stover : ₹ 1.5 kg⁻¹

Appendix-D: Economics of wheat as influenced by weed management practices of wheat (Pooled data of 2020-2021 and 2021-2022)

Treatments	Gross return (₹ ha⁻¹)	Cost of cultivation (₹ ha⁻¹)	Net return (₹ ha⁻¹)	B:C ratio
T ₁	98470	33770	64700	1.92
T ₂	97045	33383	63662	1.91
T ₃	82050	31062	50989	1.64
T ₄	89300	36865	52435	1.42
T ₅	76645	30938	45707	1.48
T ₆	85320	32128	53192	1.66
T ₇	92050	31803	60247	1.89
T ₈	43750	29002	14748	0.51

Appendix-E: Calculation of fixed cost of cultivation (₹ ha⁻¹) of green gram (Pooled data 2021 to 2022)

S. No.	Particulars	Fixed cost of cultivation (Rs ha ⁻¹)		
		Input	Price (₹)	Total cost (₹ ha ⁻¹)
1.	Land preparation			
a.	Ploughing	1 tractor (4 hr) ha ⁻¹	700 Rs hr ⁻¹	2800
b.	Harrowing and planking	1 tractors (1 hrs) ha ⁻¹	700 Rs hr ⁻¹	700
2.	Seeds and sowing			
a.	Cost of seed	12 kg ha ⁻¹	100 Rs kg ⁻¹	1200
b.	Sowing and fertilizer application	1 tractor (2 hrs) ha ⁻¹	800 Rs hrs ⁻¹	1600
3.	Irrigation	4 labourers	200 Rs laboure ⁻¹	800
4.	Fertilizer			
a.	Urea	43.5 kg ha ⁻¹	7 Rs kg ⁻¹	305
b.	SSP	250 kg ha ⁻¹	10 Rs kg ⁻¹	2500
5.	Plant protection			
a.	Spraying (1) Cost of Dichlorovos (76 % EC)	1.5 liter ha ⁻¹	750 Rs liter ⁻¹ + 600	1350
5.	Harvesting, Threshing and Winnowing	13 laboures	250 Rs laboure ⁻¹	3250
A.	Common cost			14505
B.	Miscellaneous 10 % of common cost			1450
	Grand total			15955.00

Rs = Rupees, ha⁻¹ = Hectare, hrs⁻¹ = Per hours, g = Gram, kg⁻¹ = Per kilogram, % = Percent

Appendix-F: Variable cost (₹ ha⁻¹) of green gram (Pooled data 2021 to 2022)

Weed management practices	Dose (g a. i. ha ⁻¹)	Price (₹ ha ⁻¹)	Variable cost (Rs ha ⁻¹)	
			Cost of application (₹ ha ⁻¹)	Total variable cost (₹ ha ⁻¹)
T ₁ : Imazethapyr 10 % SL	60	38	1000	1038
T ₂ : Pendimethalin 30 EC	1000	600	1000	1600
T ₃ : Pendimethalin 30 EC + Imazethapyr 10 % SL	1000 + 50	600+32	1000	1632
T ₄ : Hand weeding		4000		4000
T ₅ : Quizalofop-p-ethyl 5 % EC	75	141	1000	1141
T ₆ : Imazethapyr 35 % + Imazamax 35 % WG (RM)	75	150	1000	1150
T ₇ Sodium Aciflurofen 16.5 % and Clodinafop- propargyl 8 % EC	180	405	1000	1405
T ₈ Unweeded check (Control)	-	-	-	-

Hand weeding twice	= 20 labour ha ⁻¹ @ 300 Rs day ⁻¹ labour ⁻¹ ,
Pendimethalin (Stomp)	= 600 Rs litre ⁻¹ ,
Imazethapyr 10 % SL (Tata vaar)	= 800 Rs litre ⁻¹ ,
Quizalofop-p-ethyl 5 % EC (Targa super)	= 1882 Rs litre ⁻¹ ,
Imazethapyr 35 % + Imazamax 35 % WG (RM) (Bingo or Jodi)	= 2000 Rs litre ⁻¹ ,
Sodium Aciflurofen 16.5 % and Clodinafop-propargyl 8 % EC (IRIS)	= 445 Rs litre ⁻¹ ,

Appendix-G: Total cost incurred by different weed management practices of green gram (Pooled data 2021 to 2022)

Sr. No.	Treatments	Weed Management cost (ha ⁻¹)	Cost of cultivation on (ha ⁻¹)	Interest on the column 3+4 @ (12%per annum for 3 months (ha ⁻¹)	Interest on the column 3+4 @ (10 % per annum for 3 months)	Total cost of cultivation 3+4+5+6 (ha ⁻¹)
1	2	3	4	5	6	7
1	T ₁	1038	15955	472	425	17890
2	T ₂	1600	15955	488	439	18482
3	T ₃	1632	15955	489	440	18515
4	T ₄	4000	15955	554	499	21008
5	T ₅	1141	15955	475	427	17998
6	T ₆	1150	15955	475	428	18008
7	T ₇	1405	15955	482	434	18276
8	T ₈	-	15955	443	399	16797

(D): SALES PRICE OUTPUT

Seed : ₹ 70 kg⁻¹

Stover : ₹ 2 kg⁻¹

Appendix-H: Economics of green gram as influenced by weed management practices of green gram (Pooled data of 2021 and 2022)

Treatments	Gross return (₹ ha⁻¹)	Cost of cultivation (₹ ha⁻¹)	Net return (₹ ha⁻¹)	B:C ratio (₹ ha⁻¹)
T₁	52014	17890	34124	1.91
T₂	53746	18482	35264	1.91
T₃	55646	18515	37131	2.01
T₄	53732	21008	32724	1.56
T₅	43932	17998	25934	1.44
T₆	45870	18008	27862	1.55
T₇	48266	18276	29990	1.64
T₈	26734	16797	09937	0.59

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