EVALUATION OF PRE AND POST EMERGENCE HERBICIDES ON WEED CONTROL AND GROWTH AND YIELD OF MAIZE-COWPEA CROPPING SYSTEM UNDER TRANS- GANGETIC PLAINS OF PUNJAB

Thesis Submitted for the Award of the Degree of

DOCTOR OF PHILOSOPHY

in

Agronomy

By

Khose Pratap Jambuwant

Registration Number: 11915261

Supervised By

Dr. Sandeep Menon
(UID 25213)

Head, Department of Agronomy LPU.

Transforming Education Transforming India

LOVELY PROFESSIONAL UNIVERSITY, PUNJAB
2023

<u>**DECLARATION**</u>

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

(Signature of Scholar)

Name of the scholar: Khose Pratap Jambuwant

Registration No.: 11915261

Department/school: Department of Agronomy, school of Agriculture

Lovely Professional University,

Punjab, India

<u>CERTIFICATE</u>

This is to certify that the work reported in the Ph. D. thesis entitled **EVALUATION OF PRE AND POST EMERGENCE HERBICIDES ON WEED CONTROL AND GROWTH AND YIELD OF MAIZE-COWPEA CROPPING SYSTEM UNDER TRANS- GANGETIC PLAINS OF PUNJAB** submitted in fulfillment of the requirement for the reward of degree of **Doctor of Philosophy (Ph.D)** in the Department of Agronomy, is a research work carried out by **Khose Pratap Jambuwant** (Registration No. 11915261), is bonafide record of his/her original work carried out under my supervision and that no part of thesis has been submitted for any other degree, diploma or equivalent course.

(Signature of Supervisor)

Name of supervisor: Dr. Sandeep Menon

Designation: HOD, Agronomy

Department/school: School of Agriculture

University: Lovely Professional University

ABSTRACT

A field trial was conducted at LPU Phagwara, Punjab, during the *spring* and *Kharif* seasons of 2021 and 2022 in order to discover an efficient weed management methods for the maize-cowpea cropping system. The observations and analysis were carried out in accordance by the recognized methods. The eight treatments were implemented in three replications under RBD: T_1 Atrazine 700 g PE at 2 DAS; T_2 Atrazine 500 g PE by HW one month after sowing; T_3 Metribuzin 800 g PE; T_4 Tembotrione 120 g PoE at 30 DAS; T_5 2-D Na Salt 800 g PoE + HW at 60 DAS; T_6 Topramezone 200 g PoE at 30 DAS; T_7 HW 2 times at 30 and 60 DAS; and un-weeded check T_8. Among the herbicide treatments, PoE use of 2, 4-D Na 800 g PoE at 30 DAS and HW at 60 DAS successfully reduced the density as well as the weed dry matter of (*Cynodon dactylon,Chenopodium album, Commelina bengalensis, Parthenium hysterophorus, Cyperus rotundus, and Sinapis arvensis, Cannabis sativus*). Atrazine 500 g PE combine with HW at 30 DAS had a superior WCE of 85.62 percent and the lowest WI. PoE 2, 4-D Na 800 g after 30 DAS combined with HW at 60 DAS lead to the highest plant height, weed dry matter, yield attribute of maize (number of kernel rows per cob, weight of kernels per cob), also test weight, along with seed yield of maize (4.60 t), net revenues (56222₹) and benefit cost ratio (1: 83).

In cowpea, four herbicides were tested by the combination of HW: T_1 Pendimethalin PE 1.0 kg 2 DAS; T_2 Pendimethalin 1.0 kg PE combined with HW at 20 DAS; T_3 Imazethapyr 50 g PoE at 20 DAS; T_4 Quizalofop-ethyl 50 g PoE at 20 DAS; T_5 Metolachlor 0.70 kg PE combined with HW at 40 DAS; T_6 Quizalofop-ethyl 40 g PoE at 20 DAS; T_7 2 HW on 30 and 60 DAS and un-weeded check T_8. PE use of pendimethalin 1.0 kg, one of the herbicide treatments, effectively reduced the weed dry matter and density. (*Commelina bengalensis*, *Cynodon dactylon*, *Cyperus rotundus, Boerhavia erecta, and Parthenium hysterophorus*) by a greater WCE of 83.43 percent and the lowest WI following PE Metolachlor 1.0 kg (83.38%). Pendimethalin PE 1.0 kg combined by HW at 20 DAS resulted in the highest plant height, branching plant^{-1}, root nodules, plant dry matter and yield characteristics of cowpea (pods plant^{-1}, pods length, and also seeds pod^{-1}) as well as a higher seed yield (7.61 q/ha), net profits (46420 ₹), and the highest benefit cost ratio (1: 98). (All the doses of herbicides used in the experiment are on a hectare basis).

ACKNOWLEDGEMENT

I am grateful to the God for the good health and wellbeing that were necessary to complete this thesis. I would like to express my deepest gratitude to my advisor, Dr. Sandeep Menon Head Department of Agronomy, for her excellent guidance, caring, patience, and providing me with an excellent atmosphere for doing research.

I am privileged to express sincere and deep sense of gratitude to Dr. Ramesh Kumar Sadavarti Honorable Dean and head of School, Dr. Chandra Mohan Mehta Deputy dean, Dr. Sandeep Menon head, department of Agronomy, Dr. Gurpreet Singh Assistant Professor, School of Agriculture, Lovely Professional University Punjab. With deepest sense of humility and gratefulness, I feel myself duly bound to express my heartfelt and sincere thanks to Dr. Sagar Chormole for his due attention and encouragement during the study period and also for providing me the necessary facilities during the course of study.

Words can hardly register the sincere and heartfelt feeling, which I have for my batch mates Laxman Somanath Vyvahare, Avinash Kadam, Diptanu Banik, Jasprit singh, Harnek Singh, and Jagdeep Chahal for their kind, co-operation and help as when needed.

Finally, I express my ever gratefulness and indebtedness to "God" for blessing me and keep me healthy all time, I also deeply great full to my lovely parents, Mr. Jambuvant Khose & Mrs. Rekha Khose, and my grand Mother (*Akka*) and grand Father (*Bhau*), and my sister Miss. Madhuri Jadhav and her husband Mr. Dayanand Jadhav and son Dhruva Jadhav and Durva Lavhare. My beloved teacher Mr. Gadekar Sir and Prithviraj Deshmukh Sir, Mr. Pandurang Terkar and Mr. Sambhaji Dukle, Akshay Mane For their great economic support, endless prayers, blessing and support to reach me at this level of higher education.

Place – **KHOSE PRATAP JAMBUWANT**
Date -

TABLE OF CONTENT

List of Figures

List of Tables

LIST OF ABBREVIATIONS

Abbreviations	Description	Abbreviations	Description
+	Plus	Max.	Heighest
%	Percent	Min.	Heighest
@	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	Sr. No.	Serial number
et al.	And co-worker	SEm±	Standard error of mean
Fig	Figure	T	Tonnes
g	Gragm	*Viz*.	Namely
ha	Hectare	WCE	Weed control efficiency
ha^{-1}	Per hectare	WP	Wettable powder
HI	Harvest index		
Hrs	Hour		
m	Meter		
m^{-2}	Per meter square		

I. INTRODUCTION

One of India's most significant cereal crops is maize (*Zea mays* L.), which is essential to the agricultural economy as a raw material for industries as well as a major source of food and feed for a huge portion of the population and livestock. The average grain of maize contains 9.1% less protein than other grains, 4.4% less fat, and 1.04% more ash, but 73.4% more starch. In terms of production, maize ranks as the second-most significant cereal crop on the globe Kakade *et al*. (2016). It's one of the most adaptable crops; maize can be successfully grown in a variety of seasons and ecologies and is useful for several purposes. Due to its superior genetic yield potential compared to other cereals, maize is referred to internationally as the "Queen" of cereals. It produces 36% (782 m t) of the world's grain production and is cultivated on over 150 million hectares in around 160 countries through a wide variety of soil types, temperatures, and management practices (Rao *et al*., 2014). After rice and wheat, maize ranks as India's third-most important food crop. Andhra Pradesh (20.9%) is the most important maize-growing state, contributing more than 82% of the total maize production. (16.5%) Karnataka (9.9%) Rajasthan, Gujarat (9.1%), Bihar (8.1%), UP (6.1%), MP (5.7%), and Himachal (4.4%) Parihar (2011).

In all of India's states, maize is grown year-round for a variety of products, including grain, forage, green cobs, sweet corn, baby corn, and popcorn in peri-urban areas. The area under maize crop maximum in Punjab, a significant maize-growing state in India, is 165 thousand hectares, by a production of 610 thousand tons. Approximately 3697 kg/ha of maize are produced in Punjab, according to the Department of Agriculture (2018). During its early growth stage, maize is extremely susceptible to weed competition. The first three to four weeks of maize plants' growth are very modest, and weeds sprout quickly and intensify their competition. The time between two and six weeks after sowing (WAS) is when maize is most susceptible to weed struggle, indicating the necessity of keeping the crop free of weeds at this crucial time. The observed yield damage in maize owing to unchecked weed development varied from 40% to 60%. (Sharma *et al*., 2010). The strong and persistent rains that come by the rainy season, combined by the manpower shortage, make it challenging to eradicate weeds using traditional, cultural, and technical means. As a result, chemical weed management is important in maize. Higher yield loss from weed competition in maize is thought to happen in the first three to six weeks, or once the cover has grown thick enough to cover the weeds (Sharma *et al*., 2010).

Weed control is the most important factor among biotic and abiotic conditions that affect maize yield. One of the greatest problems to optimizing crop yield is severe weed competition. These days, there is prevaention about ecological safety, the usage of agrochemicals like herbicides, and the persistence of these chemicals in agricultural ecosystems (Patel *et al*., 2006). In this scenario, spreading rapid-growing intercrops in wider row crops comparable to maize helps to cover vacant row gaps quickly and also keeps weeds at by rather than relying on continuous chemical control. Intercropping boosts the total production of the system in addition to lowering wedding expenses. As a result, to reduce the overuse of herbicides and their negative effects, such as residual toxicity, etc., planting initial maturing intercrops such as pulses in maize's wider row gaps leaves less area for weed development and better maize yield.

Wider row spacing and slow crop growth during the initial 3-4 weeks (Rao *et al*., 2014) make maize very delicate to weed race for up to 6 weeks of the growing period. Weeds can establish and grow rapidly during this period and can cause immense loss to crop growth and yield. To attain heighest profits in maize, nominal weed managing is required throughout the first 6 weeks of crop development, which is considered main for crop weed competition. Furthermore, the increased global concern for environmental safety, as well as the increased usage of agrochemicals for example herbicides also their tenacity in the agro-ecosystem, required the usage of chemical control in conjunction by additional weed supervision techniues to retain the weeds below control, and reducing the budget of weed control also refining the total output of the system will support farmers fight together with the weeds.

Cowpea *(Vigna unguiculata)* the major legume is grown widely in subtropical and tropical sections of the sphere (Asia, Africa, Central America, and South America) (Rathore *et al*., 2015). In addition to providing accessible nitrogen to the soil, cowpea can be a very significant contributor to cattle feed (Andargie *et al*., 2011). It is an appealing double-purpose crop, especially in dry and semi-arid ecosystems around the world. It is grown on roughly 0.5 million ha in India, by an ordinary production of 750 kg of seeds per hectare (Mohanty and Satyasa, 2015). Minor plots of cowpea are established all over the country for food and fodder. Cowpea grain comprises 20–25%

protein, which is double the protein content of other cereals. It is a deep-seated, hardy crop by a good drought-resistant capacity. Cowpea is a flexible crop that may be farmed as a solitary crop, intercrop, climb crop, relay crop, blanket crop, compost crop, and and so on in many agroecological locations across the world. Due to their little input necessities and tolerance of drought, pulses like cowpea show a dynamic role in cropping systems in arid regions of the world. As a result, they function better than other crops in the similarly severe climate that prevails in these areas of the world. Because of its great nutritional content and lack of toxicity, the cowpea is equally significant as nutrient-rich fodder for animals in addition to being a grain legume (Gupta *et al*., 2016). Inadequate sources and sinks are the true cowpea yield limiting factor, preventing the development of high-quality seeds (Muthuram *et al.*, 2018). In addition to this, lesser weed control was found to be a significant cause of the yield difference. Because of its smothering potential, combining it by other legumes and cereals reduced weed problems, resulting in higher grain output and dry feed yield than in solo crops and higher net profits for farmers.

It has been long believed that pertinent research on weed control methods in maize by sequential use herbicides like PE or PoE is required, especially in focus of the challenges associated by other agronomic practices. By this in mind, during the years 2021 and 2022, at the investigation farm of LPU, a field trial was conducted by the following objectives:

❖ Research objectives (Maize and Cowpea)

- To study the weed flora of maize- cowpea cropping system and different weed management practices,

- To study the effect of pre and PoE herbicides on the growth and yield of maize-cowpea and,

- To work out the economics of the use of pre and PoE herbicides in maize and cowpea cropping systems.

II. Review of Literature

2.1. I. Maize weed flora

Rajeshkumar (2018) stated that in maize, all groups of vegetation were present in un-weeded plots, like *Eleusine indica*, *Egyptian spp.*, and *Dactyloctenium; Echinochloa colona* was grass*; nut grass* was sedge*;* and *Boerhaavia spp., Digera arvensis, and Trianthema portulacastrum* were *BLW spp.*

Sapna *et al.* (2019) reported that sedge weeds were dominating in maize as associated by grasses and broad-leaf weeds. *Eleusine indica, Echinochloa colona,* plus *Dactyloctenium Egyptian* amongst the greenswards*;* sedges like *Cyperus rotundus*; then wide-leaved weeds remained *Trianthema portulacastrum;* also *Digera arvensis and Boerhaavia diffusa* remained the dominant species.

Chhokar *et al.* (2019) reported that fields were infected by *Digitaria sanguinalis*, *Dactyloctenium aegyptium*, *Echinochloa crus-galli*, *Phyllanthus niruri*, and *Digera arvensis.*

2.1.2 Weed density in cowpea

Swetha *et al.* (2015) observed that weed density was greatly reduced by various weed management techniques, resulting in lower grass density (4.50/m^{-2}) and lower sedge density (19.72/m^{-2}) in intercropped cowpea.

Shaik *et al.* (2017) reported that weeds associated by cowpea fields *are: Borreria hispida* (6%); Digitaria *sanguinalis* (12%); *Boerhavia erecta* (55%); *Cyperus spp.* (5%); *Trichodesma spp.* (4%); *Phyllanthus spp.* (4%); and Digera arvensis (3%)

Prithwiraj Dey (2018) found that the field was infested by *Chenopudium album* (5.86%), *Amaranthus retroflexus* (5.72%), *Celosia argentea* (6.56%), *Cleome viscosa* (16.07%), *Ageratum conyzoides* (3.27%), and *Dactyloctenium aegypticum* (10.60%). *Brachiaraia mutica* (7.16%)

2.1.3 Weed spectrum in cowpea

Taramani Yadav (2017) noticed that constant weeds include *Cynodon dactylon and Plantago lanceolate*, *Cyperus ssp*, *primarily Cyprus spp, C. esculentus,* and *wide-leaved* wild plants like *Convolvulus spp*, *Launae spp*, *Plucheala spp* (simple perennials).

Tripathi and Singh (2001) observed that *Cyperus rotundus* (12.8%), *Dactyloctenium spp.* (41.8%), *Gnaphalium indicum* (14.4%), and *Eleusine indica* (15.7%) were dominant in maize fields.

According to Sunday and Udensi (2013), weeds have a negative impact on crop during the first 3–4 weeks of crop growth.

Madukwe *et al.* (2012) reported that weeds in Nigeria reduced yields of legumes like cowpea by 53-60%.

2.1.4 Weed control methods. (Maize)

Kakade *et al*. (2016) noticed that consecutive uses of PE by PoE herbicides, mutual by atrazine 50 g. at 30 DAS, are both more cost-effective and effective at controlling weeds in maize.

Samant *et al.* (2015) found that when 1.5 kg of atrazine was applied, the germination and growth of weeds were suppressed in maize.

Sonali Biswas (2018) recorded that PE treatments of atrazine and tembotrione (Laudis) at 25 DAS reduced weed vegetation and increased the growth of maize.

Javid Ehsas (2016) observed that PE treatment by atrazine 0.75 kg + pendimethalin 0.75 kg recorded higher grain and straw yields in maize (4160 kg per hectare).

Samant *et al*. (2015) noticed that maximum grain yield of maize, up to 44.48 q ha^{-1}, was in atrazine.

Sraw *et al.* (2016) observed that 30 DAS maize intercropped by cowpea (used as mulch) and cowpea (used as fodder) had the greatest yield of maize grain (4.9 t), which was greater than control by 27.9 and 22.2%.

Sahoo *et al*. (2017) observed that PE atrazine at 1 kg used in maize resulted in the highest seed yield (81.38 q ha^{-1}).

Ramesh Babu (2019) noticed that in the weed management techniques atrazine use as PE by HW (One month) recorded greater grain yield (6692 kg and 6996 kg)

According to Satyendra Kumar (2017) the combination of herbicides atrazine and pendimethalin (0.75 grecorded superior grain yield (7.0 t ha^{-1}) in maize.

Sheela Barla (2016) found that applying pretilachlor plus metribuzin 0.75 + 0.175 kg results in a decrease in weed population and enhanced control of broad-leaf weeds in maize.

Parvati Deewan (2018) noticed that Metribuzin 0.25 kg pre-emergent *fb* single hoeing 30 days after seeding found that grassy and wide leaf weeds were better controlled than by conventional weed management methods in maize.

Acccording to Sheela Barla (2016) PoE use of pretilachlor plus metribuzin 0.75 + 0.175 kg resulted in a maximum grain yield in maize that was 65.6% greater than unweeded.

Anil Kumar (2017) recorded that metribuzin 0.25 kg, sinks weed population and growth in maize.

Parvati Deewan (2018) stated that PE metribuzin suppresses weed growth and raises the yield up to (23.63 q).

Triveni *et al.* (2017) noticed that use of PoE tembotrione 50 g plus atrazine 0.5 kg at 20 DAS was found to be successful in weed control as well as yield and economics of maize.

Tarundeep Kaur (2018) ststed that, in comparison to atrazine and an untreated plot, the spraying of Tembotrione at 110 and 120 g effectively controlled all grasses and broadleaf weeds while also considerably reducing weed density and biomass in maize.

Biswas *et al*. (2018) observed that atrazine PE 1.5 kg + tembotrione (Laudis) 120 g as PoE at 25 days by sowing reduced weed growth and dry weight in maize.

Varshitha (2019) found that the herbicide combination of topramezone + 2, 4-D, is successful in suppressing the grasses and broad-leaved weeds.

Kumar *et al.* (2019) observed that effective herbicide for control of grasses and non-grass weeds, highest WCE (90%) in maize, was a PoE tembotrione of 120 g.

Sundari *et al.* (2019) noticed that PE atrazine at 3 DAS and post-emergent use of tembotrione at 21 DAS result in superior control of broad-leaved weeds and decrease in the weed vegetation in maize.

Varshitha *et al.* (2019) recorded that topramezone + 2, 4-D successfully suppresses weed growth and considerably increases grain yield (5582 kg) and net profits (Rs 53769) in maize.

Mahesh Kumar (2019) reported that atrazine PE was applied at 1.5 kg after the 120 g per hectare PoE tembotrione at 25 DAS (6.34 and 6.37 t) grain yield per hectare of maize.

Biswas *et al*. (2018) observed that consecutive use of atrazine 1.5 kg at 30 DAS + 120 g tembortrion increased seed yield of maize up to 3969 kg and 3844 kg.

According to Kaur *et al*. (2018) PoE Tembotrione usage at 110 and 120 g resulted raised in maize grain yields of up to 7.5 ha^{-1}.

Triveni *et al*. (2017) observed that 50 g tembotrione plus 0.5 kg atrazine increased grain yields in maize (9.65 and 8.61 t in 2015 and 2016), while HW was performed (9.79 and 8.7 t).

Kakade *et al.* (2016) recorded that PE and PoE in sequences of 0.50 kg atrazine and 50 g 2, 4-D Na post-emergent at 30 DAS prove more effective at suppressing weeds and are more cost-effective than traditional weed management practices in maize.

Bahirgul Sabiry (2019) noticed that 2, 4-D Na salt at 20 DAS controls wide leaf weeds in maize and creates a weed-free environment for crops, fostering favourable conditions for crop growth.

Hatti *et al.* (2014) found that 200 g of oxyflurofen plus 500 g of PoE 2, 4-D Na increased grain yield in maize and was comparable to HW at 20 and 40 DAS.

Nagdeve *et al*. (2014) observed that the plots treated by 2, 4-D Na recorded maximum grain yields of up to 2.6 t ha^{-1}), but not by the other herbicides that were put to the test in maize.

Zhang *et al*. (2013) noticed that topramezone, when applied PoE on weeds at the 2-3 and 4-5 leaf stage at a rate of 25 gin sandy loam soils of the North China Plain, could efficiently control broadleaf and grass, reducing WCE by 67% and lacking the total WCE and maximum grain production in maize.

Shambulinga (2017) recorded that the PoE use of Topramezone 33.6% Capsule Suspension + 33.6 g MSO adjuvant was as effective for controlling broad leaf weeds and reducing weed populations in maize.

Satrndra Kumar Gupta (2017) reported the superior yield of maize grain (7.00 t ha^{-1}) observed in the PE use of atrazine plus 750 g pendimethalin at 1 day after seeding.

Bahirgul Sabiry (2019) observed that Topramezone 12.5 g plus atrazine 625 g PE successfully controlled both grasses and wide leaf weeds, providing broad-spectrum weed control in maize.

According to Varshitha *et al*. (2019) reduced weed growth and decreased count of weeds such as (3.00 0.5 m^{-2}) grasses, (2.67 0.5 m^{-2}) sedge, and BLS were seen by topramezone 12.5 g + 2, 4-D (2.00 0.5 m^{-2}) in maize.

Tiwari *et al*. (2017) found that in maize, the use of Topramezone PE at doses of 20.1 and 25.2 g results in a higher maximum yield (5 qtl) than the lowest dose of 13.4 g similar pattern was observed when Topramezone by an adjuvant was used.

Kumar *et al*. (2013) recorded that pre-planting uses of 40 ml + 500 g of glyphosate and topramezone plus atrazine (as post-emergent uses at 30 DAS on sandy loam soils in Sabour, Bihar) considerably increased grain yield (6360 kg) in maize associated by an unweeded

Shambulinga *et al*. (2017) found that Topramezone 33.6% SC at 33.6 g + MSO adjuvant as post-emergent on 20–25 days after seding resulted in higher yields of grain (6.14 t) and straw (6.87 t) in maize.

2.1.5 Weed control methods. (Cowpea)

Rajeshkumar (2017) observed that pre-emergent use of pendimethalin as some rotary weeding in maize mixed by cowpea intercropping systems lowered the weed species and improved the efficiency of weed control.

Rajeshkumar (2017) noticed that 0.75 kg pendimethalin by pre-emergent and subsequently one rotational hoeing under the maize + cowpea intercropping system resulted in superior grain yield (5225 kg).

According to Yadav *et al*. (2015) PoE use of 0.075 kg imazethapyr on 20 DAS + 1 HW on 40 DAS after 1.0 kg pre-emergent pendimethalin (PE) + 1 HW on 40 DAS, respectively, decreased the overall weed density by 56.0%, 47.8%, 44.7%, and 34.6% in cowpea.

Yadav *et al*., (2015) stated that superior grain of yield (580 kg) was recived when (1.0 kg pre-emergent pendimethalin + 1 HW on 40 DAS) than (0.075 g PoE imazethapyr on 20 DAS + 1 HW at 40 DAS).

Madukwe *et al*. (2012) noticed that Imazethapyr used PoE improved effective control efficiency of weeds, up to 89% in cowpea at 30-35 DAS.

Priyanka (2018) found that the pre-emergent and use of 150 g of Imazethapyr on 4 DAS produced the high grain production of cowpea (750 kg) associated by other herbicidal usages.

Pravindra Kumar (2017) reported that post-emergent Quizalofop-ethyl on 20–25 DAS + one HW + one IC on 40–45 DAS, recorded effective control of all types of weeds, including sedges, monocots, and dicots in cowpea.

Kumar *et al*. (2017) found that quizalofop-ethyl 20–25 DAS as a PoE plus 1 HW + 1 IC at 40–45 DAS produced the highest yield of straw and grain (1441.66 and 1900.46 kg) in cowpea.

Mekonnen (2016) obsrved that using 1.0 kg of S-metolachlor plus HW reported the highest (91.6%) efficacy of weed control in cowpea.

Mekonnen (2016) reported that S-metolachlor and physical weeding in cowpea resulted in the greatest yield of grain (3960 kg).

Gupta *et al*. (2018) noticed that treatments by the highest grain production in cowpea were those that applied 37.5 g quizalofop-ethyl in addition to 50 g fenaxoprop-ethyl.

Sinchana (2020) observed that HW at 25 days intervals successfully controls all weed groups and can increase WCE up to 91.6% in cowpea.

Sinchana (2020) found that at 20 & 40 DAS, HW results in a higher yield of green pods (6.2 t) different weed control treatments in cowpea.

2.1.6 WCE (Maize)

Madhavi (2013) found that the lowermost weed dry weight and greatest WCE in maize were obtained in HW (89.8%), *fb* atrazine (87.5%), oxyfluorfen (84.2%), and pendimethalin (81.3%).

Mukherjee *et al*. (2015) noticed that the use of 1.0 kg atrazine as PE plus 1.1 kg atrazine as a PoE showed the highest WCE and lowest values of the WI in maize.

Shankar (2015) found that atrazine 1.25 kg + pendimethalin 2.5 lit produced the highest (89%) WCE in maize.

Anil Kumar (2015) observed that Tembotrione 120 g + surfactant (1.L) on 15-20 DAS recognized superior weed control at 90.3% in maize.

Anil Kumar (2015) reported that various tank mixtures of atrazine through alachlor,pendimethalin, metolachlor, 2,4-D, metribuzin, etc. were tried in various investigation trials above various agro-climatic situations, and their respective weed control efficiencies were 80, 67–97, 90–94, 89, and 53–67% in maize.

Samant *et al*. (2015) recorded that efficacy of weed control ranged from 80.87% supremacy in farmers' practices to a lowest of 54.12% by the use of 1.5 kg pendimethalin *fb* single HW at 30 DAS. The weed control efficiency was greater (71.31%) when atrazine was applied as PE *fb* on 30 DAS one HW (associated by other herbicide treatments in maize).

Ehsas *et al.* (2016) found that PE 0.75 g atrazine combined by 0.75 g pendimethalin (88.97%), 1.5 kg alachlor plus 0.5 g atrazine (80.75%), and 0.75 g atrazine combined by 500 g 2, 4-D (80.25%) recorded the highest weed control efficiency in maize.

Kakade *et al*. (2016) observed that the high weed control efficiency (80.09%) and the lowest index of weed (13.50%) were attained by 0.50 kg atrazine used in PoE 0.5 kg 2, 4-D Na 30 DAS in maize.

Sraw *et al*. (2016) noticed that maize (mulching 30 DAS) and cowpea *fb* maize: cowpea ensured the greatest weed control efficiency (91.6%). (Fodder at 30 DAS.) Due to the increased weed dry weight, 1 kg atrazine DAS HW by 30 DAS yielded the least weed control efficiency (70.45 g besides 45.6 g m^{-2}).

According to Sharma (2018) combined use of tembotrione plus atrazine in maize reported the highest weed control efficacy (94.4%) on 60 DAS.

Nagasai *et al*. (2020) observed that the most effective method for controlling weeds in maize is alachlor by HW by 30 DAS (WCE 90.33% at 20 DAS).

Sapna Bhagat (2019) reported that (PoE) 100 g tembotrione + atrazine tanked as a mixture of 750 g on 15–20 days later seeding (DAS) had greater weed control efficacy (93.22 and 93.71%) in maize.

2.1.7 WI (Maize)

The crop yields that are collected throughout the different weed control studies are used to create a WI. In the assessment of weed-free plots or, in certain cases, minimally weed-infected plots, including the double- or three-handed-weeded plots employed in an experiment, it is a means to measure the amount of crop yield lost by treatments. Almost all weed control studies use it as the deciding element when assessing if one treatment is better than another.

Ravisankar *et al*. (2017) found that hand-weeding in rain-fed maize at 20 days intervals had a weed control efficacy of 89.2%, which is similar to 1.25 kg of metolachlor.

Puscal Sharma (2018) obsrved that Tembotrione + surfactant + atrazine 500 g demonstrated the best efficiency at weed control in maize (94.4%) at 60 DAS.

Kaur *et al*. (2018) noticed that tembotrione 120 g (1.60) and 110 g had the lowest index of weed (2.53) in maize.

Mahesh Kumar (2019) recorded that PE pendimethalin and atrazine plus 0.4 kg at 2, 4-D amine 25 DAS as PoE and 1.5 kg atrazine as pre-emergent DAS (120 g tembotrione at PoE at 25 DAS) noted the lowest WI (4.9 and 3.9%) in maize.

Mukherjee *et al.* (2019) reportd that PoE atrazine in the first cutting of *FB* PoE reported a lower WI (1.1%) in maize.

Varshitha *et al*. (2020) observed that maize had a considerably reduced WI value (7.07%) by the use of topramezone + 2, 4-D in comparison to the advised weed controlling measures.

Sapna Bhagat (2019) noticed that the lowest WI in maize, 3.1%, was found in tembotrione 100 g + 15-20 DAS 750 g atrazine, subsequently 100 g tembotrione + atrazine 500 g at 15-20 DAS.

2.2 Plant characters (Maize)

2.1.1 Plant height

Barad *et al*. (2016) observed that weed-free conditions improved plant height at harvesting time (159.4 cm), dried material plant^{-1} at harvesting (179.2 g), cob length (19.0 cm), total panicles plant^{-1} (2.07), amount of grains cob^{-1} (421), grain mass cob^{-1} (86.96 g), yield of grain (36.93 q ha^{-1}), and fodder (73.50 q) in maize.

Kumar *et al*. (2018) noticed that 2, 4-D was used post-emergently at 21 DAS along by HW at 40 DAS. The maximum cob length (19.53), diameter (11.56), weight (297.71 g), test weight (235 g), and quantity of grains per cob (293), are all in maize accordance by each other.

Rao *et al*. (2020) recorded that 20 and 40 DAS HW observed the maximum plant height (232 cm), at par by 1.0 kg pendimethalin (217 cm) and 1.0 kg atrazine (20 DAS), in that order, which endured statistically comparable to HW then IC on 15 plus 30 DAS 0.5 kg atrazine as pre-emergent *fb* HW then interculture on 30 DAS in maize.

Ramesh (2019) reported that the use of PE 0.50 kg atrazine + 2 wheel hoes weeded at 30 DAS (230.5 cm) resulted in dry material (13963 kg) and grain yield (6461 kg) that were both higher than average in maize.

Sundari (2019) found that at 20 and 40 DAS, double HW formed the extreme cob length (22.80 cm), cob diameter (9.8 cm), and number of grains per cob (369) in maize.

2.2.2 Yield attribute and yield (Maize)

Bahirgul *et al.* (2019) reported that in maize, the highest (6882 kg) grain production and net profit (99535 rs ha^{-1}) were acquired by the use of 1.25 kg atrazine (PRE) and IC+ HW.

Sundari *et al*. (2019) noticed that in maize, the supreme yield of grains (6202 kg) and the yield of straw (9070 kg) were noted during twice-HW at 20 days intervals.

Ramesh (2019) observd that yield of grain (12006 kg) in maize and net profits (70402 rs) were noted by use of atrazine 0.50 kg PE plus 2 times wheel hoeing at 30 DAS.

Mahesh Kumar (2019) noticed that PE use of 1.0 kg pendimethalin 1 day after sowing and 0.75 kg atrazine + 0.4 kg 2, 4-D amine at 25 DAS as PoE obtained (6.38 and 6.41 t) grain yield.

PE (PE) atrazine use at 1 kg combined by HW by 35 DAS formed a greater yield of grain (7.85 t), in maize, which is statistically comparable to PE atrazine use at 1 kg ha1 plus 2 wheel hoe weeding at 35 DAS (7.61 t), according to Sathyapriya *et al*. (2019).

Sandhya Rani (2019) found that HW 2 times at 15 and 30 DAS resulted in greater straw production (7168 kg) in maize.

According to Hargilas *et al*. (2020) atrazine as PE and POE tembotrione at 25 DAS, the weed-free treatment produced yield qualities, including grain yield (6.31 to 6.86 t), lasting yield (6.87 to 8.15 t), HEI (67.51%), and gross revenues (Rs 88363) in maize.

2.2.3 B: C ratio (Maize)

According to Barad *et al*. (2016) PE atrazine use resulted in the highest B: C of 3.00 *fb* HW and IC at 30 DAS in maize.

Mitra *et al*. (2018) noticed that the largest net revenues (74210 Rs/a) and B: C ratio (2.73) were seen when atrazine as a PE was paired by tembotrione + atrazine as a PoE in maize.

According to Ramesh (2019) in a maize spacing of 60 cm x 25 cm, along by the use of atrazine at a rate of 0.50 kg and 2 wheel hoeing at a rate of 0.75 kg on 30 DAS, B:C ratios of (2.25, then 2.29).

Hargilas *et al*. (2020) observed that atrazine PE followed by tembotrione as POE at 25 DAS resulted in the highest B: C relation (2.05) in maize, compared to weed-free and the other treatments.

2.2.4 Weed control efficiency and index of weed (cowpea)

Madukwe *et al*. (2012) noticed that Pendimethalin 40 DAS of HW in cowpea resulted in higher weed control efficacy up to (91%).

Pravindra Kumar (2017) found that (2 HW + 2 IC @ 20 plus 40 DAS) had the lowest WI (0.89%) in cowpea.

Madukwe *et al*. (2012) observed that pendimethalin 3.5 L plus HW at 6 weeks produced the greatest value in plant height, amount of pods per plant, and 100 grain mass in cowpea.

Silva *et al*. (2003) stated that at 2 to 3 leaf stages, chemical weeding combined by HW on 50 DAS increased cowpea grain yield (68%) and looks to be effective at controlling weeds in cowpea.

2.10 Economic study of (cowpea)

Hanumanthappa (2012) noticed that at 0.75 kg, PE pendimethalin use combined by 1 hoeing on 20–25 DAS provided wide-range weed control and increased cowpea seed yield and B: C (2.1).

Madukwe *et al*. (2012) reported that 1.0 kg of pendimethalin combination by HW on 40 DAS produced higher efficiencies of weed control of up to (91%) in cowpea.

Pravindra Kumar (2017) stated that (2 HW plus 2 IC on 20 and 40 DAS), recorded the WI (0.89%) in cowpea.

According to Madukwe *et al*. (2012) in comparison to hand-weeded in cowpea, pendimethalin at an amount of 3.5 L plus hand-weeding at 6 weeks observed higher of plant height, cobs per plant.

Silva *et al*. (2003) noticed that 2 to 3 leaf stage weeds control bio-chemical weeding, and combined by HW 50 days later, seeding increased cowpea grain yield (68%) and looks to be effective at controlling weeds in cowpea.

Hanumanthappa (2012) state that pre-emergent 0.75 kg of pendimethalin, combined by a single hoeing on 20 days intervals, provided BLW control and increased cowpea yield.

2.3 Research gap identification

- The management of all weed kinds cannot be achieved by using a single herbicide. Every year, farmers employ the same herbicide chemical, which causes weeds to become resistant to it. Farmers utilise outdated herbicides not bystanding the market's availability of some more modern and recent herbicide compounds. Some crops that are difficult to control are morphologically similar to weed species.
- Farmers lack knowledge regarding the use and handedling of herbicides. Farmers frequently pass away each year as a result of their ignorance about pesticide doses and uses. Because the farmer failed to read the herbicide's leaflet, the crop occasionally fails as a result of an herbicide overdose that results in phytotoxicity.
- In the Maize-cowpea cropping system, use of IWM for proper weed management as well as next generation herbicides to improve outcomes and boost production.

III. MATERIALS AND METHODS

The field trial was conducted on **"Evaluation of pre and PoE herbicides on weed control, growth, and yield of the maize-cowpea cropping system." under the trans-Gangetic Plains of Punjab,** trial was started in the *spring* of 2021 (11 February 2021) and ended on September 3, 2022, by a maize-cowpea sequence cropping system. This section briefly describes the soil, climate conditions, resources utilized, and methodologies employed during the study.

3.1 Testing sight

The research was conducted at Lovely Professional University's research field in Jalandhar, Punjab, India. The experimental site's topography was constant.

3.2 Geographical location

Geographically, Lovely Professional University is situated 10 km east of Jalandhar, India, which is situated at "31.25°N and latitude 75.70°E" longitude. In the plains of Punjab, the average elevation above sea level is around 330 meters. Mean sea level (MSL)

3.3 Climate and soil

The climate of Punjab is divided into three seasons. They are the months of summer, which last from the middle of April until the close of June. The rainy season in Punjab lasts from early July until late September. The wintertime in Punjab lasts from early December until the end of February. The post-monsoon and post-winter seasons are transitional seasons in Punjab. The average annual rainfall at the site is 610.3 mm. Monthly meteorological data for the experimental site during the cropping season was received from Punjab Agriculture University Ludhiana (PAU). The average highest temperature, minimum temperature, and rainfall of the winter season are shown in the chart.

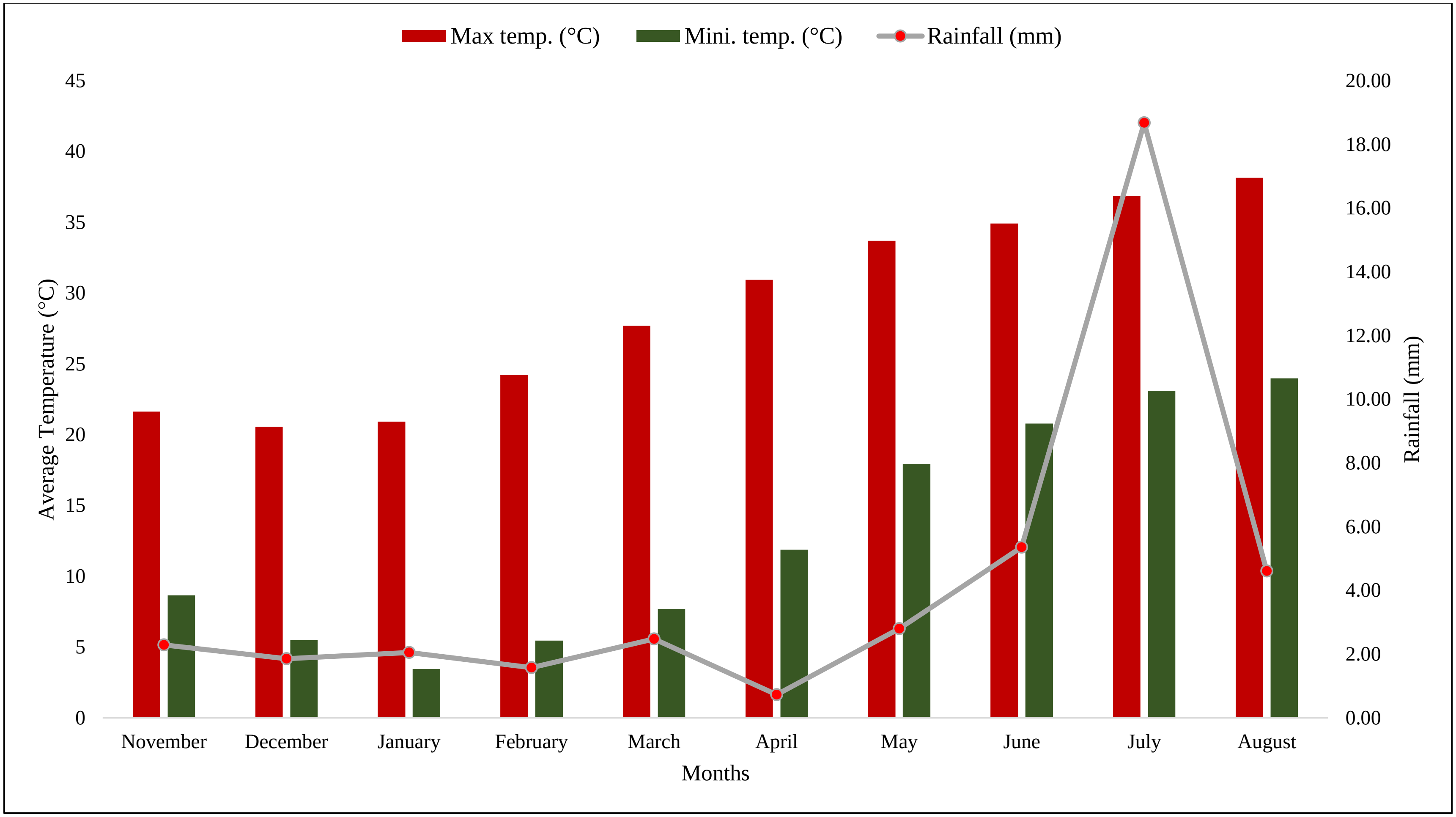
Chart 3.1: Weekly climate data throughout the investigational period (November-2020 to August 2021)

Month & year	Met. week	Mean Temperature (°C)		Absolute humidity (%)		Rain (mm)
		Max.	**Min.**	**Morning**	**Evening**	
Nov 2020	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
Dec 2020	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
Jan 2021	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
Feb 2021	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
Mar 2021	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
April 2021	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
May 2021	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
June 2021	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
July 2021	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
Aug 2021	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

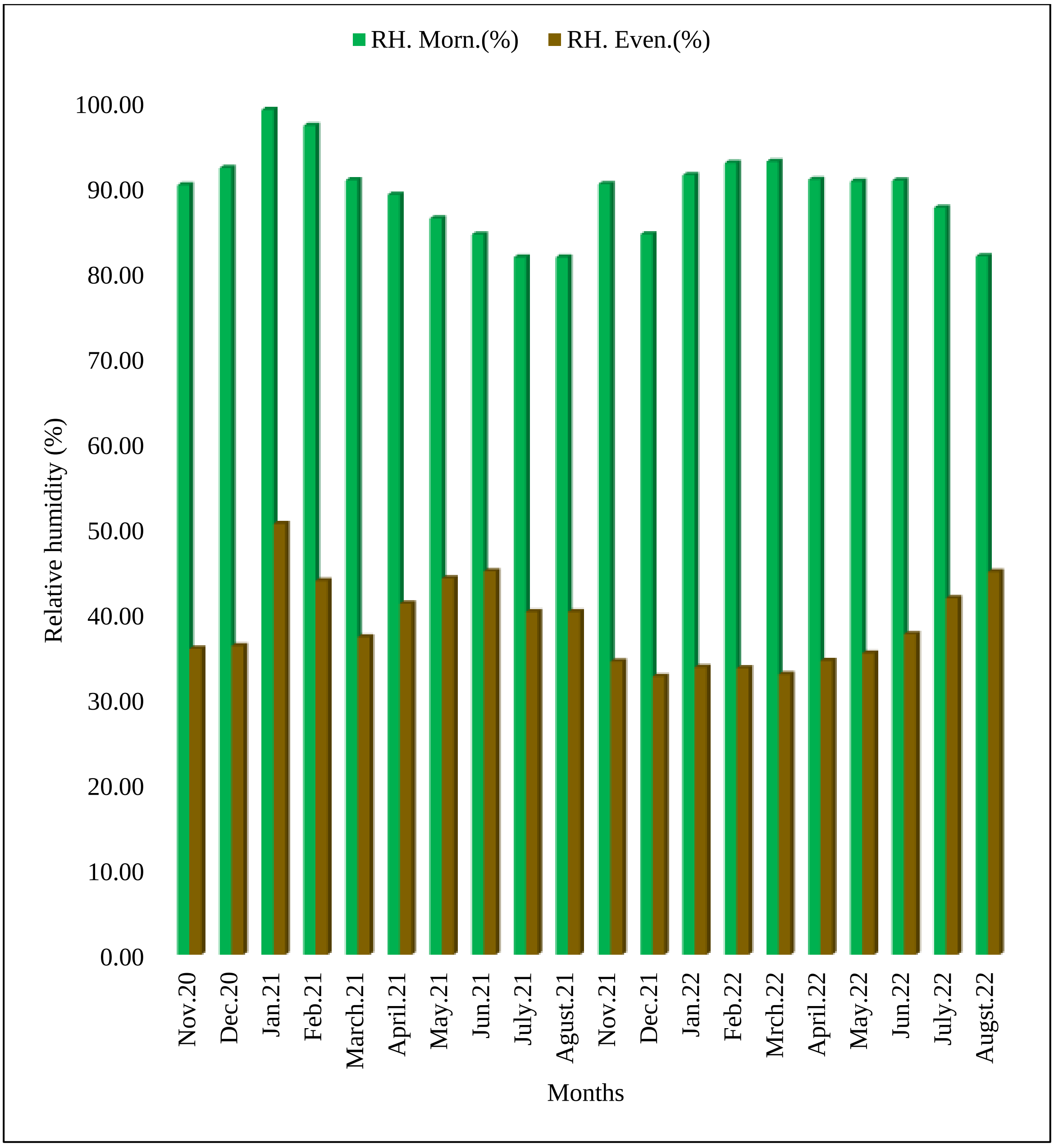
Chart 3.2: Weekly weather data throughout the experimental period (November 2021 to August 2022)

Month and year	Met. week	Mean Temperature (°C)		Relative humidity (%)		Rainfall (mm)
		Max.	Min.	Morning	Evening	
Nov	45	17.8	9.5	92.3	33	4.0
2021	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
Dec	49	18.4	6.2	86.2	35	0.0
2021	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
Jan	1	19.6	4.2	89	34	0.2
2022	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
Feb	5	22.1	3.9	91.6	33.6	0.0
2022	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
Mar	9	25.12	4.2	92.5	32.5	0.0
2022	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
Apr	13	27.0	7.2	90.6	33.7	0.5
2022	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
May	17	31.2	16.55	91.40	34.7	5.0
2022	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
June	21	34.0	20.0	90.6	37.0	3.5
2021	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
July	25	37.1	24.2	89.6	42.11	10.2
2022	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
Aug	29	36.9	27.5	84.2	45.6	3.3
2022	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 and Rainfall during (November 2020 to August 2022) in Maize-Cowpea cropping system



Graph 3.3 Average Relative humidity (%) during (November 2020 to August 2022) in Maize-Cowpea cropping system

3.4 Experimental soil properties

To evaluate the nutritional position of the research plot soil, ten soil tasters were randomly taken from the trial field to a depth of 30 cm using a soil auger to govern the automated and compound composition. A complex soil section was taken from the typical mixed samples and then used for analysis. Detailed physicochemical characteristics of the testing field’s soil are shown in Chart 3.3.

Chart 3.3 composition of soil of testing location

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

Chart 3.4 Physiochemical composition of the soil of investigational field

Sr. No	Particulars	Method used	Test value	Normal range	Interpretation
A.	**Chemical properties**				
1.	Soil pH	Glass electrode pH meter (Piper, 1967)	8.15	6.6-7.3	Moderate
2.	Electric Conductivity (dsm^{-1})	Solubridge method (Black and Evans, 1965)	0.194	<2.00	Non-saline
3.	Accessible N (kg)	Alkaline permanganate (Subbiah and Asija, 1956)	183	280-560	Medium
4.	Accessible P (kg)	Olsen’s (Olsen, 1954)	20.21	10-25	Medium
5.	Accessible K (kg)	Flame Photometric method (Jackson, 1967)	182.8	120-280	Medium
6.	Organic carbon (%)	Walkey and Black method (Black, 1965)	0.79	0.12-1.13	High

Chart 3.5 Research plot cropping history

S. No.	Year	Cropping System *Spring*	Cropping System *Kharif*
1.	2017-18	Black gram	Rice
2.	2018-19	Green gram	Maize
3.	2019-20	Soybean	Groundnut
4.	2020-21	Maize	Cowpea
5.	2021-22	Maize	Cowpea

3.5 Layout and experimental details

Three replications of the test were set up using a randomized block design (RBD). Eight (8) distinct treatment arrangements, either alone or in conjunction by one-HW or non-marital control, involved pre- and PoE treatments of various herbicide compounds. The experimental design plan and treatment information are assumed in Charts 3.9–3.10 and illustrated in Fig. 3.4.

Chart 3.6 Experimental detail (Maize) 2021 and 2022

Crop	**:** Maize
Variety	**:** DKC-9108
Design used	**:** Randomized Block Design
Treatment	**:** 8
Replication	**:** 03
Gross plot size	**:** 6 m x 7m = 42 m^2
Net plot size	**:** 5.40 m x 6.40 m = 34.56 `m^2
Total experimental area	**:** 18 m x 56 m = 1008 m^2
Spacing	**:** 60 cm x 25 cm
Date of sowing (2021)	**:** 11^{th} February, 2021
Date of sowing (2022)	**:**17^{th} February, 2022
Harevesting date (2021)	**:** 10^{th} June, 2021
Harevesting date (2021)	**:** 19^{th} June, 2022
Spacing between plots	**:** 0.5m
Space among replications	**:** 1m

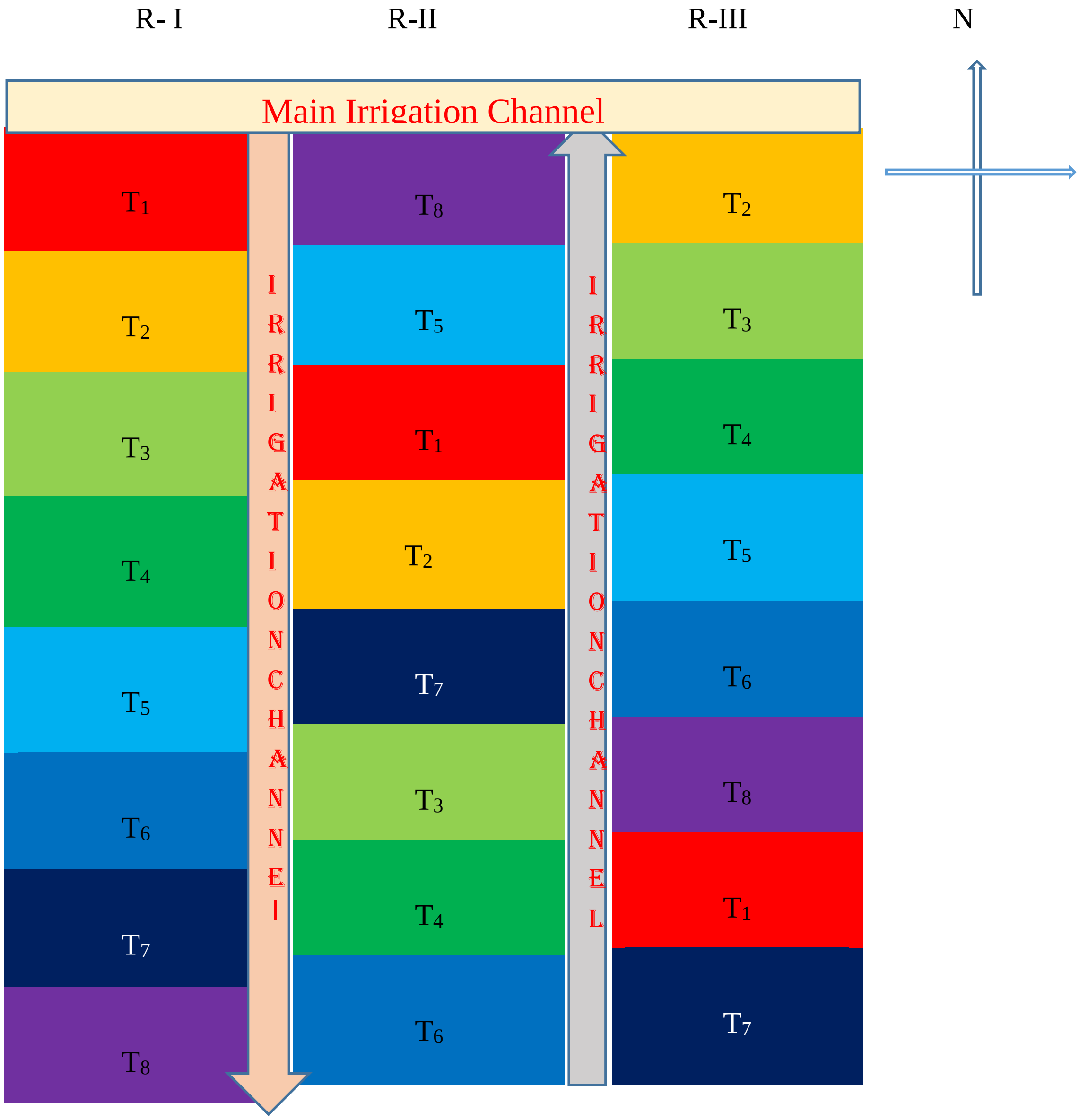
Chart 3.7 Experimental detail (Cowpea) 2021 and 2022

Crop	**:** Cowpea
Variety	**:** CL-367
Design	**:** Randomized Block Design
Treatment	**:** 8
Replication	**:** 03
Gross plot size	**:** 6m x 7m = 42 m^2
Net plot size	**:** 5.40 m x 6.40 m = 34.56 `m^2
Total investigational area	**:** 18 m x 56 m = 1008 m^2
Spacing	**:** 30 cm x 15 cm
Date of sowing	**:** 29th June, 2021
Date of sowing	**:** 2th July, 2022
Date of harvesting	**:** 16th September, 2021
Date of harvesting	**:** 19th September, 2022
Spacing between plots	**:** 0.5m
Spacing between replications	**:** 1m

Chart 3.8 Details of variety (2021 and 2022)

Crop	**Maize**	**Cowpea**
Variety	DKC-9108	CL-367
Sowing time/ season	*Spring*/February	*Kharif*/June
Seed rate	12-15 kg	7-8 kg
Fertilizer dose	120:60:40	20:40:20
Sowing methods	Dibbling (rigid-furrow)	Line sowing
Duration of crop	115-120 days	65-70 days
Resistance to	Low temperature (chilling injury)	Water stress

Fig 3.4 Research Design



Fieldwork Photos

Flowering and Grain filling stage of Maize crop

Harvesting of Maize

Herbicide Persistiance Study (Bioassy)

Cowpea Field

Cowpea Crop

Chart 3.9 Detail of the treatment (Maize) (2021 and 2022)

Treatment	Dosage g ha^{-1}
Atrazine PE	700 g
Atrazine PE + HW (30 DAS)	500 g
Metribuzin PE	800 g
Tembotrione PoE	120 g
2, 4-D Na Salt PoE +HW at 60 DAS	800 g
Topramezone PoE	200 g
HW 30 and 60 DAS	----
Weedy check	----

Note: PE: Pre- emergent, PoE: post emergence

Chart 3.10 Detail of the treatment (Cowpea) (2021 and 2022)

Treatment	Dosage g ha^{-1}
Pendimethalin PE	1.0 kg
Pendimethalin PE HW at 20 DAS	1.0 kg
Imazethapyr PoE 20 DAS	50 g
Metolachlor PE + HW 20 DAS	50 g
Quizalofop-ethyl PoE 20 DAS	1.0 kg
HW 20 and 40 DAS	40 g
Weedy check	---

Note: PE: Pre- emergent, PoE: post emergence, DAS: DAS.

3.6 Cultural operations of Maize-Cowpea (2021 and 2022)

Chart 3.11 and 3.12 shows the time of the various cultural operations that were conducted during of the exament.

Chart 3.11 Schedule of cultural operations (Maize) 2021 and 2022.

S. No.	Cultural operation	Implement/method used	Date 2021	Date 2021
1	Ploughing and harrowing	Tractor drawn cultivator then disc harrow	05-02-2021	10-02-2022
2	Soil specimen	Soil testing auger	07-02-2021	12-02-2022
3	Planking	Tractor driven planker	08-02-2021	15-02-2022
4	Layout making	Manually	10-02-2021	15-02-2022
5	Treatment to seed, fertilizer use and sowing	Seed cum ferti drill	11-02 -2021	17-02-2022
6	Irrigation	Controlled flow	12-02-2021	18-02-2022
7	Use of herbicide Pre-emergent herbicide	Knapsack sprayer through flat fan nozzle	13-02-2021	19-02-2022
	Post emergent herbicide Dissolve in Water	Knapsack sprayer through flat fan nozzel 500 liter ha^{-1}	13-03-2021	20-03-2021
8	HW	Manual	13-03-2021	20-03-2022
	30 DAS and 60 DAS	Manual	14-04-2121	21-04-2122
9	Irrigation	Controlled flood	12-02-2021	18-02-2022
			24-02-2021	27-02-2022
			09-03-2021	12-03-2022
			26-03-2021	29-03-2022
			17-04-2021	14-04-2022
			29-04-2021	26-04-2022
			12-05-2021	10-05-2022
			24-05-2021	21-05-2022
10	Harvesting	Manual	10-06-2021	19-06-2022
11	Threshing and Winnowing	Manual	15-06-2021	24-06-2022

Chart 3.12 Schedule of cultural operations (Cowpea) 2021 and 2022.

S. No.	Cultural action	Instrument/technique used	Day 2021	Day 2021
1	Ploughing and harrowing	Tractor drawn cultivator and disc harrow	24-06-2021	26-06-2022
2	Soil sampling	Soil auger	25-06-2021	27-06-2022
3	Planking	Tractor drawn planker	26-06-2021	30-06-2022
4	Layout preparation	Manual	27-06-2021	30-06-2022
5	treatment of seed, seeding and use of fertilizer	Seed cum ferti drill	29-06-2021	02-07-2022
6	Irrigation	Controlled flow	30-06-2021	03-07-2022
7	Use of herbicide PE herbicide	Knapsack sprayer by flat nozzle	2-07-2021	04-07-2022
	Post emergence herbicide	Knapsack sprayer by flat nozzle	23-07-2021	25-07-2022
8	HW	Manual	24-07-2021	25-07-2022
	20 and 40 DAS	Manual	20-08-2021	14-08-2022
9	Irrigation	Controlled flood	30-06-2021	03-07-2022
			07-07-2021	13-07-2022
			12-08-2021	02-08-2022
10	Harvesting	Manual	16-09-2021	19-09-2022
11	Threshing and Winnowing	Manual	19-09-2021	24-09-2022

3.7 Cultivation Details

The following sections provide information on cultivation procedures:

3.7.1 Fieldwork preceding

The land was prepared by plowing twice to create a well-fine seed bed, then plowing by a tractor-operating plough. A plank was then used to level the field. To create a seed bed free of weeds and agricultural residue, the excess weeds and crop material were removed.

3.7.2 Fertilizer use

The prescribed nutrient doses per hectare for cowpea "20:40:20 of kg N: P2O5: K2O" and maize "120:60:40 kg N: P2O5: K2O" kg were administered at the time of seeding in rows uniformly on each plot using urea, Single Super Phosphate (SSP), then Muriate of Potash (MOP).

3.7.3 Irrigation

The first irrigation was applied by a controlled flooding technique just after sowing in order to ensure good germination of the seeds. The next irrigation was applied at 10-day intervals.

3.7.4 Rate, treatment, and sowing of seeds

On February 11, 2021, and February 17, 2022, the maize crop was manually seeded. Row space was 60 cm by 12 kg ha^{1} of certified seed. Before planting, seeds were sterilized by Carbendizm at a rate of 2 g per kilogram of seeds in order to stop soil- and seed-borne diseases. The seeds remained planted once they had dried in the shade.

The cowpea crop was sown on June 29, 2021, and on July 2, 2022. Row space was 30 cm, by a certified seed of 10 kg. To prevent soil and seed-bearing diseases, seeds were treated by Carbendizm at 2 g/kg before seeding. After dehydrating in the shade, the seeds remained sown.

3.7.5 Gap closing and thinning

After 10 days of sowing, the plant was uprooted to sustain the intra-row specing. Gaps were filled in order to sustain an ideal plant population of maize and cowpea.

3.7.6 Use of herbicide

In the experiment, the chemical used was recorded in Chart 3.9 and 3.10, which contains information on the herbicide. The needed amount of maize-cowpea herbicide was diluted in water and sprayed evenly by a "knapsack sprayer" at a spray frequency of 500 L as showed by the treatments, equipped by a "flat fan nozzle". HW was done manually by labour in treatments T_2, T5, and T7, while in un-weeded, weeds remain permissible to grow throughout the crop growth timing.

3.7.7 Plant Safety (Maize and Cowpea)

To defend against armyworms, carbofuran (3g) granules were used as a preventative measure at 25 DAS. The presence of a leaf-eating caterpillar was discovered. To suppress the pest, 3 mL/L of chloropyrifos was sprayed in water at 30 and 60 DAS.

3.7.8 Harvest of crop

When the harvest matured, the cobs remained dried. The boundary rows of each plot remained picked earliest, leaving only the net plot part. After segregating the plants allocated for record biometric clarifications, the net plot part was harvested. Cobs gathered from the net plot part remained properly dehydrated in the sun. The straws were dehydrated individually in order to record the straw mass treatment by treatment. Cowpea pods were handpicked at ripeness. The plants were then hauled out, wrapped, sundried, and weighed to determine stover production.

3.7.9 Separating grains

Maize cobs were shelled manually by an individual cob maize sheller, and the product from every plot was cleared. The grain's weight was measured and converted to kg per acre.

The yield from every plot was winnowed and cleaned, and the cowpeas were manually threshed. The weight was noted and translated to kilograms per acre.

3.7.10 Weed management practices

Weed control practises were implemented in accordance by the treatments and in treatment T_2, T_5 and T_7 for maize, HW was used twice at 30 and 60 DAS.

In treatments T_2, T_5, and T_7 for cowpea, physical weeding 2 times at 20 and 40 DAS.

3.7.10.1 Chemical weed management for (Maize)

According to the treatments in the trial, several weed management techniques were used. (T_1) Atrazine 700 g pre-emergent on 2 DAS; (T_2) Atrazine pre-emergent 500 g combined by HW on 30 DAS; (T_3) Metribuzin pre-emergent 800 g; (T_4) Tembotrione 42% CS @ 120 g PoE on 30 DAS; (T_5) Post-emergent 2, 4-D Na Salt 800 g on 30 DAS combined by HW on 60 DAS; (T_7) HW twice (30 and 60) DAS;

3.7.10.2 Chemical weed management for (Cowpea)

According to the treatments in the trial, several weed management techniques were used. (T_1) pre-emergent Pendimethalin 1.0 kg on 2 days later seeding; (T_2) pre-emergent Pendimethalin 1.0 kg combined by labour-intensive weeding on 20 DAS; (T_3) post-emergent Imazethapyr 50 g on 20 DAS; (T_4) post-emergent Quizalofop-ethyl 50 g on 20 DAS; (T_5) pre-emergent Metolachlor 1.0 kg combined by physical weeding at 40 DAS; (T_6) post-emergent Quizalofop-ethyl 40 g on 20 days later seeding; (T_7) HW twice 30 and 60 DAS;

3.8: Some important information about herbicides used in trial.

3.8.1 Atrazine

Group : Triazine

Trade Name : AATREX

Common Name : Atrazine

Empirical formula : $C_8H_{14}C_lN_5$

Structural formula :

Dynamic Ingredient (a.i. %) : 50 EC

Useing period : Pre & post-emergent

Kind of weed controller : Yearly grass and wide sheet weeds

Choosiness : Selective

Name of crop in which it is suggested: Maize, sorghum, Soybean besides sugarcane.

Mode of action

Hunger and oxidative injury brought on by an error in the electron transportation mechanism kill plants. High light intensity accelerates oxidative damage. By exposing cells also cell organelles to harsh situations, oxidation ultimately effects in the damage of chlorophyll and other colours like carotenoids after cell membranes, causing collapse, disintegration, and finally weed death.

3.8.2 Metribuzin

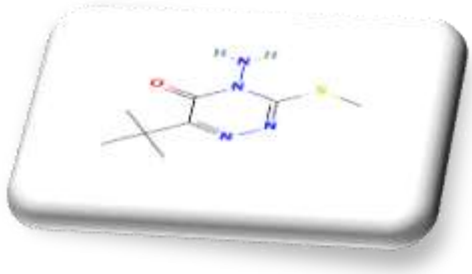
Group : Triazine

Tradeing Name : Sencor

Mutual Name : Tata Metri

Experiential formula: $C_8H_{14}N_4OS$

Structural formula :



Active ingredients (a.i. %) : 70% EC

Useing period : Pre & post-emergent

Kind of weed controller : Yearly grass and wide sheet weeds

Choosiness : Selected

Names of crop in which it is suggested: Maize, sorghum, Potato and sugarcane.

Mode of action

The suppression of the photosynthetic path, exactly photosystem II, These PSII herbicides all bind to the D1 protein complex's QB binding site, which is located in the chloroplast thylakoid membrane, to block the photosynthetic pathway. In addition to blocking the formation of nicotinamide adenine dinucleotide hydrogen phosphate (NADPH2), which is necessary for a number of metabolic pathways involved in plant growth and development, binding also interferes by the electron carriage system (ETS) that runs from QA to QB. The plant is incapable to reoxidize QA, which results in triplet chlorophyll, which reacts by molecular oxygen to produce singlet oxygen (O2), as a result of a blockage at the level of the electron transport chain (ETC) (O2). In the presence of triplet chlorophyll (3 Chl) and singlet oxygen (O2), unsaturated fatty acids and lipids release hydrogen to create a lipid radical, which leads to lipid peroxidation. Reactive oxygen species are created when bilayer lipids and other proteins undergo oxidation due to lipid peroxidation (ROS). Some of these herbicides also interfere by the transcription machinery also the biosynthesis pathways for carotenoid, anthocyanin, and protein. Some weeds have developed resistance to these PSII-inhibiting herbicides, like atrazine and metribuzin, as a result of their excessive use.

3.8.3 Tembotrione

Group : Triketone

Trade Name : Tembotrione

Empirical formula : $C_{17}H_{16}ClF_3O_6S$

Structural formula :

Dynamic Ingredient (a.i. %) : 42% CS

Useing period : Post-emergent

Kind of weed controller : Yearly grass and wide sheet weeds

Choosiness : Selected

Names of crop in which it is suggested: Maize, sorghum, Potato and sugarcane.

Mode of action

These herbicides eliminate chlorophyll, a green pigment that is necessary for photosynthesis in plant life. These herbicides are too recognized as bleaches because, after coming into touch by plant vegetation, they cause plant tissues to turn white. This cause's cell and tissue damage, which ultimately results in the weed's death. These herbicides are also known as HPPD inhibitors since one of their main modes of action involves inhibiting pigment formation, particularly the catalysis of the enzyme 4-hydroxyphenylpyruvate dioxygenase (HPPD).

3.8.4 2, 4-D Na

Group : Acetic acid

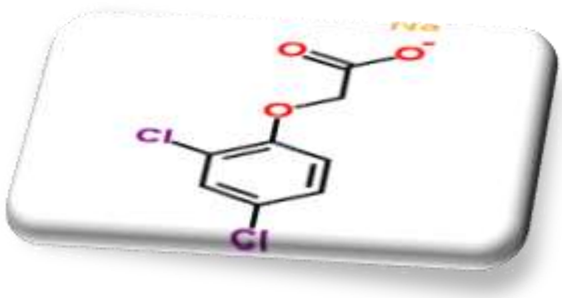
Profession Name : Hedonal

General Name : Weed killer

Chemically Named : Sodium 2, 4-dichlorophenoxyacetate; 2,4-Dichlorophenoxyacetic acid Na

Empirical formula : $C_8H_5Cl_2NaO_3$

Structural formula :



Actived Element (a.i. %) : 80% WP

Useing period : Post-emergent

Kind of weed controller : Yearly grass and wide leaf weeds

Choosiness : Selected

Suggested crops : Maize, sorghum, wheat and sugarcane.

Mode of action

This class of herbicides, commonly referred to as synthetic auxins, is used to prevent wide leaf weeds in the refinement of corn, wheat, then sorghum. Weedicide since the chemical family characterized as benzoic acid, phenoxy-carboxylic acid, pyridinecarboxylic acid, then quinolinecarboxylic acid imitate the activity of endogenous indoleacetic acid (IAA) in a given system. The molecular tie site liable for the activation of IAA is still unclear and has not yet been identified. These controls imitate the function of IAA, boosting transcription, translation, and protein synthesis in the cell, causing unchecked vascular development that eventually leads to cell rupture.

3.8.5 Topramezone

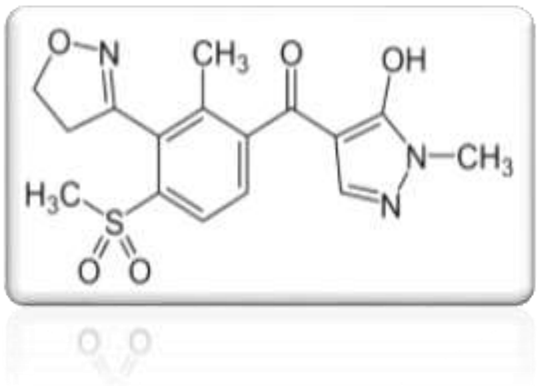
Group : Pigment synthesis inhibitors (27)

Trade Name : IMPACT

Common Name : Tinzer

Empirical formula : $C_{16}H_{17}N_3O_5S$

Structural formula :



Actived Element (a.i. %) : 33.6 %

Useing period : Post-emergent

Kind of weed controller : Yearly grass and wide sheet weeds

Choosiness : Selected

Crop names through which it is implied: Maize, chickpea, and sugarcane etc.

Mode of action

Such herbicides, also recognized as carotenoid and biosynthesis inhibitors, destroy the chlorophyll, a green stain, which is essential for photosynthesis in vegetation. Those herbicides are also recognized as bleaches because they because plant tissues to turn white when they come into touch by them, and the plant's leaves induce weeds to die by damaging their cells and tissues. These herbicides are also known as HPPD-inhibitors since one of their main modes of action is the inhibition of pigment formation, specifically the catalysis of the enzyme 4-hydroxyphenylpyruvate dioxygenase (HPPD). Isoxazole is a chemical family that belongs to group 27 and also includes HPPD inhibitors. In healthy plants, carotenoids are essential for quenching the oxidative control of singlet O2. The quantity of carotenoids is decreased following treatment by these herbicides (Groups 12, 13 and 27) that contain inhibitors of pigment production, which results in the existence of unbound lipid radicals. These lipid radicals pose a hazard to the uptake of lipids and fat acids in cell membranes that lead to lipid peroxidation and the production of chlorophyll, as well as other lipids in other cell membranes and some non-functional proteins. The contents of the cell were exposed and swiftly destroyed as a result of membrane leakage, which led to the wilting and final death of the plants.

3.8.6 Pendimethalin

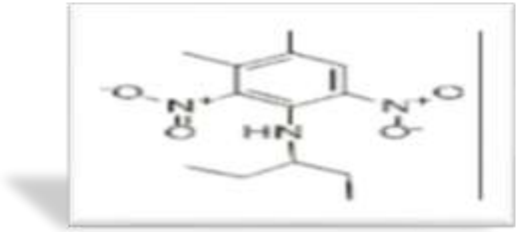
Group : Dinitroaniline

Trader Name : Stomp

General Name : Pendimethalin/ penoxalin

Experiential formula: $C_{13}H_{19}N_3O_4$

Fundamental formulation :



Activated Element (a.i. %) : 30 EC

Useing period : Post-emergent

Kind of weed controller : Yearly grass and wide sheet weeds

Choosiness : Selected

Crop names through which it is implied: Soybean, maize, tobacco, sorghum, rice.

Mode of action

The quantity of carotenoids is decreased following treatment by these herbicides (Groups 12, 13 and 27) that contain inhibitors of pigment production, which results in the existence of liberated lipid radicals. Such lipid radicals pose a hazard to the uptake of lipids and fat acids in cell membranes that lead to lipid peroxidation and the production of chlorophyll, as well as other lipids in other cell membranes and some non-functional proteins. The contents of the cell were exposed and swiftly destroyed as a result of membrane leakage, which led to the wilting and final death of the plants.

3.8.7 Imazethapyr

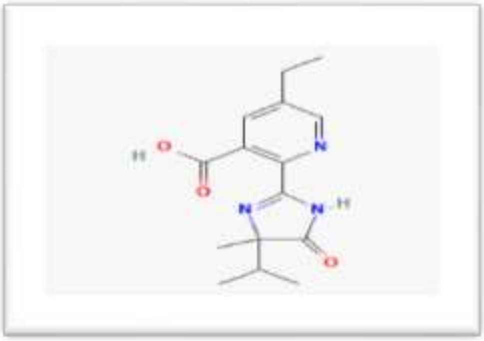
Group : Imidazolinone

Trade Name : Persuit

Common Name : Imazethapyr

Empirical formula : $C_{15}H_{19}N_3O$

Structural formula:



Activeed Element : 10 % WP

Useing period : Post-emergent

Kind of weed controller : Yearly grass and wide sheet weeds

Choosiness : Selected

Name of crop in which it is suggested: Gram, Ground nut, soybean.

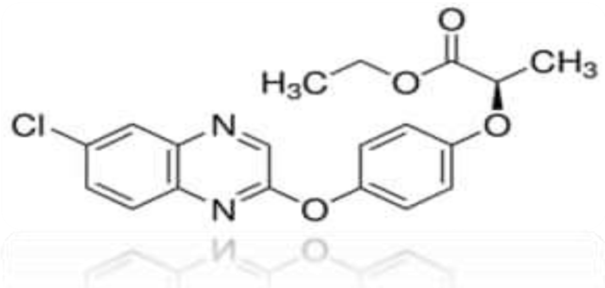
Mode of action

Imazethapyr is used to control broadleaf weeds and annual and perennial grasses. It gets after the plant through the leaves and roots. Pre-emergent treatment causes seedlings to emerge but their growth to halt at the cotyledon stage. Growth will be stopped by the PoE spray, and meristems may swell and die.

3.8.8 Quizalofop-ethyl

Group	: aryloxyphenoxypropionate
Trade Name	: Targa Super
Common Name	: Pilot Super
Empirical formulation	: $C_{19}H_{17}ClN_2O_4$

Structural formula:



Actived Element	: 5 % CS
Useing period	: Post-emergent
Kind of weed controller	: Yearly grass and wide sheet weeds
Choosiness	: Selected

Names of crop in which it is suggested: vegetables, sugar beets, peanuts, Soybean, potatoes and cotton.

Mode of action

These herbicides, also referred to as lipid biosynthesis inhibitors, wich inhibit the ACC ASE enzyme also are normally employed for weed control during crop rotation or broadleaf cropping variety. The primary stage in fatty acid production is catalysed by the enzyme ACCase, which prevents the development of the phospholipids required for the synthesis of the lipid bilayer, which is essential for cell structure also function. Aryloxyphenoxypropionate, cyclohexanedione, and phenyl pyrazoline are chemical compounds that block the activity of the ACCase enzyme. The chemical family names FOP, DIM, and DEN are further names for these herbicides. A robust and less sensitive ACCase system gives several types of broadleaf crops, including grasses, a natural resistance to these herbicides.

3.8.9 Metolachlor

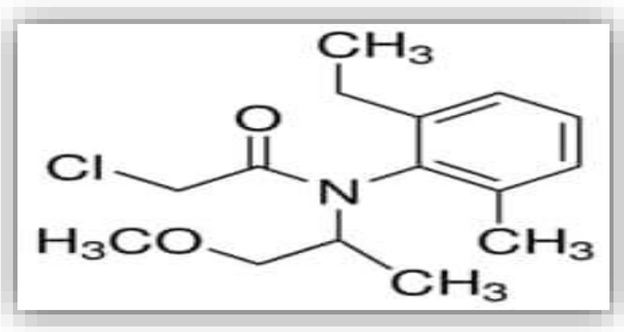
Group : Thiocarbamates

Trade Name : Milocep

Common Name : S-Metolachlor

Empirical formula: $C_{15}H_{22}ClNO_2$

Structural formula:



Activeed Element : 7.6 % EC

Useinf period : Post-emergent

Kind of weed controller : Yearly grass and wide sheet weeds

Choosiness : Selected

Names of crop in which it is suggested: Corn, peanuts, and soybean.

Mode of action

These herbicides, also recognized as slip root development inhibitors, work by preventing cell division, which prevents root elongation and growth. They are used on ornamental and vegetables plants prior to emergence. Their mechanism of action occurs at the microtubule, and they are distinguished by the assembly of an herbicide-tubulin complex there. By assembly, this compound prevents microtubule polymerization, although it is unaffected during depolymerization Causes cell death by interfering by the development of the cell wall as a result of spindle misaligned filaments and chromosomal non-separation during mitotic cell division. Benzamide, benzoic acid [dimethyl-2, 3, 5, 6-tetrachloroterephthalate (DCPA), di-nitroaniline, phosphoramidate, and the pyridine substance family are members of this group, which work by preventing the production of microtubules, which obstructs cell division.

3.9 Observation schedule

3.9.1 Weed flora

According to the type of cotyledons, the significant weed species connected to the maize and cowpea crops in the field under experimentation were divided into monocot and dicot weeds. After 30 days of sowing, the composition of the weed flora was noted.

3.9.2 Relative Weed density (%)

The species-wise and total weed density remained observed for 30, 60, and 90 DAS and harvesting in maize and cowpea by 20, 40, and 60 DAS and harvest. 2 spots were nominated erratically in a separate plot using a 0.25 m^2 quadrate to mark the part. The data were noted for statistical analysis. Before doing an analysis of variance, weed density was transformed by the square root, or (X + 0.5), wherever X is the entire amount of weeds.

3.9.3 Weed's dry weight (g/m^2)

At 30, 60, and 90 days and at harvest after planting, the dry weight of each species of weed was measured, as well as at 20, 40, 60, and the time of harvest for maize and cowpea. The square-shaped weeds that were already there were carefully plucked out by the roots. The samples roots were removed, and only the aerial portions were scoured, dried, and then dried for 48 hours in an oven at 60 ^oC. The dry weight of various weed species was measured after competitive oven drying. Using an electronic scale for dry weighing Weed dry weight was transformed using the square root, or (X + 0.5).

3.9.4 WI (%)

It is a measure that represents the decline in yield brought on by the existence of weeds when compared to a weed-free environment. It was said in percent, then calculated by using the following formula:

$$\mathrm{WI} = \frac{\text{Higer seed yield} - \text{Seed yield of treated plot}}{\text{Highest seed yield}} \times 100$$

3.9.5 Weed control efficiency (%)

According to Mani *et al*. (1973), the percentage of dry weight of weeds in treated plots associated by weedy control was used to compute species-specific and overall weed control efficacy at 30, 60, and 90 DAS as well as at harvest in maize and cowpea.

$$WCE = \frac{DWC - DWT}{DWC} \times 100$$

Where,

WCE = Weed control efficiency (%)

DWC = Weeds in the overgrown check patch, dry weight (g)

DWT = Weeds dry weight in the treatment plot (g)

3.10 Studies on crop (Maize-cowpea)

3.10.1 Plant population

The plant population in each plot was counted in five randomly selected rows by the help of a measuring scale. A meter scale was placed randomly in five rows of each plot, and then plants were counted in meter^{-1} running row length at 30 DAS of the average population of maize and cowpea during both years.

3.10.2 Plant height (cm)

In maize and cowpea, the height of 5 labelled plants in an individual plot remained taken in cm on 30, 60, and 90 DAS, as well as during harvest, and used for statistical analysis. Plant height stayed measured in centimetres after the earth to the tallest leaf. The mean length was then determined by dividing the total by five.

3.10.3 Branches per plant

In each plot, the total number of branches was calculated from five randomly labelled plants.and average value was calculated.

3.10.4 Accumulation of dry matter per plant (g)

In maize dry weight was taken at 30 days intervals and in cowpea 20 days intarvals was taken. Selected and uprooted 5 plants randomly and dried in shade and dried in oven for 48 hours in hot air at 60 °C constant weight calculed their average value.

3.10. Root nodules plant^{-1}

Data on 20 and 40 DAS, cowpea plants from five randomly chosen plants in each plot's border rows were counted for the quantity of nodules plant^{-1}. Plants were carefully excavated along by the soil of the active root zone from individually plot. Roots of plant were carefully wash away in sieve through flowing water then root nodules detached then counted.

3.10.6 LAI

LAI is a dimensionless quantity that characterizes plant canopies. The ratio of leaf area to ground area occupied by plant leaves. It is measured at 30 DAS interval in maize and 20 DAS intervals in Cowpea during both year.

$$\text{LAI} = \frac{\text{leaf area meter square}}{\text{ground area meter square}}$$

3.10.7 Days to 50% blossoming

The plots inspected everyday, and the exact day while 50% of the plants in the experimental plot reached blooming stage was noted. Times were tallied beginning on the dates that the cowpea and maize were sown in both years.

3.10.8 Crop growth rate (CGR) g/cm2/gay

At intervals of 60-30, 90 -60, then 120 -90 DAS, the growth rate of crop of maize was measured, and at intervals of 20 to 40 and 40 to 60 DAS for cowpea. The increase in the amount of dry weightper unit of land per unit duration is known as the rate of growth of crop. The dimension is in g m^2 day^1

$$\text{CGR} = \frac{\mathbf{W2-W1}}{\mathbf{T2-T1}} \text{X} \frac{\mathbf{1}}{\mathbf{A}}$$

3.10.9 Rate of relative growth (RGR) g/g/day

At intervals of 30 - 60, 60 - 90, then 90 - 120 DAS, the rate of relative growth the maize crop was measured, and at intervals of 20 to 40 and 40 to 60 DAS for the cowpea crop. The rise in dry weightper unit of previously existing dry weightis referred to as the relative growth rate. It's stately in g per g per day.

$$RGR = \frac{\text{Log e W2} - \text{Log e W1}}{\text{T2} - \text{T12}}$$

3.11 Studies on yield attribute & yield

3.11.1 Cobs per Plant

Total cobs are harvested of tagged plants and calculated total quantity of cobs each plant.

3.11.2 Kernels rows per cobs

The total quantity of kernel rows per cob was calculated by including the total amount of grain rows on each cob of the labelled plants.

3.11.3 Seeds per Cob

Total quantity of seeds since 5 cobs was calculated and stated as average quantity of grains per cob.

3.11.4 Pods per plant

To evaluate the influence of different treatments on pod yoeld in the cowpea, a total amount of pods collectd and calculated from five accidentally labelled plants in an individual plot. The mean was calculated by dividing the overall number of pods by 5, which was then utilized for statistical examination.

3.11.5 Seeds per pod

At random selection pods pick from 5 labeled plants from individually plot taken up and the kernels stood counted, and mean quantity of seeds/pod was considered by averaging pods of five marked plants.

3.11.6 Seed Index (g)

Seed samples were obtained at random from each maize and cowpea net plot. Hundreds of healthy seeds were counted from each plot's crop and oven dried at 60 C until the consistent weight was achieved, after which mass was carefully noted in grams using an electronic digital scale.

3.11.7 Seed (kg per hectare)

Each net plot's seed production was noted and converted to kilogrammes per hectare (kg) after maize and cowpea were threshed, winnowed, and dried in bright sunlight. In Maize the moisture content was 14% after sun drying.

3.11.8 Straw (kg per hectare)

The harvested maize and cowpea output from separately net plot stood sundried then bundled in bundles individually, and the bundle weight (biological yield) was calculated by the help of a spring weighing scale. After bydrawing the yield of seed from a pack weight of the individual plot, the plot's living yield was noted. Stover yield was calculated in kg/hectare.

3.11.9 HI

The harvesting index was calculated using Donald's (1962) method by taking the mean rate of grain production then the biotic output on the harvest time

Index of Harvest $= \frac{\text{Economical yield}}{\text{Biological yield}} \times 100$

Whereas,

Inexpensive yield = grain/kernal yields

Biotic yield = grain yield + Straw yield.

3.12 Herbicide persistence studies bioassay

Bioassays are the experiments that use to check the activity of herbicides remain stuck in soil.

3.12.1. Bioassay (Maize)

The composite soil samples were obtained from 2 depths of each treated plot, namely 0-15 and 15-30 cm, at 0, 1, 2, 5, 30, 60, and 90 days following herbicide usage (30 days interval up to harvest). Soil samples were treated via 2 mm sieve. 500 g sieved soil was placed on bioassay plates 15 cm X 14 cm X 3.5 cm in size. In each pot, ten cucumber seeds were sowed around 5 mm deep. Every day, the plates were watered. The plants were plucked after 7 days and carefully cleaned to eliminate the dirt. The shoot and root lengths were measure, and the normal value of the shoot and root length was used.

3.12.2 Bioassay (Cowpea)

The composite soil examples were obtained from 2 depths of each treated plot, namely 0-15 and 15-30 cm, at 0, 1, 2, 5, 30 and 60 days following herbicide usage (30 days interval up to harvest. Ground soil tasters were treated via 2 mm sieve. 500 g sieved soil was placed on bioassay plates 15 cm X 14 cm X 3.5 cm in size. In each plate, ten oat seeds were sowed around 5 mm deep. Every day, the plates were watered. The plants were plucked after 7 days and carefully cleaned to eliminate the dirt. The shoot also rooting lengths stayed then measure, and the normal value of the shoot plus root extents was used.

3.13 Economics

The economics of maize and cowpea crop yield in relation to each treatment have been calculated in terms of cultivation costs. In order to calculate the gross return (Rs ha^{-1}), the harvested produce was converted into money during the duration of the experiments for each treatment at the going market rate. By subtracting cultivation costs from gross return, net profit (Rs ha^{-1}) was computed. By the use of the subsequent method, the benefit: cost ratio was determined:

Net profit = Gross profit – Cultivation budget

$$\text{Benefit: cost ratio} = \frac{\text{Net returns (Rs/ha)}}{\text{Cost of Cultivation/ha}} \times 100$$

3.14 Statistics analysis

A randomised block design (RBD) was used to set up the experiment. The information collected on different factors were tabulated, collected, and analysed statistically. Prior to performing an analysis of variance, the weed density and dry weight data were squad transformed, and formatted, i.e. (x+0.5). The impact of treatment was examined using the 'F' test, and when the 'F' test revealed consequence, the amounts of treatment stood associated using the crucial difference on the 5% probability of level. Analysis of the variance skeleton then equation used aimed at various assumptions stand provided further down (Gomez and Gomez, 1984).

Chart 3.13. Stastics and analysis of variances

Source of variance	**D.F.**	**SS**	**MSS**	**F Cal**	**F Tab (5%)**	**SEm ±**	**CD 5 %**
Replication (r)	(r-1) (2)	RSS	RMS	RMS/EMS	_	--	--
Treatment (t)	(t-1) (7)	TrSS	TrMS	TrMS/ES	_	--	--
Error	(r-1) (14) (t-1)	ESS	EMS	--	--	--	--
Total	rt-1 (23)	TSS	--	--	--	--	--

The subsequent formulas remained used to estimate standard error, critical difference, and then constant of variance.

(a) S.Em± = √(EMS/r)

(b) C.D. = S.Em x √(2) x t(p=0.05) at error d.f

(c) C.V. (%) = √(EMS/GM) x 100

Where,

r = replication numbers

t = treatments number

d.f. = Freedom degree

M.S.S. = Mean sum of square

S.Em± = mean of standard error

EMS = Error mean squares

C.D. = Critical change.

4. Results and Discussion

During the *spring* and *Kharif* of 2021 and 2022, a field trial was conducted at Lovely Professional University's department of agriculture in Jalandhar entitled "**Evaluation of pre and PoE herbicides on weed control, growth, and yield of maize-cowpea cropping systems" under Trans-Gangetic Plains of Punjab.** This chapter presents and describes the research's results.

4.1. Weeds studies

4.1.1. Weed flora associated with maize crop

The following weeds were discovered in the investigational fields, listed in order of ascendency: Concerning all weed species, was dominant at all crop growth phases.

Sr. No.	Common Name	Botanical Name	Family
A	**Monocot**		
1.	Tropical spiderwort	*Commelina benghalensis* L.	Commelinaceae
2.	Bermuda grass	*Cynodon dactylon*	Poaceae
B	**Sedges**		
3.	Purple nutsedge	*Cyperus rotundus* L.	Cyperaceae
C	**Dicot**		
4.	Common lambs quarter	*Chenopodium album* L.	Amaranthaceae
5.	congress grass	*Parthenium hysterophorus* L.	Asteraceae
6.	Hemp.	*Cannabis Sativa*L.	Cannabaceae – hemp
7.	Wild mustard.	*Sinapis arvensis* L.	Brassicaceae

Chart 4.2 Weed flora detected in the investigational area from germination to harvest. (2021 and 2022)

Sr. No.	Weed species	30 DAS	60 DAS	90 DAS	Harvest
1	*Commelina bengalensis*	✓	✓	✓	✓
2	*Cynodon dactylon*	✓	✓	✓	✓
3	*Cyperus rotundus*	✓	✓	✓	✓
4	*Chenopodium album*	✓	✓	✓	✓
5	*Parthenium hysterophorus*	✓	✓	✓	✓
6	*Cannabis sativus*	✓	✓	✓	✓
7	*Sinapis arvensis*	✓	✓	✓	✓

✓ Represent present of weeds

The most common types of weed found in the test location were *Commelina bengalensis*, *Cynodon dactylon* among monocots, and *Cyperus rotundus* among *sedges, Chenopodium album*, *Parthenium hysterophorus*, *Cannabis sativus, and Sinapis arvensis* among dicots. Among all the 3 weed sets, the experimental plots' weed flora was identified and categorized using its ontogeny and morphology. In maize in 2021 and 2022. All the weed species observed were most prevalent in the field throughout the two years. Comparable weed flora was also discovered by Swetha *et al.* (2015), Ram *et al*. (2018), Sapna *et al.* (2019), and Rajeshkumar *et al.* (2018).

Chart 4.3: Influnce of herbicides on count of *Commelina benghalensis* L. in maize at monthly intervals. (2021 and 2022).

Treatments	30 DAS (2021)	30 DAS (2022)	Pooled data	60 DAS (2021)	60 DAS (2022)	Pooled data	90 DAS (2021)	90 DAS (2022)	Pooled data	Harvest (2021)	Harvest (2022)	Pooled data
T_1	1.55*	81.58	1.56	1.64	1.67	1.65	1.67	1.70	1.68	1.64	1.64	1.64
	(2.4)**	**(2.52)**	**(2.46)**	**(2.70)**	**(2.81)**	**(2.75)**	**(2.80)**	**(2.91)**	**(2.84)**	**(2.70)**	**(2.72)**	**(2.71)**
T_2	1.73	1.94	1.84	1.00	1.04	1.03	1.04	1.04	1.04	0.99	1.05	1.02
	(2.50)	**(3.78)**	**(3.39)**	**(1.02)**	**(1.09)**	**(1.05)**	**(1.09)**	**(1.10)**	**(1.10)**	**(0.99)**	**(1.11)**	**(1.05)**
T_3	1.64	1.63	1.63	1.70	(1.69	1.70	1.76	1.79	1.77	1.75	1.50	1.62
	(2.70)	**(2.67)**	**(2.68)**	**(2.90)**	**2.88)**	**(2.89)**	**(3.10)**	**(3.22)**	**(3.16)**	**(3.00)**	**(2.28)**	**(2.64)**
T_4	2.12	2.14	2.1	1.55	1.25	1.57	1.64	1.61	1.62	1.61	1.59	1.60
	(4.51)	**(4.59)**	**(4.55)**	**(2.40)**	**(2.57)**	**(2.48)**	**(2.70)**	**(2.60)**	**(2.65)**	**(2.6)**	**(2.55)**	**(2.57)**
T_5	2.29	2.27	2.28	1.00	1.05	1.02	1.03	1.04	1.03	0.98	1.01	1.00
	(5.25)	**(5.17)**	**(5.21)**	**(1.00)**	**(1.11)**	**(1.05)**	**(1.07)**	**(1.10)**	**(1.08)**	**(0.97)**	**(1.03)**	**(1.00)**
T_6	2.31	2.30	2.30	1.73	1.79	1.76	1.79	1.51	1.65	1.63	1.66	1.64
	(5.37)	**(5.29)**	**(5.33)**	**(3.00)**	**(3.22)**	**(3.11)**	**(3.20)**	**(2.29)**	**(2.74)**	**(2.65)**	**(2.75)**	**(2.70)**
T_7	2.35	2.34	2.34	1.09	1.13	1.11	1.00	1.00	1.00	0.91	0.98	0.95
	(5.55)	**(5.49)**	**(5.52)**	**(1.20)**	**(1.29)**	**(1.24)**	**(1.00)**	**(1.00)**	**(1.00)**	**(0.83)**	**(0.97)**	**(0.90)**
T_8	2.44	(2.42	2.62	2.92	2.72	2.82	2.79	2.83	2.81	2.79	2.81	2.80
	(6.00)	**(5.86)**	**(6.88)**	**(8.53)**	**(7.44)**	**(7.89)**	**(7.81)**	**(7.99)**	**(7.90)**	**(7.79)**	**(7.91)**	**(7.85)**
SEm (±)	**0.08**	**0.06**	**0.07**	**0.13**	**0.08**	**0.11**	**0.18**	**0.09**	**1.14**	**0.23**	**0.10**	**0.17**
CD (p=0.05)	**0.25**	**0.17**	**0.21**	**0.39**	**0.23**	**0.31**	**0.54**	**0.28**	**1.14**	**0.71**	**0.31**	**0.51**

I. Maize

4.1.2 Species-wised and total weed count

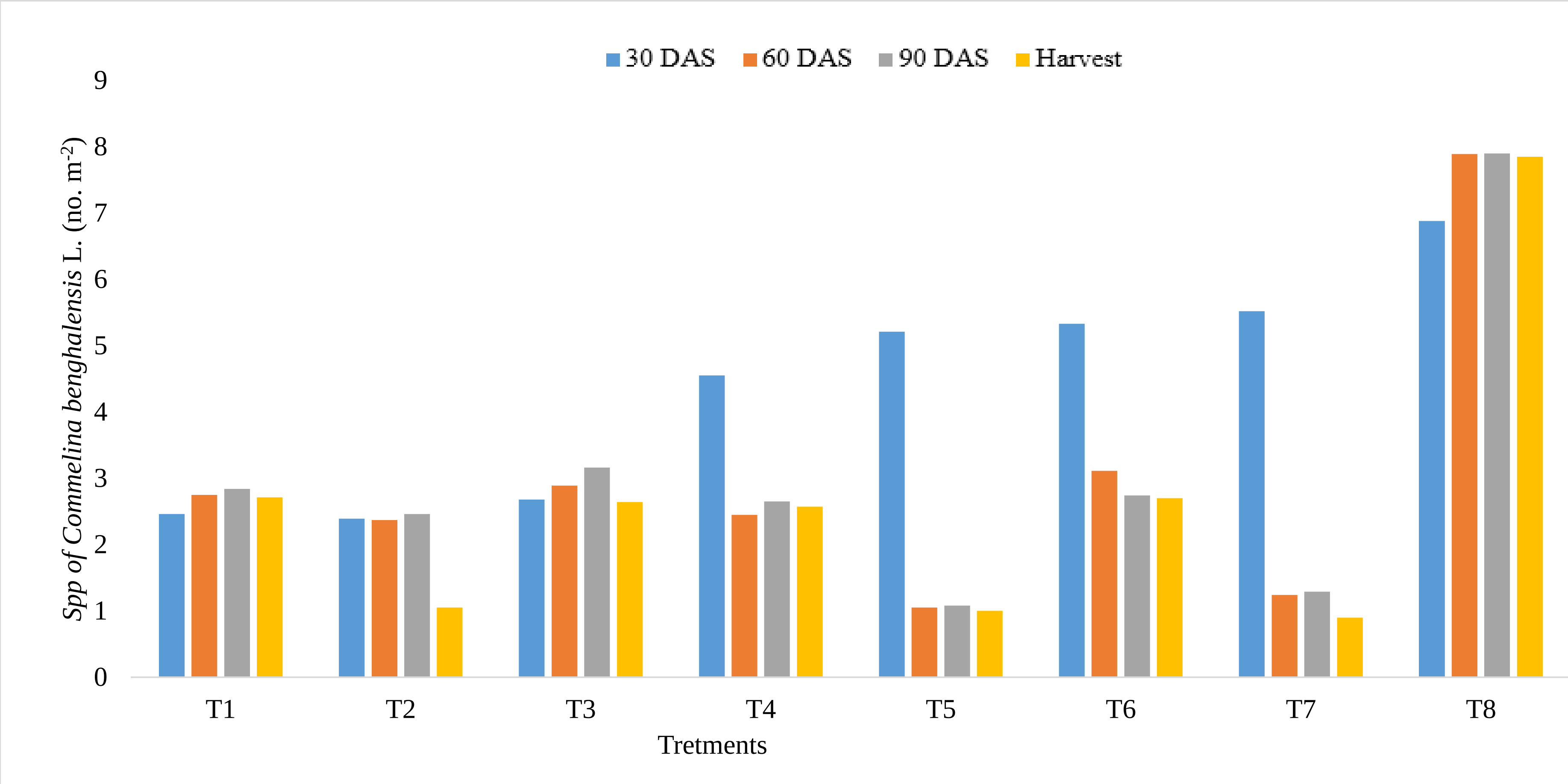
The data concerning the weed count at 30, 60, 90 and then harvest, shows all weeds recorded species-wise and total.

4.1.2.1 *Commelina benghalensis* L.

The data concerning the weed population of *Commelina benghalensis* L. effect ofdifferent weed control treatments in every phase of observations in the years 2021 and 2022, as presented in Chart 4.3 and Fig. 1, shows that the weed control actions had a substantial impact on *Commelina benghalensis* L. at all phases of observations.

Data on *Commelina benghalensis* L. populations from 2021 and 2022 showed that all weed management methods considerably reduced the population of the weed over the unweeded. At 30 DAS, PE treatment noted a minimum count of *Commelina benghalensis* L. as associated by PoE treatment. At 60 DAS, the highest count of *Commelina benghalensis* L. was obtained in the use of Topramezone 200 g PoE, closely followed by Metribuzin 800 g PE. The minimum count in 2, 4-D Na 800 gPoE combined by HW on 60 DAS tracked by HW twice (30 and 60 DAS) and comparable outcomes were noted by Samant *et al.* (2015). At 90 days between sowing and harvest, the same treatment noted minimum and superior counts of *Commelina benghalensis* L. during both seasons as associated by the unweeded.

The cumulative data are represented by chart 4.3 and graph 4.1, which resulted in 30 days after the sowing PE request of Metribuzin 800 g PE and Atrazine 700 g PE arresting the growth of *Commelina benghalensis* L. as associated by other treatments. At 60 DAS, all the herbicidal actions resulted from the minimum count of *Commelina benghalensis* L. over the un-weeded check. Post-emergent use of 2, 4-D Na 800 g + HW at 60 DAS was noted as the minimum weed count.



Graph 4.1 Influnce of herbicides on count of *Commelina benghalensis* L. in maize at monthly intervals. (2021 and 2022).

Chart 4.4: Influnce of herbicides on count of *Cynodon dactylon* L. in maize on a monthly basis (2021 and 2022).

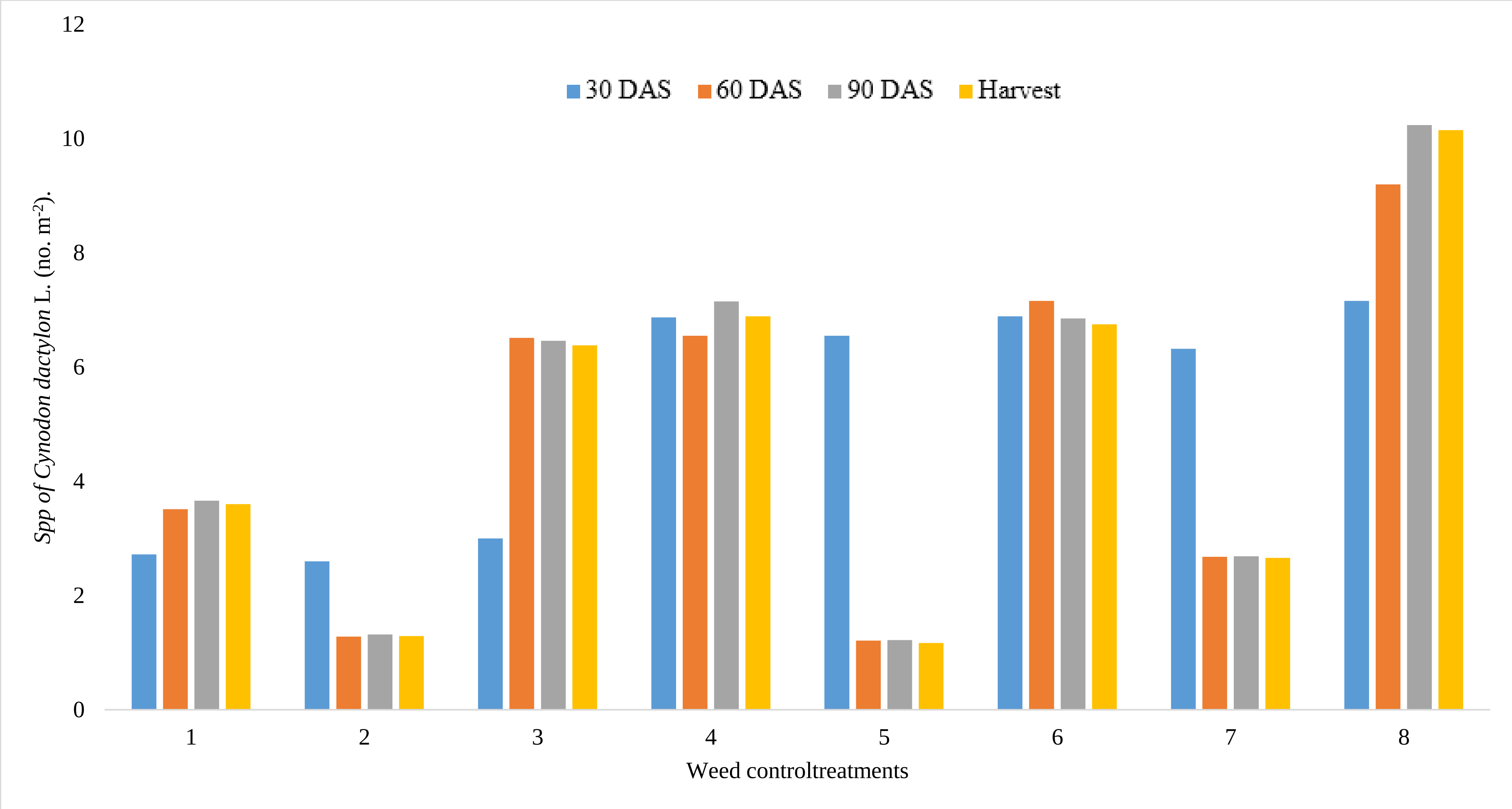
Treatments	30 DAS (2021)	30 DAS (2022)	Pooled data	60 DAS (2021)	60 DAS (2022)	Pooled data	90 DAS (2021)	90 DAS (2022)	Pooled data	Harvest (2021)	Harvest (2022)	Pooled data
T_1	1.87* **(2.73)****	1.92 **(2.72)**	1.89* **(2.72)****	2.34 **(3.50)**	2.35 **(3.83)**	2.34 **(3.51)**	2.49 **(3.20)**	2.02 **(4.12)**	1.83 **(3.66)**	1.88 **(3.53)**	1.92 **(3.67)**	1.90 **(3.60)**
T_2	1.64 **(2.70)**	1.58 **(2.51)**	1.67 **(2.60)**	1.09 **(1.20)**	1.15 **(1.33)**	1.13 **(1.28)**	1.14 **(1.28)**	1.16 **(1.35)**	1.15 **(1.32)**	1.12 **(1.25)**	1.15 **(1.33)**	1.14 **(1.29)**
T_3	1.70 **(2.90)**	1.76 **(3.10)**	1.73 **(3.00)**	2.55 **(6.50)**	2.55 **(6.52)**	2.55 **(6.51)**	2.55 **(6.50)**	2.53 **(6.43)**	2.54 **(6.46)**	2.52 **(6.35)**	2.53 **(6.41)**	2.53 **(6.38)**
T_4	2.64 **(7.00)**	2.72 **(6.74)**	2.62 **(6.87)**	2.57 **(6.60)**	2.55 **(6.51)**	2.55 **(6.55)**	2.68 **(7.20)**	2.66 **(7.11)**	2.67 **(7.15)**	2.62 **(6.84)**	2.63 **(6.94)**	2.62 **(6.89)**
T_5	2.77 **(7.70)**	2.86 **(8.20)**	2.81 **(7.95)**	1.09 **(1.20)**	1.10 **(1.23)**	1.10 **(1.21)**	1.10 **(1.24)**	1.10 **(1.21)**	1.11 **(1.22)**	1.06 **(1.12)**	1.10 **(1.22)**	1.08 **(1.17)**
T_6	2.88 **(8.30)**	2.81 **(7.93)**	2.84 **(6.12)**	2.68 **(7.20)**	2.66 **(7.12)**	2.67 **(7.16)**	2.60 **(6.80)**	2.62 **(6.91)**	2.61 **(6.85)**	2.60 **(6.74)**	2.61 **(6.82)**	2.60 **(6.78)**
T_7	2.47 **(6.10)**	2.55 **(6.54)**	2.51 **(6.32)**	1.64 **(2.70)**	1.63 **(2.66)**	1.63 **(2.68)**	1.14 **(2.68)**	1.15 **(2.70)**	1.15 **(2.69)**	1.62 **(2.62)**	1.64 **(2.70)**	1.63 **(2.66)**
T_8	3.14 **(9.90)**	2.72 **(7.43)**	2.94 **(8.60)**	2.94 **(8.63)**	3.13 **(9.77)**	3.03 **(9.20)**	3.19 **(10.18)**	3.21 **(10.28)**	3.20 **(10.24)**	3.16 **(10.00)**	3.21 **(10.30)**	3.19 **(10.15)**
SEm (±)	**0.06**	**0.08**	**0.07**	**0.10**	**0.07**	**0.09**	**0.14**	**0.09**	**0.12**	**0.16**	**0.11**	**0.14**
CD (p=0.05)	**0.17**	**0.25**	**0.21**	**0.29**	**0.20**	**0.25**	**0.41**	**0.27**	**0.34**	**0.48**	**0.34**	**0.41**

4.1.2.2 *Cynodon dactylon* L.

In the years 2021 and 2022 concerning the weed population and the number of individuals of *Cynodon dactylon* L. effect ofvarious weed control methods at all observational stages showed that weed control methods affected the population of *Cynodon dactylon* L. at all observational methods.

Data on the number of species of *Cynodon dactylon* L. in 2021 and 2022 showed that all weed management methods considerably reduced the species' population. At 30 DAS, PE herbicide arrests the weed population of *Cynodon dactylon* L. At 60 days intervals, the minimum count of *Cynodon dactylon* L. post-emergent use of 2, 4-D Na (800 g) combined through physical weeding on 60 DAS and subsequently HW twice (30 & 60 DAS) Comparable outcomes were also reported by Sonali Biswas *et al.* (2018) and were heaviest in Topramezone (200 gPoE) over an un-weeded check. At 90 DAS and harvest, a lower minimum count of *Cynodon dactylon* L. was obtained after the post-emergent use of 2, 4-D Na 800 g combined by HW at 60 DAS and the heaviest Tembotrione 120 gPoE over the un-weeded check.

The cumulative data represented by chart 4.4 and represented in graph 4.2 suggest the heaviest count of *Cynodon dactylon* L. in PoE treatment because there is no use of herbicides up to 30 DAS. The pre-emergent action of Atrazine 500 g PE plus one HW (30 DAS) effectively controls *Cynodon dactylon* L. At 60 DAS PoE 2, 4-D Na 800 g combined by HW at 60 DAS noted the minimum weed population as paralleled to HW over the check. At 90 days between sowing and harvest, the heaviest count of *Cynodon dactylon* L. in Tembotrione 120 g PoE and minimum by 2, 4-D Na 800 g PoE in addition to HW on 60 DAS over an un-weeded.



Graph. 4.2 Influnce of herbicides on count of *Cynodon dactylon* L. in maize on a monthly basis (2021 and 2022).

Chart 4.5: Influnce of herbicides on count of *Cyperus rotundus* L.in maize at monthly intervals. (2021 and 2022)

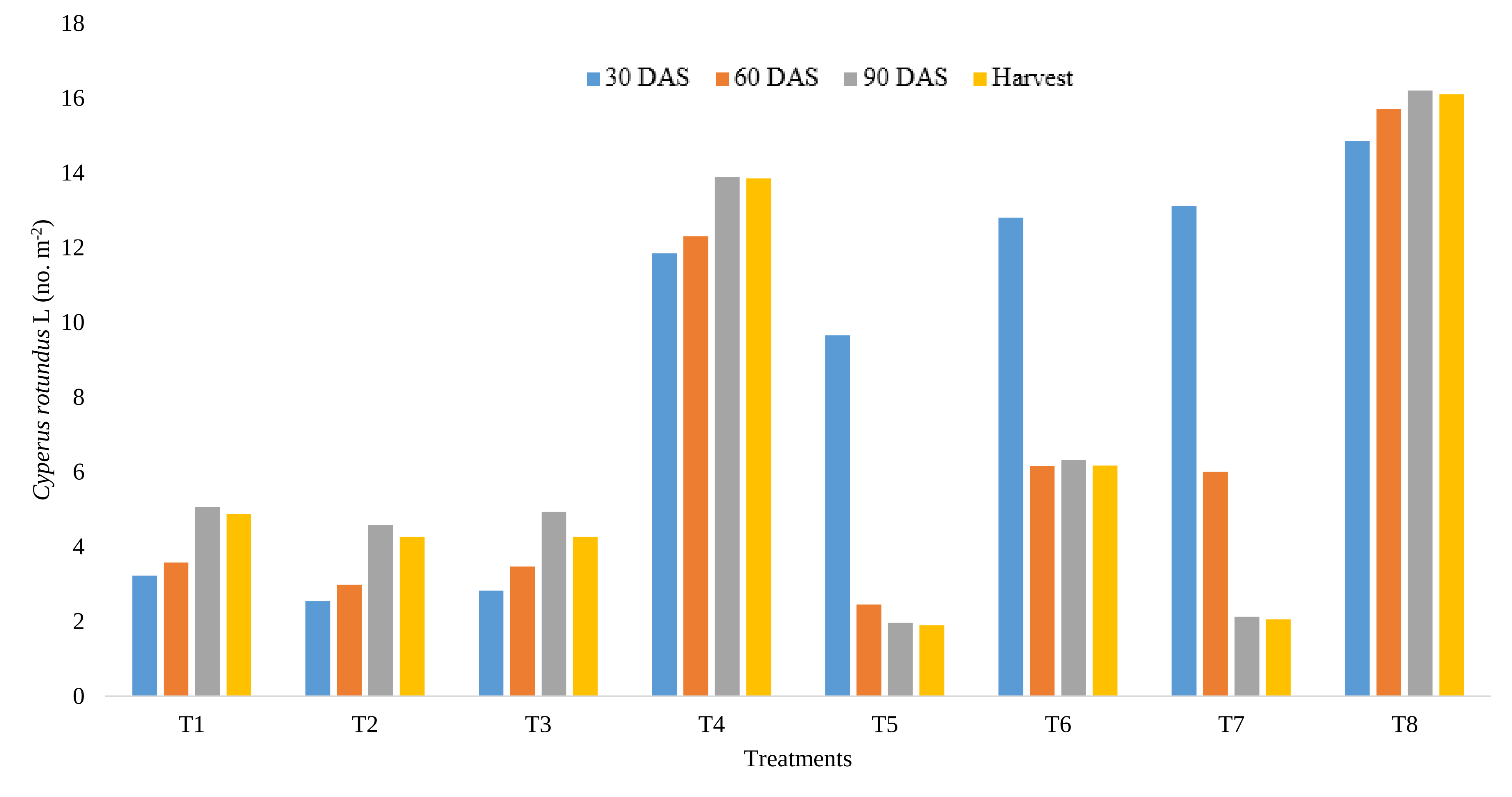
Treatments	30 DAS (2021)	30 DAS (2022)	Pooled data	60 DAS (2021)	60 DAS (2022)	Pooled data	90 DAS (2021)	90 DAS (2022)	Pooled data	Harvest (2021)	Harvest (2022)	Pooled data
T_1	1.79*	1.80	1.79	1.90	1.88	1.88	2.24	2.26	2.24	2.19	2.22	2.20
	(3.20)**	**(3.25)**	**(3.22)**	**(3.60)**	**(3.55)**	**(3.57)**	**(5.00)**	**(5.12)**	**(5.06)**	**(4.80)**	**(4.96)**	**(4.88)**
T_2	1.57	1.60	1.59	1.73	1.72	1.72	2.12	2.16	2.14	2.05	2.07	2.06
	(2.50)	**(2.59)**	**(2.54)**	**(3.00)**	**(2.96)**	**(2.98)**	**(4.50)**	**(4.67)**	**(4.58)**	**(4.20)**	**(4.32)**	**(4.26)**
T_3	1.67	1.68	1.67	1.87	1.85	1.86	2.21	2.22	2.22	2.12	2.09	2.14
	(2.80)	**(2.84)**	**(2.82)**	**(3.50)**	**(3.44)**	**(3.47)**	**(4.90)**	**(4.96)**	**(4.93)**	**(4.50)**	**(4.67)**	**(4.58)**
T_4	3.38	3.50	3.44	3.56	3.44	3.50	3.82	3.63	3.72	3.71	3.73	3.72
	(11.40)	**(12.30)**	**(11.85)**	**(12.70)**	**(11.90)**	**(12.30)**	**(14.60)**	**(13.18)**	**(13.89)**	**(13.77)**	**(13.93)**	**(13.85)**
T_5	3.08	3.13	3.10	1.57	1.55	1.56	1.41	1.38	1.40	3.36	1.40	1.38
	(9.50)	**(9.80)**	**(9.65)**	**(2.50)**	**(2.41)**	**(2.45)**	**(2.00)**	**(1.92)**	**(1.96)**	**(1.84)**	**(1.96)**	**(1.90)**
T_6	3.58	3.60	3.57	2.40	2.49	2.48	2.51	2.51	2.51	2.47	2.49	2.48
	(12.80)	**(13.00)**	**(12.80)**	**(6.10)**	**(6.23)**	**(6.16)**	**(6.30)**	**(6.35)**	**(6.32)**	**(6.10)**	**(6.24)**	**(6.17)**
T_7	3.62	3.62	3.62	2.43	2.46	2.44	1.45	1.46	1.45	2.41	1.45	1.43
	(13.10)	**(13.13)**	**(13.11)**	**(5.90)**	**(6.10)**	**(6.00)**	**(2.10)**	**(2.15)**	**(2.12)**	**(2.00)**	**(2.11)**	**(2.05)**
T_8	3.87	3.83	3.85	3.95	3.97	3.96	4.02	4.03	4.02	4.00	4.02	4.01
	(15.00)	**(14.70)**	**(14.85)**	**(15.62)**	**(15.78)**	**(15.70)**	**(16.14)**	**(16.26)**	**(16.20)**	**(16.03)**	**(16.17)**	**(16.10)**
SEm (±)	**0.08**	**0.06**	**0.07**	**0.09**	**0.08**	**0.09**	**0.12**	**0.09**	**0.11**	**0.15**	**0.12**	**0.14**
CD (p=0.05)	**0.23**	**0.18**	**0.21**	**0.28**	**0.23**	**0.26**	**0.35**	**0.28**	**0.32**	**0.45**	**0.37**	**0.41**

4.1.2.3 *Cyperus rotundus* L.

The data concerning the weed population of *Cyperus rotundus* L. is effect ofvarious weed control treatments at all phases of observations in the years 2021 and 2022, as presented in Chart 4.5, and indicates that substantial result on the *Cyperus rotundus* L. at every phase of observations.

Records on the number of individuals of *Cyperus rotundus* L. for the years 2021 and 2022 (Chart 4.5) showed that weed control treatments considerably decrease the species of *Cyperus rotundus* L. associated by the un-weeded check. At 30 DAS, PE herbicides noted a minimum count of *Cyperus rotundus* L. over PoE treatment. At 60 DAS 2, 4-D Na 800 g PoE in conjunction by HW at 60 DAS was noted as the minimum weed count of *Cyperus rotundus* L., and the heaviest count was noted in Tembotrione 120 g PoE as associated by herbicidal treatments over the un-weeded check. At 90 DAS and harvest, the minimum weed count noted in 2, 4-D Na, 800 g PoE, in conjunction by HW at 60 DAS, HW twice (30 and 60 days after seedig), Comparable outcomes were established by Kakade *et al.* (2016) and Hatti *et al.* (2014). All the herbicidal treatments have the highest control of *Cyperus rotundus* L. except Tembotrione 120 g PoE as associated by HW above the un-weeded check.

The cumulative data shown in chart 4.5 and represented in ghaph 4.3 shown that no herbicides applied in PoE treatment cause a higher count of *Cyperus rotundus* L. up to 30 days after seedig. At 60 days after seedig, a minimum count of *Cyperus rotundus* L. was noted in 2, 4-D Na 800 g PoE combined by HW at 60 days after seedig next to Metribuzin 800 gPE as associated by HW over the un-weeded check. The heaviest count has been noted in Tembotrione PoE. At 90 days after seedig and harvest, the superior performance of the use of 2 4-D Na 800 g PoE combined by HW at 60 days after seedig and HW during both years is shown.



Graph 4.3 Influnce of herbicides on count of *Cyperus rotundus* L.in maize at monthly intervals. (2021 and 2022)

Chart 4.6: Influnce of herbicides on count of *Chenopodium album* L. in maize at monthly intervals. (2021 and 2022).

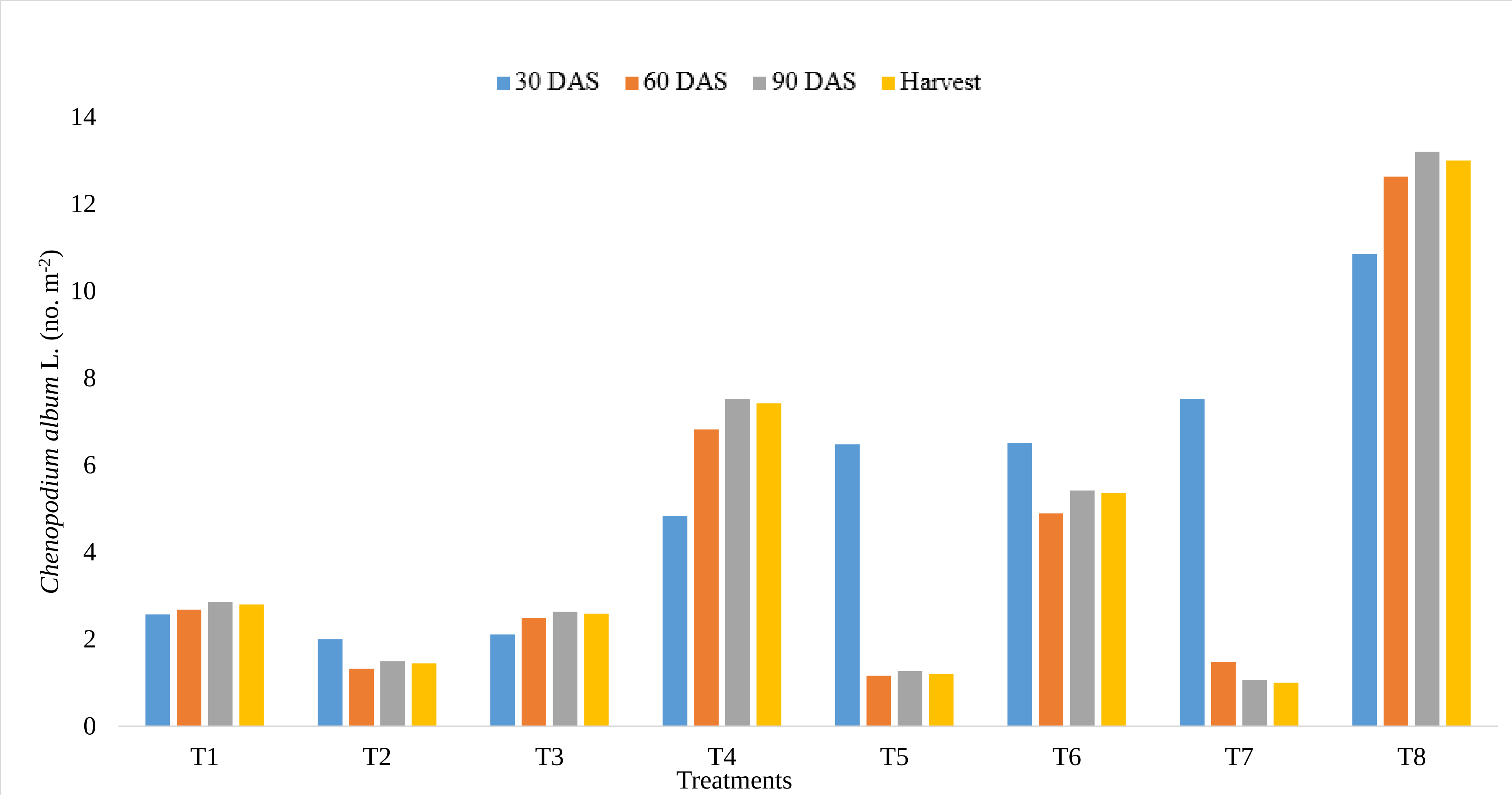
Treatments	30 DAS (2021)	30 DAS (2022)	Pooled data	60 DAS (2021)	60 DAS (2022)	Pooled data	90 DAS (2021)	90 DAS (2022)	Pooled data	Harvest (2021)	Harvest (2022)	Pooled data
T_1	1.58*	1.62	1.60	1.61	1.66	1.63	1.67	1.70	1.69	1.66	1.69	1.67
	(2.50)**	**(2.64)**	**(2.57)**	**(2.60)**	**(2.77)**	**(2.68)**	**(2.80)**	**(2.92)**	**(2.86)**	**(2.76)**	**(2.84)**	**(2.80)**
T_2	1.37	1.44	1.41	1.08	1.20	1.14	1.18	1.13	1.22	1.18	1.22	1.20
	(1.90)	**(2.10)**	**(2.00)**	**(1.20)**	**(1.44)**	**(1.32)**	**(1.40)**	**(1.59)**	**(1.49)**	**(1.39)**	**(1.49)**	**(1.44)**
T_3	1.41	1.49	1.45	1.51	1.63	1.57	1.58	1.66	1.62	1.57	1.64	1.61
	(2.00)	**(2.23)**	**(2.11)**	**(2.30)**	**(2.68)**	**(2.49)**	**(2.50)**	**(2.76)**	**(2.63)**	**(2.48)**	**(2.70)**	**(2.59)**
T_4	2.17	2.22	2.19	2.61	2.54	2.61	2.68	2.80	2.74	2.72	2.73	2.72
	(4.70)	**(4.96)**	**(4.83)**	**(6.80)**	**(6.84)**	**(6.82)**	**(7.20)**	**(7.84)**	**(7.52)**	**(7.38)**	**(7.46)**	**(7.42)**
T_5	2.51	2.58	2.54	1.01	1.10	1.07	1.09	1.14	1.12	1.09	1.10	1.10
	(6.30)	**(6.67)**	**(6.48)**	**(1.10)**	**(1.23)**	**(1.16)**	**(1.22)**	**(1.32)**	**(1.27)**	**(1.19)**	**(1.21)**	**(1.20)**
T_6	2.51	2.59	2.55	2.19	2.23	2.21	2.27	2.37	2.32	2.30	2.33	2.32
	(6.30)	**(6.72)**	**(6.51)**	**(4.80)**	**(4.98)**	**(4.89)**	**(5.20)**	**(5.64)**	**(5.42)**	**(5.31)**	**(5.41)**	**(5.36)**
T_7	2.68	2.80	2.74	1.18	1.25	1.21	0.99	1.06	1.02	0.99	1.01	1.00
	(7.20)	**(7.84)**	**(7.52)**	**(1.40)**	**(1.57)**	**(1.48)**	**(1.00)**	**(1.13)**	**(1.06)**	**(0.98)**	**(1.02)**	**(1.00)**
T_8	3.24	3.34	3.29	3.55	3.56	3.55	3.62	3.65	3.63	3.59	3.62	3.61
	(10.50)	**(11.20)**	**(10.85)**	**(12.58)**	**(12.68)**	**(12.63)**	**(13.10)**	**(13.30)**	**(13.20)**	**(12.86)**	**(13.14)**	**(13.00)**
SEm (±)	**0.09**	**0.06**	**0.08**	**0.11**	**0.09**	**0.10**	**0.15**	**0.12**	**0.14**	**0.18**	**0.13**	**0.16**
CD (p=0.05)	**0.29**	**0.18**	**0.24**	**0.34**	**0.26**	**0.30**	**0.44**	**0.36**	**0.40**	**0.54**	**0.40**	**0.47**

4.1.2.4 *Chenopodium album* L.

The data concerning the weed population of *Chenopodium album* L. as effect ofvarious weed control treatments at all phases of observations in the years 2021 and 2022, as existing in Chart 4.6 and illustrated in Fig. 4.4, exposed that weed control actions had a major influence on the *Chenopodium album* L. populace at all phases of observations.

Entirely weed management methods considerably reduce *Chenopodium album* L. population over the un-weeded, according to data collected in 2021 and 2022 on the total number of specimens of *Chenopodium album* L. Chart 4.6 and graph 4.4 show this. Data on the 30 days later seeding minimum count of *Chenopodium album* L. in the use of Atrazine 500 g PE mutual by poienter weeding (30 days after seeding) and Metribuzin 800 g PE Data on 60 days later seeding the superior count of *Chenopodium album* L. was noted in Tembotrione 120 g PoE afterward Topramezone 200 g PoE. The minimum count of *Chenopodium album* L. was noted in 2, 4-D Na 800 g mutual by poienter weeding at 60 days later seeding and Atrazine 500 g mutual by handeded weedings (30 days later seeding) as asociated to HW similar agreement by the outcomes of Javid Ehsas *et al.* (2016). At 90 days after seedig and harvest, the minimum count of *Chenopodium album* L. HW twice (days after seedig of 30 and 60) closely followed by 2, 4-D Na 800 g PoE combined by HW at 60 days later seeding and Atrazine 500 g + single HW (30 days later seeding), then a higher count in Tembotrione 120 gPoE over the un-weeded check.

The cumulative data chart no. 4.6 shown then represented in Fig. 4.4 indicated that pre-emergent herbicides controlled the population of *Chenopodium album* L. up to 30 days after seepage. Using PoE 60 days after seedig 2, 4-D Na 800 g mutual by poienter weeding at 60 days after seedig, we noted a minimum count of *Chenopodium album* L. and noted the best weed control treatment among other herbicidal treatments. Data on days after seedig and at harvest HW twice (30 and 60 days later seeding) noted the minimum weed sum as associated by the repose of the action Hhigher weed count in PoE of Tembotrione 120 g then Topramezone 200 g over the un-weeded.



Graph. 4.4 Influnce of herbicides on count of *Chenopodium album* L. in maize at monthly intervals. (2021 and 2022).

Chart 4.7: Influnce of herbicides on count of *Parthenium hysterophorus* L. in maize at monthly intervals. (2021 and 2022)

Treatments	30 DAS (2021)	30 DAS (2022)	Pooled data	60 DAS (2021)	60 DAS (2022)	Pooled data	90 DAS (2021)	90 DAS (2022)	Pooled data	Harvest (2021)	Harvest (2022)	Pooled data
T_1	1.81*	1.86	1.83	1.87	1.84	1.85	1.97	2.02	2.00	1.95	1.97	1.96
	(3.30)**	**(3.46)**	**(3.38)**	**(3.50)**	**(3.41)**	**(3.45)**	**(3.90)**	**(4.12)**	**(4.01)**	**(3.80)**	**(3.91)**	**(3.85)**
T_2	1.67	1.72	1.69	1.13	1.12	1.13	1.22	1.29	1.25	1.22	1.25	1.24
	(2.80)	**(2.97)**	**(2.88)**	**(1.30)**	**(1.26)**	**(1.28)**	**(1.50)**	**(1.67)**	**(1.58)**	**(1.49)**	**(1.57)**	**(1.53)**
T_3	1.73	1.81	1.77	1.76	1.83	1.79	1.84	1.89	1.86	1.83	1.84	1.83
	(3.00)	**(3.31)**	**(3.15)**	**(3.10)**	**(3.37)**	**(3.23)**	**(3.40)**	**(3.58)**	**(3.49)**	**(3.35)**	**(3.41)**	**(3.38)**
T_4	2.68	2.78	2.73	2.74	2.73	2.74	2.75	2.75	2.75	2.75	2.74	2.74
	(7.20)	**(7.74)**	**(7.47)**	**(7.54)**	**(7.48)**	**(7.51)**	**(7.60)**	**(7.58)**	**(7.60)**	**(7.58)**	**(7.52)**	**(7.55)**
T_5	3.00	3.14	3.45	1.00	1.04	1.02	1.02	1.07	1.05	1.04	1.02	1.03
	(9.00)	**(9.91)**	**(9.45)**	**(1.00)**	**(1.10)**	**(1.05)**	**(1.06)**	**(1.16)**	**(1.11)**	**(1.09)**	**(1.05)**	**(1.07)**
T_6	2.77	2.84	2.81	1.73	1.79	1.76	1.86	1.81	1.84	1.82	1.85	1.84
	(7.70)	**(8.10)**	**(7.90)**	**(3.00)**	**(3.22)**	**(3.11)**	**(3.50)**	**(3.31)**	**(3.40)**	**(3.32)**	**(3.42)**	**(3.37)**
T_7	2.91	2.95	2.86	1.09	1.11	1.10	1.99	1.00	1.00	0.95	1.00	0.97
	(8.50)	**(8.74)**	**(8.20)**	**(1.20)**	**(1.24)**	**(1.22)**	**(1.00)**	**(1.00)**	**(1.00)**	**(0.90)**	**(1.00)**	**(0.95)**
T_8	3.08	3.17	3.13	4.26	4.29	4.27	4.42	4.44	4.43	4.41	4.42	4.42
	(15.50)	**(10.11)**	**(16.80)**	**(18.13)**	**(18.37)**	**(18.25)**	**(19.55)**	**(19.71)**	**(19.63)**	**(19.46)**	**(19.54)**	**(19.50)**
SEm (±)	**0.07**	**0.07**	**0.07**	**0.10**	**0.09**	**0.10**	**0.13**	**0.11**	**0.12**	**0.18**	**0.12**	**0.15**
CD (p=0.05)	**0.20**	**0.21**	**0.21**	**0.32**	**0.26**	**0.29**	**0.41**	**0.35**	**0.38**	**0.55**	**0.37**	**0.46**

4.1.2.5 *Parthenium hysterophorus* L.

The data concerning the weed population of *Parthenium hysterophorus* L. as effect ofvarious weed control treatments at all phases of observations in the years 2021 and 2022, as existing in Chart No. 4.7, showed that weed controller actions had a major effect on the population of *Parthenium hysterophorus* L. at all stages of observations.

Data on the *Parthenium hysterophorus* L. showed that all weed management methods considerably reduced the plant's population. 30 days later, the heaviest count of *Parthenium hysterophorus* L. in the untreated plot was associated by PoE herbicidal treatment. Data on 60 DAS showed better control of *Parthenium hysterophorus* L. in 2, 4-D Na 800 g PoE in addition to manually weeding at 60 days later sowing, followed by HW twice (30 and 60 days later sowing) and Atrazine 500 g in addition to manually weeding (30 days after seeding). At 90 days after seeding and harvesting HW twice (30 and 60 DAS), the minimum count of *Parthenium hysterophorus* L. through both years over the Un-weeded. The results are consistent and these outcomes are in accord of A. Sundari *et al.* (2019).

Cumulative data shown in chart 4.7 and represented in Fig. 4.5 indicated that no reduction in weed species was noted in PoE herbicidal treatments up to 30 DAS as associated by PE usages. On 60 DAS, a successfully arrested weed population was noted in 4-D Na 800 g PoE in addition to manually weeding at 60 DAS next to HW twice (30 and 60 DAS), then Atrazine 500 g PE + single HW (30 DAS), and greater in Tembotrione 120 g PoE. Data on 90 days after seeding and harvest (2 HWs) (30 and 60 days after seeding) noted a minimum count of *Parthenium hysterophorus* L. and remained the best amongst the herbicidal actions during both years over the un-weeded check.

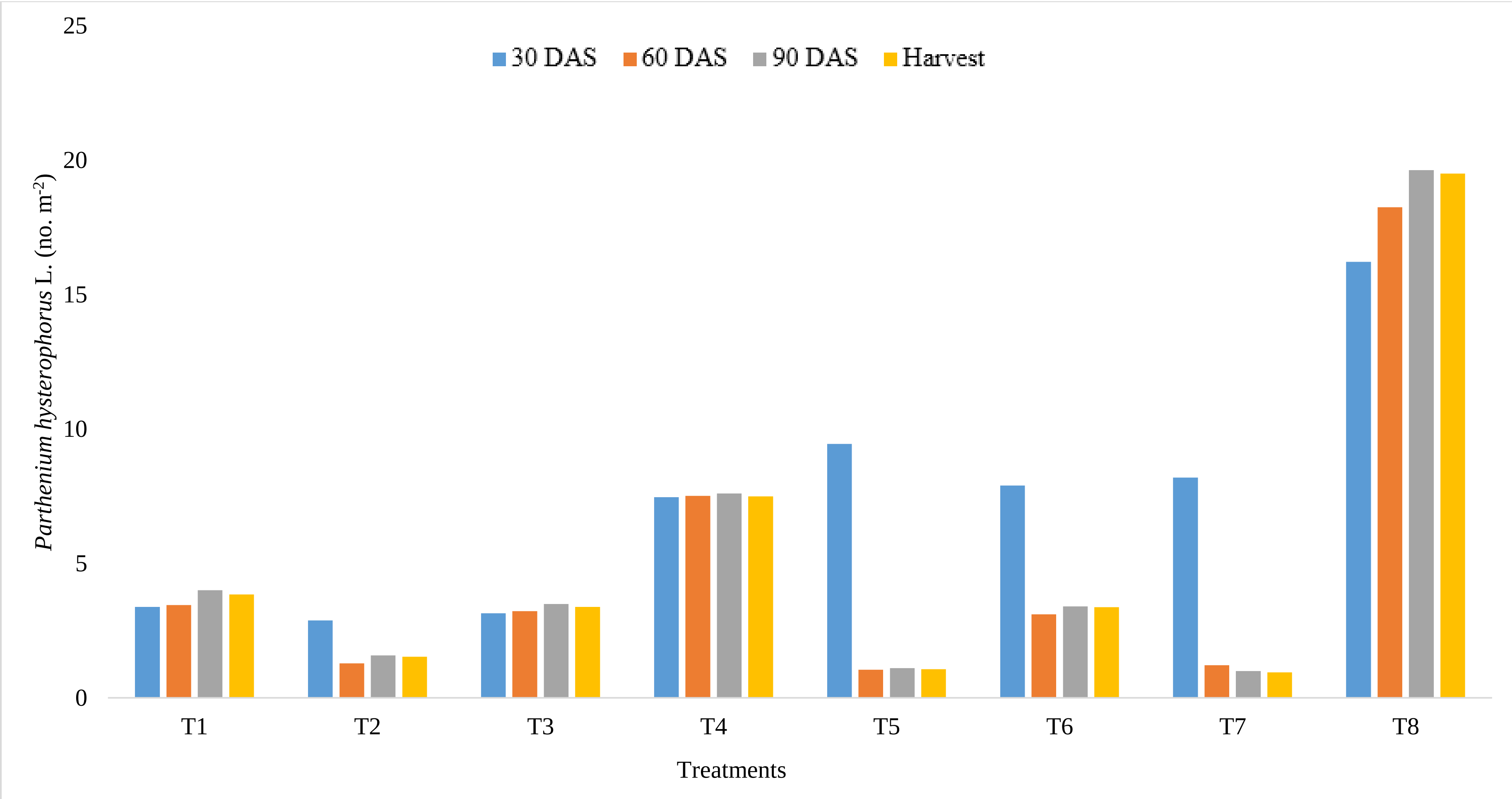


Fig. 4.5 Influnce of herbicides on count of *Parthenium hysterophorus* L. in maize at monthly intervals. (2021 and 2022)

Chart 4.8. Influnce of herbicides on count of *Cannabis sativus* L. of maize at monthly intervals. (2021 and 2022)

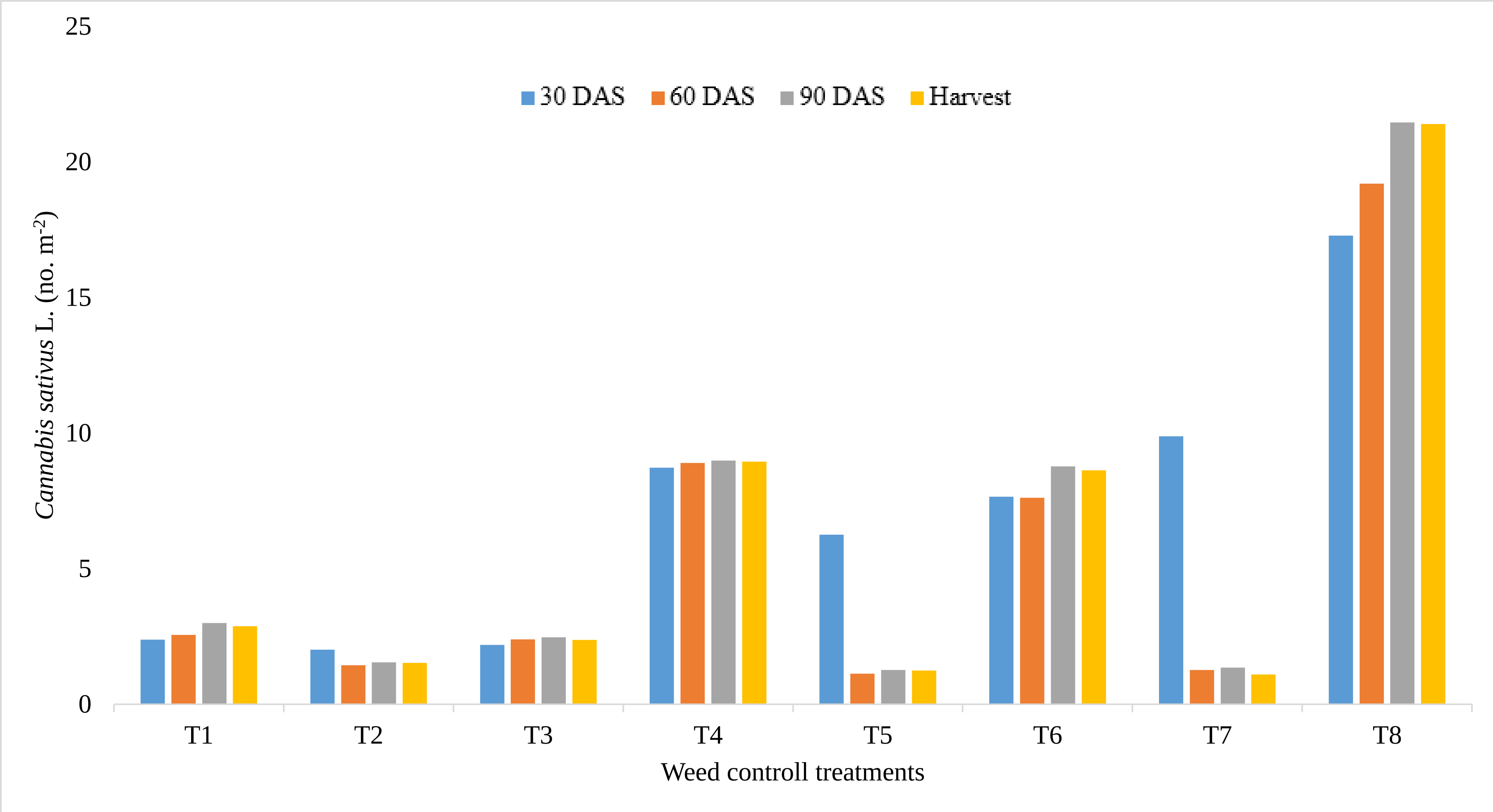
Treatments	30 DAS (2021)	30 DAS (2022)	Pooled data	60 DAS (2021)	60 DAS (2022)	Pooled data	90 DAS (2021)	90 DAS (2022)	Pooled data	Harvest (2021)	Harvest (2022)	Pooled data
T_1	1.52*	1.56	1.54	1.58	1.61	1.60	1.79	1.76	1.73	1.67	1.72	1.69
	(2.3)**	**(2.46)**	**(2.38)**	**(2.5)**	**(2.62)**	**(2.56)**	**(2.9)**	**(3.10)**	**(3.00)**	**(2.8)**	**(2.97)**	**(2.88)**
T_2	1.37	1.45	1.41	1.17	1.21	1.20	1.22	1.26	1.24	1.17	1.29	1.23
	(1.9)	**(2.13)**	**(2.01)**	**(1.4)**	**(1.48)**	**(1.44**	**(1.5)**	**(1.61)**	**(1.55)**	**(1.4)**	**(1.67)**	**(1.53)**
T_3	4.45	1.51	1.47	1.498	1.60	1.54	1.55	1.59	1.57	1.51	1.56	1.53
	(2.1)	**(2.29)**	**(2.19)**	**(2.29)**	**(2.58)**	**(2.39)**	**(2.4)**	**(2.54)**	**(2.47)**	**(2.3)**	**(2.45)**	**(2.37)**
T_4	2.88	3.02	2.95	2.97	2.98	2.98	2.98	3.01	2.99	2.99	2.98	2.99
	(8.3)	**(9.16)**	**(8.73)**	**(8.88)**	**(8.92)**	**(8.90)**	**(8.91)**	**(9.07)**	**(8.99)**	**(8.99)**	**(8.91)**	**(8.95)**
T_5	2.49	2.50	2.50	1.04	1.07	1.06	1.08	1.14	1.12	1.10	1.13	1.11
	(6.2)	**(6.30)**	**(6.25)**	**(1.1)**	**(1.16)**	**(1.13)**	**(1.2)**	**(1.32)**	**(1.26)**	**(1.21)**	**(1.27)**	**(1.24)**
T_6	2.79	2.69	2.76	2.74	2.78	2.76	2.93	2.98	2.96	2.93	2.94	2.93
	(7.8)	**(7.52)**	**(7.66)**	**(7.5)**	**(7.74)**	**(7.62)**	**(8.6)**	**(8.94)**	**(8.77)**	**(8.6)**	**(8.66)**	**(8.63)**
T_7	3.03	2.97	3.14	1.08	1.14	1.12	1.13	1.18	1.14	0.99	1.10	1.04
	(9.2)	**(8.86)**	**(9.88)**	**(1.2)**	**(1.32)**	**(1.26)**	**(1.3)**	**(1.41)**	**(1.35)**	**(1.00)**	**(1.21)**	**(1.10)**
T_8	3.24	3.25	3.21	4.37	4.39	4.38	4.62	4.64	4.63	4.62	4.63	4.63
	(16.5)	**(17.57)**	**(17.28)**	**(19.14)**	**(19.26)**	**(19.20)**	**(21.39)**	**(21.53)**	**(21.46)**	**(21.35)**	**(21.45)**	**(21.40)**
SEm (±)	**0.05**	**0.07**	**0.06**	**0.10**	**0.09**	**0.10**	**0.16**	**0.11**	**0.14**	**0.20**	**0.16**	**0.18**
CD (p=0.05)	**0.15**	**0.20**	**0.18**	**0.29**	**0.26**	**0.28**	**0.49**	**0.35**	**0.42**	**0.61**	**0.47**	**0.54**

4.1.2.6 *Cannabis sativus* L.

The data concerning the weed population of *Cannabis sativa* L. as effect ofseveral weed control methods at all observational phases, as presented in chart 4.8 for the years 2021 and 2022, showed that weed control methods affected the community of *Cannabis sativus* L. at all observational methods.

Data on the *Cannabis sativus* L. showed that all weed-control methods considerably reduced the plant's population. At 30 DAS, a minimum count of *Cannabis sativus* L. was noted in Atrazine 500 g PE + single-HW (30 DAS) and Metribuzin 800 g PE as equated to further treatments. At 60 DAS, the minimum weed population is noted in 2, 4-D Na 800 g PoE combined by HW at 60 DAS, HW twice (30 and 60 DAS), and heaviest in Tembotrione 120 g PoE. Data on 90 days between sowing and harvesting the heaviest count of *Cannabis sativus* L. was noted down in Tembotrione 120 g PoE and Topramezone 200 g PoE. 2, 4-D Na 800 g PoE combined by HW at 60 DAS noted the best weed control of *Cannabis sativus* L. and superior weed control among the herbicidal treatments which noted minimum weed count up to harvest as asociated to the unweeded check. Such discoveries are reliable by the discoveries of Mahesh Kumar *et al.* (2019).

The cumulative data shown in chart 4.8 and represented in Fig. 4.6 showed that all weed control actions considerably controlled the population of *Cannabis sativus* L. Among PE herbicides, they arrest the weed population of *Cannabis sativus* L. for up to 30 days after the sowing period of the treatments. Data on the 60-day minimum count of *Cannabis sativus* L. was noted in PoE 2, 4-D Na 800 g joint by HW at 60 DAS and HW twice (30 and 60 DAS) and heaviest in Tembotrione 120 g PoE. At 90 days after seeding, the heaviest count of *Cannabis sativus* L. was verified in Tembotrione 120 g PoE and Topramezone 200 g PoE. 2, 4-D Na 800 g PoE combined by small-HW at 60 DAS noted the best weed control of *Cannabis sativus* L. and superior weed control among the herbicidal treatments, which noted the minimum weed count up to harvest as associated by the un-weeded.



Graph 4.6 Influnce of herbicides on count of *Cannabis sativus* L. of maize at monthly intervals. (2021 and 2022).

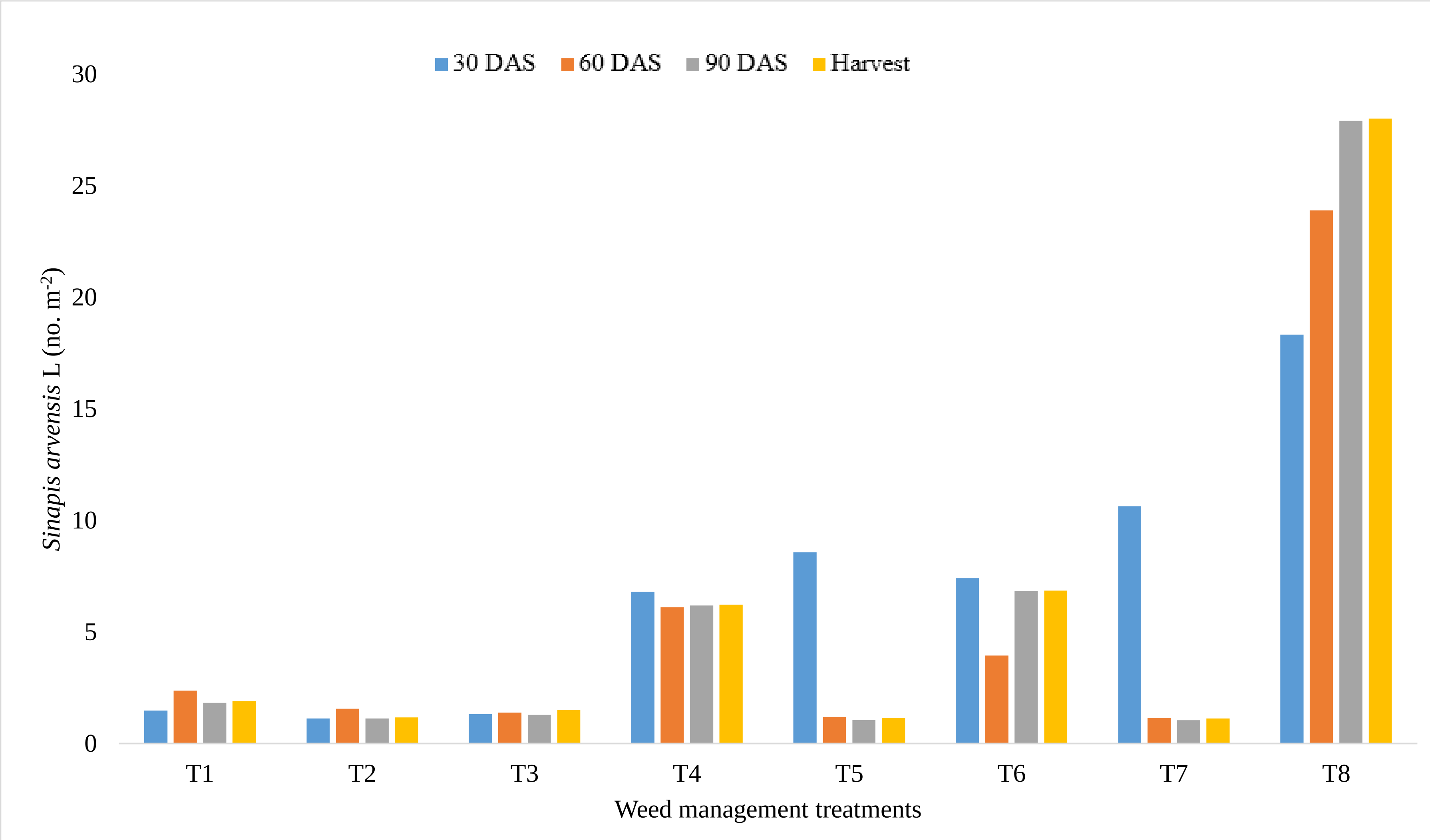
Chart 4.9: Influnce of herbicides on count of *Sinapis arvensis* L.in maize at monthly intervals. (2021 and 2022).)

Treatments	30 DAS (2021)	30 DAS (2022)	Pooled data	60 DAS (2021)	60 DAS (2022)	Pooled data	90 DAS (2021)	90 DAS (2022)	Pooled data	Harvest (2021)	Harvest (2022)	Pooled data
T_1	1.18* **(1.40)****	1.24 **(1.56)**	1.21 **(1.48)**	1.22 **(1.50)**	1.31 **(1.74)**	1.53 **(2.37)**	1.32 **(1.80)**	1.36 **(1.85)**	1.34 **(1.82)**	1.14 **(1.30)**	1.33 **(1.77)**	1.23 **(1.53)**
T_2	1.07 **(1.10)**	1.10 **(1.23)**	1.06 **(1.13)**	1.09 **(1.50)**	1.27 **(1.62)**	1.24 **(1.56)**	1.05 **(1.10)**	1.08 **(1.17)**	1.06 **(1.13)**	0.99 **(1.00)**	1.08 **(1.18)**	1.04 **(1.09)**
T_3	1.09 **(1.20)**	1.20 **(1.44)**	1.14 **(1.32)**	1.13 **(1.30)**	1.22 **(1.49)**	1.17 **(1.39)**	1.18 **(1.40)**	1.21 **(1.48)**	1.20 **(1.44)**	1.09 **(1.20)**	1.11 **(1.25)**	1.10 **(1.22)**
T_4	2.49 **(6.20)**	2.72) **(7.41)**	2.60 **(6.80)**	2.62 **(6.89)**	2.68 **(7.23)**	2.65 **(7.06)**	2.66 **(7.11)**	2.67 **(7.15)**	2.67 **(7.13)**	2.62 **(6.89)**	2.68 **(7.21)**	2.65 **(7.05)**
T_5	2.90 **(8.40)**	2.95 **(8.74)**	2.92 **(8.57)**	1.03 **(1.13)**	1.12 **(1.26)**	1.09 **(1.19)**	1.00 **(1.00)**	1.05 **(1.12)**	1.02 **(1.06)**	0.99 **(1.00)**	1.00 **(1.00)**	1.00 **(1.00)**
T_6	2.68 **(7.20)**	2.76 **(7.65)**	2.72 **(7.42)**	2.43 **(5.90)**	2.23 **(4.99)**	1.98 **(3.94)**	2.60 **(6.80)**	2.62 **(6.89)**	2.61 **(6.84)**	2.60 **(6.76)**	2.62 **(6.84)**	2.61 **(6.80)**
T_7	3.22 **(10.40)**	3.30 **(10.89)**	3.26 **(10.64)**	1.06 **(1.12)**	1.08 **(1.17)**	1.06 **(1.14)**	1.00 **(1.00)**	1.05 **(1.11)**	1.02 **(1.05)**	0.97 **(0.94)**	1.00 **(1.00)**	0.98 **(0.97)**
T_8	3.46 **(18.00)**	3.66 **(19.46)**	3.52 **(18.73)**	4.51 **(20.33)**	4.53 **(20.49)**	4.52 **(20.41)**	4.59 **(21.06)**	4.60 **(21.16)**	4.59 **(21.11)**	4.57 **(20.86)**	4.60 **(21.14)**	4.58 **(21.00)**
SEm (±)	**0.04**	**0.07**	**0.06**	**0.07**	**0.08**	**0.08**	**0.12**	**0.15**	**0.14**	**0.16**	**0.13**	**0.15**
CD (p=0.05)	**0.11**	**0.22**	**0.17**	**0.21**	**0.24**	**0.23**	**0.37**	**0.46**	**0.42**	**0.47**	**0.39**	**0.43**

4.1.2.7 ***Sinapis arvensis* L.**

Data from 2021 and 2022 on the population of *Sinapis arvensis* L. showed that all weed management methods greatly reduced the population of this plant. Data on the 30 DAS minimum count of *Sinapis arvensis* L. was noted in Atrazine 500 g PE + single-HW (30 DAS) and Metribuzin 800 g PE as associated by other actions. On 60 DAS, the minimum weed population is noted in 2, 4-D Na Salt 800 g PoE combined by HW at 60 DAS and hands weeding twice (30 and 60 DAS) and higher in Tembotrione 120 g PoE. Data on 90 DAS and harvest shows a minimum count of *Sinapis arvensis* L. was noted at 2, 4-D Na 800 g PoE in addition to manually weeding at 60 DAS, subsequently 2 HW (30 and 60 DAS), then Atrazine 500 g PE + HW (30 DAS) over the un-weeded.

The cumulative data shown in chart 4.9 and represented in graph 4.7 indicated that at 30 DAS, a minimum count of *Sinapis arvensis* L. was noted in PE treatment. Superior weed counts were noted in the PoE treatment because there were no herbicide sprays in this treatment up to 30 DAS. Data on 60 DAS noted a minimum weed count in all herbicidal treatments except Tembotrione 120 g PoE. HW twice (30 and 60 DAS) and 2, 4-D Na (800 g PoE) combined by HW at 60 DAS Data on 90 days between sowing and harvest showed similar treatment for the heaviest and minimum counts of *Sinapis arvensis* L. during both years over check.



Graph 4.7 Influnce of herbicides on count of *Sinapis arvensis* L.in maize at monthly intervals. (2021 and 2022).

Chart 4.10: Influnce of herbicides on count of total weed population in maize as at monthly intervals (2021 and 2022)

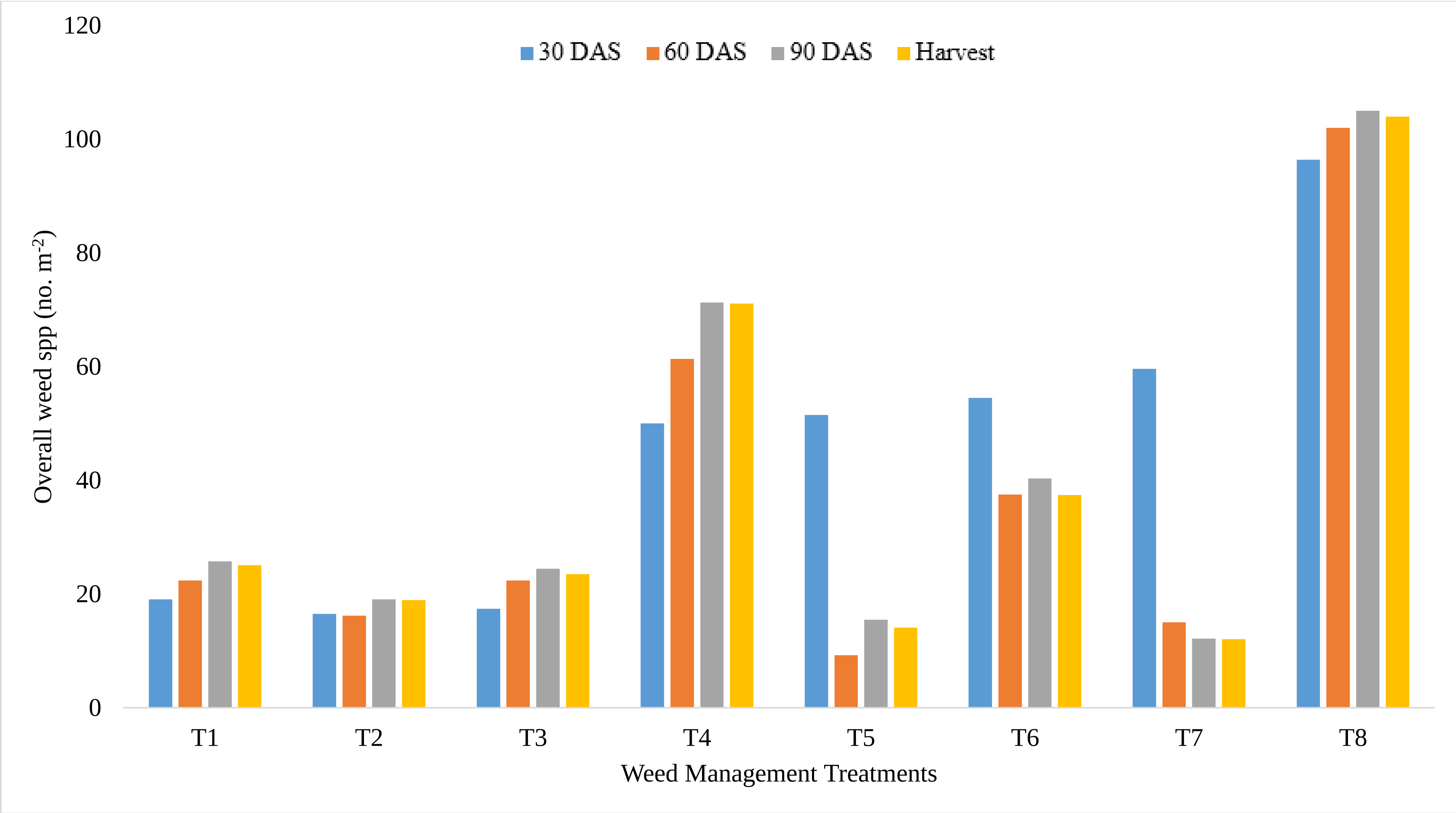
Treatments	30 DAS (2021)	30 DAS (2022)	Pooled data	60 DAS (2021)	60 DAS (2022)	Pooled data	90 DAS (2021)	90 DAS (2022)	Pooled data	Harvest (2021)	Harvest (2022)	Pooled data
T_1	4.31* **(18.60)****	4.42 **(19.61)**	4.37 **(19.10)**	4.75 **(22.10)**	4.76 **(22.73)**	4.73 **(22.41)**	5.04 **(25.40)**	5.11 **(26.14)**	5.07 **(25.77)**	4.91 **(24.20)**	5.1 **(26.01)**	5.00 **(25.10)**
T_2	3.99 **(15.90)**	4.14 **(17.17)**	4.06 **(16.53)**	3.97 **(15.80)**	4.07 **(16.63)**	4.02 **(16.21)**	4.32 **(18.70)**	4.41 **(19.49)**	4.36 **(19.09)**	4.30 **(18.50)**	4.40 **(19.42)**	4.35 **(18.96)**
T_3	4.12 **(17.00)**	4.22 **(17.88)**	4.17 **(17.44)**	4.67 **(21.80)**	4.79 **(22.96)**	4.73 **(22.38)**	4.90 **(24.00)**	4.99 **(24.97)**	4.94 **(24.45)**	4.83 **(23.35)**	4.86 **(23.68)**	4.84 **(23.51)**
T_4	6.92 **(47.9)**	7.22 **(52.14)**	7.07 **(50.02)**	7.86 **(61.80)**	7.80 **(60.99)**	7.83 **(61.39)**	8.44 **(71.30)**	8.44 **(71.28)**	8.44 **(71.29)**	8.42 **(70.86)**	8.45 **(71.34)**	8.43 **(71.10)**
T_5	7.16 **(51.3)**	7.19 **(51.72)**	7.17 **(51.51)**	3.00 **(9.00)**	3.08 **(9.50)**	3.04 **(9.25)**	3.76 **(14.12)**	4.10 **(16.89)**	3.93 **(15.50)**	3.70 **(13.67)**	3.81 **(14.58)**	3.75 **(14.12)**
T_6	7.35 **(54.00)**	7.41 **(55.04)**	7.38 **(54.52)**	6.12 **(37.5)**	6.12 **(37.50)**	6.12 **(37.50)**	6.36 **(40.40)**	6.35 **(40.33)**	6.35 **(40.36)**	6.09 **(37.10)**	6.14 **(37.77)**	6.11 **(37.43)**
T_7	7.62 **(58.50)**	7.79 **(60.76)**	7.72 **(59.63)**	3.84 **(14.75)**	3.91 **(15.35)**	3.87 **(15.05)**	3.46 **(12.00)**	3.51 **(12.39)**	3.49 **(12.19)**	3.46 **(11.97)**	3.50 **(12.23)**	3.48 **(12.10)**
T_8	8.39 **(98.4)**	8.56 **(96.33)**	8.47 **(97.86)**	9.97 **(99.35)**	10.23 **(104.65)**	10.10 **(102.00)**	10.11 **(102.3)**	10.40 **(108.16)**	10.26 **(105.23)**	1016 **(103.22)**	10.24 **(104.78)**	10.20 **(104.00)**
SEm (±)	**0.03**	**0.05**	**0.04**	**0.05**	**0.07**	**0.06**	**0.08**	**0.09**	**0.09**	**0.10**	**0.11**	**0.11**
CD (p=0.05)	**0.10**	**0.14**	**0.12**	**0.15**	**0.22**	**0.19**	**0.24**	**0.27**	**0.26**	**0.29**	**0.32**	**0.31**

4.1.2.8 Total weed count

The data concerning the weed population of total weed species as effect of various weed control methods affected on weeds in the years 2021 and 2022, as shown in Chart 4.10 and presented in Graph 4.8.

According to data from 2021 and 2022 on the population of total weeds, all weed management methods considerably reduce the population of total weeds. Data on 30 DAS suggests a larger population of total weed spp. was detected in PoE usage because there was no herbicidal use. However, as evidenced by the weed density at 30 DAS, delaying weed emergence the minimum population of total weed species was noted in PE treatment. A 60-day minimum population of total weed species was noted in 2-D Na 800 g PoE combined by HW on 60 DAS tracked by 2 HW (30 and 60 DAS) and heaviest in Tembotrione 120 g PoE and Topramezone 200 g PoE. Data on 90 DAS besides harvest minimum total weed species were noted in HW twice (30 and 60 DAS) and subsequently 2, 4-D Na 800 g PoE + HW on 60 DAS over the un-weeded check. When The2, 4-D Na, and HW were combined, there was a considerable reduction in weed thickness. Poorer weed thickness and dry matter have been detected as a result of two-HW, other intercultural processes, post-emergent and pre-emergent herbicide applications, and various crop durations. As a result of actual weed control, consequences follow from the discoveries of V.K. Dobariya (2019), D.P. Nagdeve (2014), and Bahirgul Sabiry (2019).

The overall weed population was considerably controlled by all herbicidal treatments at all phases of observation, according to the cumulative results reported in chart 4.10 and exposed in graph 4.8. Data on 30 DAS showed higher total weed species in PoE treatment as compared to PE treatment. At 60 DAS, the minimum total weed population was noted in 2, 4-D Na, 800 g PoE, in addition to manually weeding at 60 DAS, subsequently 2 HW (30 and 60 DAS), and Metribuzin, 800 g PE, and higher in Tembotrione, 120 g PoE. Data on 90 DAS, then harvest, the minimum total weed population was noted in double HW (30 and 60 DAS), then 2, 4-D Na, 800 g PoE, mutual by HW on 60 DAS as paralleled to check.



Graph 4.8 Influnce of herbicides on count of total weed population in maize as at monthly intervals (2021 and 2022)

Chart 4.11: Influnce of herbicides on weed dry weight of *Commelina benghalensis* L. in maize at monthly intervals. (2021 and 2022)

Treatments	30 DAS (2021)	30 DAS (2022)	Pooled data	60 DAS (2021)	60 DAS (2022)	Pooled data	90 DAS (2021)	90 DAS (2022)	Pooled data	Harvest (2021)	Harvest (2022)	Pooled data
T_1	0.24 * **(0.059)****	0.25 **(0.0670)**	0.25 **(0.063)**	0.30 **(0.09)**	0.31 **(0.097**	0.30 **(0.093)**	0.33 **(0.11)**	0.36 **(0.131)**	0.34 **(0.120)**	0.40 **(0.16)**	0.34 **(0.12)**	0.37 **(0.14)**
T_2	0.25 **(0.061)**	0.26 **(0.0720)**	0.25 **(0.066)**	0.26 **(0.07)**	0.28 **(0.084**	0.27 **(0.077)**	0.30 **(0.09)**	0.31 **(0.10)**	0.30 **(0.095)**	0.37 **(0.14)**	0.34 **(0.12)**	0.36 **(0.13)**
T_3	0.26 **(0.066)**	0.24 **(0.0624)**	0.25 **(0.064)**	0.33 **(0.11)**	0.34 **(0.12**	0.33 **(0.115)**	0.36 **(0.13)**	0.37 **(0.137)**	0.36 **(0.133)**	0.40 **(0.16)**	0.37 **(0.14)**	0.38 **(0.15)**
T_4	0.37 **(0.112)**	0.34 **(0.117)**	0.33 **(0.114)**	0.31 **(0.099)**	0.31 **(0.10**	0.31 **(0.099)**	0.32 **(0.10)**	0.35 **(0.124)**	0.33 **(0.112)**	0.32 **(0.10)**	0.34 **(0.12)**	0.33 **(0.11)**
T_5	0.35 **(0.12)**	0.36 **(0.131)**	0.35 **(0.125)**	0.14 **(0.02)**	0.15 **(0.025**	0.14 **(0.022)**	0.26 **(0.07)**	0.30 **(0.09)**	0.28 **(0.08)**	0.36 **(0.13)**	0.31 **(0.10)**	0.34 **(0.12)**
T_6	0.34 **(0.115)**	0.35 **(0.126)**	0.34 **(0.120)**	0.25 **(0.10)**	0.33 **(0.115**	0.32 **(0.107)**	0.40 **(0.16)**	0.41 **(0.17)**	0.40 **(0.165)**	0.34 **(0.16)**	0.42 **(0.18)**	0.48 **(0.17)**
T_7	0.36 **(0.13)**	0.36 **(0.135)**	0.36 **(0.132)**	0.24 **(0.06)**	0.25 **(0.067**	0.25 **(0.063)**	0.17 **(0.06)**	0.26 **(0.070)**	0.30 **(0.095)**	0.34 **(0.12)**	0.31 **(0.10)**	0.33 **(0.11)**
T_8	0.51 **(0.27)**	0.53 **(0.28)**	0.52 **(0.275)**	0.56 **(0.32)**	0.57 **(0.33**	0.57 **(0.325)**	0.67 **(0.45)**	0.68 **(0.47)**	0.67 **(0.46)**	0.72 **(0.52)**	0.69 **(0.48)**	0.70 **(0.50)**
SEm (±)	**0.02**	**0.02**	**0.02**	**0.03**	**0.02**	**0.03**	**0.01**	**0.02**	**0.02**	**0.02**	**0.04**	**0.03**
CD (p=0.05)	**0.06**	**0.05**	**0.06**	**0.09**	**0.05**	**0.07**	**0.05**	**0.07**	**0.06**	**0.05**	**0.11**	**0.08**

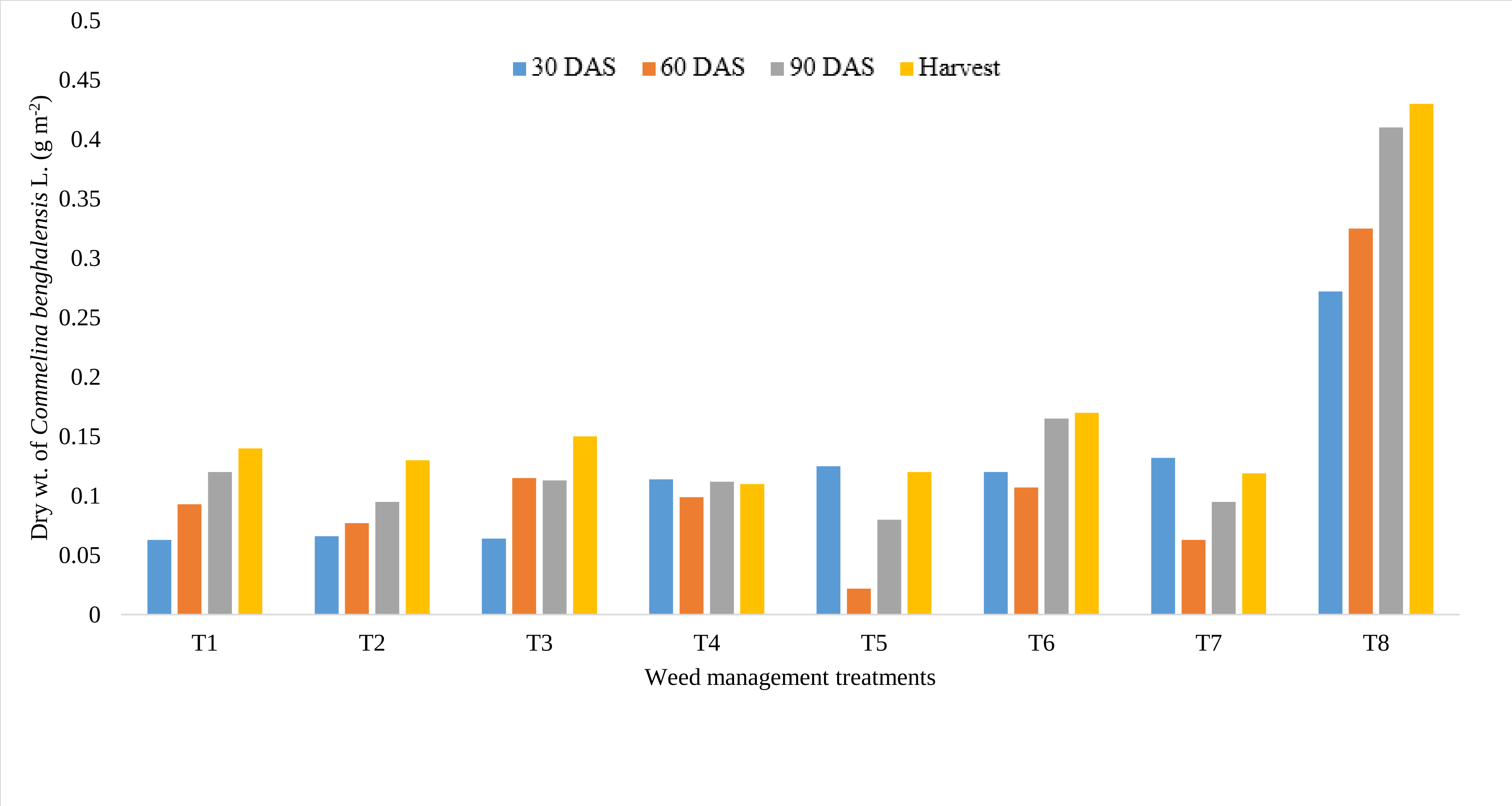
4.1.3 Species wise and total weeds dry weights.

4.1.3.1 *Commelina benghalensis* L.

The data concerning the weed dry weight of *Commelina benghalensis* L. as effect ofvarious weed control treatments at all phases of observations in the years 2021 and 2022, as existing in chart 4.11, showed in graph 4.9 that weed director actions ensured a substantial impact on the dry material of *Commelina benghalensis* L. at all phases of the statement.

In the years 2021 and 2022, the data shown in chart 4.11 In comparison to other herbicidal treatments, Atrazine 700 g PE, Atrazine 500 g PE + single HW (30 DAS), and Metribuzin 800 g PE produced the least amount of *Commelina benghalensis* L. dry weight at 30 DAS. Data on 60 DAS of minimum dried material of *Commelina benghalensis* L. was noted in the treatment of 2, 4-D Na 800 g combined by HW on 60 DAS, followed by HW twice (30 and 60 DAS) and high in Topramezone 200 g PoE and Metribuzin 800 g. data on 90 DAS, then harvest HW twice (30 and 60 DAS) tracked by 2, 4-D Na 800 g PoE combined by H weeding on 60 DAS noted the minimum dried weightiness of *Commelina benghalensis* L. as compared to other herbicidal treatments. Higher dry weight is noted in Metribuzin 800 g PE and Topramezone 200 g PoE over un-weeded.

Cumulative data shown in chart 4.11 and depicted in Fig. 4.9 at 30 days after the sowing minimum dry weight is noted in PE herbicidal treatments as well as PoE treatments. At 60 DAS, the minimum dry weight of *Commelina benghalensis* L. was noted in 2, 4-D Na 800 g PoE combined by HW at 60 DAS next to HW twice (30 and 60 DAS) and higher in Topramezone 200 g PoE. In comparison to previous herbicidal treatments over un-weeded check, data on 90 DAS and harvesting the least dry weight of *Commelina benghalensis* L. were noted in the treatment by 2, 4-D Na 800 g PoE paired by HW at 60 DAS subsequent to HW twice (30 and 60 DAS).



Graph 4.9 Influnce of herbicides on weed dry weight of *Commelina benghalensis* L. in maize at monthly intervals. (2021 and 2022)

Chart 4.12: Influnce of herbicides on weed dry weightof *Cynodon dactylon* L. in maize at monthly intervals. (2021 and 2022).

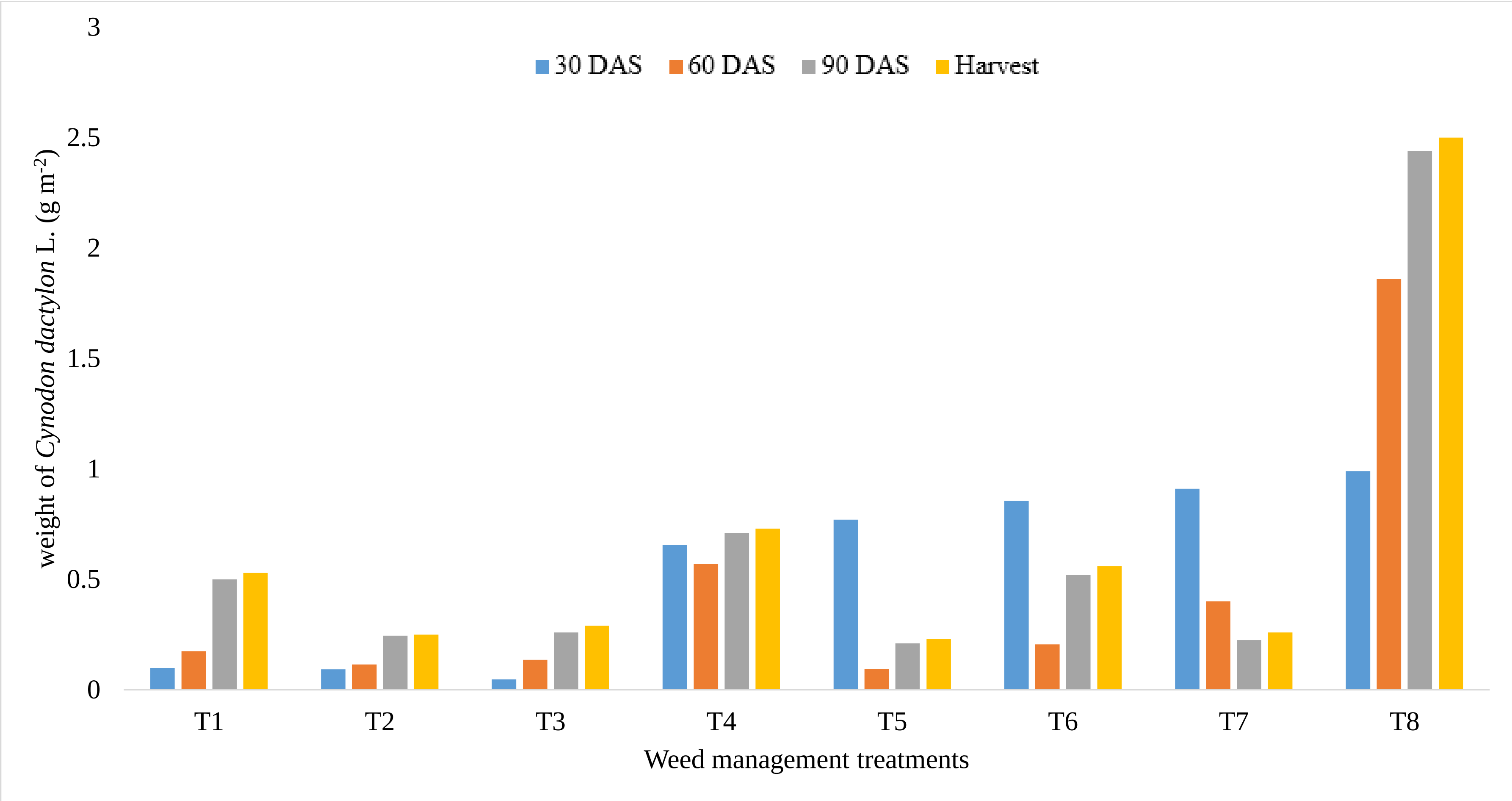
Treatments	30 DAS (2021)	30 DAS (2022)	Pooled data	60 DAS (2021)	60 DAS (2022)	Pooled data	90 DAS (2021)	90 DAS (2022)	Pooled data	Harvest (2021)	Harvest (2022)	Pooled data
T_1	0.31* **(0.0970)****	0.31 **(0.10)**	0.31 **(0.098))**	0.40 **(0.16)**	0.43 **(0.19)**	0.41 **(0.175)**	0.70 **(0.49)**	0.71 **(0.51)**	0.70 **(0.50)**	0.74 **(0.55)**	0.71 **(0.51)**	0.72 **(0.53)**
T_2	0.31 **(0.091)**	0.30 **(0.095)**	0.30 **(0.093)**	0.32 **(0.10)**	0.36 **(0.13)**	0.33 **(0.115)**	0.50 **(0.25)**	0.48 **(0.24)**	0.49 **(0.245)**	0.50 **(0.26)**	0.48 **(0.24)**	0.50 **(0.25)**
T_3	0.31 **(0.035)**	0.24 **(0.060)**	0.21 **(0.047)**	0.35 **(0.12)**	0.38 **(0.15)**	0.36 **(0.135)**	0.52 **(0.27)**	0.52 **(0.28)**	0.51 **(0.27)**	0.52 **(0.28)**	0.54 **(0.30)**	0.53 **(0.29)**
T_4	0.77 **(0.60)**	0.84 **(0.71)**	0.80 **(0.655)**	0.74 **(0.55)**	0.76 **(0.59)**	0.75 **(0.57)**	0.84 **(0.70)**	0.86 **(0.74)**	0.84 **(0.72)**	0.86 **(0.74)**	0.84 **(0.72)**	0.85 **(0.73)**
T_5	0.84 **(0.70)**	0.91 **(0.84)**	0.87 **(0.77)**	0.30 **(0.092)**	0.30 **(0.096)**	0.30 **(0.094)**	0.44 **(0.19)**	0.47 **(0.23)**	0.45 **(0.21)**	0.45 **(0.21)**	0.50 **(0.25)**	0.47 **(0.23)**
T_6	0.89 **(0.80)**	0.95 **(0.91)**	0.92 **(0.855)**	0.44 **(0.19)**	0.46 **(0.22)**	0.45 **(0.205)**	0.71 **(0.50)**	0.73 **(0.54)**	0.72 **(0.52)**	0.75 **(0.57)**	0.74 **(0.55)**	0.74 **(0.56)**
T_7	0.92 **(0.85)**	0.98 **(0.97)**	0.95 **(0.91)**	0.15 **(0.39)**	0.64 **(0.41)**	0.63 **(0.40)**	0.47 **(0.22)**	0.47 **(0.23)**	0.47 **(0.225)**	0.50 **(0.25)**	0.47 **(0.23)**	0.48 **(0.24)**
T_8	0.99 **(0.98)**	1.00 **(1.00)**	0.99 **(0.99)**	1.39 **(2.00)**	1.49 **(2.23)**	1.45 **(2.11)**	0.54 **(2.5)**	1.65 **(2.73)**	1.62 **(2.63)**	1.64 **(2.72)**	1.63 **(2.68)**	1.64 **(2.70)**
SEm (±)	**0.02**	**0.02**	**0.02**	**0.06**	**0.04**	**0.05**	**0.09**	**0.07**	**0.08**	**0.07**	**0.07**	**0.07**
CD (p=0.05)	**0.07**	**0.06**	**0.07**	**0.19**	**0.12**	**0.16**	**0.27**	**0.21**	**0.24**	**0.22**	**0.20**	**0.21**

4.1.3.2 *Cynodon dactylon* L.

The data concerning the weed dry weight of *Cynodon dactylon* L. as effect ofvarious weed control treatments at all phases of reports in the years 2021 and 2022, as existed in Charts 4 and 12, showed that weed control actions had an important effect on the dry weight of *Cynodon dactylon* L. at all phases of observations.

Findings displayed in chart 4.12 and shown in graph 4.10 for the years 2021 and 2022 indicate that atrazine's minimum dry weight concentration of 500 g + single HW (30 DAS) Comparing PoE treatment by atrazine 700 g PE, atrazine 500 g PE + single HW (30 DAS), and metribuzin Data on 60 DAS the all-out dry weight of *Cynodon dactylon* L. was noted in the treatment of Tembotrione 120 g PoE. Minimum dry weight was noticed in 2, 4-D Na 800 g PoE in addition to manually weeding at 60 DAS and atrazine 500 g PE + HW (30 DAS). Data on 90 DAS, then harvest the lowest dry weight observed in atrazine 500 g PE + 1 HW (30 DAS) next to HW twice (30 and 60 DAS). At harvest, higher dry weight was noted by Tembotrione 120 g and the latter seeding of Topramezone 200 g PoE as associated by the un-weeded.

The cumulative data shown in chart 4.12 is then represented in graph 4.10 at 30 DAS. The extreme dry weight of the weed was observed in PoE treatment because herbicidal spray was taken as associated by PE treatment. At 60 DAS 2, 4-D Na 800 g PoE mutual by HW on 60 DAS minimum dry weight of *Cynodon dactylon* L., subsequently Atrazine 500 g PE + Single HW (30 DAS) over the un-weeded check. At 90 DAS and harvesting the minimum dry weight noted in 2, 4-D Na 800 g PoE collective by HW at 60 DAS, subsequently small-HW twice (30 and 60 DAS) over another herbicidal treatment over check.



Graph 4.10: Influnce of herbicides on the weed dry weight of *Cynodon dactylon* L. in maize at monthly intervals (2021 and 2022).

Chart 4.13: Influnce of herbicides on weed dry weightof *Cyperus rotundus* L. in maize at monthly intervals. (2021 and 2022).

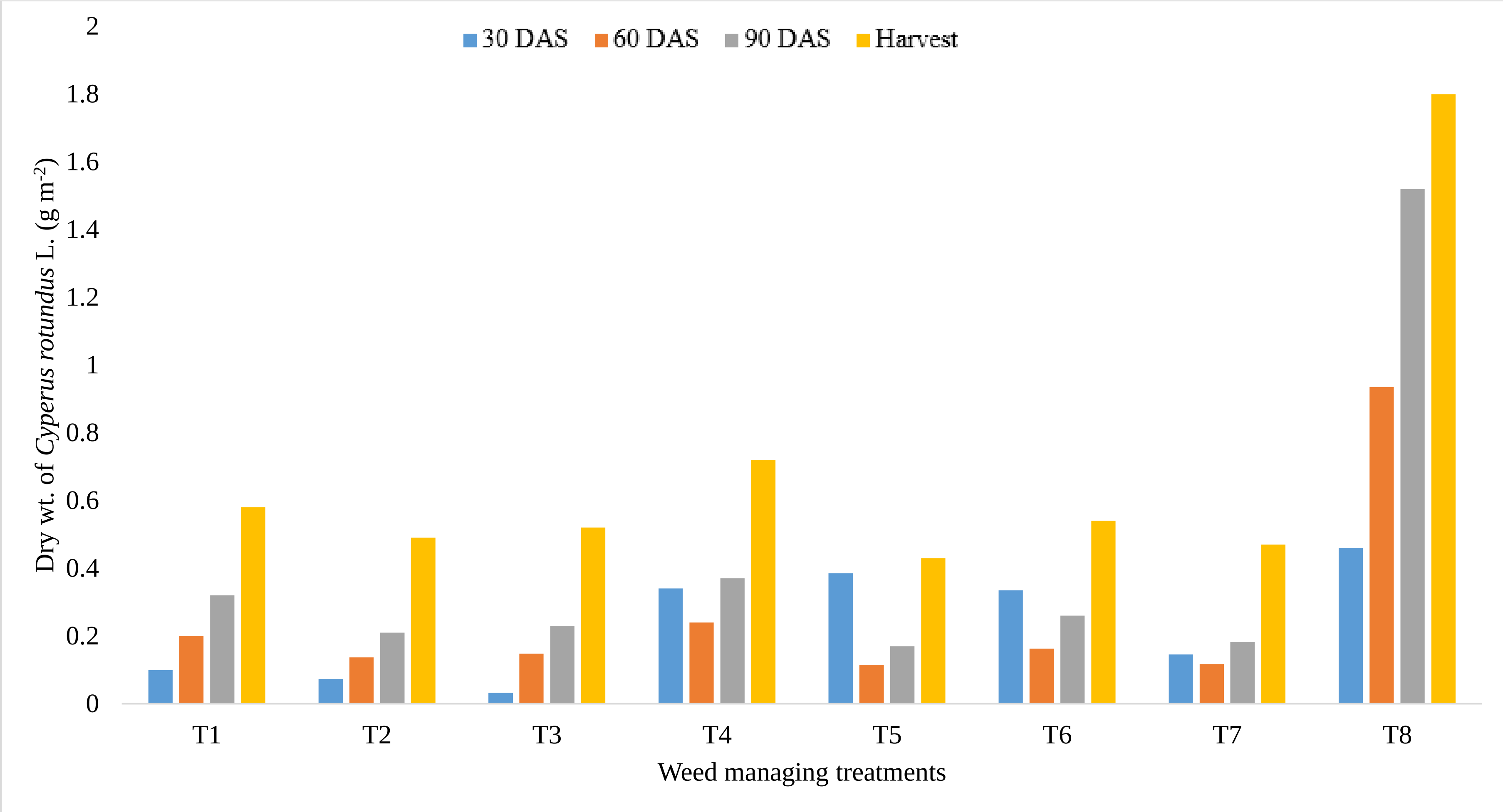
Treatments	30 DAS (2021)	30 DAS (2022)	Pooled data	60 DAS (2021)	60 DAS (2022)	Pooled data	90 DAS (2021)	90 DAS (2022)	Pooled data	Harvest (2021)	Harvest (2022)	Pooled data
T_1	0.031* **(0.098)****	0.31 **(0.10)**	0.31 **(0.099)**	0.43 **(0.19)**	0.45 **(0.21)**	0.44 **(0.20)**	0.56 **(0.31)**	0.57 **(0.33)**	0.56 **(0.32)**	0.32 **(0.57)**	0.77 **(0.60)**	0.76 **(0.585)**
T_2	0.26 **(0.070)**	0.27 **(0.077)**	0.27 **(0.073)**	0.37 **(0.135)**	0.37 **(0.14)**	0.37 **(0.137)**	0.45 **(0.20)**	0.46 **(0.22)**	0.45 **(0.21)**	0.22 **(0.47)**	0.71 **(0.51)**	0.70 **(0.49)**
T_3	0.17 **(0.030)**	0.18 **(0.035)**	0.17 **(0.032)**	0.38 **(0.145)**	0.38 **(0.151)**	0.38 **(0.148)**	0.487 **(0.23)**	0.48 **(0.234)**	0.48 **(0.232)**	0.25 **(0.50)**	0.73 **(0.54)**	0.72 **(0.52)**
T_4	0.56 **(0.32)**	0.60 **(0.36)**	0.58 **(0.34)**	0.48 **(0.23)**	0.50 **(0.25)**	0.48 **(0.24)**	0.68 **(0.47)**	0.52 **(0.275)**	0.60 **(0.372)**	0.50 **(0.71)**	0.85 **(0.73)**	0.84 **(0.72)**
T_5	0.62 **(0.38)**	0.62 **(0.39)**	0.62 **(0.385)**	0.32 **(0.10)**	0.36 **(0.13)**	0.33 **(0.115)**	0.41 **(0.17)**	0.42 **(0.181)**	0.41 **(0.175)**	0.18 **(0.42)**	0.67 **(0.45)**	0.65 **(0.435)**
T_6	0.59 **(0.35)**	0.56 **(0.32)**	0.57 **(0.335)**	0.40 **(0.160)**	0.40 **(0.166)**	0.40 **(0.163)**	0.51 **(0.26)**	0.51 **(0.266)**	0.51 **(0.263)**	0.27 **(0.52)**	0.75 **(0.57)**	0.73 **(0.545)**
T_7	0.63 **(0.40)**	0.65 **(0.43)**	0.64 **(0.415)**	0.34 **(0.115)**	0.34 **(0.119)**	0.34 **(0.117)**	0.42 **(0.18)**	0.42 **(0.184)**	0.42 **(0.182)**	0.20 **(0.45)**	0.70 **(0.49)**	0.68 **(0.47)**
T_8	0.67 **(0.45)**	0.68 **(0.47)**	0.67 **(0.46)**	0.93 **(0.90)**	0.98 **(0.97)**	0.96 **(0.935)**	1.23 **(1.53)**	1.22 **(1.51)**	1.23 **(1.52)**	1.64 **(2.70)**	1.70 **(2.90)**	1.68 **(2.85)**
SEm (±)	**0.03**	**0.02**	**0.03**	**0.05**	**0.03**	**0.04**	**0.09**	**0.09**	**0.09**	**0.10**	**0.05**	**0.08**
CD (p=0.05)	**0.08**	**0.06**	**0.07**	**0.15**	**0.09**	**0.12**	**0.27**	**0.26**	**0.27**	**0.29**	**0.17**	**0.23**

4.1.3.3 *Cyperus rotundus* L.

The data concerning the dry weight of *Cyperus rotundus* L. as effect ofvarious weed control treatments on all phases of assessments in the years 2021 and 2022, as offered in Table 4.13, showed that weed control actions obligated a substantial result on the dry substance of *Cyperus rotundus* L. at all observation sites.

In the years 2021 and 2022, the data is shown in chart 4.13, which shows the minimum dry weight recorded in Atrazine 500 g PE + single-HW (30 DAS). Atrazine 700 g PE, Atrazine 500 g PE + single-HW (30 DAS), and Metribuzin 800 g PE as compared to PoE treatment Data on dry weight 60 DAS showed that the higher dry weight of *Cyperus rotundus* L. was noted in the action of Tembotrione 120 gPoE. The smallest dry weight stayed noted in 2, 4-D Na 800 g PoE by single-HW at 60 DAS, and Atrazine 500 g PE by single-HW (30 DAS) as associated by HW. Data on 90 DAS and harvesting, minutest dry weight of 2, 4-D Na salt 800 g PoE mutual by HW at 60 DAS, afterward Atrazine 500 g PE + single-HW (30 DAS). At harvest, optimum dry weight was noted in Tembotrione and subsequently in Topramezone (200 gPoE) as over by the un-weeded.

Cumulative data shown in chart 4.13 is then represented in fig. 4.11 at 30 DAS. The heaviest dried material was noted down in PoE treatment because there was herbicidal spray associated by PE treatment. At 60 DAS DAS 2, 4-D Na 800 g PoE combined by HW at 60 DAS minimum dry weight of *Cyperus rotundus* L. tracked by Atrazine 500 g PE + single-HW (30 DAS) over an unweeded. At 90 DAS, also harvest the smallest dry weight recorded in 2, 4-D Na 800 g PoE joined by HW at 60 DAS, subsequently double-HW (30 and 60 DAS) over another herbicidal treatment over the un-weeded. The heaviest dry weight was noted in the action of Tembotrione (120 gPoE) and Topramezone (200 g PoE).



Graph 4.11 Influnce of herbicides on weed dry weightof *Cyperus rotundus* L. in maize at monthly intervals. (2021 and 2022).

Chart 4.14: Influnce of herbicides on weed dry weightof *Chenopodium album* L. in maize at monthly intervals. (2021 and 2022).

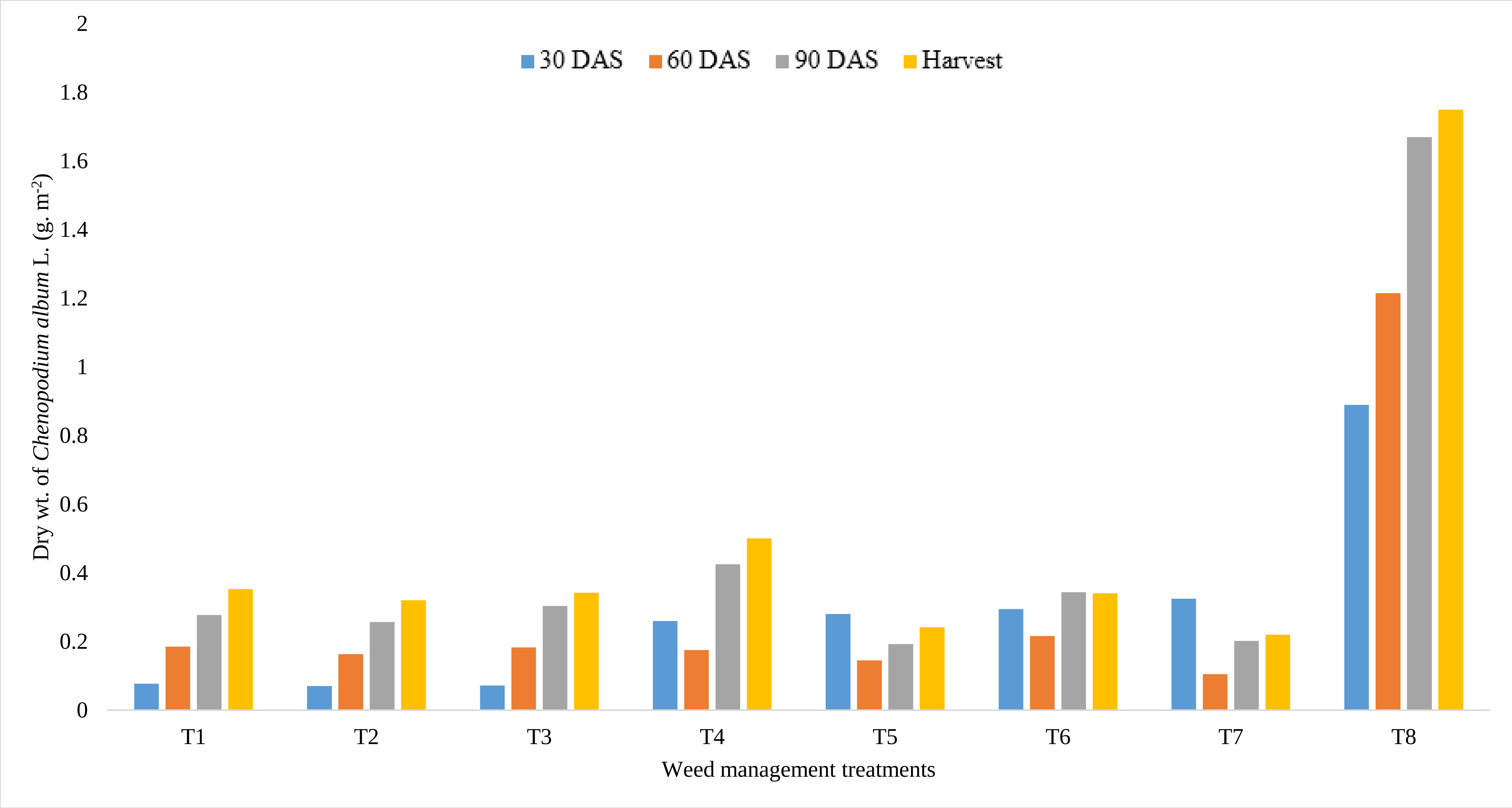
Treatments	30 DAS (2021)	30 DAS (2022)	Pooled data	60 DAS (2021)	60 DAS (2022)	Pooled data	90 DAS (2021)	90 DAS (2022)	Pooled data	Harvest (2021)	Harvest (2022)	Pooled data
T_1	0.26* (0.070)**	0.28 (0.084)	0.27 (0.077)	0.42 (0.18)	0.43 (0.191)	0.43 (0.185)	0.52 (0.275)	0.52 (0.28)	0.52 (0.277)	0.59 (0.35)	0.59 (0.356)	0.59 (0.353)
T_2	0.25 (0.065)	0.27 (0.075)	0.26 (0.070)	0.40 (0.16)	0.40 (0.167)	0.40 (0.163)	0.51 (0.25)	0.51 (0.265)	0.50 (0.257)	0.53 (0.32)	0.56 (0.321)	0.56 (0.320)
T_3	0.26 (0.068)	0.27 (0.077)	0.26 (0.072)	0.41 (0.18)	0.43 (0.187)	0.42 (0.183)	0.55 (0.30)	0.55 (0.309)	0.55 (0.304)	0.58 (0.34)	0.58 (0.344)	0.58 (0.342)
T_4	0.51 (0.25)	0.51 (0.27)	0.50 (0.26)	0.52 (0.27)	0.42 (0.281)	0.52 (0.275)	0.64 (0.42)	0.65 (0.431)	0.65 (0.425)	0.41 (0.50)	0.70 (0.501)	0.70 (0.501)
T_5	0.52 (0.27)	0.53 (0.29)	0.52 (0.28)	0.37 (0.14)	0.38 (0.151)	0.38 (0.145)	0.44 (0.19)	0.44 (0.197)	0.36 (0.193)	0.46 (0.24)	0.49 (0.244)	0.49 (0.242)
T_6	0.54 (0.29)	0.54 (0.30)	0.54 (0.295)	0.46 (0.21)	0.47 (0.223)	0.46 (0.216)	0.58 (0.34)	0.59 (0.349)	0.58 (0.344)	0.60 (0.37)	0.59 (0.35)	0.60 (0.36)
T_7	0.53 (0.32)	0.57 (0.33)	0.57 (0.325)	0.32 (0.10)	0.33 (0.111)	0.32 (0.105)	0.45 (0.20)	0.45 (0.204)	0.44 (0.202)	0.48 (0.24)	0.46 (0.22)	0.47 (0.23)
T_8	0.65 (0.42)	0.67 (0.45)	0.65 (0.435)	1.3 (1.1)	1.15 (1.33)	1.10 (1.215)	1.25 (1.6)	1.31 (1.74)	1.29 (1.67)	1.25 (1.7)	1.34 (1.81)	1.32 (1.75)
SEm (±)	**0.02**	**0.02**	**0.02**	**0.05**	**0.04**	**0.05**	**0.09**	**0.04**	**0.07**	**0.10**	**0.07**	**0.09**
CD (p=0.05)	**0.05**	**0.07**	**0.06**	**0.16**	**0.12**	**0.14**	**0.28**	**0.11**	**0.20**	**0.29**	**0.20**	**0.25**

4.1.2.4 *Chenopodium album* L.

The data concerning the weed dry weight of *Chenopodium album* L. as effect ofdifferent weed control measures at all phases of observation in the two years 2021 and 2022, as existed in Chart 4.14, exposed that weed regulation treatments had a major impact on *Chenopodium album* L. dry material at all phases of monitoring.

In the years 2021 and 2022, the data is shown in chart 4.14. Minimum dry weight at 30 days later seeding was recorded in Atrazine 500 g PE + 1 HW (30 days later seeding), Atrazine 700 g PE DAS, Atrazine 500 g PE + Single HW (30 days later seeding), and Metribuzin 800 g PE as compared to PoE action. Superior dry weight at 60 days after seeding of *Chenopodium album* L. was noted in the treatment of Tembotrione 120 g PoE. Minimum dry weight was noted in HW twice (30 and 60 days later seeding) next to 2, 4-D Na 800 g as a PoE combined by HW at 60 days later seeding next to Atrazine 500 g as a PE + single HW (30 days later seeding) as compared to indicator weeding. Data on 90 days later seeding, then harvest the smallest dry weight of 2, 4-D Na 800 g as a PoE mutual by HW at 60 days later seeding, afterward hand clearing twice (30 and 60 days later seeding), and Atrazine 500 g as a PE + HW (30 days later seeding). Data on harvesting higher dry weight was noted by Tembotrione PoE and subsequently Topramezone 200 g PoE as associated by the check. These outcomes were in agreement by the discoveries of V. Varshitha *et al.* (2019).

In the cumulative data shown in chart 4.13 and represented in Fig. 4.12 at 30 days after seeding, the heaviest dry material was noted in PoE treatment because herbicidal spray was taken as associated by PE treatment. At 60 days later seeding, HW twice (30 and 60 days later seeding) DAS 2, 4-D Na 800 g as a PoE combined by HW at 60 days later seeding the minimum dry weight of *Chenopodium album* L., subsequently Atrazine 500 g as a PE + single HW (30 days later seeding) over a check. In comparison to the unweeded check, the heaviest defoliated mass was seen in the Tembotrione 120 g PoE treatment, DAS Topramezone 200 g PoE. At harvest, 2,4-D Na (800 g minimum dry weight) was noted, along by HW twice (30 and 60 days after seeding) over additional herbicidal use over the un-weeded.



Graph 4.12 Influnce of herbicides on weed dry weightof *Chenopodium album* L. in maize at monthly intervals. (2021 and 2022).

Chart 4.15: Influnce of herbicides on weed dry weightof of *Parthenium hysterophorus* L. in maize at monthly intervals. (2021 and 2022)

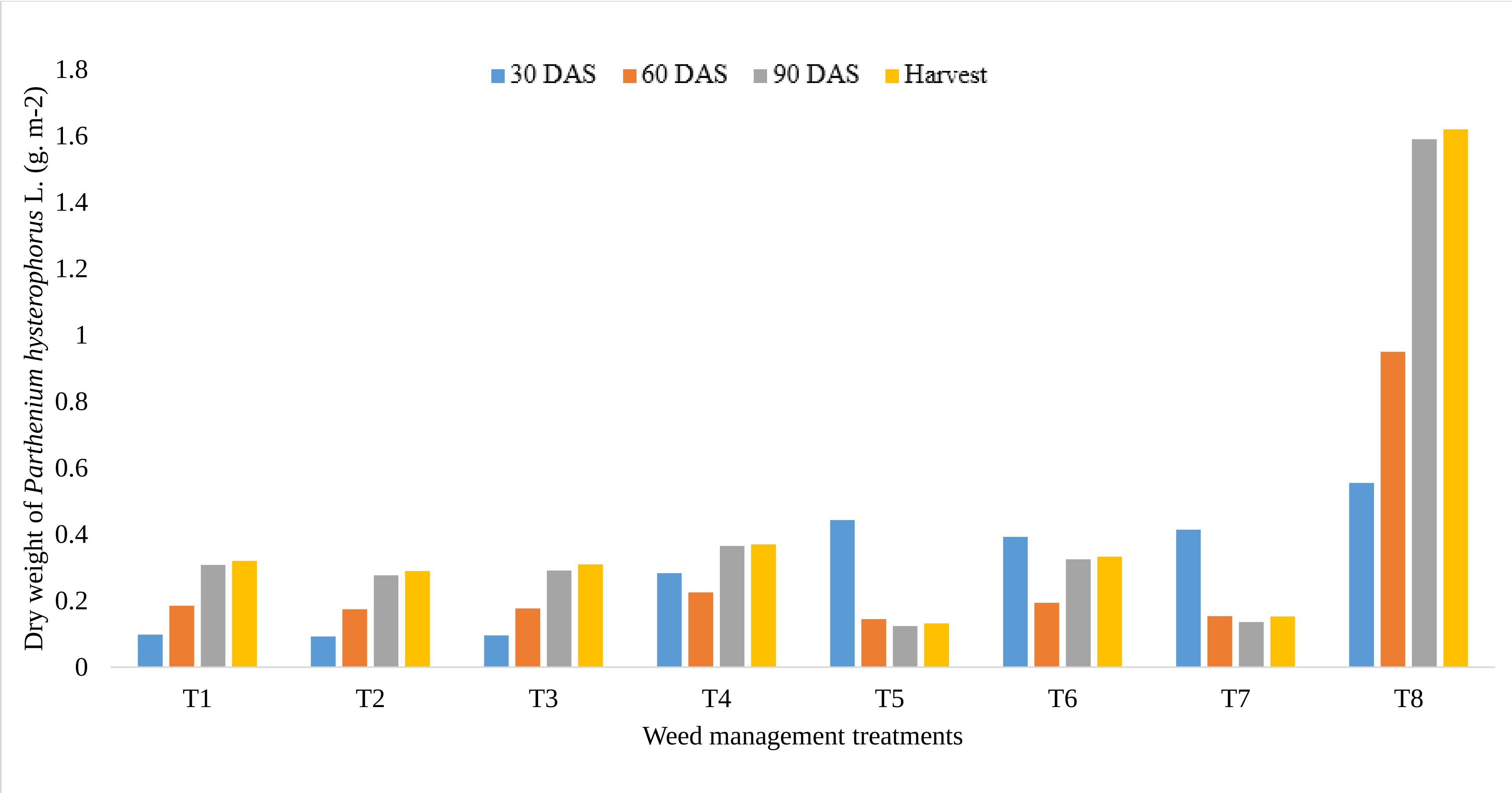
Treatments	30 DAS (2021)	30 DAS (2022)	Pooled data	60 DAS (2021)	60 DAS (2022)	Pooled data	90 DAS (2021)	90 DAS (2022)	Pooled data	Harvest (2021)	Harvest (2022)	Pooled data
T_1	0.31*	0.31	0.31	0.42	0.43	0.43	0.55	0.56	0.55	0.57	0.55	0.59
	(0.097)**	**(0.099)**	**(0.098)**	**(0.18)**	**(0.191)**	**(0.185)**	**(0.30)**	**(0.316)**	**0.308)**	**(0.33)**	**(0.31)**	**(0.32)**
T_2	0.30	0.30	0.30	0.41	0.42	0.41	0.52	0.53	0.52	0.52	0.54	0.53
	(0.091)	**(0.096)**	**(0.093)**	**(0.17)**	**(0.181)**	**(0.175)**	**(0.27)**	**(0.285)**	**(0.277)**	**(0.28)**	**(0.30)**	**(0.29)**
T_3	0.31	0.31	0.30	0.42	0.42	0.42	0.54	0.54	0.53	0.54	0.56	0.55
	(0.095)	**(0.097)**	**(0.096)**	**(0.175)**	**(0.179)**	**(0.177)**	**(0.29)**	**(0.299)**	**(0.291)**	**(0.30)**	**(0.32)**	**(0.31)**
T_4	0.53	0.53	0.53	0.47	0.47	0.47	0.60	0.60	0.60	0.61	0.60	0.60
	(0.28)	**(0.287)**	**(0.283)**	**(0.22)**	**(0.23)**	**(0.225)**	**(0.36)**	**(0.371)**	**(0.365)**	**(0.37)**	**(0.371)**	**(0.370)**
T_5	0.66	0.66	0.66	0.37	0.38	0.38	0.34	0.35	0.35	0.36	0.36	0.36
	(0.44)	**(0.447)**	**(0.443)**	**(0.14)**	**(0.151)**	**(0.145)**	**(0.12)**	**(0.129)**	**(0.124)**	**(0.13)**	**(0.135)**	**(0.132)**
T_6	0.62	0.62	0.62)	0.44	0.44	0.44	0.57	0.57	0.57	0.57	0.57	0.57
	(0.39)	**(0.396)**	**(0.393)**	**(0.19)**	**(0.20)**	**(0.195)**	**(0.32)**	**(0.331)**	**(0.325)**	**(0.33)**	**(0.336)**	**(0.333)**
T_7	0.64	0.64	0.64	0.39	0.39	0.39	0.36	0.37	0.36	0.39	0.39	0.39
	(0.41)	**(0.419)**	**(0.414)**	**(0.15)**	**(0.159)**	**(0.154)**	**(0.13)**	**(0.142)**	**(0.136)**	**(0.15)**	**(0.156)**	**(0.153)**
T_8	0.74	0.74	0.74	0.95	0.97	0.97	1.18	1.3	1.26	1.26	1.28	1.28
	(0.55)	**(0.56)**	**(0.555)**	**(0.95)**	**(0.96)**	**(0.95)**	**(1.5)**	**(1.69)**	**(1.59)**	**(1.59)**	**(1.65)**	**(1.62)**
SEm (±)	**0.01**	**0.03**	**0.02**	**0.05**	**0.04**	**0.05**	**0.08**	**0.06**	**0.07**	**0.10**	**0.06**	**0.08**
CD (p=0.05)	**0.04**	**0.10**	**0.07**	**0.17**	**0.14**	**0.16**	**0.26**	**0.20**	**0.23**	**0.32**	**0.17**	**0.25**

4.1.2.4 ***Parthenium hysterophorus* L.**

Data concerning the weed dry weight of *Parthenium hysterophorus* L. by different weed control practices at all phases of statements in the years 2021 and 2022, indicating that weed regulate therapies had a major effect on dries matter pertaining to *Parthenium hysterophorus* L. at all phases of monitoring.

In the years 2021 and 2022, the data is shown in chart 4.15. At 30 DAS at the minimum dry weight of Atrazine 500 g PE + Single HW (30 DAS) Atrazine 700 g as a PE DAS Atrazine 500 g as a PE + Single HW (30 DAS) then Metribuzin 800 g as a PE as compare to PoE action. Data expressed 60 DAS the supreme dried matter of *Parthenium hysterophorus* L. was noted in the treatment of Tembotrione 120 g as a PoE. least dried weight was noted in 2 HW (30 & 60 DAS DAS) afterwards 2, 4-D Na 800 g as a PoE mutual by HW at 60 DAS then Atrazine 500 g as a PE + 1HW (30 DAS) as compare to small HW. At 90 DAS then harvest the smallest dried weight of 2, 4-D Na 800 g as a PoE combined by HW at 60 DAS DAS DAS HW twice (30 & 60 DAS) then Atrazine 500 g as a PE + Single HW (30 DAS). Harvesting noted heighest dried weight in Tembotrione 120 g as a PoE DAS Topramezone 200 g as a PoE as paralleled to the un-weeded. Alike outcomes are in settlement by the discoveries of A. Sundari *et.al* (2019).

Cumulative data shown in chart 4.13 and described in fig 4.13 at 30 DAS the heighest dry material was observed in PoE treatment because there was herbicidal spray was taken as asociated to PE treatment. At 60 DAS 2, 4-D Na 800 g as a PoE mutual by HW at 60 DAS minimum dry weight of *Parthenium hysterophorus* L. subsequently Atrazine 500 g as a PE + Single HW (30 DAS) over the check. At 90 DAS also harvest the minimum dry weight noted in 2, 4-D Na 800 g as a PoE collective by HW at 60 DAS subsequently HW twice (30 & 60 DAS) over herbicidal action over check.



Graph 4.13 Influnce of herbicides on weed dry weightof *Parthenium hysterophorus* L. in maize at monthly intervals. (2021 and 2022).

Chart 4.16: Influnce of herbicides on weed dry weightof *Cannabis sativus* L. in maize at monthly intervals. (2021 and 2022).

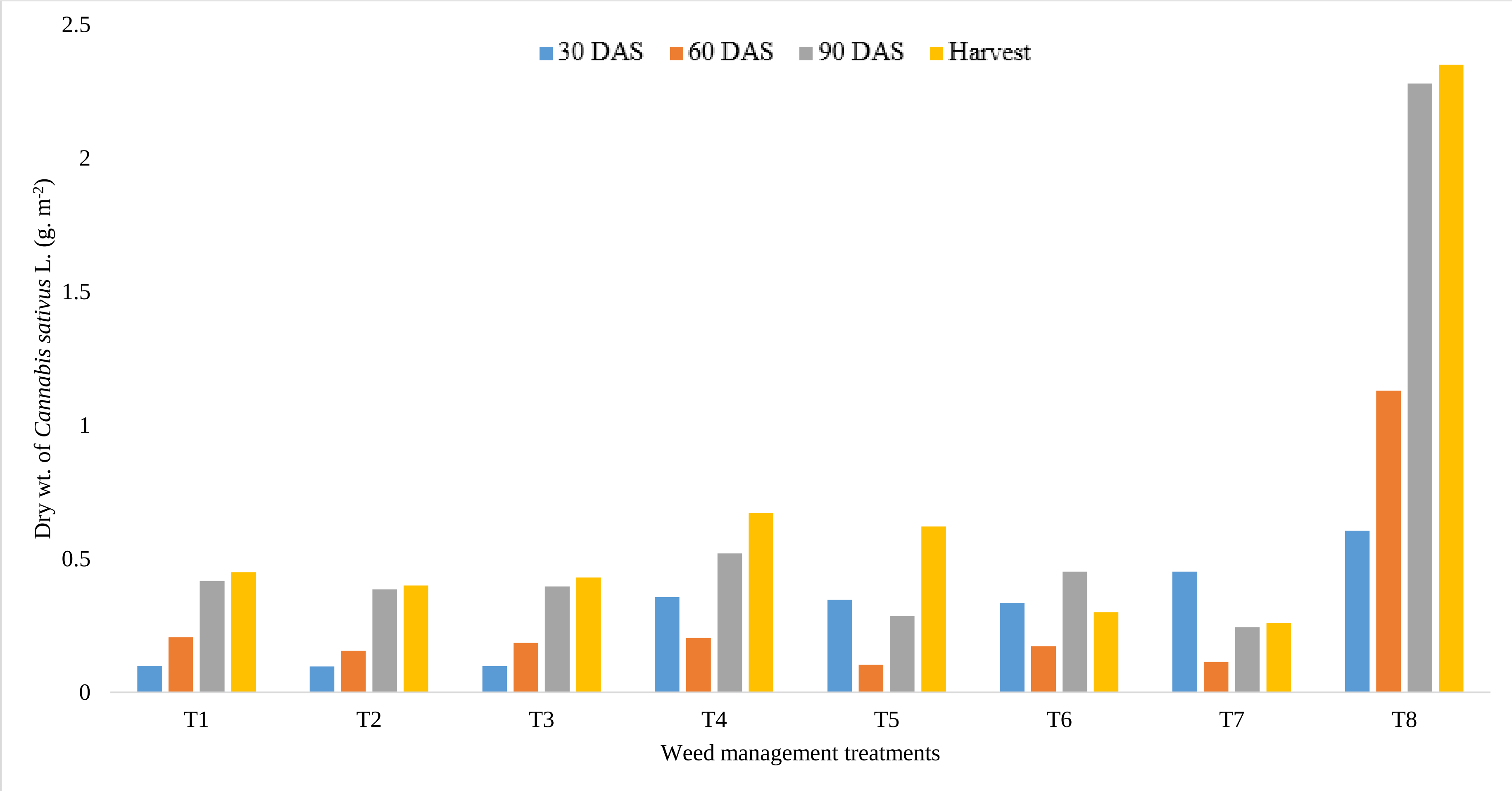
Treatments	30 DAS (2021)	30 DAS (2022)	Pooled data	60 DAS (2021)	60 DAS (2022)	Pooled data	90 DAS (2021)	90 DAS (2022)	Pooled data	Harvest (2021)	Harvest (2022)	Pooled data
T_1	0.31* **(0.098)****	0.31 **(0.10)**	0.31 **(0.099)**	0.45 **(0.20)**	0.46 **(0.212)**	0.45 **(0.206)**	0.64 **(0.41)**	0.65 **(0.424)**	0.64 **(0.417)**	0.67 **(0.46)**	0.66 **(0.44)**	0.67 **(0.45)**
T_2	0.31 **(0.096)**	0.30 **(0.099)**	0.31 **(0.097)**	0.38 **(0.15)**	0.40 **(0.163)**	0.39 **(0.156)**	0.62 **(0.38)**	0.62 **(0.392)**	0.62 **(0.386)**	0.64 **(0.41)**	0.62 **(0.39)**	0.63 **(0.40)**
T_3	0.31 **(0.097)**	0.30 **(0.099)**	0.30 **(0.098)**	0.42 **(0.18)**	0.43 **(0.191)**	0.43 **(0.185)**	0.72 **(0.39)**	0.63 **(0.402)**	0.65 **(0.396)**	0.66 **(0.44)**	0.64 **(0.42)**	0.63 **(0.43)**
T_4	0.59 **(0.35)**	0.60 **(0.365)**	0.59 **(0.357)**	0.50 **(0.20)**	0.45 **(0.209)**	0.45 **(0.204)**	0.52 **(0.52)**	0.72 **(0.529)**	0.72 **(0.520)**	0.90 **(0.82)**	0.90 **(0.823)**	0.81 **(0.671)**
T_5	0.58 **(0.34)**	0.59 **(0.354)**	0.58 **(0.347)**	0.31 **(0.10)**	0.32 **(0.107)**	0.32 **(0.103)**	0.47 **(0.22)**	0.48 **(0.232)**	0.53 **(0.286)**	0.55 **(0.31)**	0.53 **(0.29)**	0.54 **(0.30)**
T_6	0.58 **(0.33)**	0.58 **(0.341)**	0.57 **(0.335)**	0.41 **(0.17)**	0.42 **(0.177)**	0.41 **(0.173)**	0.63 **(0.40)**	0.70 **(0.504)**	0.67 **(0.452)**	0.68 **(0.47)**	0.72 **(0.53)**	0.70 **(0.50)**
T_7	0.67 **(0.45)**	0.67 **(0.454)**	0.67 **(0.452)**	0.30 **(0.11)**	0.34 **(0.119)**	0.33 **(0.114)**	0.49 **(0.24)**	0.49 **(0.248)**	0.49 **(0.244)**	0.51 **(0.27)**	0.50 **(0.25)**	0.50 **(0.26)**
T_8	0.76 **(0.60)**	0.78 **(0.61)**	0.77 **(0.605)**	1.4 **(1.1)**	1.08 **(1.17)**	1.06 **(1.13)**	1.44 **(2.2)**	1.53 **(2.36)**	1.50 **(2.28)**	1.53 **(2.37)**	1.52 **(2.33)**	1.53 **(2.35)**
SEm (±)	**0.04**	**0.02**	**0.03**	**0.06**	**0.05**	**0.06**	**0.09**	**0.05**	**0.07**	**0.12**	**0.08**	**0.10**
CD (p=0.05)	**0.11**	**0.07**	**0.09**	**0.19**	**0.14**	**0.17**	**0.27**	**0.16**	**0.22**	**0.36**	**0.23**	**0.30**

4.1.3.6 *Cannabis sativus* L.

The data concerning the weed dry weight of *Cannabis sativus* L. as effect ofvarious weed control treatments at all phases of data observations in the years 2021 and 2022, as displayed in Chart 4.16 showed in graph. 4.14, showed that weed control actions shows important result on the dried matter of *Cannabis sativus* L. at all phases of observation.

In the years 2021 and 2022, the data shown in chart 4.16. At 30 DAS the minimum dry weightof *Cannabis sativus* L was reported by Atrazine 500 g PE + 1 HW (30 DAS) Atrazine 700 g PE and Metribuzin 800 g PE as compare to PoE action. Data obtained on 60 DAS the supreme dried weight of *Cannabis sativus* L. was noted in the action of Tembotrione 120 g PoE. minimum dried weight was noted in 2, 4-D Na 800 g PoE association by HW at 60 DAS afterward 2 HW (30 & 60 DAS) then Atrazine 500 g PE + Single HW (30 DAS). Data shown on 90 DAS then harvest the minimum dry weight found by 2, 4-D Na 800 g PoE combined by HW at 60 DAS next HW twice (30 & 60 DAS) and Atrazine 500 g PE mutual by HW (30 DAS). At 90 DAS and at harvest higher dried weight was noted in Tembotrione 120 g PoE day's latter seeding Topramezone 200 g PoE as asociated to un-weeded check.

At 30 DAS the higher dry material noticed in PoE treatment because there was herbicidal spray was taken as asociated to PE treatment. At 60 DAS 2, 4-D Na 800 g PoE combined by HW at 60 DAS minimum dry weight of *Cannabis sativus* L. subsequently 2 HW (30 & 60 DAS) then Atrazine 500 g PE by HW (30 DAS) over the Un-weeded. Data on 90 DAS minimum dry weight observed in HW double (30 & 60 DAS) then 2, 4-D Na 800 g PoE mutual too HW at 60 DAS over another herbicidal treatment over check.



Graph 4.14 Influnce of herbicides on weed dry weightof *Cannabis sativus* L. in maize at monthly intervals. (2021 and 2022).

Chart 4.17: Influnce of herbicides on weed dry weightof *Sinapis arvensis* L. in maize at monthly intervals. (2021 and 2022).

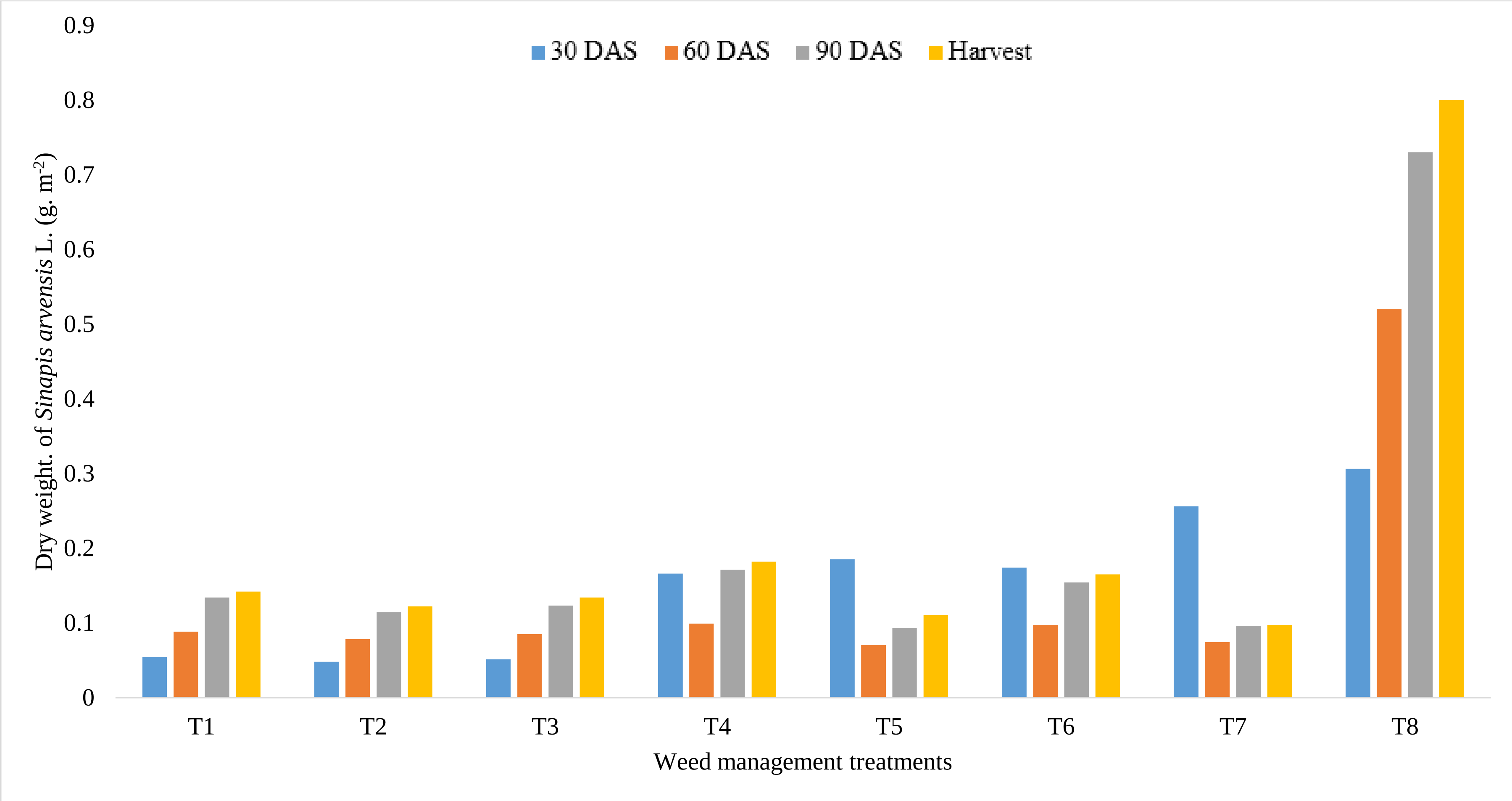
Treatments	30 DAS (2021)	30 DAS (2022)	Pooled data	60 DAS (2021)	60 DAS (2022)	Pooled data	90 DAS (2021)	90 DAS (2022)	Pooled data	Harvest (2021)	Harvest (2022)	Pooled data
T_1	0.22* **(0.050)****	0.24 **(0.059)**	0.23 **(0.054)**	0.29 **(0.085)**	0.30 **(0.091)**	0.29 **(0.088)**	0.36 **(0.13)**	0.37 **(0.137)**	0.36 **(0.134)**	0.37 **(0.14)**	0.37 **(0.143)**	0.37 **(0.142)**
T_2	0.21 **(0.046)**	0.22 **(0.051)**	0.21 **(0.048)**	0.27 **(0.075)**	0.28 **(0.082)**	0.27 **(0.078)**	0.33 **(0.11)**	0.34 **(0.117)**	0.33 **(0.114)**	0.34 **(0.12)**	0.35 **(0.124)**	0.34 **(0.122)**
T_3	0.22 **(0.047)**	0.23 **(0.055)**	0.22 **(0.051)**	0.29 **(0.083)**	0.29 **(0.088)**	0.29 **(0.085)**	0.34 **(0.12)**	0.35 **(0.125)**	0.35 **(0.123)**	0.36 **(0.13)**	0.37 **(0.137)**	0.36 **(0.134)**
T_4	0.40 **(0.16)**	0.41 **(0.172)**	0.40 **(0.166)**	0.31 **(0.099)**	0.31 **(0.10)**	0.31 **(0.099)**	0.41 **(0.17)**	0.41 **(0.172)**	0.41 **(0.171)**	0.42 **(0.18)**	0.42 **(0.184)**	0.42 **(0.182)**
T_5	0.42 **(0.18)**	0.43 **(0.189)**	0.43 **(0.185)**	0.26 **(0.066)**	0.27 **(0.074)**	0.026 **(0.070)**	0.30 **(0.090)**	0.30 **(0.096)**	0.30 **(0.093)**	0.34 **(0.12)**	0.31 **(0.10)**	0.33 **(0.11)**
T_6	0.41 **(0.17)**	0.42 **(0.177)**	0.41 **(0.174)**	0.31 **(0.095)**	0.31 **(0.099)**	0.031 **(0.097)**	0.39 **(0.15)**	0.39 **(0.158)**	0.39 **(0.154)**	0.40 **(0.16)**	0.41 **(0.169)**	0.40 **(0.165)**
T_7	0.50 **(0.25)**	0.51 **(0.261))**	0.50 **(0.256)**	0.26 **(0.070)**	0.28 **(0.079)**	0.027 **(0.074)**	0.31 **(0.094)**	0.31 **(0.099)**	0.30 **(0.096)**	0.31 **(0.096)**	0.31 **(0.099)**	0.98 **(0.097)**
T_8	0.55 **(0.30)**	0.55 **(0.312)**	0.55 **(0.306)**	0.69 **(0.50)**	0.72 **(0.53)**	0.72 **(0.52)**	0.80 **(0.70)**	0.87 **(0.76)**	0.85 **(0.73)**	0.90 **(0.82)**	0.88 **(0.78)**	0.89 **(0.80)**
SEm (±)	**0.02**	**0.02**	**0.02**	**0.04**	**0.03**	**0.04**	**0.07**	**0.03**	**0.05**	**0.09**	**0.04**	**0.07**
CD (p=0.05)	**0.05**	**0.07**	**0.06**	**0.12**	**0.08**	**0.10**	**0.20**	**0.10**	**0.15**	**0.27**	**0.12**	**0.20**

4.1.3.7 *Sinapis arvensis* L.

The data concerning the weed dry weight of *Sinapis arvensis* L. as effect ofvarious weed control treatments at all phases of observations in the years 2021 and 2022, as chart 4.17 displays cumulative data showed that weed control actions had an important result on dry matter of *Sinapis arvensis* L. at all phases of statement.

In the years 2021 and 2022, the data is shown in chart 4.17. At the minimum dry weightof *Sinapis arvensis* was recorded in Atrazine 500 g PE + 1HW (30 DAS) and Metribuzin 800 g PE as compare to PoE treatment. Data on 60 DAS extreme dried weight of *Sinapis arvensis* L. was observed in the action of Tembotrione 120 g PoE. Smallest drid weight was noted in 2, 4-D Na 800 g PoE joint by HW at 60 DAS tracked by 2 HW (30 & 60 DAS) and Atrazine 500 g PE + Single HW (30 DAS) as associate to HW. Data represent on 90 DAS then harvest, smallest dry weightof 2, 4-D Na 800 gPoE mutual by HW at 60 DAS next to HW twice (30 & 60 DAS) then Atrazine 500 g PE + HW (30 DAS). Higher dry weightwas noted in Tembotrione 120 g PoE day's latter seeding Topramezone 200 g PoE as associated to the check at harvest. Such consequences are in arrangement through the discoveries of Hatti *et al.*, (2014).

Cumulative data shown in chart 4.17 and showed in graph 4.15 on 30 DAS the higher dry material was record in PoE treatment because there was no herbicidal spray was taken as asociated to PE treatment. At 60 DAS 2, 4-D Na 800 g PoE combined by HW at 60 DAS minimum dry weight of *Sinapis arvensis* L. DAS 2 HW (30 & 60 DAS) then Atrazine 500 g PE + HW (30 DAS) over a check. Data on 90 DAS then harvest the minimum dry weightnoted in 2, 4-D Na 800 g PoE combined by HW at 60 DAS physical weeding twice (30 & 60 DAS) over another herbicidal action over the Un-weeded.



Graph 4.15 Influnce of herbicides on weed dry weightof *Sinapis arvensis* L. in maize at monthly intervals. (2021 and 2022).

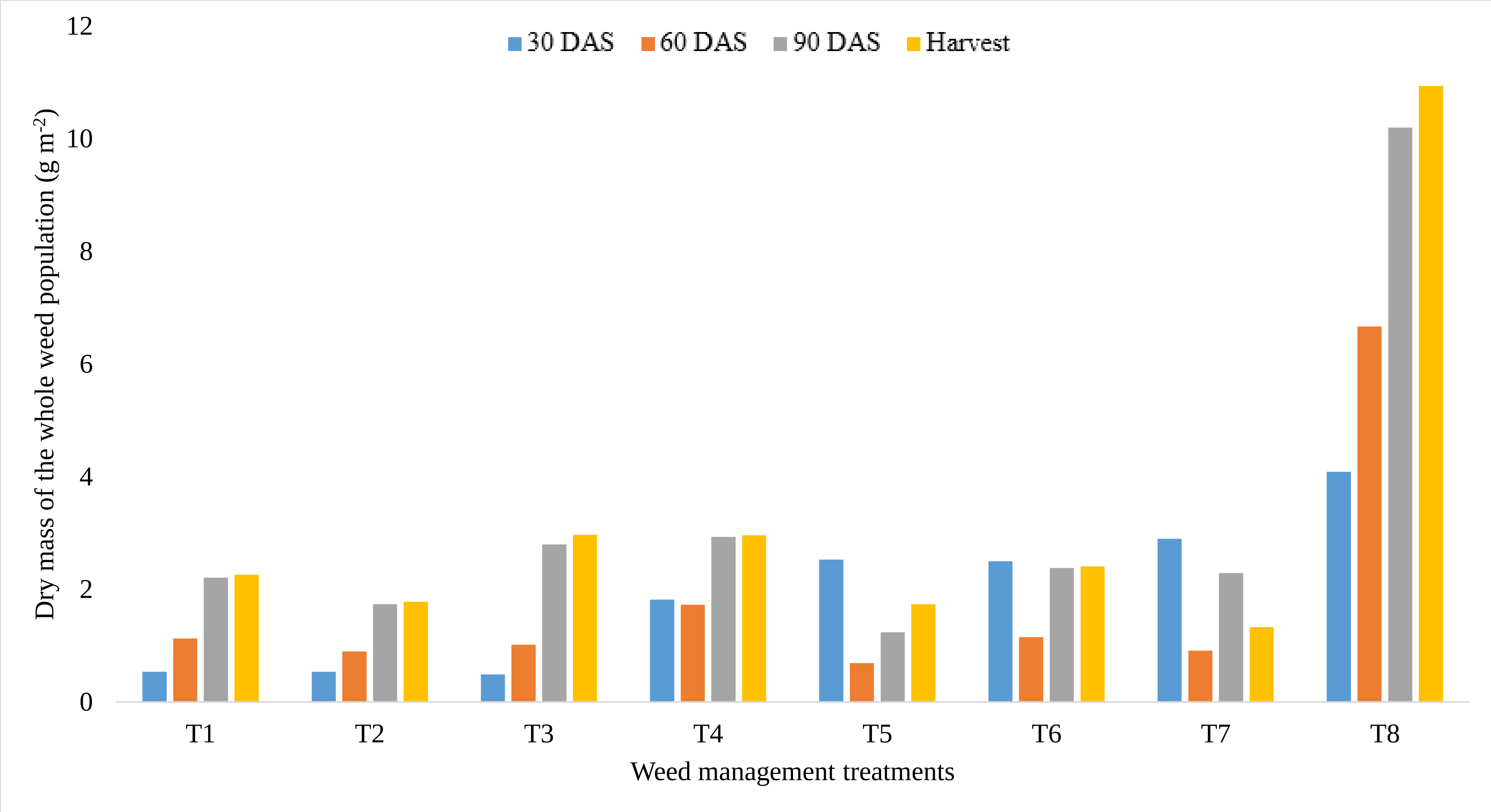
Chart 4.18: Influnce of herbicides on weed dry weightof total weed species in maize at monthly intervals. (2021 and 2022).

Treatments	30 DAS (2021)	30 DAS (2022)	Pooled data	60 DAS (2021)	60 DAS (2022)	Pooled data	90 DAS (2021)	90 DAS (2022)	Pooled data	Harvest (2021)	Harvest (2022)	Pooled data
T_1	0.75* **(0.569)****	0.71 **(0.512)**	0.73 **(0.540)**	1.04 **(1.085)**	1.08 **(1.18)**	1.06 **(1.13)**	1.43 **(2.035)**	1.54 **(2.40)**	1.48 **(2.21)**	1.48 **(2.20)**	1.51 **(2.31)**	1.50 **(2.26)**
T_2	0.72 **(0.52)**	0.74 **(0.558)**	0.73 **(0.539)**	0.93 **(0.86)**	0.97 **(0.95)**	0.95 **(0.90)**	1.25 **(1.57)**	1.38 **(1.91)**	1.31 **(1.74)**	1.32 **(1.76)**	1.34 **(1.80)**	1.33 **(1.78)**
T_3	0.70 **(0.498)**	0.69 **(0.485)**	0.70 **(0.491)**	0.99 **(0.99)**	1.02 **(1.06)**	1.00 **(1.02)**	1.32 **(1.75)**	1.44 **(2.10)**	1.67 **(2.80)**	1.72 **(2.99)**	1.71 **(2.95)**	1.72 **(2.97)**
T_4	1.16 **(1.372)**	1.50 **(2.28)**	1.34 **(1.82)**	1.31 **(1.718)**	1.31 **(1.76)**	1.31 **(1.73)**	1.66 **(2.77)**	1.76 **(3.10)**	1.71 **(2.93)**	1.75 **(3.06)**	1.60 **(2.87)**	1.72 **(2.96)**
T_5	1.56 **(2.43)**	1.62 **(2.64)**	1.59 **(2.53)**	0.81 **(0.658)**	0.85 **(0.734)**	0.83 **(0.69)**	1.03 **(1.06)**	1.19 **(1.43)**	1.11 **(1.24)**	1.13 **(1.29)**	1.14 **(1.31)**	1.14 **(1.30)**
T_6	1.56 **(2.445)**	1.60 **(2.57)**	1.58 **(2.50)**	1.05 **(1.115)**	1.09 **(1.2)**	1.07 **(1.15)**	1.46 **(2.14)**	1.55 **(2.42)**	1.54 **(2.38)**	1.55 **(2.43)**	1.54 **(2.39)**	1.55 **(2.41)**
T_7	1.67 **(2.81)**	1.72 **(2.99)**	1.7 **(2.9)**	0.87 **(0.755)**	1.03 **(1.07)**	0.95 **(0.91)**	1.05 **(1.41)**	1.21 **(1.48)**	1.13 **(1.44)**	1.17 **(1.37)**	1.13 **(1.29)**	1.15 **(1.33)**
T_8	1.89 **(3.57)**	2.14 **(4.62)**	2.02 **(4.09)**	2.59 **(6.87)**	2.54 **(6.48)**	2.58 **(6.67)**	3.01 **9.12**	3.15 **(9.95)**	3.19 **(10.20)**	3.39 **(11.52)**	3.28 **(10.78)**	3.33 **(11.15)**
SEm (±)	**0.07**	**0.06**	**0.07**	**0.10**	**0.10**	**0.10**	**0.12**	**0.12**	**0.12**	**0.14**	**0.15**	**0.15**
CD (p=0.05)	**0.20**	**0.18**	**0.19**	**0.31**	**0.30**	**0.31**	**0.35**	**0.36**	**0.36**	**0.42**	**0.44**	**0.43**

4.1.3.8 Total weeds dry weight

The information provided in Chart 4.18 along by displayed in Fig. 4.16 for the years 2021 and 2022 on the dried matter of the total weeds impacted by different controlling measures at all observable phases revealed that weed controlling process had a substantial impact on dry wt.of overall weed species at all steps of observation.

As asociated to PoE treatment, Metribuzin 800 gPE at the lowermost dried matter in the years 2021 and 2022 was complemented by Atrazine 500 g PE + one HW (30 DAS) then Atrazine 700 g PE. Data occupied on 60 DAS the heighest dry weightof the total weed population was noted in the treatment of Tembotrione 120 g PoE. Lowest dry weightwas noted in 2, 4-D Na 800 g PoE joint by HW at 60 DAS DAS 2 HW (30 & 60 DAS) and Atrazine 500 g PE + Single HW (30 DAS) as associate to HW. When 2, 4-D Na 800 g PoE at 60 DAS HW were used composed, there was a substantial reduction in weed thickness. Lower weed density and dry weighthave been detected as a consequence of HW, other intercultural operations, post-emergent and pre-emergent herbicide applications, and various crop durations. As a result of effective weed control, maize can use resources more effectively, which is also responsible for this by those treatments. The type of weed seeds existing, the weed seed bank, tillage, and additional factors all affect weed density. Due to the varying application time of the numerous weed controlling strategies, both independently and together, at different times of the year, there were variations in weed density. The crop's capacity to efficiently absorb water and nutrients may be the cause of the weed density consistently increasing, as seen by the weedy check. Alike outcomes are in settlement through the discoveries of Bahirgul Sabiry (2019), D.P. Nagdeve (2014) and Satrndra kumar Gupta (2017).



Graph 4.16 Influnce of herbicides on weed dry weightof total weed species in maize at monthly intervals. (2021 and 2022).

4.1.2.4 Weed control effeciency (%)

Chart 4.19: Influnce of herbicides on WCE of *Commelina benghalensis* L. in maize per month (2021 and 2022).

Treatments	30 DAS (2021)	30 DAS (2022)	Pooled data	60 DAS (2021)	60 DAS (2022)	Pooled data	90 DAS (2021)	90 DAS (2022)	Pooled data	Harvest (2021)	Harvest (2022)	Pooled data
T_1	78.14	76.07	77.1	71.87	70.60	71.23	70.55	70.12	70.68	69.23	75.00	70.22
T_2	77.40	74.28	75.84	78.12	74.54	74.83	73.89	73.42	73.92	73.08	74.38	73.22
T_3	75.55	77.71	76.63	75.00	73.63	74.31	71.11	70.85	70.98	69.23	70.83	70.03
T_4	58.51	58.21	58.36	69.06	69.60	69.33	77.77	73.61	76.42	78.67	74.17	75.69
T_5	55.55	53.21	54.38	78.75	79.42	79.22	79.44	80.07	79.12	79.00	79.17	79.09
T_6	57.40	55.00	56.2	68.75	65.15	67.16	64.44	63.82	64.13	67.25	62.50	64.88
T_7	51.85	51.78	51.81	81.25	85.69	84.21	83.33	84.10	83.52	80.12	80.15	80.47
T_8	-	-	-	-	-	-	-	-	-	-	-	-

4.1.4 Weed control efficacy (%)

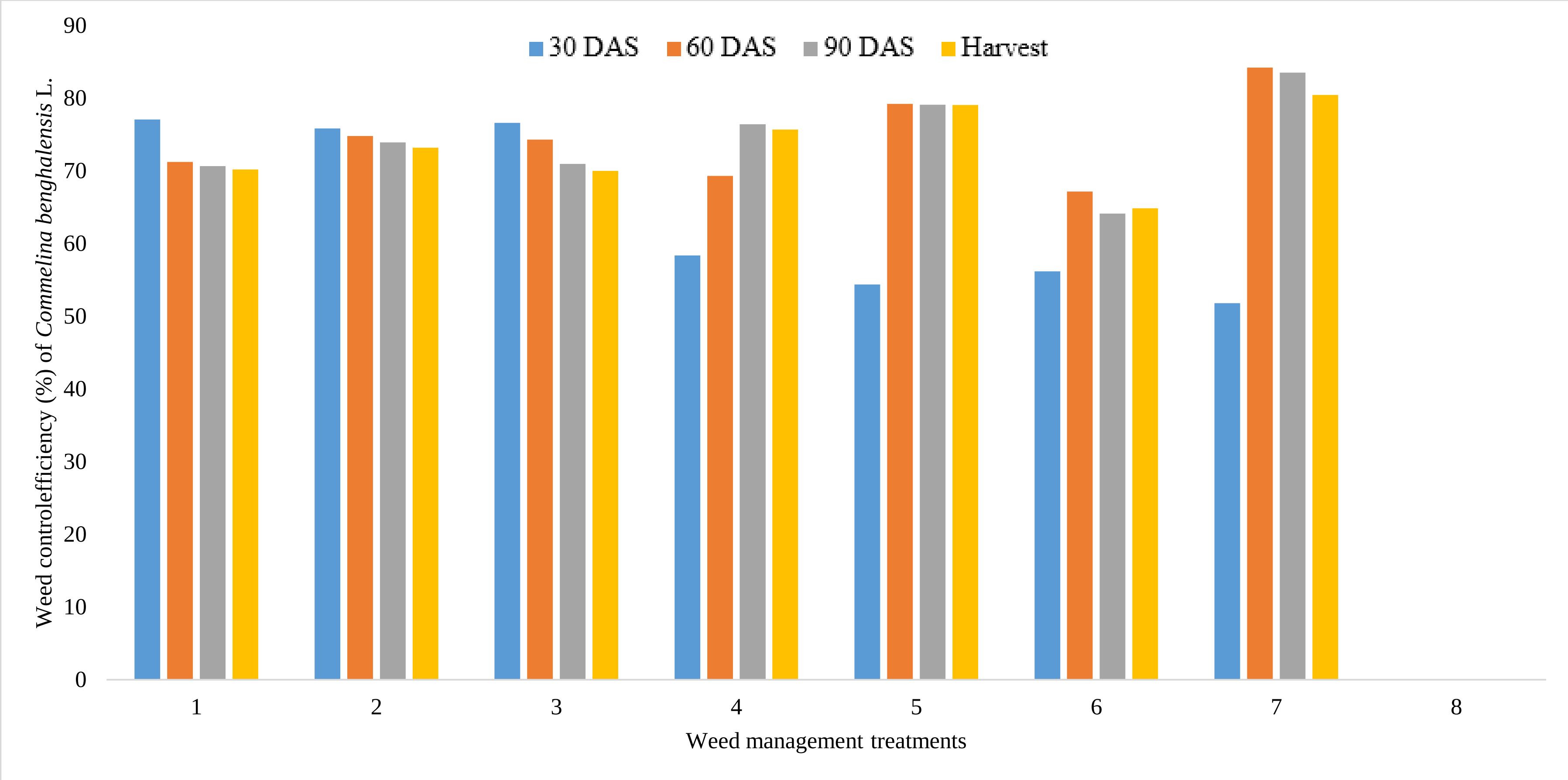
The data concerning the species-wise efficacy of weed control of all weeds was noted at 30, 60, 90, and up to harvest.

4.1.4.1 *Commelina benghalensis* L.

The data concerning the WCE of *Commelina benghalensis* L. as effect of various weed control treatments at all phases of observations in the years 2021 and 2022, as existing in chart 4.19 then revealed in graph. 4.17, showed there weed control actions ensured a substantial impact on the WCE of *Commelina benghalensis* L. at all phases of report.

In the years 2021 and 2022 data shown in chart 4.19 and at 30 DAS greater weed control efficiency was observed in Atrazine 700 g PE DAS Atrazine 500 g PE + Single HW (30 DAS) then Metribuzin 800 gPE as compare to post-emergent actions. Data found on 60 DAS superior weed control efficiency was noted 2, 4-D Na 800 g PoE combined by HW at 60 DAS then 2 HW (30 & 60 DAS). The lowest weed control efficiency was noted in the action of Tembotrione 120 g PoE and Topramezone 200 g PoE. Higher weed control efficiency on 90 DAS also harvest was noted 2, 4-D Na 800 g PoE + HW at 60 DAS then twice HW (30 & 60 DAS). The minimum weed control efficiency of *Commelina benghalensis* L. has been noted in Topramezone 200 g PoE and Metribuzin 800 g PE as paralleled to the check. Similar outcomes are in promise by the discoveries of Kakade *et al.,* (2016).

Cumulative information in the years 2021 and 2022 shown in board 4.19 and illustrated in graph 4.17 exposed Atrazine 500 g PE + 1 HW (30 DAS) efficiency extreme weed control was recorded and Metribuzin 800 g PE over the Un-weeded. At 60 DAS then HW twice (30 & 60 DAS) as associated to further herbicidal usages. Data found on 90 DAS then harvest efficiency lowermost weed control was detailed in Topramezone 200 g PoE and efficiency extreme weed control stood reported in HW twice (30 & 60 DAS) then 2, 4-D Na 800 g PoE + HW at 60 DAS over check.



Graph 4.17 Influnce of herbicides on WCE of *Commelina benghalensis* L. in maize at monthly intervals. (2021 and 2022).

Chart 4.20: Influnce of herbicides on WCE of *Cynodon dactylon* L. in maize at monthly periods. (2021 and 2022).

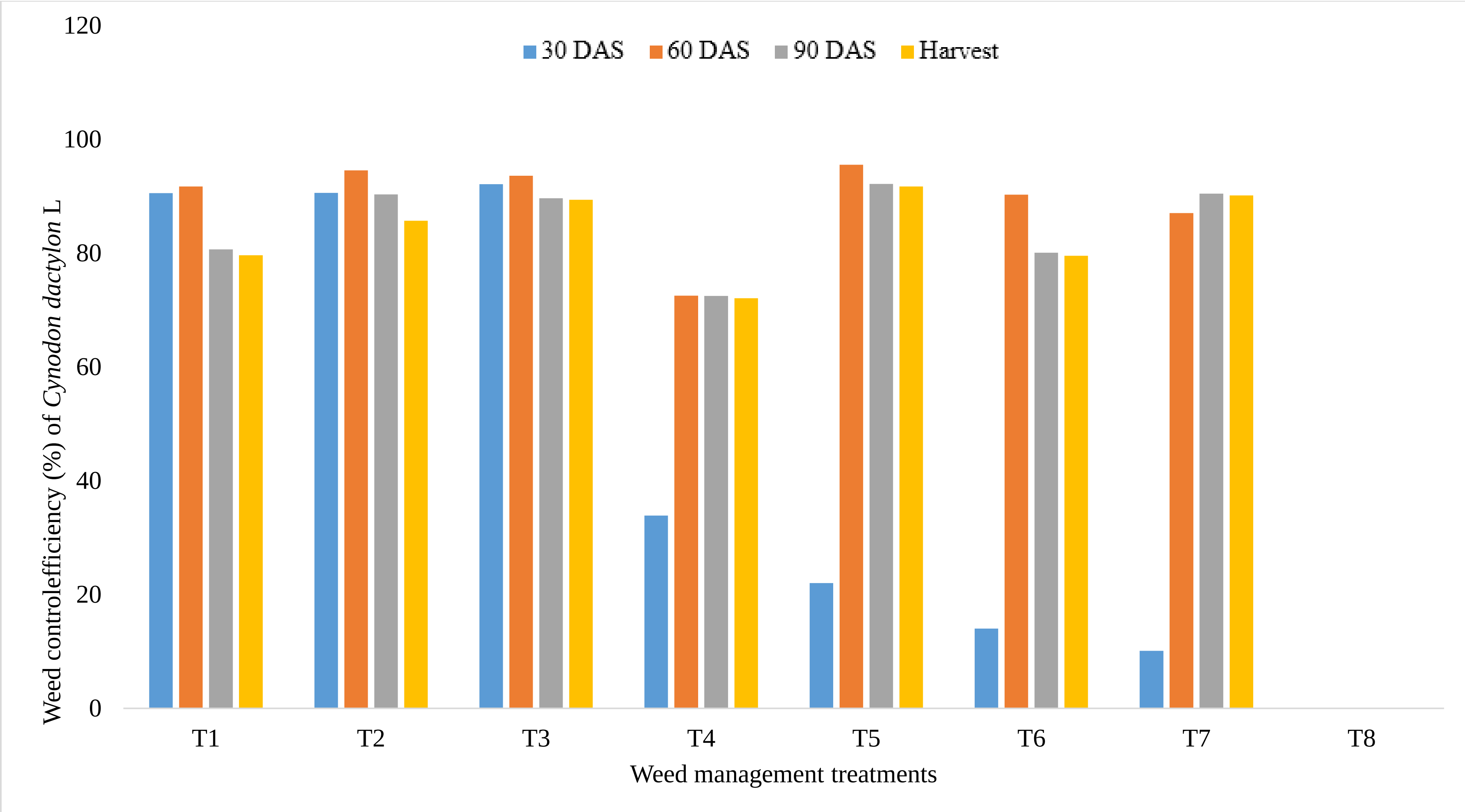
Treatments	30 DAS (2021)	30 DAS (2022)	Pooled data	60 DAS (2021)	60 DAS (2022)	Pooled data	90 DAS (2021)	90 DAS (2022)	Pooled data	Harvest (2021)	Harvest (2022)	Pooled data
T_1	90.10	90.00	90.55	92.00	91.47	91.73	80.40	80.98	80.69	79.78	79.48	79.63
T_2	90.71	90.50	90.60	95.00	94.17	94.58	90.00	90.68	90.34	90.44	80.97	85.71
T_3	90.30	94.00	92.15	94.00	93.27	93.63	89.20	90.11	89.65	89.71	89.04	89.38
T_4	38.77	29.00	33.88	72.50	73.54	72.52	72.00	73.00	72.50	72.19	74.81	72.10
T_5	28.00	16.00	22.00	95.40	95.69	95.54	92.40	92.01	92.20	92.28	91.13	91.71
T_6	18.36	10.00	14.00	90.50	90.13	90.31	80.00	80.22	80.11	79.04	80.02	79.53
T_7	13.26	07.00	10.13	92.50	81.61	87.05	91.20	91.44	91.32	90.81	89.48	90.15
T_8	-	-	-	-	-	-	-	-	-	-	-	-

4.1.4.2 *Cynodon dactylon* L.

The data concerning the WCE of *Cynodon dactylon* L. as effect ofvarious weed management strategies at all phases of observations in the years 2021 and 2022, as existing in chart 4.20 and illustrated in graph 4.18, showed that weed control strategies had a substantial impact on *Cynodon dactylon* L. WCE at all times of observation.

In the years 2021 and 2022, as shown in chart 4.20 at 30 DAS, higher weed control efficiency was observed in Atrazine 500 g PE + HW (30 DAS) than in Metribuzin 800 g PE as associated by post-emergent actions. Data was taken on 60 DAS, and minimum weed control efficiency was noted in the action of Tembotrione 120 gPoE and Topramezone. Superior weed control efficiency was noted. 2, 4-D Na: 800 g PoE + HW at 60 DAS; Atrazine: 500 g PE + HW (30 DAS); and HW: double (30 and 60 DAS). Data received on 90 DAS and harvest showed better efficiency of weed control. 2, 4-D Na, 800 g PoE HW at 60 DAS, also HW twice (30 and 60 DAS). The minimum weed control efficiency of *Cynodon dactylon* L. has been observed in Topramezone 200 g PoE and Metribuzin 800 g PE as associated by the check.

Cumulative data in the years 2021 and 2022 shown in chart 4.20 and represented in fig. 4.18 exposed Atrazine 500 g PE + HW (30 DAS) supreme weed control efficiency was noted, then Metribuzin 800 g PE over the check. Data on 60 DAS efficiency of higher weed control was noted in a 2-D Na Salt 800 g PoE joint by HW at 60 DAS, subsequently Atrazine 500 g PE + single weeding (30 DAS), then double HW (30 and 60 DAS) as compared to other herbicidal treatments. Data on 90 DAS and harvest minimum WCE was noted in Topramezone 200 g PoE, and efficiency of supreme weed control remained logged in 2-D Na 800 g PoE combined by physical weeding at 60 DAS and HW 2 times (30 and 60 DAS).



Graph 4.18 Influnce of herbicides on WCE of *Cynodon dactylon* L. in maize at monthly periods. (2021 and 2022).

Chart 4.21: Influnce of herbicides on WCE of *Cyperus rotundus* L. in maize at monthly intervals. (2021 and 2022).

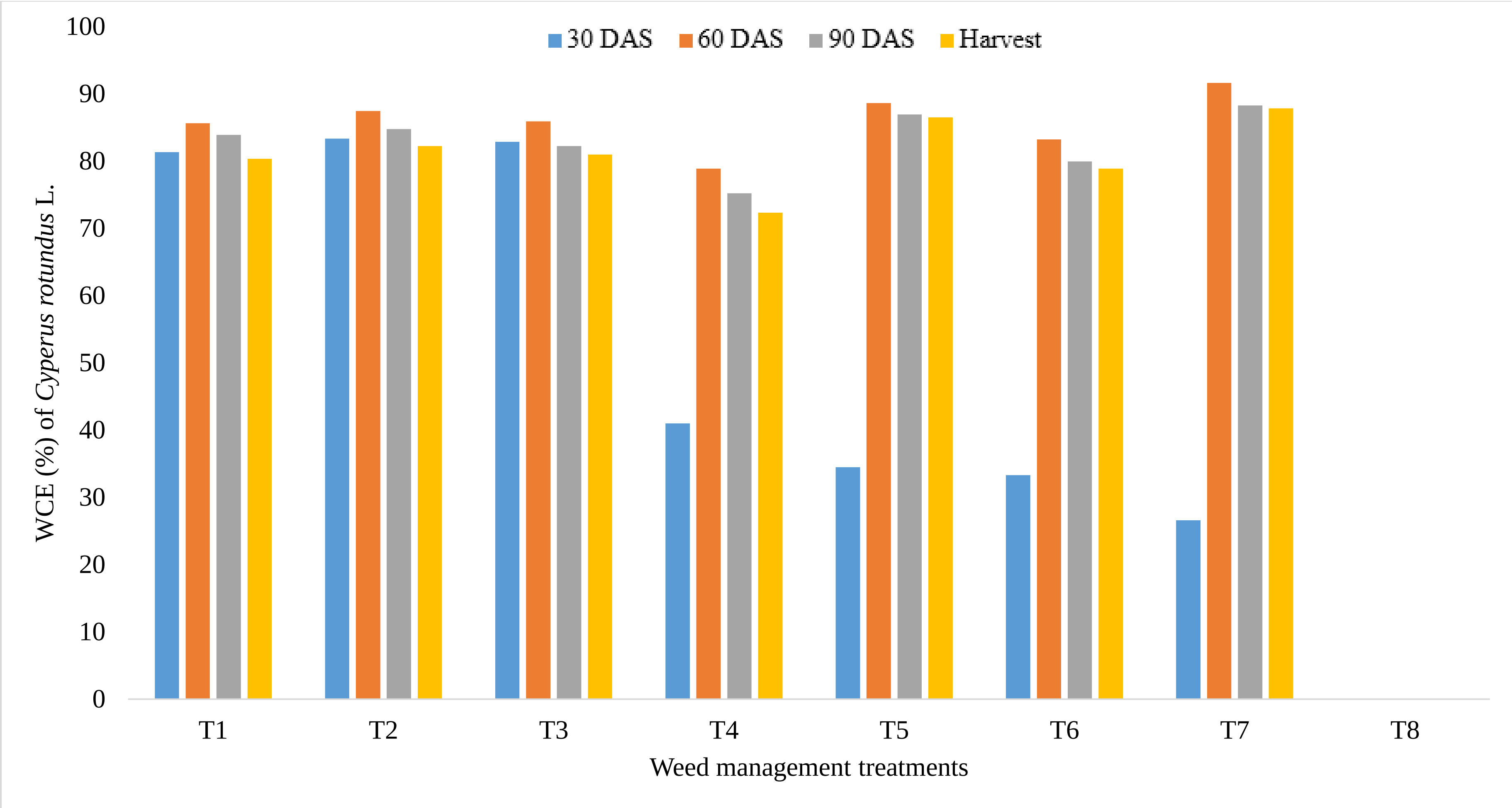
Treatments	30 DAS (2021)	30 DAS (2022)	Pooled data	60 DAS (2021)	60 DAS (2022)	Pooled data	90 DAS (2021)	90 DAS (2022)	Pooled data	Harvest (2021)	Harvest (2022)	Pooled data
T_1	78.22	78.72	78.47	78.88	78.35	78.61	79.74	78.15	78.95	78.28	79.31	78.29
T_2	84.44	83.61	84.02	85.00	85.56	85.28	86.93	85.43	86.18	82.59	82.41	82.50
T_3	83.33	92.55	87.94	83.88	84.43	84.15	84.97	84.77	84.87	81.48	81.37	81.42
T_4	28.88	23.46	26.14	74.44	74.22	74.33	69.28	82.12	75.70	73.70	74.82	74.27
T_5	15.55	17.20	16.37	88.88	86.59	84.73	88.89	88.08	88.49	84.44	84.48	84.46
T_6	22.22	31.91	27.06	82.22	82.88	82.55	83.01	86.29	84.65	80.74	80.34	80.54
T_7	11.11	8.51	09.81	87.22	87.73	87.47	88.24	88.08	88.16	83.33	83.10	83.21
T_8	-	-	-	-	-	-	-	-	-	-	-	-

4.1.4.3 *Cyperus rotundus* L.

The data shows how different weed control treatments affected the efficiency of control on *Cyperus rotundus* L. at all observational stages, as presented in Chart 4.21 and proved in Fig. 4.19, proved that in the years 2021 and 2022, weed control treatments had a significant impact on the efficiency of control *Cyperus rotundus* L. at all observational phases.

In the years 2021 and 2022 data show in chart 4.21 at 30 DAS advanced weed control efficiency was observed in Atrazine 500 g PE + HW (30 DAS) and Metribuzin 800 g PE as associated to PoE actions. Data taken on 60 D DAS minimum weed control efficiency was noted in the treatment of Tembotrione 120 g PoE and Atrazine 700 g PE. Greater weed control efficiency was noted 2, 4-D Na 800 g PoE mutual by HW at 60 DAS then 2 HW (30 & 60 DAS). Data on 90 DAS then harvest higher weed control efficiency was noted 2, 4-D Na 800 g PoE combined by HW at 60 DAS then HW twice (30 & 60 DAS). Minimum efficacy of weed control of *Cyperus rotundus* L. Noted in Topramezone 200 g PoE then Atrazine 700 g PE as related to the check. These outcomes were in concurrence by the discoveries of Vinaya Lakshmi, *et al.*, (2017).

Cumulative data in the years 2021 then 2022 shown in chart 4.21 then represented in fig 4.19 revealed greater weed control efficiency was observed in Atrazine 700 g PE afterward Atrazine 500 g PE + HW (30 DAS) then Metribuzin 800 g PE over the check. Data of 60 DAS efficiency of greater weed control was noted in 2 HW (30 & 60 DAS) next to Atrazine 500 g PE + 1HW (30 DAS) as associated to added herbicidal actions. Data on 90 DAS then harvest minimum WCE was noted in Topramezone 200 g PoE then efficiency of heighest weed control was noted in 2, 4-D Na 800 g PoE combined through physical weeding at 60 DAS then double HW twice (30 & 60 DAS) over check.



Graph 4.19 Influnce of herbicides on WCE of *Cyperus rotundus* L. in maize at monthly intervals. (2021 and 2022).

Chart 4.22: Influnce of herbicides on WCE of *Chenopodium album* L. in maize at monthly intervals. (2021 and 2022).

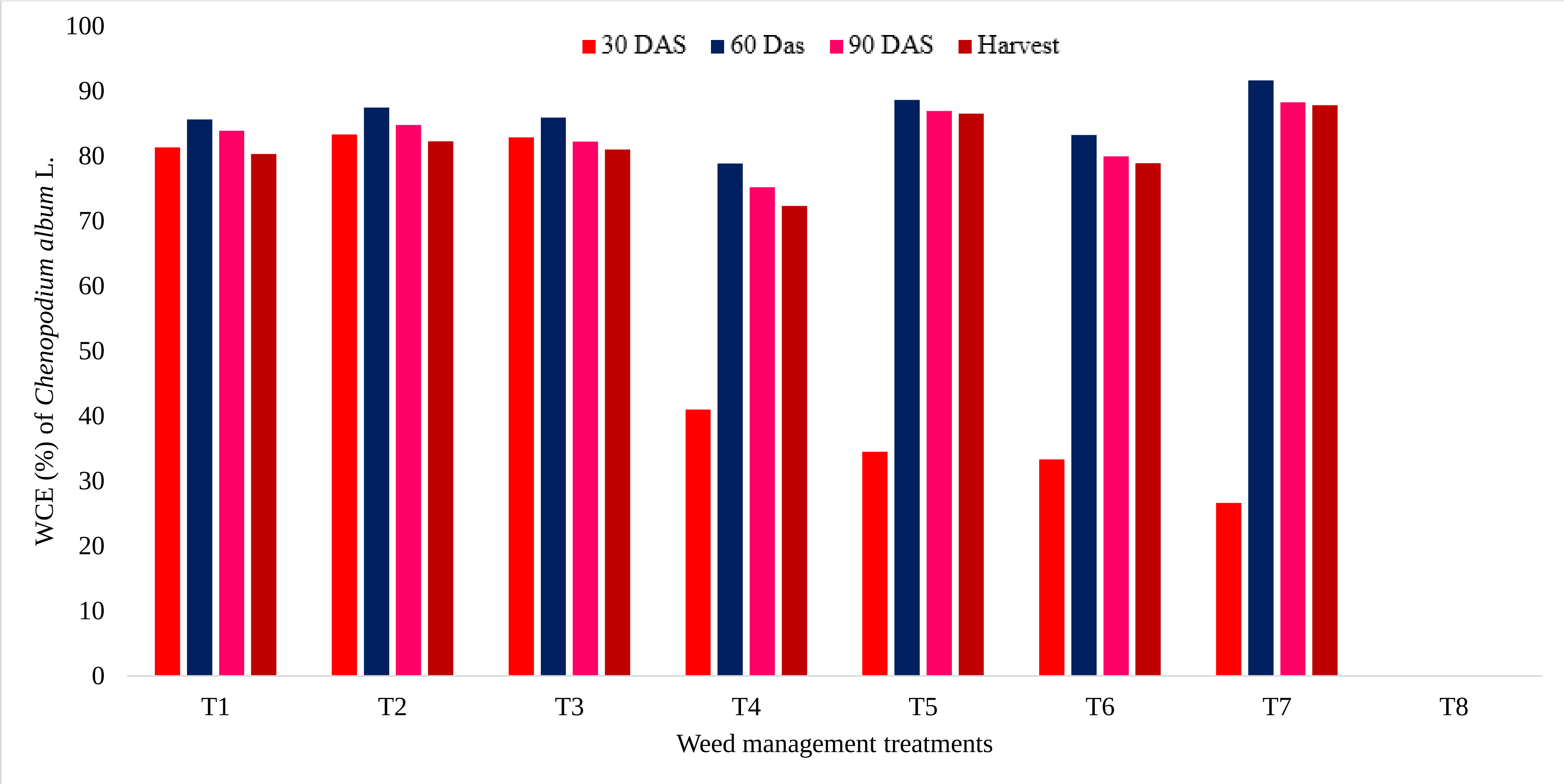
Treatments	30 DAS (2021)	30 DAS (2022)	Pooled data	60 DAS (2021)	60 DAS (2022)	Pooled data	90 DAS (2021)	90 DAS (2022)	Pooled data	Harvest (2021)	Harvest (2022)	Pooled data
T_1	83.33	81.33	81.33	83.63	85.63	85.63	82.81	83.90	83.9	79.41	80.33	80.33
T_2	84.52	83.33	83.33	85.45	87.44	87.44	84.37	84.77	84.77	81.17	82.26	82.26
T_3	83.80	82.88	82.88	83.63	85.93	85.93	81.25	82.24	82.24	80.00	80.99	80.99
T_4	40.47	41.00	41.00	75.45	78.87	78.87	73.75	75.22	75.22	70.58	72.32	72.32
T_5	35.71	34.48	34.48	87.27	88.64	88.64	88.12	86.95	86.95	87.64	86.51	86.51
T_6	33.95	33.30	33.3	80.90	83.23	83.23	78.75	79.94	79.94	78.24	80.66	79.45
T_7	23.80	26.60	26.6	90.90	91.65	91.65	87.50	88.27	88.27	85.88	87.85	86.87
T_8	-	-	-	-	-	-	-	-	-	-	-	-

4.1.4.4 *Chenopodium spp* L.

The data concerning the WCE of *Chenopodium album* L. effect ofvarious weed regulate treatments at all levels of assessment in the years 2021 and 2022, which is displayed in Chart 4.22 also highlighted in Fig. 4.20, showed that weed regulate treatments had an important effect on *Chenopodium album* L. weed regulate efficiency at every stage of statement.

In the years 2021 and 2022 data show in chart 4.22 on 30 DA DAS efficiency of higher weed control was observed in Atrazine 500 g + Single weeding (30 DAS) and Metribuzin 800 g as likened to PoE actions. Data taken on 60 DAS the minimum efficiency of heighest weed control was renowned in the actions of Tembotrione 120 g then Topramezone 200 g. higher efficacy was noted 2, 4-D Na 800 g mutual by HW at 60 DAS then double HW (30 & 60 DAS). Data on 90 DAS then harvest superior WCE was noted 2, 4-D Na Salt 800 g HW at 60 DAS then manul weeding two times (30 & 60 DAS). The minimum efficiency of heighest weed control of *Chenopodium album* L. was noted in Topramezone 200 g then Topramezone 200 g as asociated to the Un-weeded. Alike effects were also described by Sraw *et.al*, (2016) then Ehsas *et.al*, (2016).

Cumulative data in the years 2021 then 2022 shown in chart 4.22 then depicted in fig 4.20 revealed Atrazine 500 g + HW (30 DAS) that extreme efficiency of weed control was noted next to Metribuzin 800 g subsequently over the check. efficiency on 60 DAS of greater weed control was noted in 2, 4-D Na Salt 800 g +HW on 60 DAS subsequently 2 HW (30 & 60 DAS) Atrazine 500 g HW (30 DAS) as compare to other herbicidal actions. At 90 DAS then harvest minimum WCE was noted in Topramezone 200 g then supreme efficiency of weed control was observed in 2, 4-D Na 800 g combined by HW at 60 DAS then double HW (30 & 60 DAS) over the check.



Graph 4.20. Influnce of herbicides on WCE of *Chenopodium album* L. in maize at monthly intervals. (2021 and 2022).

Chart 4.23 Influnce of herbicides on WCE of *Parthenium hysterophorus L.* in maize at monthly intervals. (2021 and 2022).

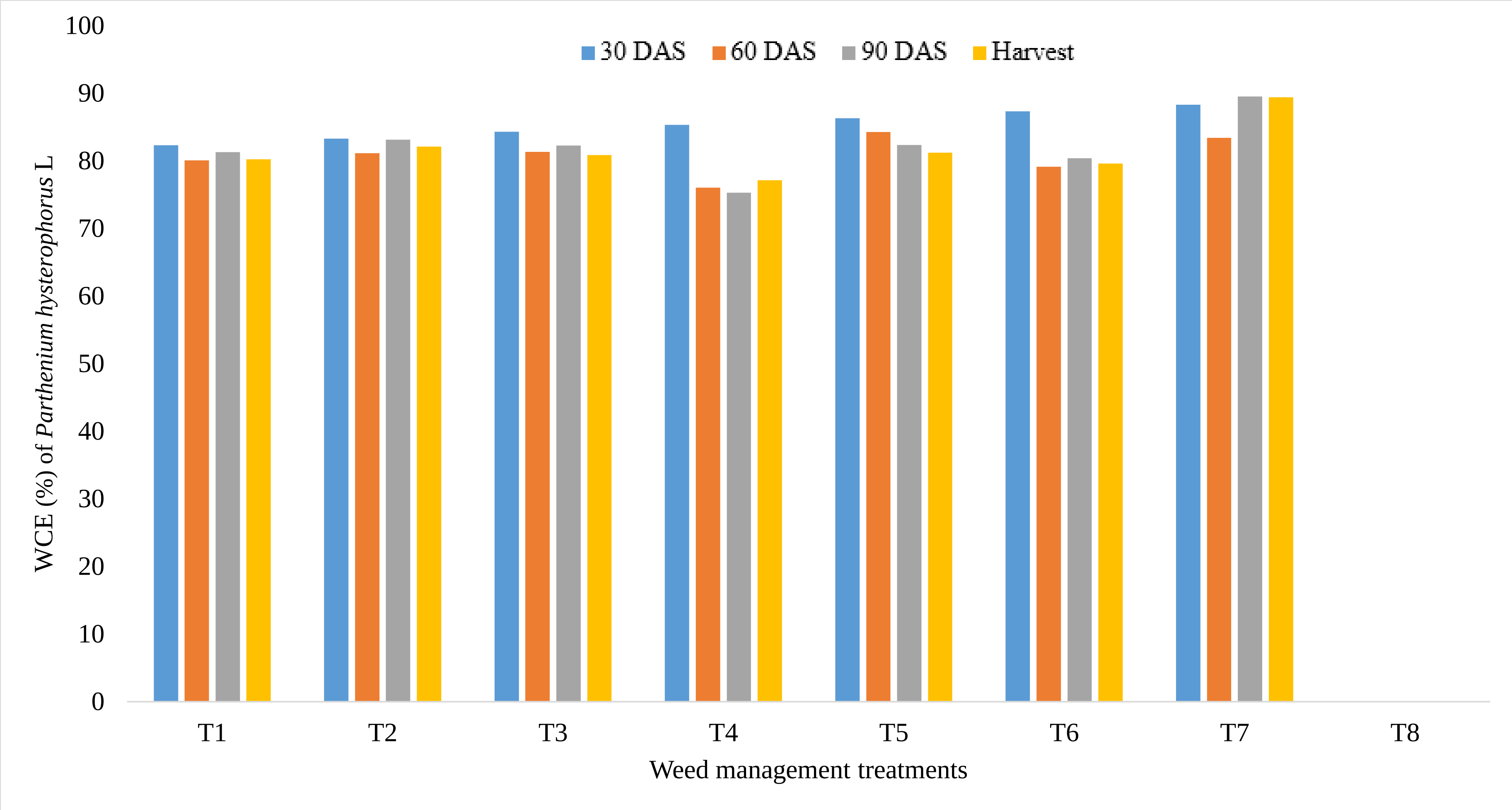
Treatments	30 DAS (2021)	30 DAS (2022)	Pooled data	60 DAS (2021)	60 DAS (2022)	Pooled data	90 DAS (2021)	90 DAS (2022)	Pooled data	Harvest (2021)	Harvest (2022)	Pooled data
T_1	82.36	82.32	82.32	81.17	80.10	80.10	80.00	81.30	81.30	79.25	81.21	80.23
T_2	83.45	82.85	83.32	82.10	81.14	81.14	82.00	83.13	83.13	82.39	81.82	82.11
T_3	82.72	82.67	84.32	81.57	81.35	81.35	80.66	82.30	82.30	81.13	80.61	80.87
T_4	49.09	48.75	85.32	76.84	76.04	76.04	76.00	77.29	77.29	76.73	77.58	77.16
T_5	20.00	20.17	86.32	85.26	84.27	84.27	92.00	92.36	92.36	91.82	92.12	91.97
T_6	29.09	29.28	87.32	80.00	79.16	79.16	78.66	80.41	80.41	79.25	80.00	79.63
T_7	25.45	25.17	88.32	84.21	83.43	83.43	91.33	91.59	91.59	90.57	90.91	90.74
T_8	-	-	-	-	-	-	-	-	-	-	-	-

4.1.4.5 *Parthenium hysterophorus* L.

The data concerning the WCE of *Parthenium hysterophorus* L. as effect offrequent weed control treatments at all steps of assessments in the years 2021 and 2022, as available in chart 4.23 and illustrated in graph. 4.21, showed that weed control treatments had a substantial impact on *Parthenium hysterophorus* L. WCE at all points of observation.

In the years 2021 then 2022 data shown in board 4.23 then represented in graph 4.21 at 30 DAS efficiency of advanced weed control was observed in Atrazine 500 g + HW (30 DAS) then Metribuzin 800 g as associated to PoE treatments. Data taken on 60 DAS the smallest weed control efficiency was detected in the action of Tembotrione 120 g then Topramezone 200 g. Superior weed control efficiency was logged 2, 4-D Na 800 g + HW at 60 DAS then HW twice (30 & 60 DAS). At 90 DAS then harvest higher weed control efficiency was noted 2, 4-D Na Salt 800 g by HW at 60 DAS then HW twice (30 & 60 DAS). The lowest weed control efficiency of *Parthenium hysterophorus* L. has been noted in Topramezone 200 g then Topramezone 200 g as associated to the check. The outcomes follow to the consequences of Sapna Bhagat *et al.*, (2019).

Cumulative data in the years 2021 then 2022 shown in chart 4.23 then showed in fig 4.21 exposed Atrazine 500 g + HW (30 DAS) that highest WCE was observed in Metribuzin 800 g subsequently Atrazine 500 g + Single HW (30 DAS) over the Un-weeded. On 60 DAS highest WCE was observed was noted in 2, 4-D Na 800 g + HW at 60 DAS next to Atrazine 500 g + Single HW (30 DAS) as associated to additional herbicidal actions. Data on 90 DAS then harvest lowest highest WCE was experiential in Topramezone 200 g then highest WCE was observed in 2, 4-D Na 800 g combined by HW at 60 DAS then 2 HW (30 & 60 DAS) over Un-weeded.



Graph 4.21 Influnce of herbicides on WCE of *Parthenium hysterophorus L.* L. in maize at monthly intervals. (2021 and 2022).

Chart 4.24 Influnce of herbicides on WCE of *Cannabis sativus* L.in maize at monthly intervals. (2021 and 2022).

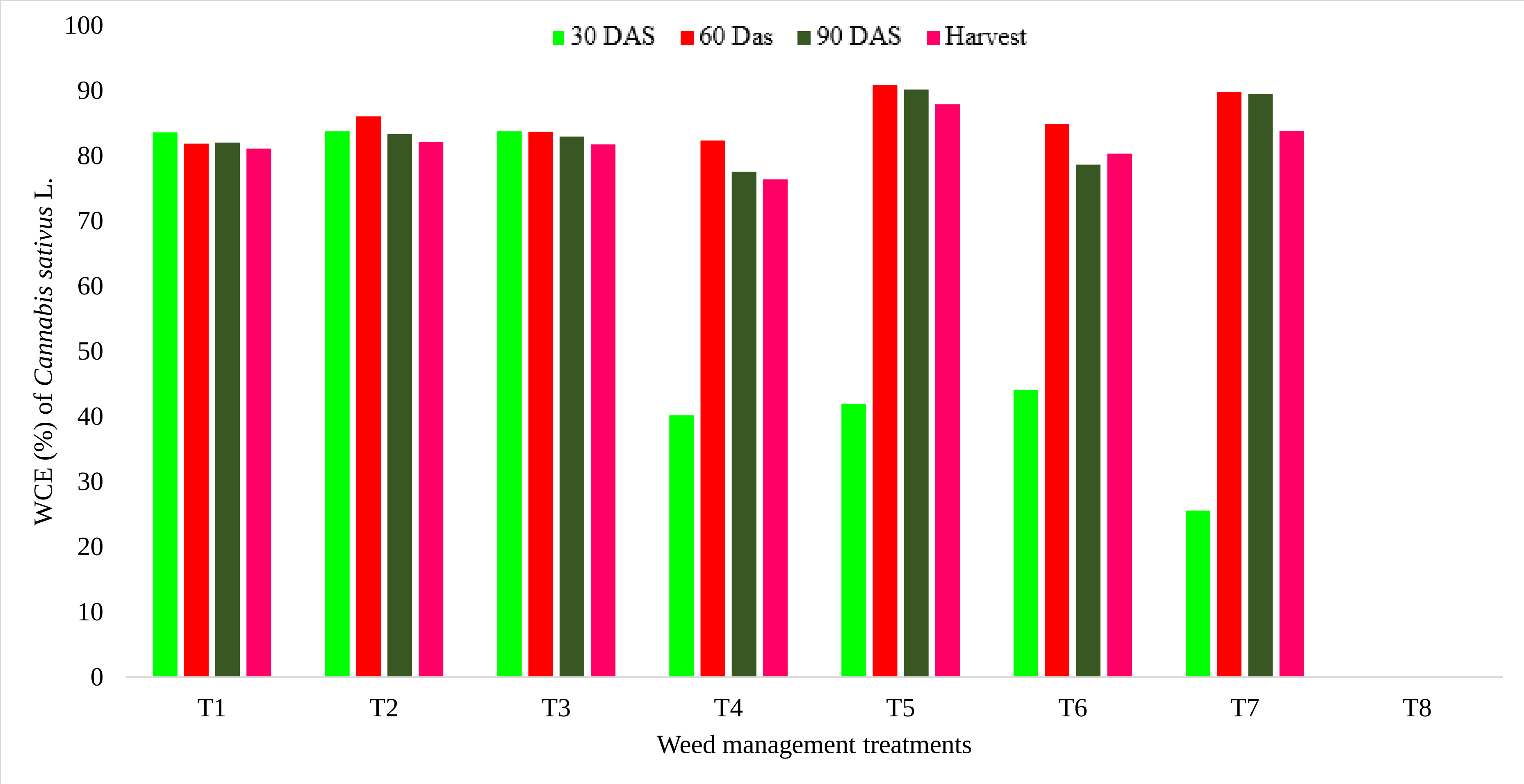
Treatments	30 DAS (2021)	30 DAS (2022)	Pooled data	60 DAS (2021)	60 DAS (2022)	Pooled data	90 DAS (2021)	90 DAS (2022)	Pooled data	Harvest (2021)	Harvest (2022)	Pooled data
T_1	83.66	83.60	83.60	81.81	81.88	81.88	81.36	82.03	82.03	80.39	81.12	80.01
T_2	84.00	83.77	83.77	86.36	86.06	86.06	82.72	83.38	83.38	82.70	83.26	82.98
T_3	83.83	83.77	83.77	83.63	83.67	83.67	82.27	82.96	82.96	81.43	81.97	81.70
T_4	41.66	40.16	40.16	77.27	82.36	82.36	76.36	77.58	77.58	65.40	64.81	65.11
T_5	43.33	41.96	41.96	90.90	90.85	90.85	90.00	90.16	90.16	86.92	87.55	87.24
T_6	45.00	44.09	44.09	84.54	84.87	84.87	81.81	78.64	78.64	80.17	77.25	78.71
T_7	25.00	25.57	25.57	90.00	89.82	89.82	89.09	89.49	89.49	88.61	89.27	88.94
T_8	-	-	-	-	--	-	-	-	-	-	-	-

4.1.4.6 *Cannabis sativus* L.

The data concerning the WCE of *Cannabis sativus* L. as effect ofdifferent weed regulate treatments at all the phases of observations in the years 2021 then 2022, shown in chart 4.24 then displayed in graph 4.22, demonstrated that weed regulates procedures had a major effect on *Cannabis sativus* L. weed normalize performance at all phases of analysis.

In the years 2021 then 2022 data shown in board 4.24 also represented in graph 4.22 at 30 DAS greater weed control efficiency was observed in Atrazine 500 g + HW (30 DAS) then Metribuzin 800 g as asociated to PoE actions. Data on 60 DAS the lowest weed control efficiency was noted in the action of Tembotrione 120 g. efficiency of Extreme weed control stood noted 2, 4-D Na 800 g by HW at 60 DAS then 2 HW (30 & 60 DAS). Data on 90 DAS then harvest the minimum efficiency of weeds control of *Cannabis sativus* L. has been noted in Topramezone 200 g associated to the check. Higher efficiency was noted 2, 4-D Na 800 g by HW at 60 DAS then 2 HW (30 & 60 DAS).

Cumulative data in the years 2021 then 2022 shown in chart 4.23 then showed in fig 4.21 revealed Atrazine 500 g by HW (30 DAS) that superior efficiency was noted next to Metribuzin 800 g over the un-weeded. Data on 60 DAS higher weed control efficiency was noted in 2, 4-D Na 800 g by HW at 60 DAS subsequently 2 HW on (30 & 60 DAS) as associated to additional herbicidal actions. Data on 90 DAS then harvest minimum weed control efficiency was noted in Topramezone 200 g then extreme weed control efficiency was noted in 2, 4-D Na 800 g combined by HW at 60 DAS over the Un-weeded.



Graph 4.22 Influnce of herbicides on WCE of *Cannabis sativus* L.in maize at monthly intervals. (2021 and 2022).

Chart 4.25 Influnce of herbicides on WCE of *Sinapis arvensis* L. in maize at monthly intervals. (2021 and 2022

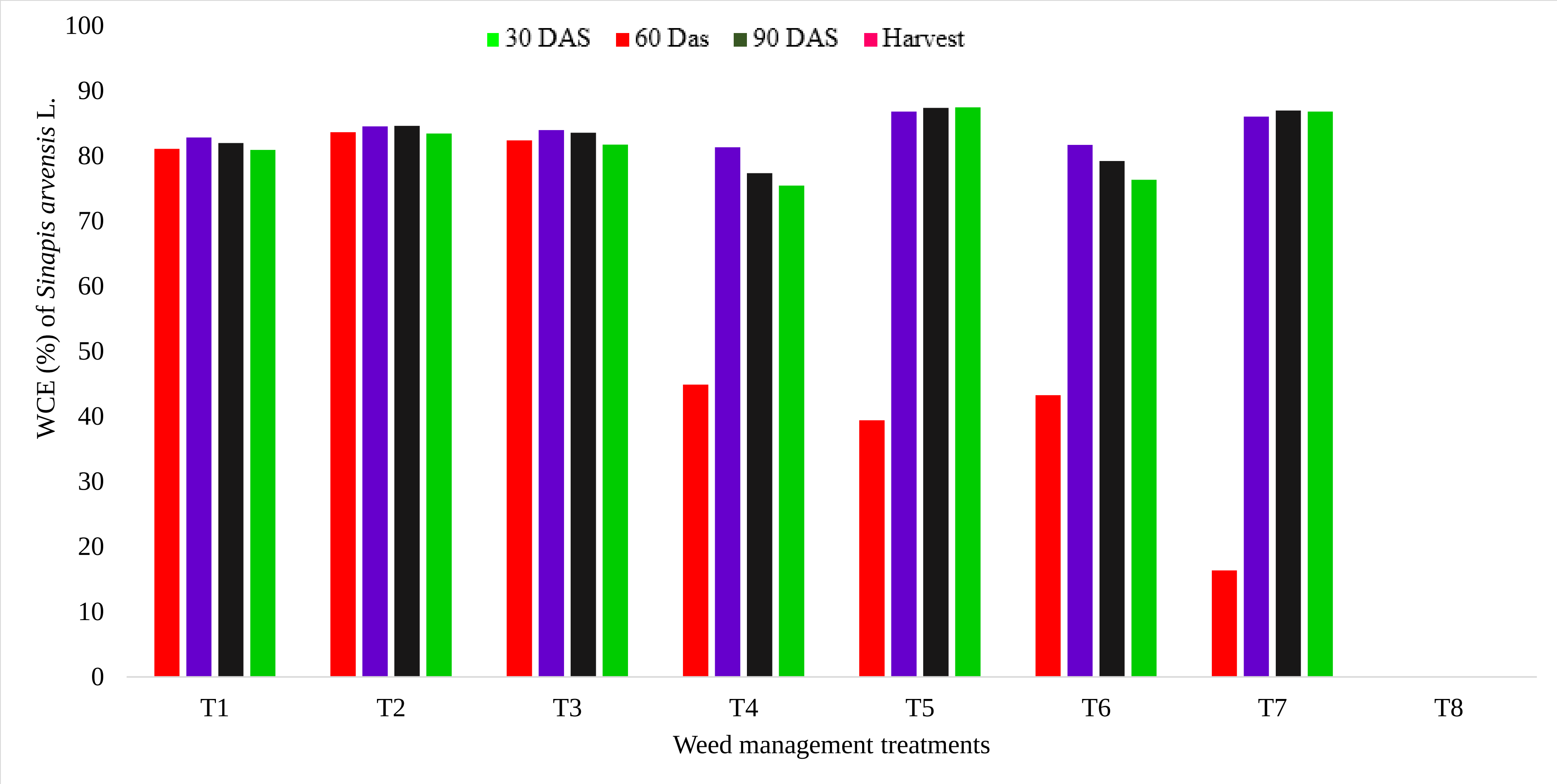
Treatments	30 DAS (2021)	30 DAS (2022)	Pooled data	60 DAS (2021)	60 DAS (2022)	Pooled data	90 DAS (2021)	90 DAS (2022)	Pooled data	Harvest (2021)	Harvest (2022)	Pooled data
T_1	83.33	81.08	81.08	83.00	82.83	82.83	81.42	81.97	81.97	80.93	81.05	80.99
T_2	84.66	83.65	83.65	85.00	84.52	84.52	84.28	84.60	84.60	84.25	84.42	84.34
T_3	84.33	82.37	82.37	83.40	83.96	83.96	82.85	83.55	83.55	83.42	83.33	83.38
T_4	46.66	44.87	44.87	80.20	81.32	81.32	75.71	77.36	77.36	75.27	76.92	76.10
T_5	40.00	39.42	39.42	86.80	86.79	86.79	87.14	87.36	87.36	87.02	87.18	87.10
T_6	43.33	43.26	43.26	81.00	81.69	81.69	78.57	79.21	79.21	78.13	79.14	78.64
T_7	16.66	16.34	16.34	86.00	86.03	86.03	86.57	86.97	86.67	85.71	86.18	85.95
T_8	-	-	-	-	-	-	-	-	-	-	-	-

4.1.4.7 *Sinapis arvensis* L.

The data concerning the WCE of *Sinapis arvensis* L. as effect ofvarious treatments in the overall observational phases, as existing in chart 4.25 and illustrated in graph 4.23, showed that weed control usages had a high impact on *Sinapis arvensis* L.'s WCE in each observational phase in the years 2021 and 2022.

In the years 2021 and 2022, data shown in chart 44.25 and shown in graph 4.23 at 30 DAS showed that higher WCE was observed in atrazine 500 g + single HW (30 DAS) and metribuzin 800 g as associated by PoE actions. 60 DAS, the efficiency of lesser weed control was noted in Tembotrione 120 g. higher efficiency was noted by 2-D Na 800 g by HW at 60 DAS, followed by HW twice (30 and 60 DAS). Data on 90 DAS and harvest shows that the least weed control efficiency of *Sinapis arvensis* L. has been noted in Topramezone 200 g, as associated by the check. Higher efficiency was noted (2, 4-D Na, 800 g combined by HW on 60 DAS) as associated by the check.

Cumulative data of both years (2021 and 2022) shown in chart 4.25 and shown in fig. 4.23 exposed Atrazine 500 g + HW (30 DAS) showed that efficiency of higher weed control was noted in Metribuzin 800 g DAS over un-weeded. Data on 60-day after sowing efficiency of higher weed control was noteed down in 2, 4-D Na Salt 800 g by HW at 60 DAS, and subsequently 2 HW (30 and 60 DAS) as associated by other herbicidal actions. Data on 90 DAS and harvest shows that the lowest weed control efficiency was noted in Topramezone 200 g, and the highest weed control efficiency was noted in 2-D Na 800 g combined by HW at 60 DAS over the un-weeded.



Geaph 4.23 Influnce of herbicides on WCE of *Sinapis arvensis* L. in maize at monthly intervals. (2021 and 2022)

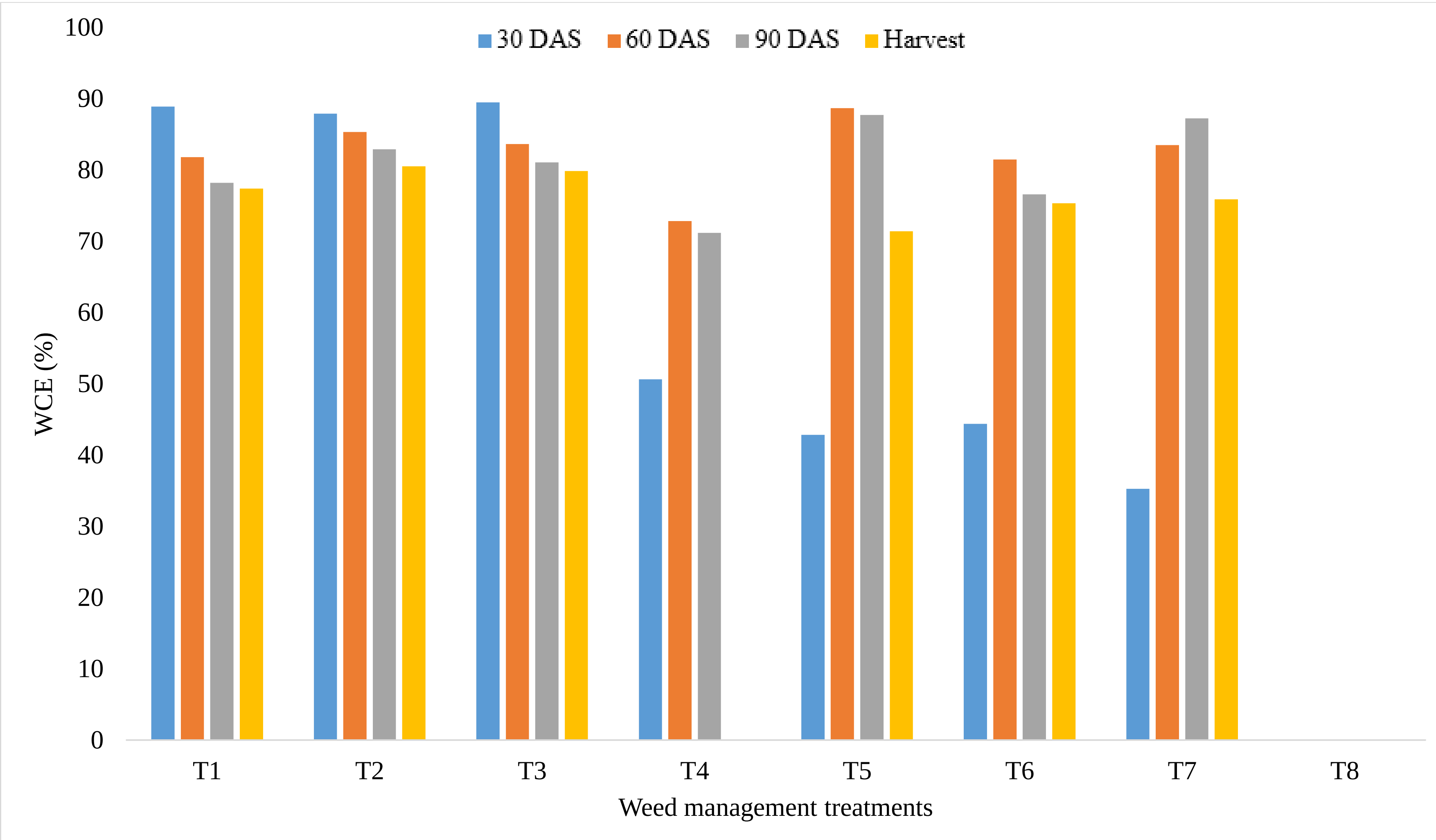
Chart 4.26 Influnce of herbicides on WCE of of total weed population in maize at monthly intervals. (2021 and 2022).

Treatments	30 DAS (2021)	30 DAS (2022)	Pooled data	60 DAS (2021)	60 DAS (2022)	Pooled data	90 DAS (2021)	90 DAS (2022)	Pooled data	Harvest (2021)	Harvest (2022)	Pooled data
T_1	84.14	88.91	88.91	84.20	81.79	81.79	80.52	75.87	78.20	80.20	74.57	77.39
T_2	85.43	87.92	87.92	87.48	85.33	85.33	84.97	80.80	82.89	79.72	81.30	80.51
T_3	86.05	89.50	89.50	85.54	83.64	83.64	83.25	78.89	81.07	82.05	77.63	79.84
T_4	61.56	50.64	50.64	74.99	72.83	72.83	73.49	68.84	71.17	72.44	70.38	71.41
T_5	31.93	42.85	42.85	90.42	88.67	88.67	89.85	85.62	87.74	88.80	86.85	87.30
T_6	31.51	44.37	44.37	83.77	81.48	81.48	79.52	73.66	76.59	78.91	72.83	75.87
T_7	21.28	35.28	35.28	89.01	83.48	83.48	89.33	85.12	87.23	88.11	85.03	86.57
T_8	-	-	-	-	-	-	-	-	-	-	-	-

4.1.4.8 WCE of total weed species

The data concerning the WCE of the total weed population in the years 2021 and 2022, as existing in chart 4.26 and illustrated in graph 4.24, showed that weed control measures expressively affected the weed control efficiency for the total weed population at all assessment stages.

In the years 2021 and 2022, as shown in chart 4.26 and represented in graph 4.24 at 30 DAS, greater weed control efficiency was detected in atrazine 500 g + HW (30 DAS) and metribuzin 800 g as compared to PoE actions. Data on 60 DAS showed the least weed control efficiency in Tembotrione 120 g. Higher weed control efficiency was noted 2-D Na (800 g) combined by HW at 60 DAS and 2 HW (30 and 60 DAS). Data on 90 DAS and harvesting time shows the least weed control efficiency of the total weed population in Topramezone 200 g and Topramezone 200 g as compared to un-weeded. Higher efficiency was noted 2-D Na 800 g combined by HW at 60 DAS and hand cleaning two times (30 and 60 DAS) as compared to un-weeded. The dry weight of weeds in treated plots compared to weedy control plots, reported as a percentage, is the foundation for determining the efficiency of weed management. At 60 and 90 DAS, WCE is highest by 2-D Na 800 g by HW at 60 DAS because this treatment arrests weed species at the early and later phases of crop growth, resulting in the lowest weed dry biomass. These concerns were in agreement by the results of Duraisamy *et al.* (2013), Madhavi *et al.* (2013), Anil Kumar *et al.* (2015), and Mukherjee *et al.* (2015).



Graph 4.24. Influnce of herbicides on WCE of of total weed population in maize at monthly intervals. (2021 and 2022).

Chart 4.27 Influnce of herbicides on the plant population of maize (m^2) at monthly intervals. (2021 and 2020)

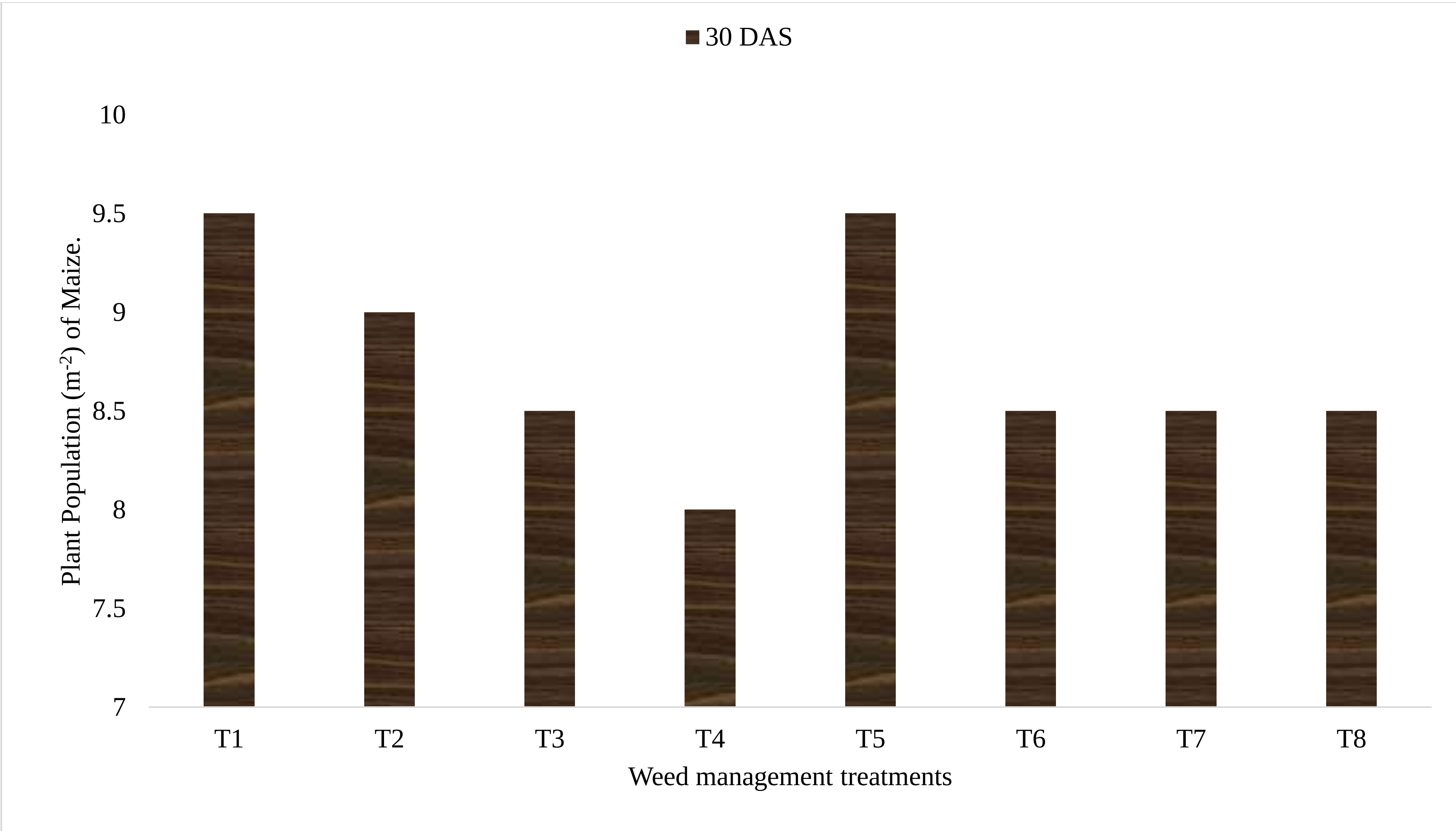
Treatments	30 DAS (2021)	30 DAS (2022)	Pooled data
Atrazine PE	9	9	9.0
Atrazine PE combined by 1 HW	9	9	9.0
Metribuzin PE	8	8	8.0
Tembotrione PoE	8	8	8.0
2,4-D Na PoE combined by HW on 60 DAS	9	9	9.0
Topramezone PoE	8	8	8.0
HW Twice (30 & 60 DAS)	9	9	9.0
Weedy check	8	8	8.0
SE(m±)	**0.43**	**0.41**	**0.42**
CD (p=0.05)	**1.30**	**1.23**	**1.26**

4.2 Study of maize

4.2.1 Plant counts

The data concerning various weed management methods substantially affecting crop stand at 30 DAS is shown in charts 4.27 and 4.25.

All weed management methods considerably enhance the crop standing of the maize next to the un-weeded, according to data from the years 2021 and 2022 provided in chart 4.27 of the maize crop stand. Because of weed management techniques, there were no discernible variations in the plant inhabitants at the beginning or at harvest.Due to weed control procedures, there were no discernible variations in the plant stands at the beginning or at harvest.



Graph 4.25 Influnce of herbicides on the plant population of maize (m^2) at monthly intervals. (2021 and 2020)

Chart 4.28 Influnce of herbicides on plant height of maize at monthly intervals. (2021 and 2022).

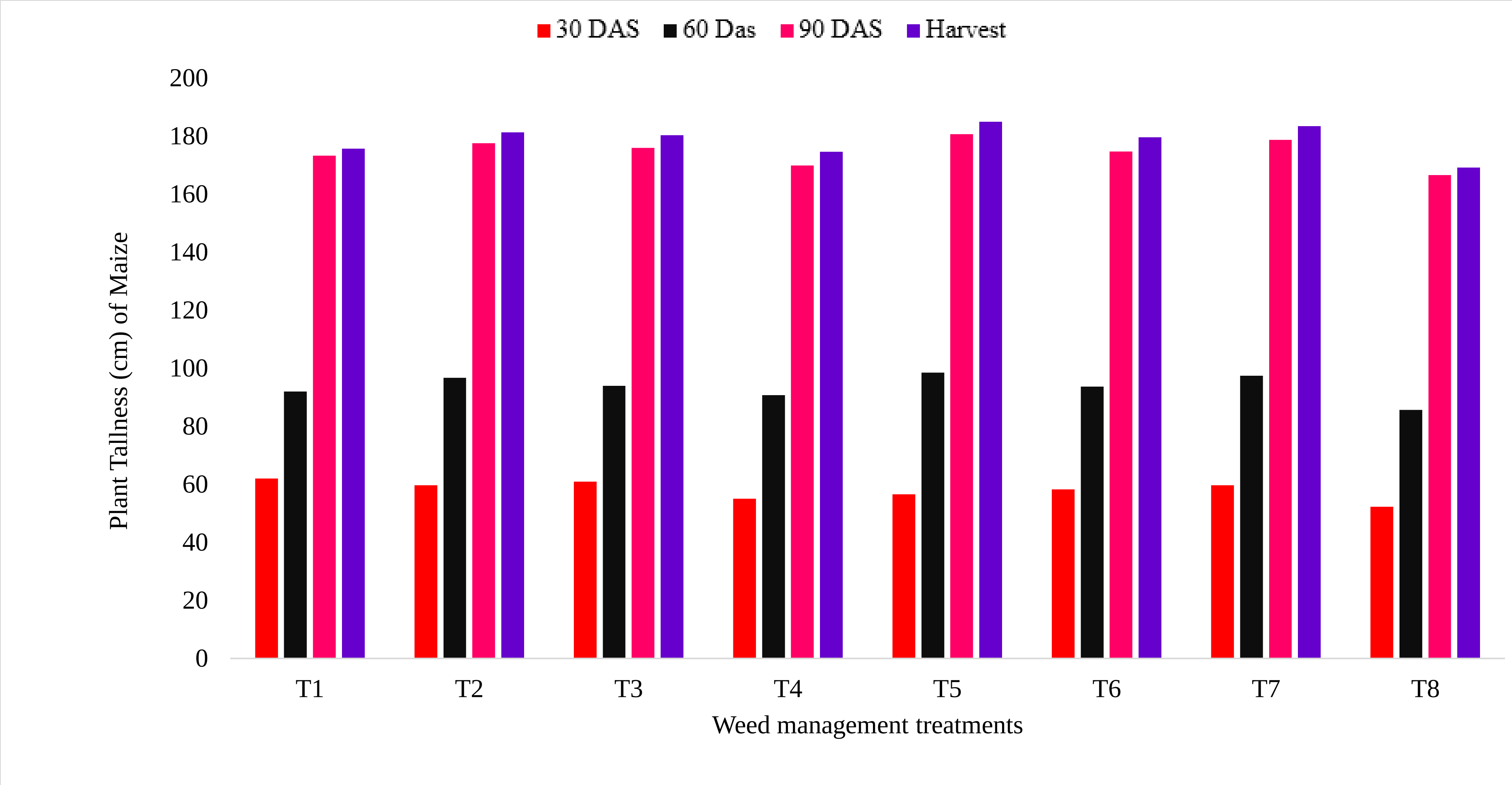
Treatments	30 DAS (2021)	30 DAS (2022)	Pooled data	60 DAS (2021)	60 DAS (2022)	Pooled data	90 DAS (2021)	90 DAS (2022)	Pooled data	Harvest (2021)	Harvest (2022)	Pooled data
T_1	62.30	61.79	62.04	92.17	91.78	91.97	173.10	173.47	173.28	176.18	175.32	175.75
T_2	60.20	59.28	59.74	96.19	97.32	96.75	177.10	178.12	177.61	181.17	181.44	181.30
T_3	61.17	60.72	60.94	94.17	93.76	93.96	176.70	175.24	175.97	180.90	179.76	180.33
T_4	55.40	54.70	55.05	90.16	91.43	90.79	1071.16	168.74	169.95	175.17	174.22	174.69
T_5	56.10	57.10	56.60	98.17	98.83	98.50	180.50	180.96	180.73	184.90	185.13	185.01
T_6	57.80	58.70	58.25	93.35	94.72	93.72	174.80	174.77	174.78	179.18	180.17	179.67
T_7	59.16	60.23	59.69	97.10	97.86	97.48	178.17	179.26	178.71	183.19	183.76	183.47
T_8	51.14	53.44	52.29	85.16	86.26	85.71	166.10	167.10	166.6	168.19	170.22	169.20
SEm (±)	**0.34**	**0.71**	**0.52**	**0.54**	**0.58**	**0.56**	**0.73**	**0.82**	**0.77**	**0.94**	**0.63**	**0.78**
CD (p=0.05)	**1.04**	**2.16**	**1.60**	**1.65**	**1.77**	**1.71**	**2.22**	**2.48**	**2.35**	**2.85**	**1.91**	**2.38**

4.2.2 Plant height

The data concerning the plant height of maize is shown in charts 4.28 and 4.26. Various weed control methods affected plant height.

In the years 2021 and 2022, as shown in chart 4.28 at 30 DAS, significant taller plants were observed in the pre-emergent use of Atrazine 700 gPE, subsequently Metribuzin 800 g, then Atrazine 500 g + single-HW (30 DAS) as associated by relaxation of the treatments over an un-weeded. At 60 DAS, superior plant height was noted in 2, 4-D Na 800 g combined by HW at 60 DAS, then 2 HW (30 and 60 DAS). The highest plant height among weed management techniques was seen in this during all phases of crop growth, which may be related to maize's unrestricted use of resources. Observations were similarly stated by B. Barad *et al.* (2016) and Rama Rao *et al.* (2016). However, the unweeded check noted the smallest plants. This may be owing to improved weed thickness all along the crop period following an unabated race by maize for growth factors influencing the progress and expansion of the crop. Data on 90 DAS, then on harvest, the minimum plant height was noted in Tembotrione 120 g, formerly Atrazine 700 g, then greater plant height was noted in 2, 4-D Na 800 g, combined by HW at 60 DAS, then 2 HW (30 and 60 DAS) over the un-weeded check.

The cumulative data shown in the years 2021 and 2022 (chart 4.28 and graph 4.26) indicated that at 30 DAS, higher plant height was noted in PE as a result of PoE treatment. At 60 DAS, the minimum plant height was noted at Tembotrione 120 g and Atrazine 700 g. The superior plant height was noted in 2, 4-D Na 800 g combined by HW at 60 DAS, then 2 HW (30 and 60 DAS). At 90 DAS, harvest all herbicidal treatments noted average plant height except Tembotrione 120 g over the un-weeded.



Graph. 4.26 Influnce of herbicides on on plant height (cm) of maize at monthly intervals. (2021 and 2022).

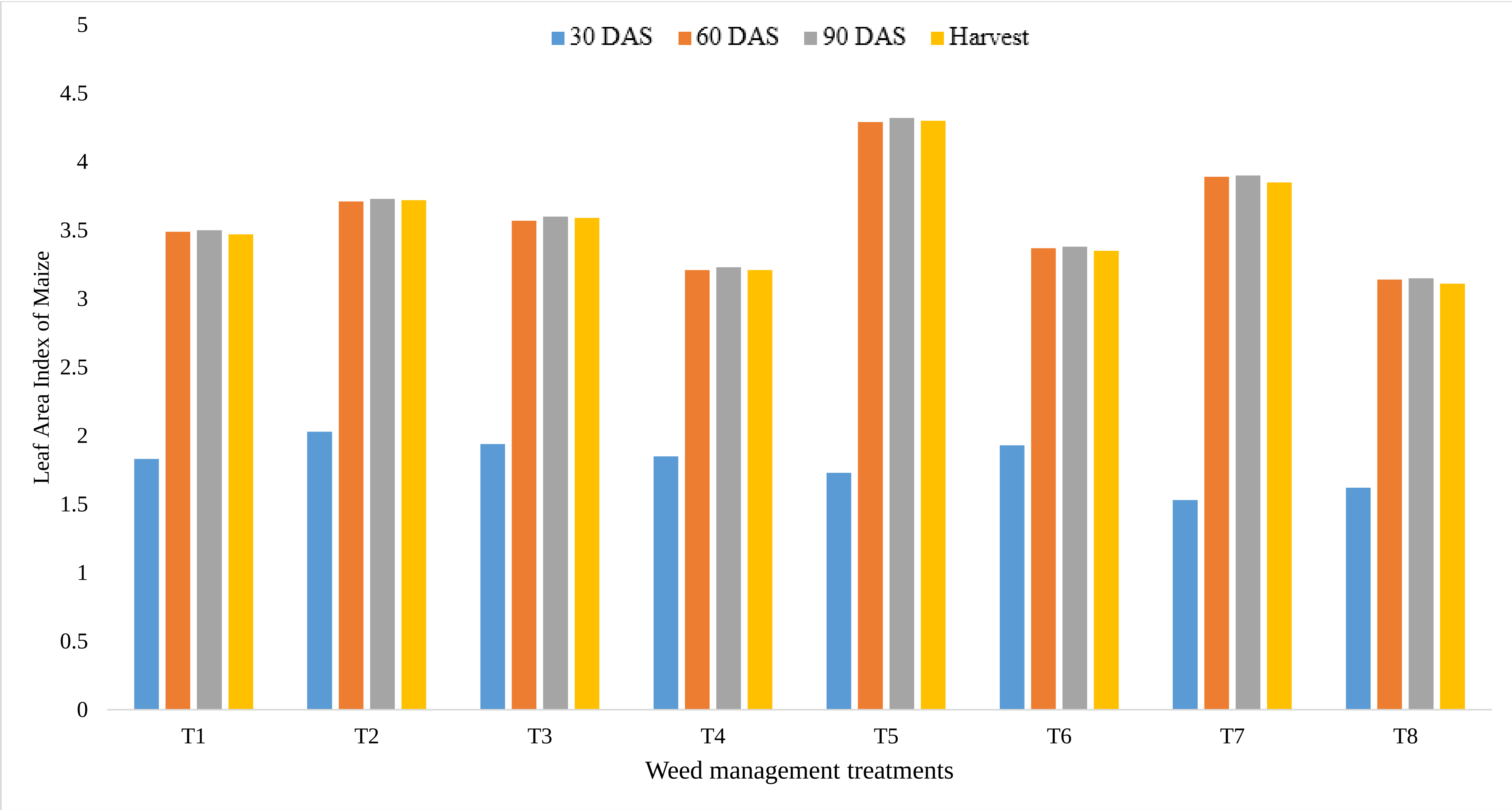
Chart 4.29 Influnce of herbicides on index of leaf area of maize at monthly intervals. (2021 and 2022).

Treatments	30 DAS (2021)	30 DAS (2022)	Pooled data	60 DAS (2021)	60 DAS (2022)	Pooled data	90 DAS (2021)	90 DAS (2022)	Pooled data	Harvest (2021)	Harvest (2022)	Pooled data
T_1	1.85	1.81	1.83	3.46	3.51	3.49	3.48	3.52	3.50	3.44	3.50	3.47
T_2	2.00	2.06	2.03	3.68	3.74	3.71	3.70	3.76	3.73	3.68	3.75	3.72
T_3	1.92	1.95	1.94	3.55	3.59	3.57	3.58	3.61	3.60	3.57	3.60	3.59
T_4	1.87	1.82	1.85	3.19	3.22	3.21	3.20	3.25	3.23	3.18	3.24	3.21
T_5	1.70	1.76	1.73	4.20	4.38	4.29	4.23	4.40	4.32	4.22	4.38	4.30
T_6	1.90	1.96	1.93	3.32	3.41	3.37	3.33	3.42	3.38	3.30	3.39	3.35
T_7	1.49	1.57	1.53	3.86	3.91	3.89	3.85	3.94	3.90	3.80	3.90	3.85
T_8	1.56	1.68	1.62	3.12	3.16	3.14	3.11	3.18	3.15	3.10	3.12	3.11
SEm (±)	**0.20**	**0.28**	**0.24**	**0.28**	**0.31**	**0.30**	**0.30**	**0.38**	**0.34**	**0.35**	**0.43**	**0.39**
CD (p=0.05)	**0.62**	**0.51**	**0.57**	**0.84**	**0.92**	**0.88**	**0.92**	**0.89**	**0.91**	**1.06**	**0.29**	**0.68**

4.2.3 Leaf area Index

According to the data concerning the index of leaf area shown in charts 4.29 and 4.27, various weed control treatments considerably affected the leaf area index.

Data for the years 2021 and 2022 are shown in charts 4.29 and 4.27. On 30 DAS, a significant advanced index of leaf area of maize was detected in the PE use of Atrazine 700 g, Metribuzin 800 g, and andAtrazine 500 g + manually weeding (30 DAS) as associated by Un-weeded. Data on 60 DAS showed a higher area of leaf index in 2, 4-D Na 800 g combined by HW at 60 DAS and 2 HW (30 and 60 DAS). The minimum index of leaf area was noted in the use of Tembotrione 120 g and Topramezone 200 g as associated by the un-weeded check. Data on 90 DAS and harvest showed that the minimum index of leaf area of maize was noted in Tembotrione 120 g and the maximum index of leaf area of maize was noted in 2, 4-D Na Salt 800 g, in addition to manually weeding at 60 DAS and HW weeding two times (30 and 60 DAS). Minor weed thickness and dry matter have been detected as an outcome of HW, other intercultural processes, post-emergent and pre-emergent herbicide applications, and various crop durations. As a result of effective weed control, maize can use resources more effectively, which is also responsible for those treatments. The consequences are similar to the discoveries of Mitra *et al.* (2018), Mukherjee, and Rai *et al*. (2015).



Graph 4.27 Influnce of herbicides on index of leaf area of maize at monthly intervals. (2021 and 2022).

Chart 4.30 Influnce of herbicides on fresh weight of maize at monthly intervals. (2021 and 2022)

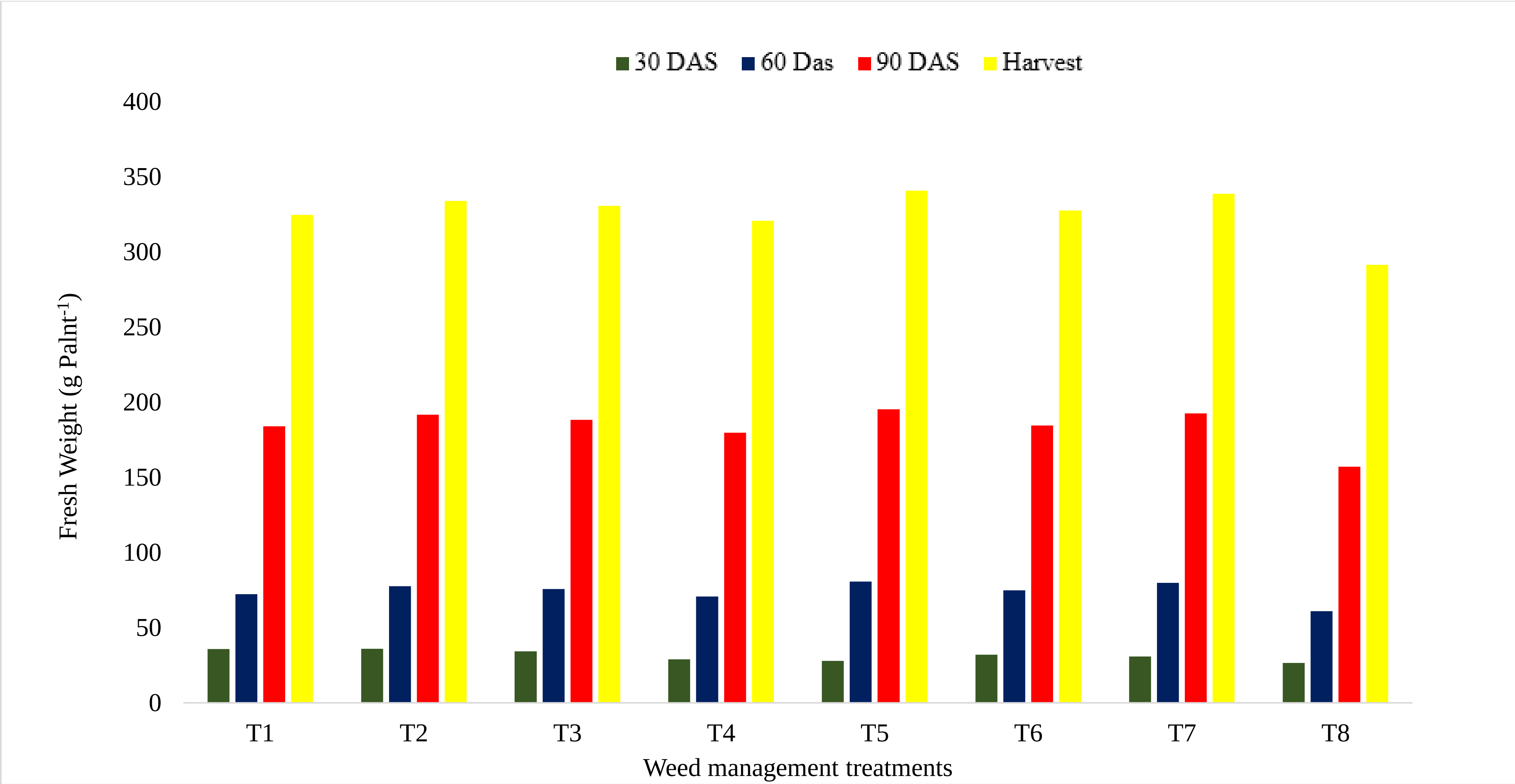
Treatments	30 DAS (2021)	30 DAS (2022)	Pooled data	60 DAS (2021)	60 DAS (2022)	Pooled data	90 DAS (2021)	90 DAS (2022)	Pooled data	Harvest (2021)	Harvest (2022)	Pooled data
T_1	36.10	35.44	35.92	72.75	72.10	72.42	183.60	184.63	184.11	324.30	325.23	324.76
T_2	35.80	36.12	35.96	77.16	78.13	77.64	191.50	192.18	191.84	333.49	334.68	334.08
T_3	34.70	33.79	34.24	76.10	75.44	75.77	188.59	188.24	188.41	330.56	331.12	330.84
T_4	29.19	28.76	28.97	71.17	70.59	70.88	180.16	179.46	179.81	321.50	320.23	320.86
T_5	27.90	28.20	28.05	80.40	81.17	80.78	195.00	195.67	195.33	340.50	341.14	340.82
T_6	32.16	31.94	32.05	74.70	75.23	74.96	185.17	184.13	184.65	327.60	327.81	327.70
T_7	31.10	30.78	30.94	79.15	80.60	79.87	193.00	192.22	192.61	338.40	339.10	338.75
T_8	26.15	27.13	26.64	60.50	61.73	61.11	156.60	157.68	157.14	290.80	292.31	291.55
SEm (±)	**0.36**	**0.43**	**0.39**	**0.41**	**0.61**	**0.51**	**0.61**	**0.62**	**0.61**	**0.76**	**0.72**	**0.74**
CD (p=0.05)	**1.09**	**1.31**	**1.20**	**1.24**	**1.84**	**1.54**	**1.84**	**1.88**	**1.86**	**2.32**	**2.18**	**2.25**

4.2.5 Fresh weight of maize (g)

According to the data concerning the fresh weight of maize shown in charts 4.30 and 4.28, various weed control methods affected the fresh weight.

Data for the years 2021 and 2022 are shown in charts 4.29 and 4.27. On 30 DAS, significant higher fresh weight was observed by pre-emergent Atrazine 700 g next to Metribuzin 800 g and Atrazine 500 g + HW over 30 DAS, as paralleled to the rest of the actions over the un-weeded. Data gathered on 60 DAS showed a higher fresh weight in 2, 4-D Na 800 g combined by HW at 60 DAS and 2 HW (30 and 60 DAS). The least weight of fresh sample remained in the use of Tembotrione 120 g and Topramezone 200 g as associated by the un-weeded. Data gathered on 90 DAS, besides harvest, the minimum fresh weight stood at 120 g in Tembotrione and Atrazine, andAtrazine a higher fresh weight was noted in 2, 4-D Na, 800 g, in addition to manually weeding at 60 DAS and manually weeding two times (30 and 60 DAS) over the un-weeded check.

The cumulative data shown in the years 2021 and 2022 in charts 4.30 and 4.28 indicated that at 30 DAS, the heaviest fresh weight was noted in PE action as associated by post-emergent treatment. In data gathered 60 DAS, the lowest weight of fresh plants was noted in Tembotrione (120 g) in addition to Atrazine (700 g). The superior fresh weight was noted in 2, 4-D Na 800 g in addition to manually weeding at 60 DAS and 2 HW (30 and 60 DAS). Data gathered on 90 DAS and harvest showed that all herbicidal treatments noted an average fresh weight except Tembotrione (120 g above the un-weeded). The higher fresh weight was noted in 2, 4-D Na 800 g in addition to manually weeding at 60 DAS and 2 HW (30 and 60 DAS) over the un-weeded.



Ghaph 4.28 Influnce of herbicides on fresh weight of maize at monthly intervals. (2021 and 2022).

Chart 4.31 Influnce of herbicides on dry weight of maize at monthly intervals. (2021 and 2022)

Treatments	30 DAS (2021)	30 DAS (2022)	Pooled data	60 DAS (2021)	60 DAS (2022)	Pooled data	90 DAS (2021)	90 DAS (2022)	Pooled data	Harvest (2021)	Harvest (2022)	Pooled data
T_1	24.17	23.14	23.65	37.17	37.96	36.56	72.20	71.19	72.20	92.30	91.20	91.75
T_2	19.90	20.12	20.01	41.15	40.12	40.63	79.17	80.13	79.65	90.45	96.33	93.42
T_3	22.10	23.13	22.61	40.15	41.37	27.26	78.20	77.46	77.83	98.40	97.49	97.95
T_4	14.25	15.22	14.73	35.90	36.13	36.01	70.80	71.24	71.02	91.30	91.30	91.30
T_5	16.15	16.96	16.55	46.15	47.21	46.68	86.00	85.12	85.56	102.10	100.12	101.11
T_6	18.20	19.21	18.70	39.17	40.11	39.64	75.14	76.61	75.87	95.40	96.11	95.76
T_7	18.70	19.73	19.21	43.70	43.20	43.45	82.15	83.23	82.69	92.47	99.30	95.89
T_8	14.16	15.84	15.00	31.15	33.13	32.14	60.29	63.27	61.78	76.30	77.11	76.71
SEm (±)	**0.39**	**0.54**	**0.46**	**0.50**	**0.46**	**0.48**	**0.57**	**0.74**	**0.65**	**0.66**	**0.70**	**0.68**
CD (p=0.05)	**1.17**	**1.63**	**1.40**	**1.52**	**1.39**	**1.45**	**1.73**	**2.24**	**1.98**	**2.00**	**2.13**	**2.06**

4.2.6 Plant dry weight (g plant^{-1})

According to the data concerning the plant dry weight shown in charts 4.31 and 4.29, various weed control methods affected the dry weight at every phase of crop growth, and there were visible differences in the accumulation of dry weight as a result of weed management practices.

In the years 2021 and 2022, data is shown in charts 4.31 and 4.29. At 30 DAS, significant increases in dry weight were detected in the pre-emergent use of Atrazine 700 g and Metribuzin 800 g next to Atrazine 500 g in addition to manually weeding (30 DAS), as stated by B. Sandhya Rani et al.*t al.* (2019) and Arun Kumar *et al.* (2018).

The cumulative data shown in the years 2021 and 2022 in charts 4.31 and 4.29 indicated that 30 DAS, higher dry weight was noted in PE action as associated by post-emergent treatment. Data were taken 60 DAS, and the least dry weight was observed in Tembotrione 120 g and Atrazine 700 g. higher dry weight was noted in 2, 4-D Na 800 g in addition to manually weeding at 60 DAS and 2 HW (30 and 60 DAS). Data took on 90 DAS andharvest all herbicidal treatments noted average dry weight except Tembotrione 120 g over the un-weeded. Supreme dry weight was noted in 2, 4-D Na 800 g in addition to manually weeding at 60 DAS and finger weeding two times (30 and 60 DAS) over the un-weeded

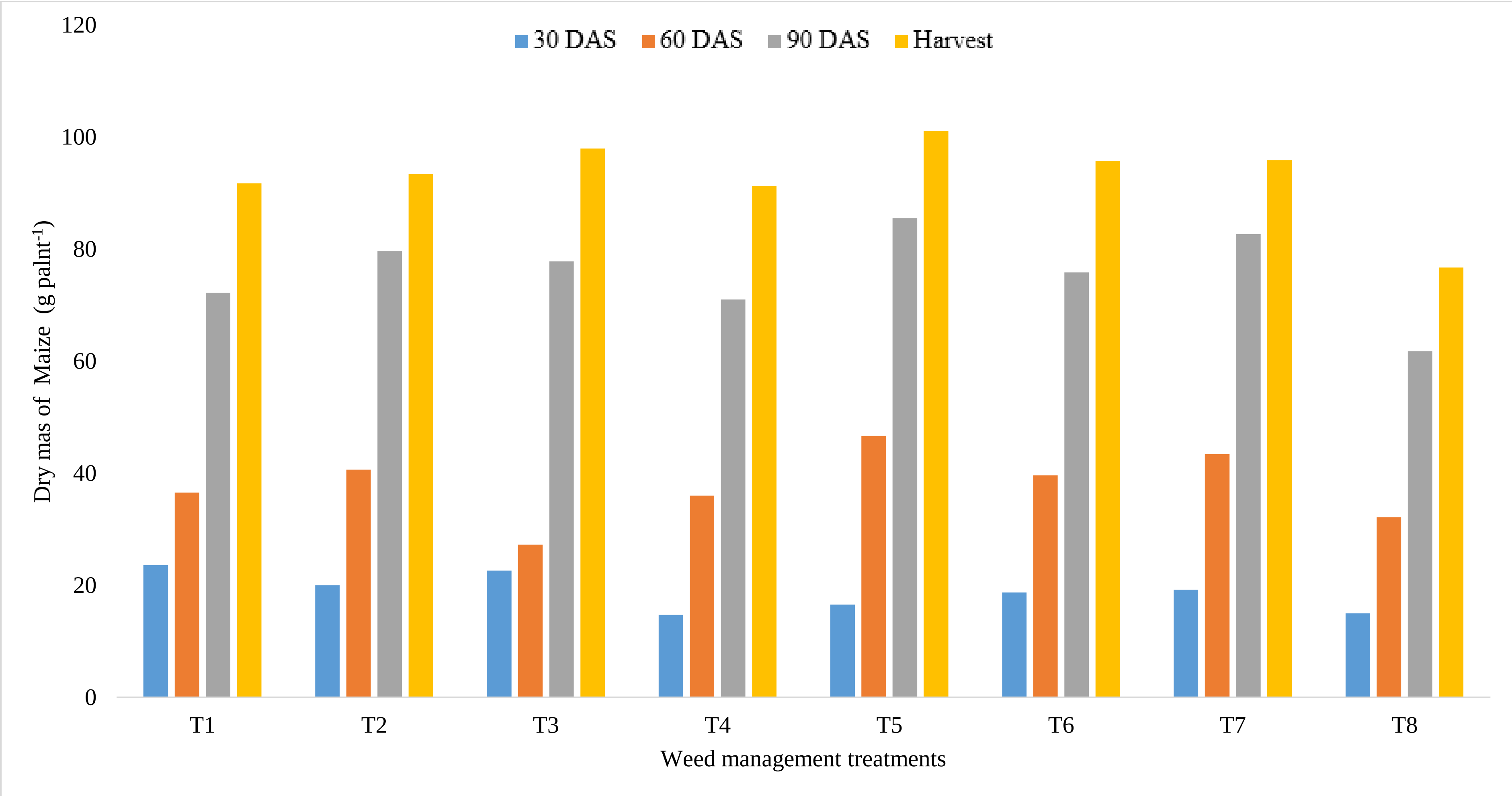


Fig 4.29 Influnce of herbicides on dry weight of maize at monthly intervals. (2021 and 2022).

Chart 4.32 Influnce of herbicides on development studies of maize at tasseling and silking stages. (2021 and 2022)

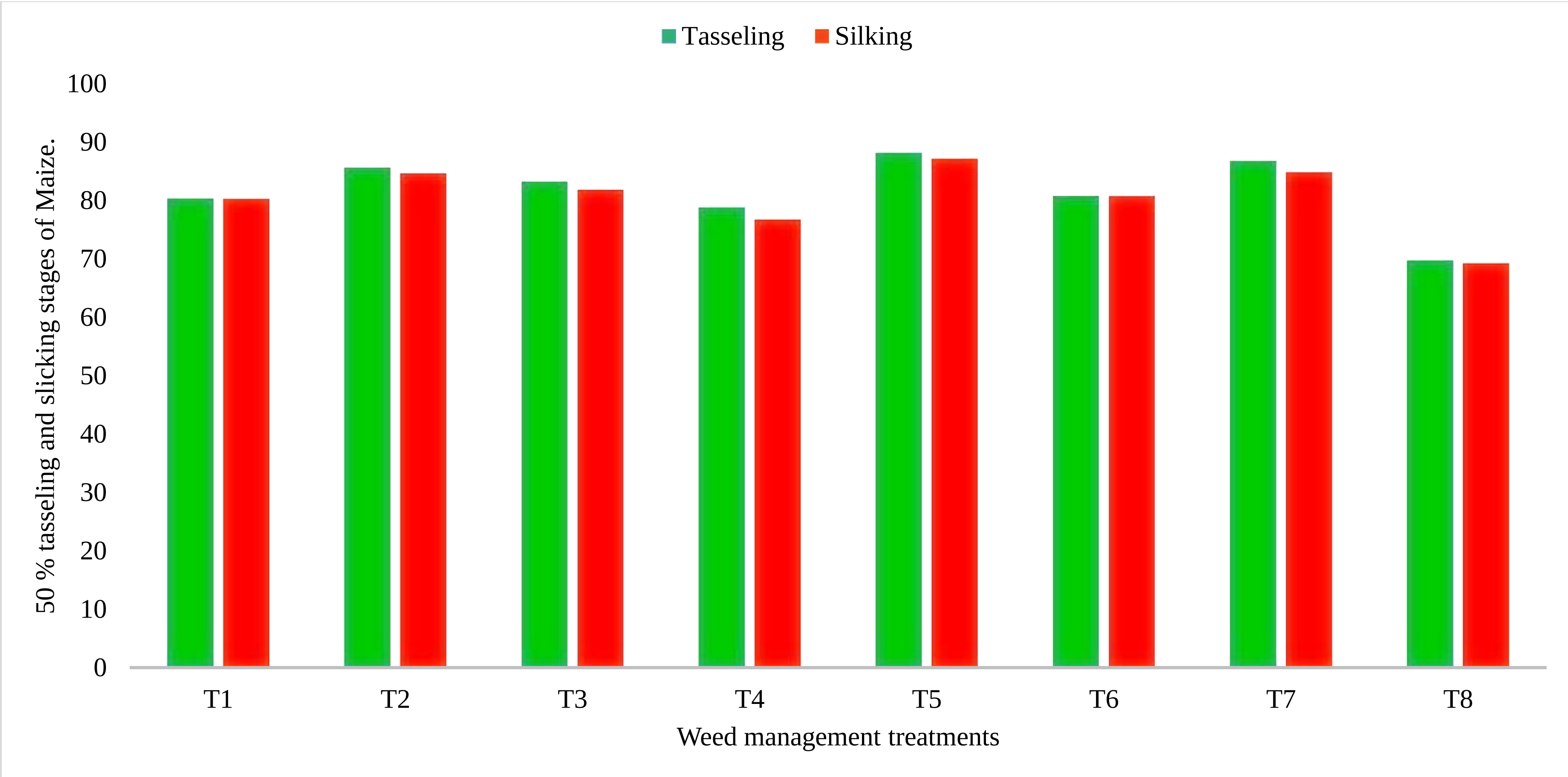
Treatments	Tasseling (2021)	tasseling (2022)	Pooled data	Silking (2021)	Silking (2022)	Pooled data
T_1	80.29	80.32	80.30	79.29	80.74	80.27
T_2	85.17	86.11	85.64	84.17	85.18	84.67
T_3	83.20	83.24	83.22	82.28	81.44	81.86
T_4	78.17	79.41	78.79	76.17	77.25	76.71
T_5	87.18	89.12	88.15	86.20	88.13	87.16
T_6	81.17	80.35	80.76	80.20	81.29	80.74
T_7	86.22	87.13	86.75	85.22	84.43	84.82
T_8	69.21	70.22	69.71	68.21	70.22	69.21
SEm (±)	**0.61**	**0.52**	**0.56**	**0.56**	**0.52**	**0.54**
CD (p=0.05)	**1.84**	**1.79**	**1.81**	**1.69**	**1.57**	**1.63**

4.2.7 Development studies

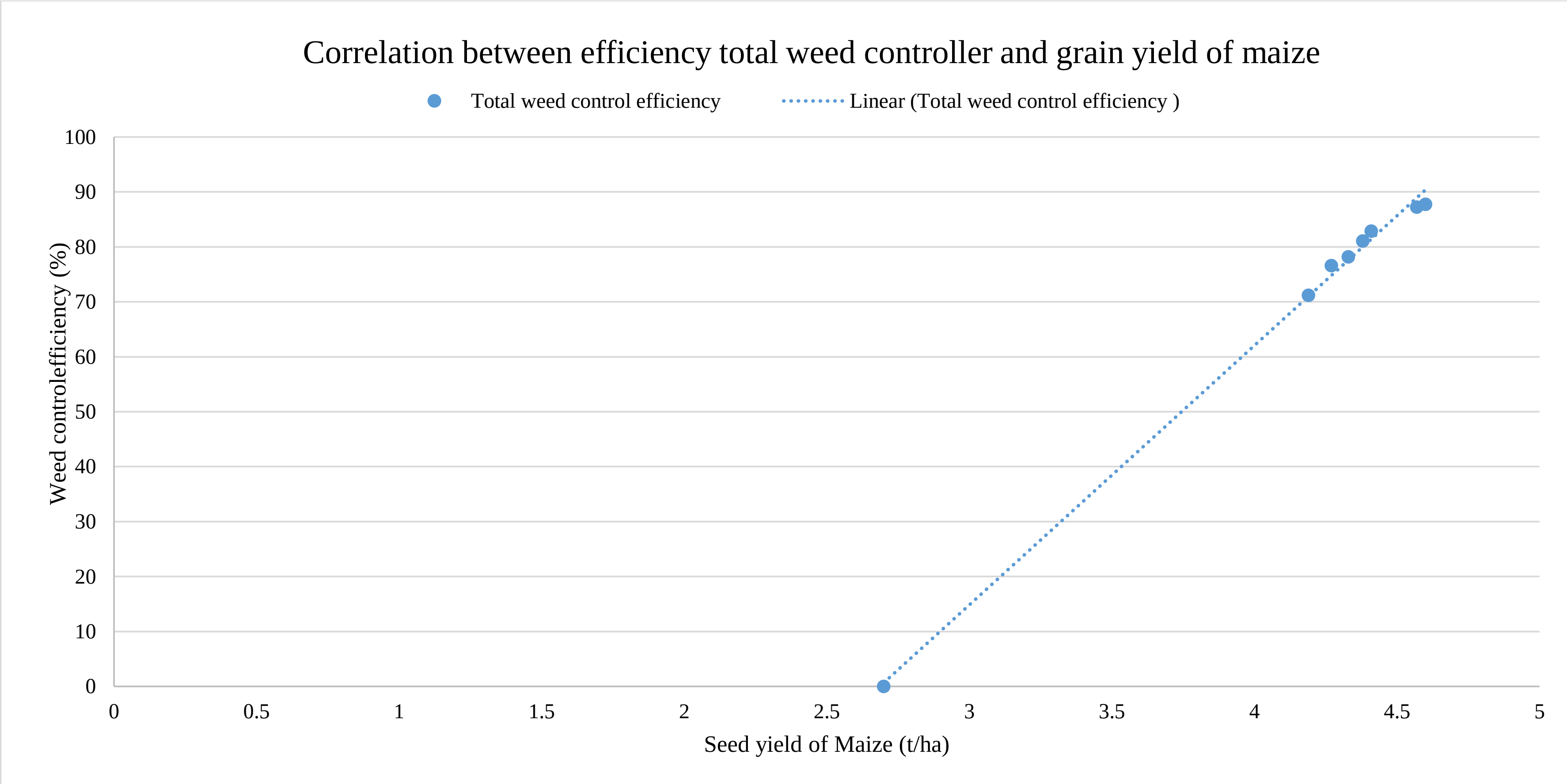
According to the data concerning the development studies shown in charts 4.32 and 4.30, various weed control treatments considerably affected the data on crop development.

Data for the years 2021 and 2022 are shown in charts 4.32 and 4.30. However, tasseling as well as silking were earlier under in 2, 4-D Na 800 g in addition to manually weeding at 60 days later seeding afterwards 2 HW (30 and 60 days later seeding) next to Metribuzin 800 g (Sharma *et al.,* 1998). Minimal tasseling was found in Tembotrione 120 g next to Topramezone 200 g. 50% silking of maize was observed 60 days after seeding. Higher silking was observed in 2, 4-D Na 800 g in addition to manually weeding at 60 days later seeding next to 2 HW (30 and 60 days later seeding) next to Metribuzin 800 g over un-weeded.

Cumulative data shown in the years 2021 and 2022 indicated that the minimum tasseling was observed in Tembotrione 120 g and Topramezone 200 g. The maximal tasseling was noted in 2, 4-D Na 800 g in addition to manually weeding at 60 and 2 HW (30 and 60 days later seeding) as linked to the un-weeded. 50% silking was noted in 2, 4-D Na 800 g in addition to manually weeding at 60 days later seeding at par by 2 HW (30 and 60 days later seeding) and Atrazine 500 g + HW over (30 days later seeding) as associated by the un-weeded.



Graph 4.30 Influnce of herbicides on development studies of maize at tasseling and silking stages. (2021 and 2022)



r=0.99

Graph: 4.30 (a) Correlation between Total WCE and Seed yield (t/h) of Maize (Pooled data 2021 and 2022)

Chart 4.33 Effect of different weed control treatments on crop growth rate (2021 and 2022).

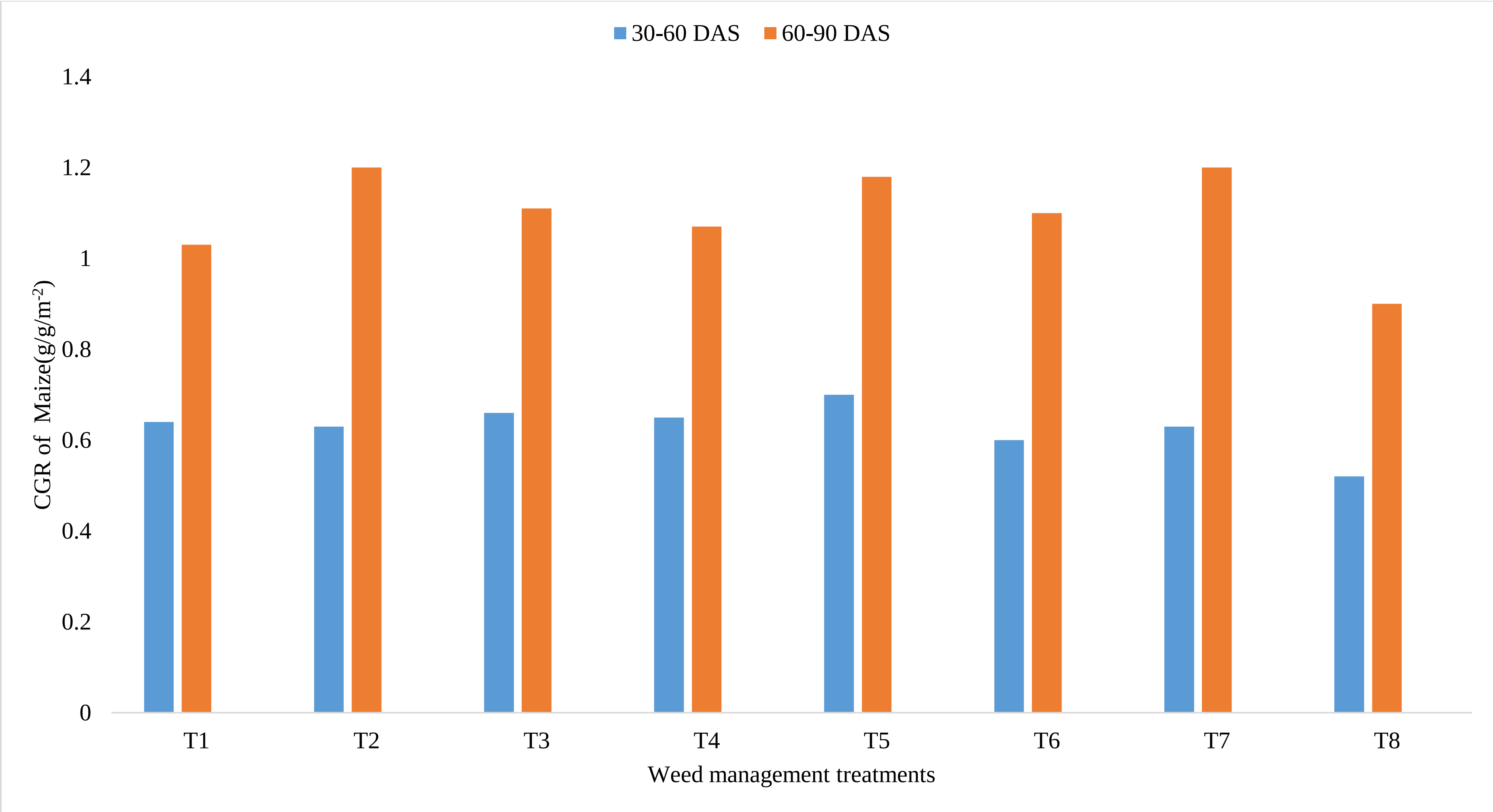
Treatments	30-60 DAS 2021	30-60 DAS 2022	Pooled data	60-90 DAS 2021	60-90 DAS 2022	Pooled data
T_1	0.581	0.701	0.64	0.969	1.10	1.03
T_2	0.587	0.666	0.63	1.050	1.34	1.20
T_3	0.593	0.721	0.66	1.020	1.20	1.11
T_4	0.598	0.697	0.65	0.965	1.17	1.07
T_5	0.608	0.799	0.70	1.100	1.26	1.18
T_6	0.497	0.696	0.60	0.995	1.21	1.10
T_7	0.597	0.669	0.63	1.060	1.33	1.20
T_8	0.470	0.576	0.52	0.806	1.00	0.90
SEm (±)	**0.04**	**0.05**	**0.05**	**0.07**	**0.09**	**0.08**
CD (p=0.05)	**0.12**	**0.16**	**0.14**	**0.22**	**0.28**	**0.24**

4.2.8 Growth rate of crop (g m^2/day)

The data concerning the rate of growth of the crop is considerably impacted by various weed control treatments, as shown in charts 4.33 and 4.31.

In the years 2021 and 2022, rate of growth of crop data is shown in chart 4.33. At 30–60 days later seeding, the highest rate of growth of crop was noted in 2, 4-D Na 800 g PoE combined through HW at 60 days later seeding, subsequently 2 HW (30 and 60 days later seeding) rate of growth of crop Metribuzin 800 g PE. The minimum rate of growth of the crop was noted in Topramezone (200 g PoE) and in Tembotrione (120 gPoE). At 90–60 days after seeding, the minimum rate of growth of the crop was noted in Tembotrione 120 g PoE as associated by un-weeded. The higher rate of growth of the crop remained noted in 2, 4-D Na 800 g PoE combined through HW at 60 DAS and subsequently HW twice (30 and 60 days later seeding).

The cumulative data shows that in 2021, the rate of growth of crop 2022 data shows in chart 4.33 the rate of growth of the crop; in graph 4.31, at 60–30 DAS, the higher rate of growth of the crop was noted in 2, 4-D Na 800 g PoE combined by HW at 60 days later seeding next to Metribuzin 800 g PE. The minimum rate of growth of the crop noted in Topramezone 200 g PoE among the herbicidal actions over the un-weeded Data on 90–60 days later seeding, the minimum rate of growth of the crop was noted in Tembotrione 120 g PoE rate of growth of the crop next to Atrazine 700 g PE rate of growth of the crop. The higher rate of growth of the crop was noted in HW twice (30 and 60 days later seeding) at par by Atrazine 500 g PE + 1 HW (30 days later seeding). rate of growth of the crop 2, 4-D Na 800 g PoE combined by HW at 60 days later seeding the un-weeded



Graph 4.31 Effect of different weed control treatments on crop growth rate (2021 and 2022).

Chart 4.34 Influnce of herbicides on relative growth rate of maize at different stage of observations. (2021 and 2022).

Treatments	60-30 DAS 2021	60-30 DAS 2022	Pooled data	90-60 DAS 2021	90-60 DAS 2022	Pooled data
T_1	0.22	0.21	0.22	0.28	0.27	0.28
T_2	0.21	0.23	0.22	0.24	0.23	0.24
T_3	0.22	0.21	0.22	0.24	0.25	0.25
T_4	0.22	0.23	0.22	0.21	0.24	0.23
T_5	0.21	0.20	0.20	0.31	0.29	0.30
T_6	0.21	0.22	0.21	0.25	0.25	0.25
T_7	0.20	0.22	0.21	0.23	0.21	0.22
T_8	0.22	0.22	0.22	0.26	0.25	0.26
SEm (±)	**0.06**	**0.07**	**0.07**	**0.09**	**0.11**	**0.10**
CD (p=0.05)	**0.18**	**0.21**	**0.22**	**0.27**	**0.32**	**0.31**

4.2.9 Relative Growth Rate (g/g day^{-1})

According to the data concerning the RGR shown in charts 4.34 and 4.32, various weed control treatments have a substantial impact on the data on the rate of relative growth.

In the years 2021 and 2022, the data shown in charts 4.34 and 4.32 at 60–30 showed a higher rate of relative growth in 2, 4-D Na 800 g, in addition to manually weeding at 60 DAS next to Atrazine 700 g. The rate of least relative growth was noticed in Tembotrione 120 g. Data taken 90–60 DAS showed that the minimum rate of relative growth was noted in 2 HW (30 and 60 DAS) as associated by un-weeded. The growth rate of the higher crop was noted in Atrazine 700 g and subsequently in Metribuzin 800 g as associated by the un-weeded.

The cumulative data shows that in the years 2021 and 2022, as shown in charts 4.34 and 4.32, at 60–30 DAS, the rate of extreme relative growth was noted in 2, 4-D Na, 800 g, in addition to manually weeding at 60 DAS. The minimum rate of relative growth was noted in Topramezone 200 g among the herbicidal treatments over the unweeded check. Data taken on 90–60 DAS showed that the smallest rate of relative growth was noted in Topramezone 200 g and 2 HW (30 and 60 DAS), and the heaviest rate of relative growth was noted in 2-D Na 800 g in addition to manually weeding at 60 DAS, besides Atrazine 500 g + 1 HW (30 DAS) over the un-weeded check.

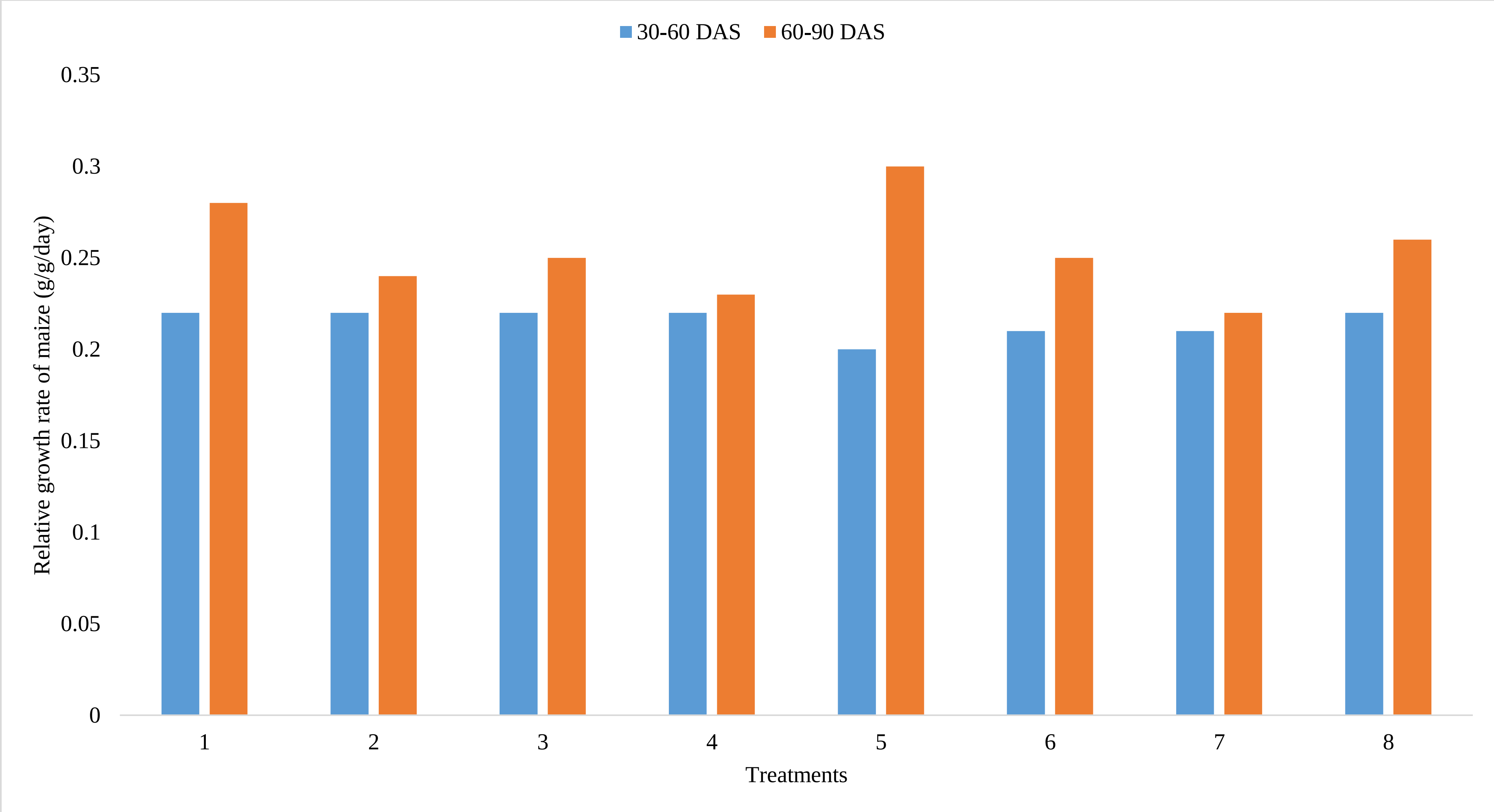


Chart 4.32 Influnce of herbicides on relative growth rate of maize at different stage of observations. (2021 and 2022).

Chart 4.35 Influnce of herbicides on yield characteristics (2021 and 2022).

Treatments	No. of cobs /plant 2021	No. of cobs /plant 2022	Pooled data	No. of kernel rows/cob 2021	No. of kernel rows/cob 2022	Pooled data	Weight of kernel /cob 2021	Weight of kernel /cob 2022	Pooled data
T_1	1.65	1.69	1.67	14.70	15.22	14.96	72.20	73.31	72.75
T_2	2.10	2.17	2.13	15.30	15.44	15.37	79.17	81.12	80.14
T_3	1.85	1.91	1.88	15.05	15.10	15.07	78.20	77.23	77.71
T_4	1.60	1.64	1.62	14.20	14.76	14.48	70.80	70.10	70.45
T_5	2.50	2.71	2.60	16.10	16.91	16.50	86.00	86.44	86.22
T_6	1.70	1.73	1.71	14.90	15.12	15.01	75.14	76.11	75.62
T_7	2.30	2.34	2.32	15.80	16.20	16.00	82.15	83.21	82.68
T_8	1.50	1.53	1.51	13.33	14.22	13.77	60.29	59.34	59.81
SEm (±)	**0.18**	**0.20**	**0.19**	**0.34**	**0.47**	**0.40**	**0.57**	**0.61**	**0.59**
CD (p=0.05)	**0.54**	**0.61**	**0.57**	**1.02**	**1.43**	**1.22**	**1.73**	**1.84**	**1.78**

4.2.10 Yield characters

The data concerning Chart 4.35 and Picture 4.33 show how various weed management methods changed the data on yield characteristics. The weed management practices impacted yield parameters measured as cobs/plant, kernel rows/cob, the weight of the kernel/cob, and 100-grain weight.

In the years 2021 and 2022, data are shown in chart 4.35 and numeral 4.33 for the quantity of cobs per plant, the quantity of kernel rows per cob, and the average weight of kernels per cob noted in all herbicidal treatments. The higher cobs/plant, sum of kernel row/cob, and weight of kernel/cob were noted in 2, 4-D Na 800 g PoE in addition to manually weeding at 60 DAS next to 2 HW (30 and 60 DAS), and Atrazine 500 g PE + single HW (30 DAS). T. Ramesh Babu *et al.* (2019), A. Sundari *et al.* (2019), Arun Kumar *et al.* (2018), and Rama Rao *et al.* (2016) The minimum cobs/plant, sum of kernel rows/cob, and weight of kernels/cob were noted in Tembotrione 120 gPoE as associated by herbicidal actions over the un-weeded.

The cumulative data shown in the years 2021 and 2022 are shown in charts 4.35 and 4.33. The amount of cobs per plant, the sum of kernel rows per cob, and the weight of kernels per cob were higher than noted in 2, 4-D Na 800 g PoE in addition to manually weeding at 60 DAS, followed by double HW (30 and 60 DAS), and Atrazine 500 gPE + in addition to manually weeding (30 DAS). The minimum quantity of cobs per plant, quantity of kernel row per cob, and weight of kernel per cob were noted in Tembotrione 120 gPoE as associated by herbicidal treatments.

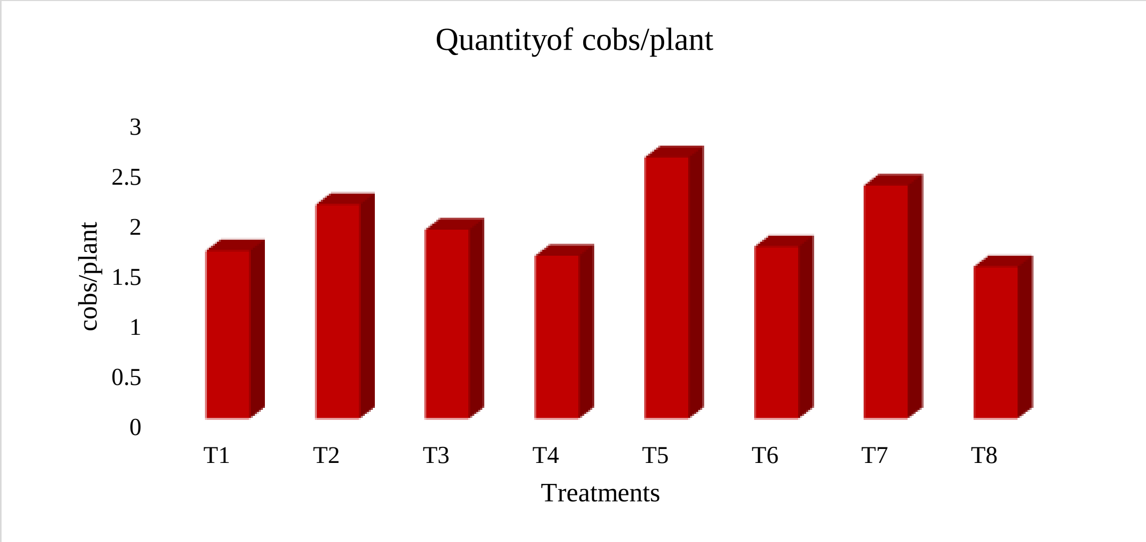


Fig 4. 33 (a) Number of cobs/plant (2021 and 2022)

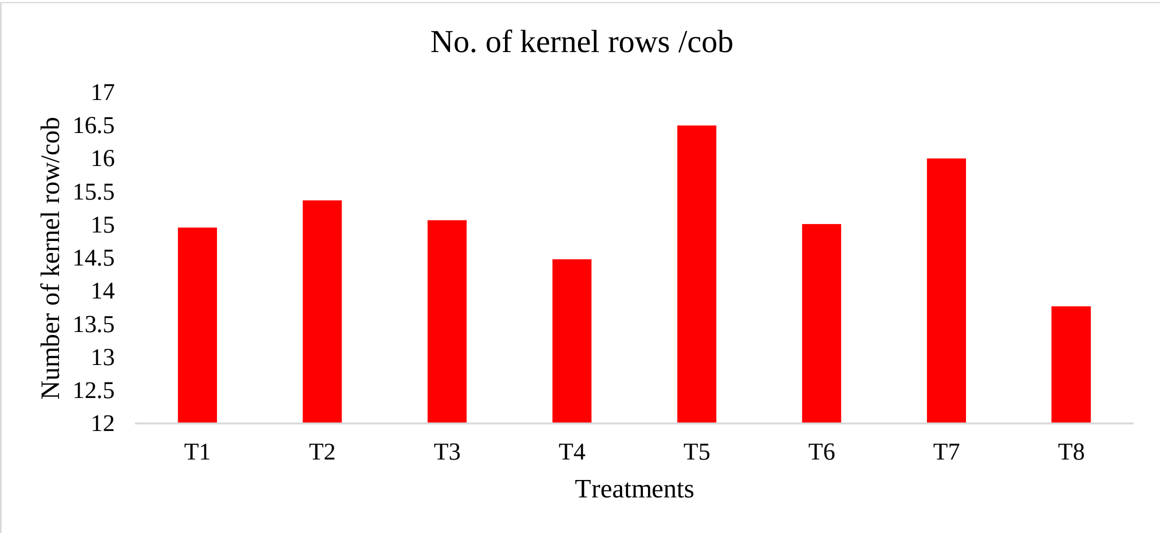


Fig 4. 33 (b) Quantity of kernel rows/cob (2021 and 2022)

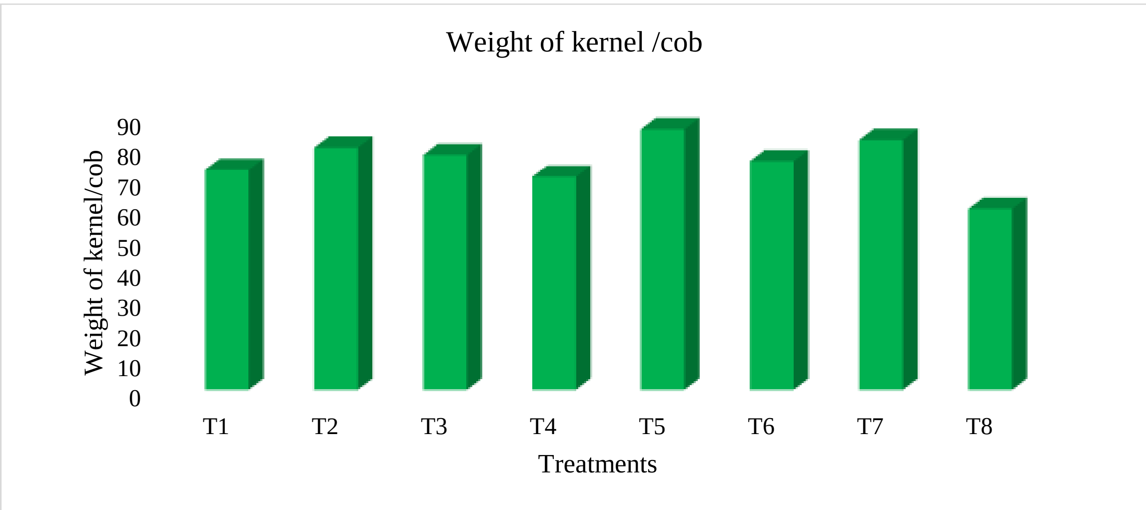


Fig 4. 33 (c) Quantity of kernel/cobs (2021 and 2022)

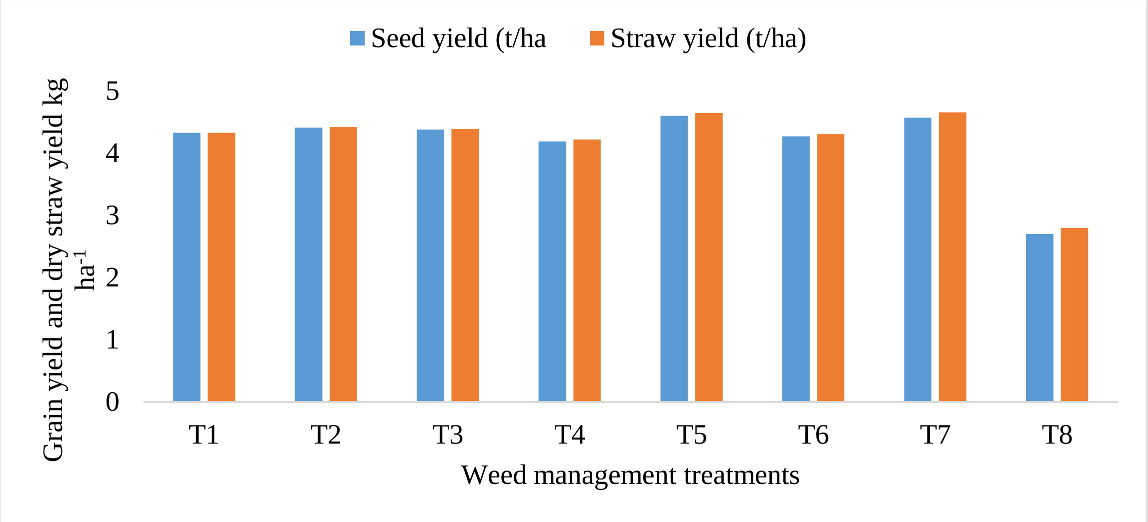
Chart 4.36 Influnce of herbicides on yield of Maize. (2021 and 2022).

Treatments	Seed yield (t/ha (2021)	Seed yield (t/ha (2022)	Pooled data	Straw yield (t/ha) (2021)	Straw yield (t/ha) (2022)	Pooled data	Seed Index (g) (2021)	Seed Index (g) (2022)	Pooled data	Harvest Index (%) (2021)	Harvest Index (%) (2022)	Pooled data	WI (%) (2021)	WI (%) (2022)	Pooled data
T_1	4.32	4.35	4.33	4.33	4.34	4.33	26.31	26.74	26.52	48.88	49.87	49.37	6.08	5.59	5.84
T_2	4.41	4.42	4.41	4.42	4.42	4.42	32.35	33.11	32.73	48.93	49.46	49.19	4.10	4.20	4.15
T_3	4.37	4.38	4.38	4.39	4.39	4.39	30.17	30.47	30.32	48.09	42.67	45.38	4.89	4.96	4.93
T_4	4.18	4.20	4.19	4.21	4.22	4.22	25.32	26.12	25.72	48.38	48.43	48.40	9.10	8.90	9.00
T_5	4.60	4.61	4.60	4.65	4.66	4.65	35.17	36.28	35.72	48.60	48.98	48.79	0.00	0.00	0.00
T_6	4.26	4.28	4.27	4.31	4.31	4.31	28.31	27.13	27.72	48.20	49.12	48.66	7.26	7.23	7.25
T_7	4.56	4.58	4.57	4.66	4.67	4.66	34.18	35.41	34.79	48.25	48.28	48.26	0.86	0.71	0.79
T_8	2.70	2.71	2.70	2.70	2.91	2.80	19.31	20.12	19.71	48.73	46.42	47.57	45.65	44.25	44.95
SEm (±)	**4.55**	**5.21**	**5.46**	**5.81**	**6.13**	**6.21**	**0.46**	**0.82**	**0.64**	**0.53**	**0.67**	**0.60**	**0.44**	**0.50**	**0.47**
CD(p=0.05)	**12.33**	**16.83**	**16.61**	**16.33**	**18.22**	**19.43**	**1.38**	**2.50**	**1.94**	**1.62**	**2.2**	**1.91**	**1.34**	**1.52**	**1.43**

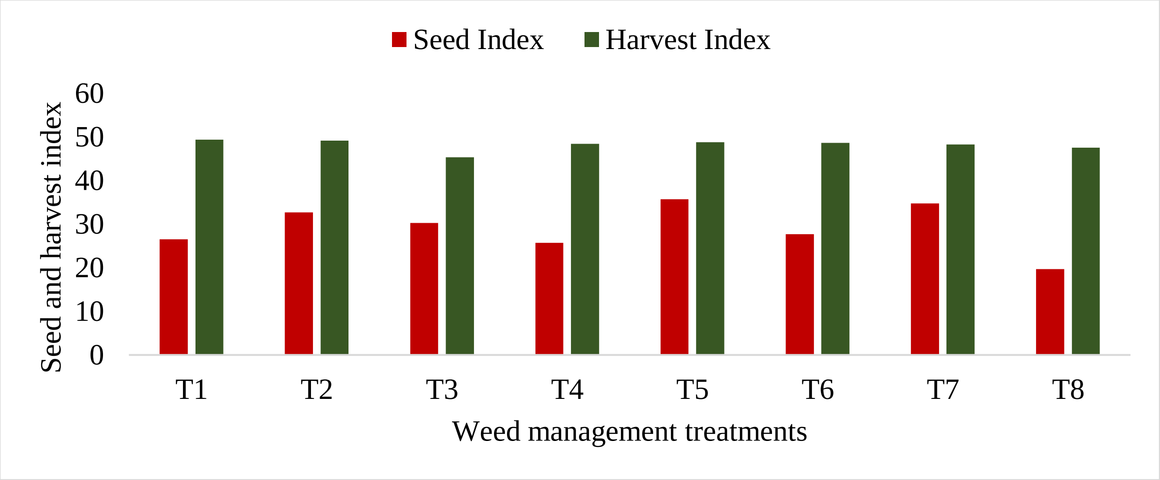
4.2.11 Yield attributes

The data concerning the yield attribute shown in chart 4.36 shows that various weed control methods considerably affected the results on yield character.

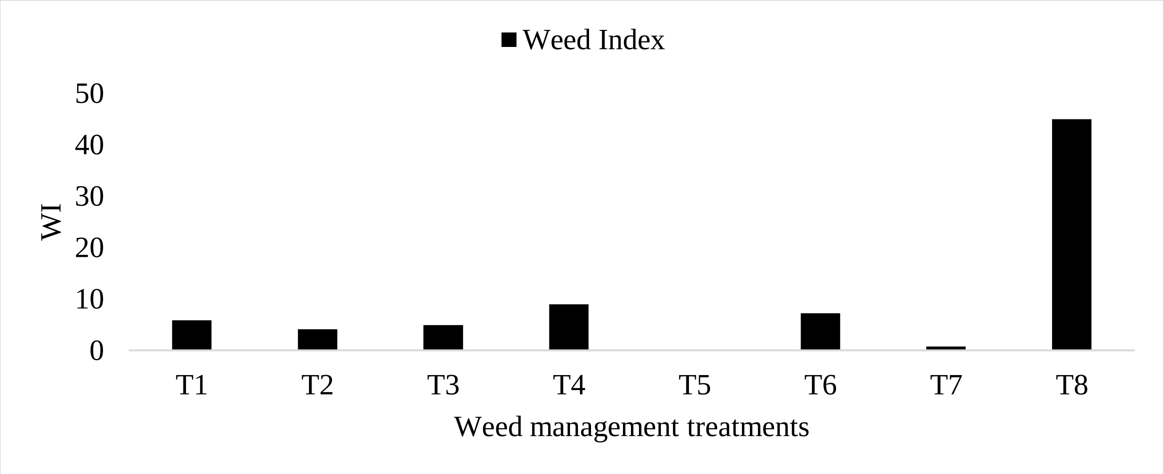
In the years 2021 and 2022, as shown in charts 4.36 and 4.34, seed and straw yield and harvest index averages were noted in all herbicidal treatments. When HW and 2, 4-D Na 800 g were combined at 60 days lateral seeding, the grain plus straw yield along by the harvest index remained noted. Subsequently, double-HW (30 and 60 DAS) and atrazine 500 g + single-HW (30 DAS) the various herbicide mixtures successfully inhibited weed growth for around a week, resulting in boosted seed production. The weedy check, which reported the lowest pod yield, would have then led to a yield loss of nearly 80%. By analyzing the bearing of weed biomass and thickness on maize production, it can be concluded that reduced weed biomass plus density might efficiently decrease the rivalry for capital between the crop and weed, which has led to an increase in maize output. This could be recognized as the complete consumption of all growing aspects by maize alone, as reported by D.P. Nagdeve *et al.* (2014), Hatti *et al.* (2014), and Bahirgul Sabiry *et al.* (2019). In unweeded, the lowest seed and straw production and harvest index were noted. The smallest WI was observed in 2, 4-D Na 800 g in addition to manually weeding at 60 DAS and subsequently double-HWs (30 and 60 DAS). V. Varshitha *et al.* (2020), Mahesh Kumar *et al.* (2019), and Puscal Sharma *et al.* (2018) noted a higher WI for Tembotrione 120 g as compared to herbicidal actions over un-weeded. The results stand in settlement through the discoveries of Tarundeep Kaur *et al.* (2018) and Pijush Kanti Mukherjee *et al.* (2019).



Graph 4.34 (a) grain and straw (t/ha) of maize. (2021 and 2022)



Graph 4.34 (b) seed and harvest index of maize. (2021 and 2022)



Graph 4.34 (c) seed and WI of maize. (2021 and 2022)

Chart 4.37 Influnce of herbicides on the economics of maize (2021 and 2022)

Treatments	Gross return (₹ ha^{-1}) 2021	Gross return (₹ ha^{-1}) 2022	Pooled data	Cost of cultivation (₹ ha^{-1}) 2021	Cost of cultivation (₹ ha^{-1}) 2022	Pooled data	Net return (₹ ha^{-1}) 2021	Net return (₹ ha^{-1}) 2022	Pooled data	B:C ratio 2021	B:C ratio 2022	Pooled data
T_1	82110	82734	82422	29848	30248	30088	52262	52486	52374	1.75	1.74	1.74
T_2	83831	83998	83914	30575	31674	30802	53256	52324	52790	1.74	1.65	1.70
T_3	83157	83341	83249	29667	30723	29909	53490	52618	53054	1.80	1.71	1.76
T_4	79513	79903	79708	29688	30894	29930	49825	49009	49417	1.68	1.59	1.63
T_5	87510	87764	87637	30310	31542	30542	57200	56222	56711	1.89	1.78	1.83
T_6	81142	81390	81266	30679	31991	30901	50463	49399	49931	1.64	1.54	1.59
T_7	86842	87217	87029	31856	32174	32061	54986	55043	55014	1.73	1.71	1.72
T_8	51351	51928	51639	27563	27900	27841	23788	24028	23908	0.86	0.86	0.86

DAS: Days after seeding. All herbicide dose is used gm. ha^{-1}

4.2.12 Economics of Maize

The data concerning the economics of maize were considerably impacted by various weed management measures, as shown in chart 4.37.

4.2.12.1 Cost of cultivation

According to the data concerning the cost of cultivation shown in chart 4.37, various weed management methods have an impact on the information on gross plus net revenues.

The data concerning the total cost of cultivation for 2021 and 2022, which is provided in chart 4.37, showed that the un-weeded check ensured the greatest cost of cultivation. Unweeded land has the lowest known cost of cultivation. Due to the additional labour required to maintain a weed-free plot, HW results in the greatest cost of cultivation.

4.2.12.2 Net and gross returns

According to the data concerning net and gross returns shown in chart 4.37, various weed management methods have an impact on total and net returns.

Chart 4.37 on maize's cumulative data for 2021 and 2022's gross and net returns shows how various weed management methods have a major impact. In the cumulative data for 2021 and 2022, the treatment (T_5) of 2, 4-D Na 800 gPoE in combination by HW at 60 DAS was reported to have the best gross profits (87637 ha^{-1}) plus net incomes (56711 ha^{-1}) in maize) in the cumulative data for 2021 and 2022. The outcomes concur by A. Sundari *et al.*, (2019).

4.2.12.3 Ratio of Benefit-cost (B: C ratio)

The data concerning the benefit cost has a considerable impact on the statistics on the ratio of benefit to cost in charts 4.37 and 4.35.

The cumulative data for the years 2021 and 2022 show that various weed management methods have a substantial impact on the ratio of benefit to cost in charts 4.37 and 4.35. The highest ratio of benefit-cost (1:83) was noted in 2, 4-D Na 800 g PoE mutual by HW at 60 DAS as associated by herbicidal actions. The highest gross revenue by lesser cultivation charges is true. In place of using a lone technique, the combination of weed management techniques has resulted in real weed control, according to Mitra *et al.* (2018) and Barad *et al.* (2016).

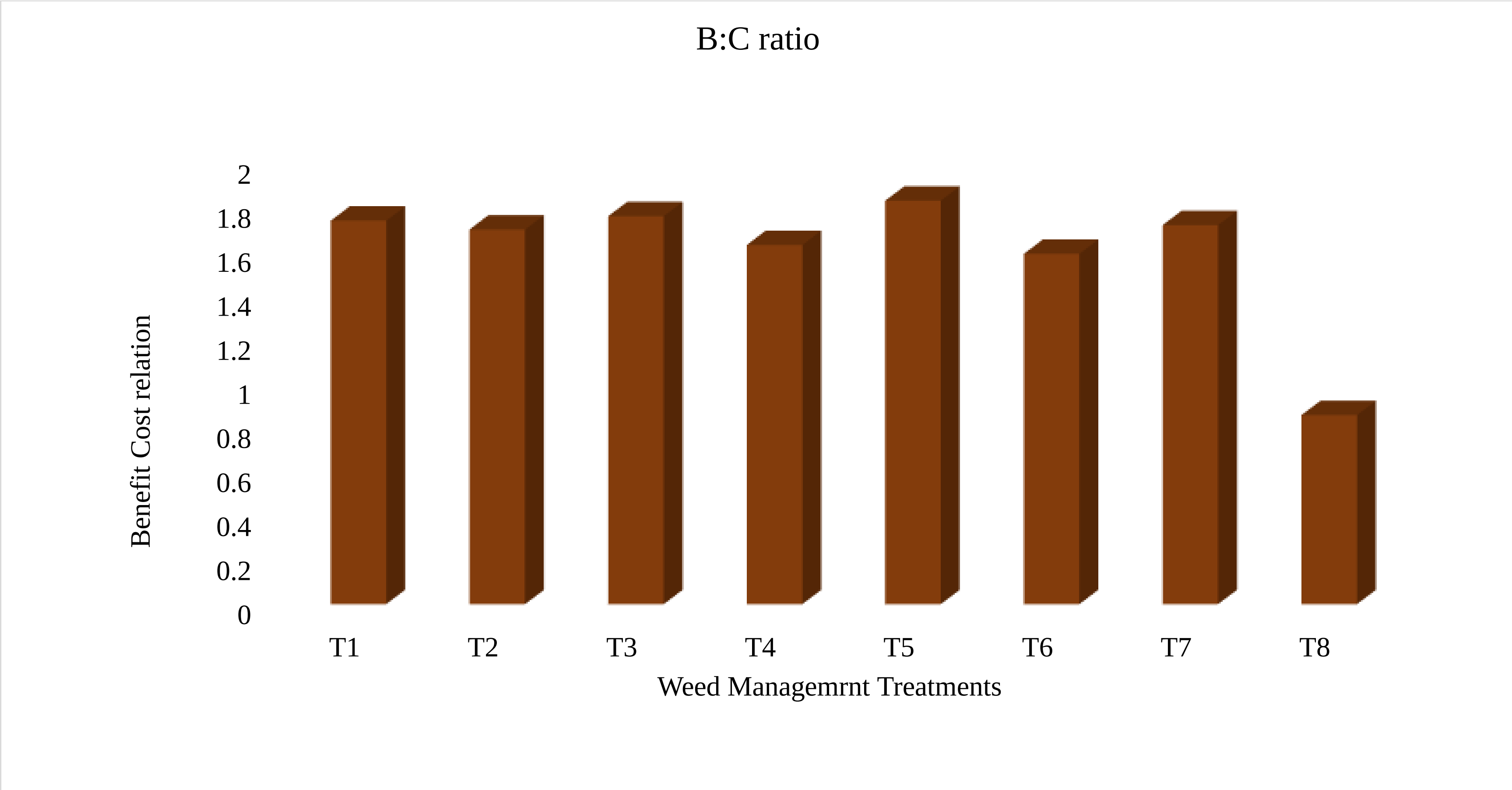


Chart 4.35. Influnce of herbicides on economics of maize (Pooled data 2021 and 2022)

4.2.5 Herbicide persistence study

Chart 4.38 Effect of herbicide residues on germination percentage of Oat (days after treatment) (2021 and 2022).

Treatments	30 DAS (2021)	30 DAS (2022)	Pooled data	60 DAS (2021)	60 DAS (2022)	Pooled data	90 DAS (2021)	90 DAS (2022)	Pooled data	Harvest (2021)	Harvest (2022)	Pooled data
T_1	48.60	49.71	49.155	57.60	60.41	59.005	75.14	77.24	76.19	80.00	81.33	80.665
T_2	50.12	53.67	51.895	62.14	64.23	63.185	78.55	79.63	79.09	82.20	83.14	82.67
T_3	56.16	58.44	57.3	66.20	68.74	67.47	77.54	78.92	78.23	81.30	82.62	81.96
T_4	80.5	81.69	81.095	47.60	49.24	48.42	72.55	73.23	72.89	84.25	85.19	84.72
T_5	82.8	83.60	83.2	55.19	56.14	55.665	73.56	75.67	74.615	86.18	87.44	86.81
T_6	84.6	85.76	85.18	52.21	53.19	52.85	79.36	80.74	80.05	84.18	86.18	85.18
T_7	83.16	84.22	83.69	84.80	85.12	52.7	84.80	85.47	85.135	84.78	85.89	85.335
T_8	85.16	86.67	85.915	85.32	86.31	84.96	85.32	86.89	86.105	85.31	86.74	86.025
SEm (±)	**0.71**	**0.76**	**0.73**	**0.83**	**0.79**	**0.81**	**0.97**	**0.92**	**0.95**	**0.90**	**1.03**	**0.96**
CD (p=0.05)	**2.16**	**2.31**	**2.24**	**2.53**	**2.41**	**2.47**	**2.93**	**2.81**	**2.87**	**2.72**	**3.09**	**2.91**

4.3 Herbicide persistence study

4.3.1 Germination percentage of oat

The data concerning the germination percentage of oat, graphs 4.36 exhibit the results on the percentage of germination of oats impacted by various weed control interventions at all observational phases.

In the year 2021 and 2022 data shown in chart 4.38 and graph 4.36 indicated that the minimum germination percentage of Oat seeds were noted in the PE use of Atrazine 700 gPE DAS Atrazine 500 g PE + Single HW (30 DAS) and Metribuzin 800 g PE. The higher germination percentage of Oat seeds was noted in PoE. At 60 DAS the higher germination percentage of Oat seeds was noted in HW as paralleled to herbicidal actions. Among the PoE herbicidal usages noted minimum germination percentage was noted because of herbicidal residue active in the soil. At 90 DAS and harvest at all herbicidal usages observed average germination percentage of Oat seeds. The minimum germination percentage observed in 2, 4-D NA Salt 800 g PoE combined by HW at 60 DAS subsequently Atrazine 700 g PE as asociated to other actions.

Cumulative data shown in the years 2021 and 2022 data shown in chart 4.38 and graph 4.36 indicated that the 30 DAS PE herbicides highly remain active in soil resulting from a minimum germination percentage of oat seed over another treatment. At 60 DAS minimum germination percentage of cucumber seeds was noted in PoE treatment as asociated to PE actions. The heighest germination percentage was noted in HW and Un-weeded check. At 90 DAS and harvest suggestively average germination percentage was observed in all chemical actions because due to less herbicidal concentration present in the soil.

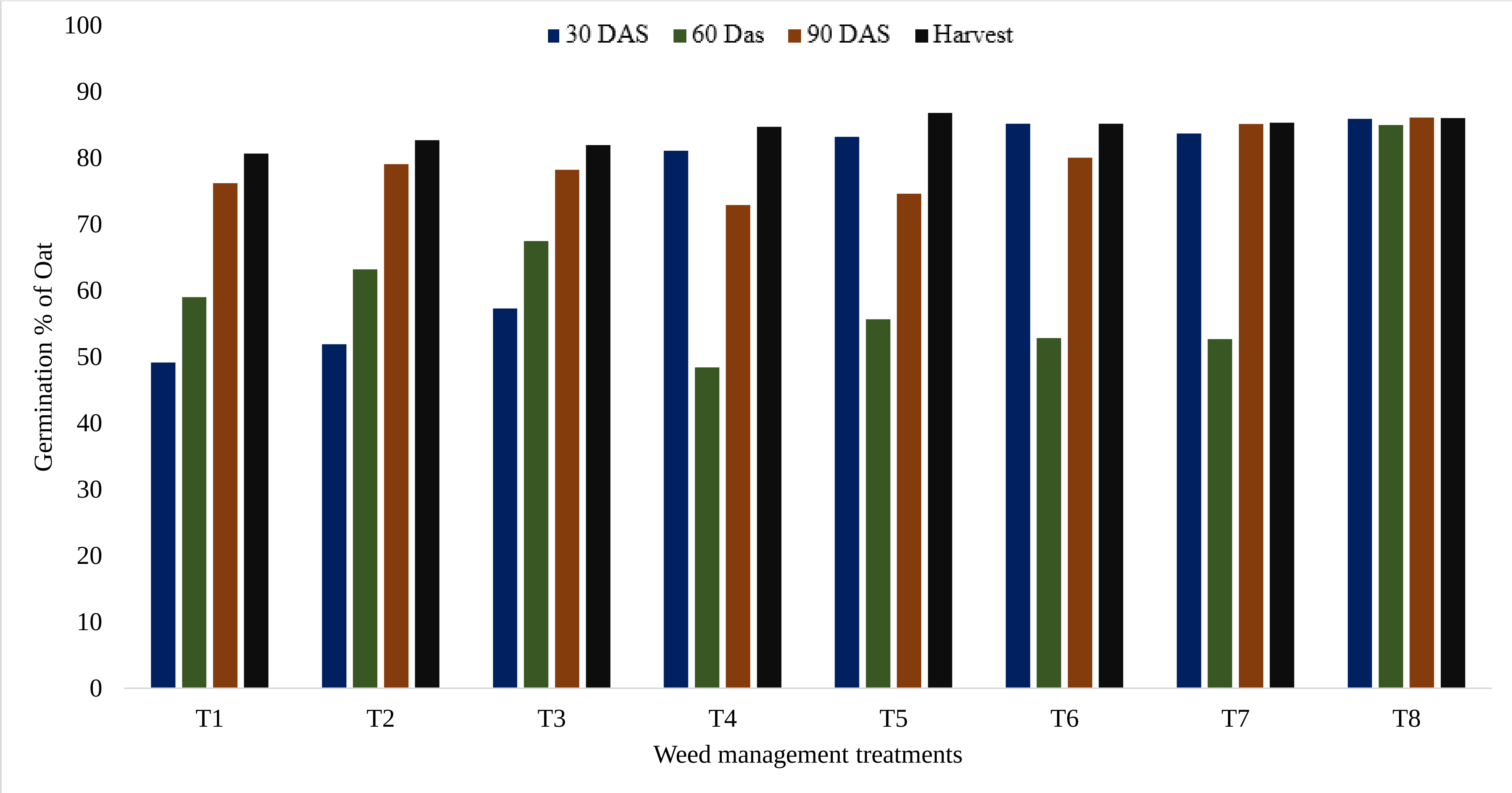


Fig 4.36 Influence of herbicide residues on germination percentage of oat (days after treatment) (Pooled data 2021 and 2022)

Chart 4.39 Impact of herbicide residues on root length of Oat (cm) of Oat at 10 DAS. (2021 and 2022)

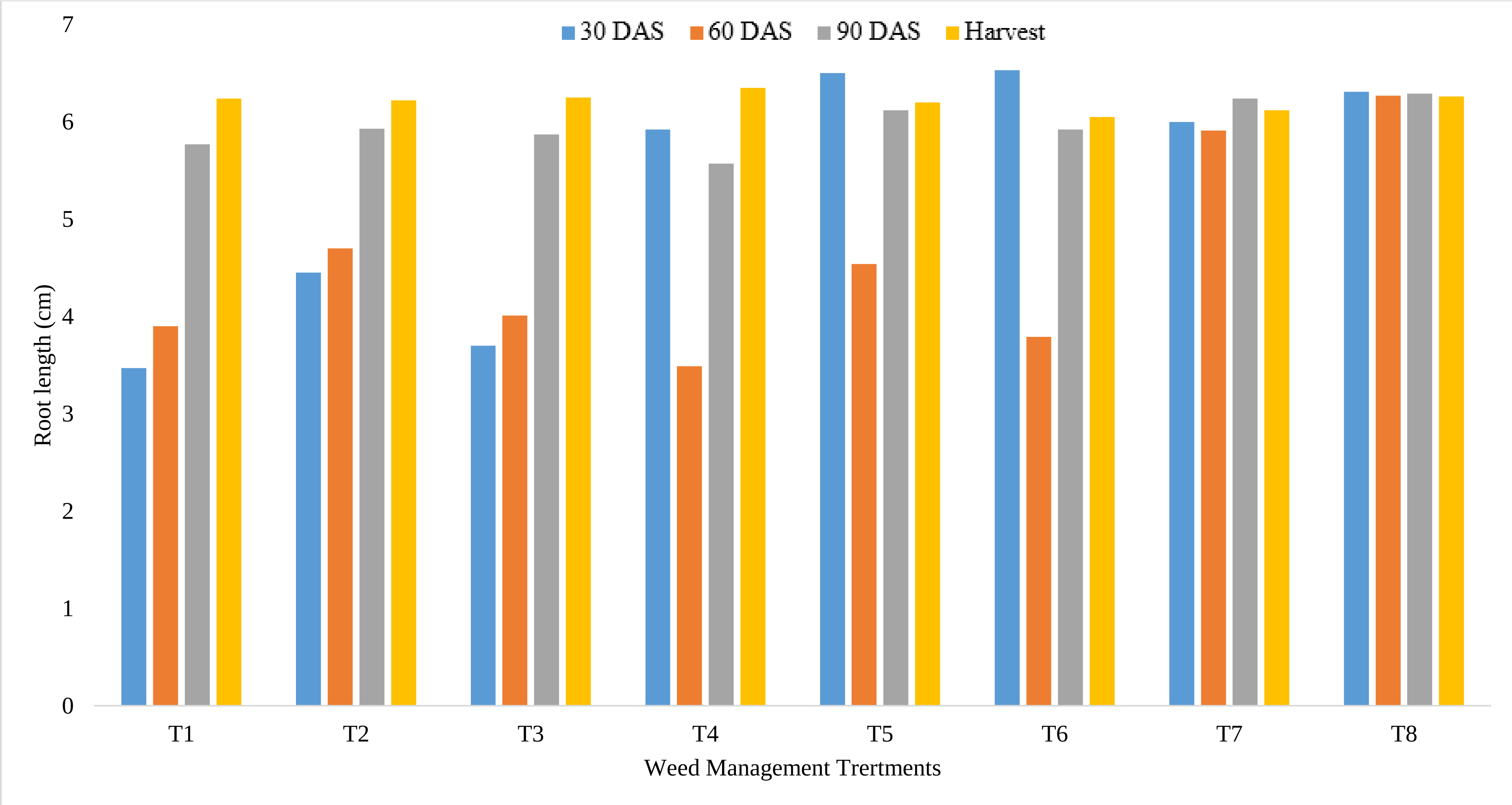
Treatments	30 DAS (2021)	30 DAS (2022)	Pooled data	60 DAS (2021)	60 DAS (2022)	Pooled data	90 DAS (2021)	90 DAS (2022)	Pooled data	Harvest (2021)	Harvest (2022)	Pooled data
T_1	3.28	3.67	3.47	3.82	3.99	3.90	5.70	5.84	5.77	6.20	6.28	6.24
T_2	4.17	4.74	4.45	4.70	4.71	4.70	5.90	5.96	5.93	6.21	6.24	6.22
T_3	3.44	3.96	3.70	3.92	4.10	4.01	5.85	5.89	5.87	6.24	6.26	6.25
T_4	5.67	6.18	5.92	3.37	3.62	3.49	5.37	5.78	5.57	6.31	6.39	6.35
T_5	6.41	6.59	6.50	4.42	4.67	4.54	6.10	6.15	6.12	6.19	6.22	6.20
T_6	6.84	6.91	6.87	3.78	3.81	3.79	5.90	5.95	5.92	6.00	6.11	6.05
T_7	5.90	6.10	6.00	5.90	5.92	5.91	6.20	6.29	6.24	6.10	6.14	6.12
T_8	6.19	6.44	6.31	6.20	6.34	6.27	6.24	6.34	6.29	6.22	6.31	6.26
SEm (±)	**0.27**	**0.43**	**0.35**	**0.52**	**0.46**	**0.49**	**0.57**	**0.53**	**0.55**	**0.60**	**0.63**	**0.62**
CD (p=0.05)	**0.82**	**1.31**	**1.06**	**1.57**	**1.38**	**1.49**	**1.72**	**1.60**	**1.66**	**1.83**	**1.92**	**1.88**

4.3.2 Root length of Oat

Chart 4.39 give information on the root length of oats that was impacted by various weed control methods at all observational stages.

In the years 2021 and 2022 data shown in chart 4.39 and graph 4.37 designated that the minimum root length of Oat seeds was observed in the PE use of Atrazine 700 g PE subsequently Atrazine 500 g PE + Single HW (30 DAS) and Metribuzin 800 g PE. The greater root length of Oat seeds was noted in PoE treatments. At 60 DAS the heighest root length of Oat seeds was noted in HW as equated to herbicidal treatments. Among the PoE herbicidal treatments noted minimum root length noted because of herbicidal residue active in the soil. Data on 90 DAS and at harvest at all herbicidal actions logged average root length of Oat seeds. The minimum root length observed in 2, 4-D Na 800 g PoE in addition to manually weeding at 60 DAS andAtrazine 700 g as asociated to other actions.

Cumulative data shown in the years 2021 and 2022 data shown in chart 4.39 and graph 4.37 indicated that the 30 DAS PE herbicides highly remain active in soil resulting from a minimum root length of Oat seed over another treatment. At 60 DAS minimum root length of Oat seeds was noted in PoE treatment as asociated to PE treatments. The heighest root length was noted in HW and Un-weeded. At 90 DAS then harvest suggestively average root length was observed in all chemical treatments because due to less herbicidal concentration present in the soil.



Graph 4.37 Influence of herbicide residues on root length of Oat (cm) of Oat at 10 DAS. (Pooled data 2021 and 2022)

Chart 4.40 Effect of herbicide residues on shoot length (cm) of Oat at 10 DAS. (2021 and 2022)

Treatments	30 DAS (2021)	30 DAS (2022)	Pooled data	60 DAS (2021)	60 DAS (2022)	Pooled data	90 DAS (2021)	90 DAS (2022)	Pooled data	Harvest (2021)	Harvest (2022)	Pooled data
T_1	2.88	2.91	2.89	3.24	3.29	3.26	4.77	4.80	4.78	5.44	5.51	5.47
T_2	3.10	3.16	3.13	3.40	3.48	3.44	4.87	4.89	4.88	5.40	5.46	5.43
T_3	3.77	3.85	3.81	3.81	3.84	3.82	4.61	4.64	4.62	5.46	5.49	5.47
T_4	4.51	4.60	4.55	3.17	3.22	3.19	5.00	5.12	5.06	5.61	5.65	5.63
T_5	4.76	4.26	4.51	2.96	2.98	2.97	4.90	4.96	4.93	5.50	5.54	5.52
T_6	4.67	4.55	4.61	3.00	3.09	3.04	5.10	5.17	5.13	5.57	5.58	5.57
T_7	5.56	5.41	5.48	5.48	5.58	5.53	5.54	5.61	5.57	5.60	5.61	5.60
T_8	5.47	5.60	5.53	5.44	5.54	5.49	5.50	5.57	5.53	5.52	5.50	5.51
SEm (±)	**0.25**	**0.32**	**0.29**	**0.35**	**0.44**	**0.40**	**0.39**	**0.49**	**0.44**	**0.42**	**0.69**	**0.55**
CD (p=0.05)	**0.77**	**0.97**	**0.88**	**1.07**	**1.33**	**1.2**	**1.18**	**1.49**	**1.35**	**1.26**	**2.09**	**1.69**

4.3.3 Shoot length of Oat

The data concerning the shoot length shown in chart 4.40 shows various weed managing methods had a considerable impact on shoot length of oat.

In the years 2021 and 2022 data shown in chart 4.40 and graph 4.38 designated that minimum shoot extent of Oat seeds was observed in the PE use of Atrazine 700 g next to Atrazine 500 g + single HW (30 DAS) and Metribuzin 800 g. The higher shoot length of Oat seeds was noted in PoE treatments. At 60 DAS the higher shoot length of Oat seeds was noted in HW as paralleled to herbicidal treatments. Among PoE herbicidal actions, noted minimum shoot length was noted because of herbicidal residue active in the soil. Data on 90 DAS and at harvest at all herbicidal actions logged average shoot length of Oat seeds. The minimum shoot length observed in 2, 4-D Na 800 g PoE collective by HW at 60 DAS subsequently Atrazine 700 g as asociated to other actions.

Cumulative data shown in the years 2021 and 2022 data shown in chart 4.40 and graph 4.38 indicated that the 30 DAS PE herbicides highly remain active in soil resulting from a minimum shoot length of Oat seed over another treatment. At 60 DAS minimum shoot length of Oat seeds was noted in PoE treatment as asociated to PE treatments. The heighest shoot length was noted in HW and Un-weeded check. Data on 90 DAS then harvest suggestively average shoot length was detected in all chemical treatments because due to less herbicidal concentration present in the soil.

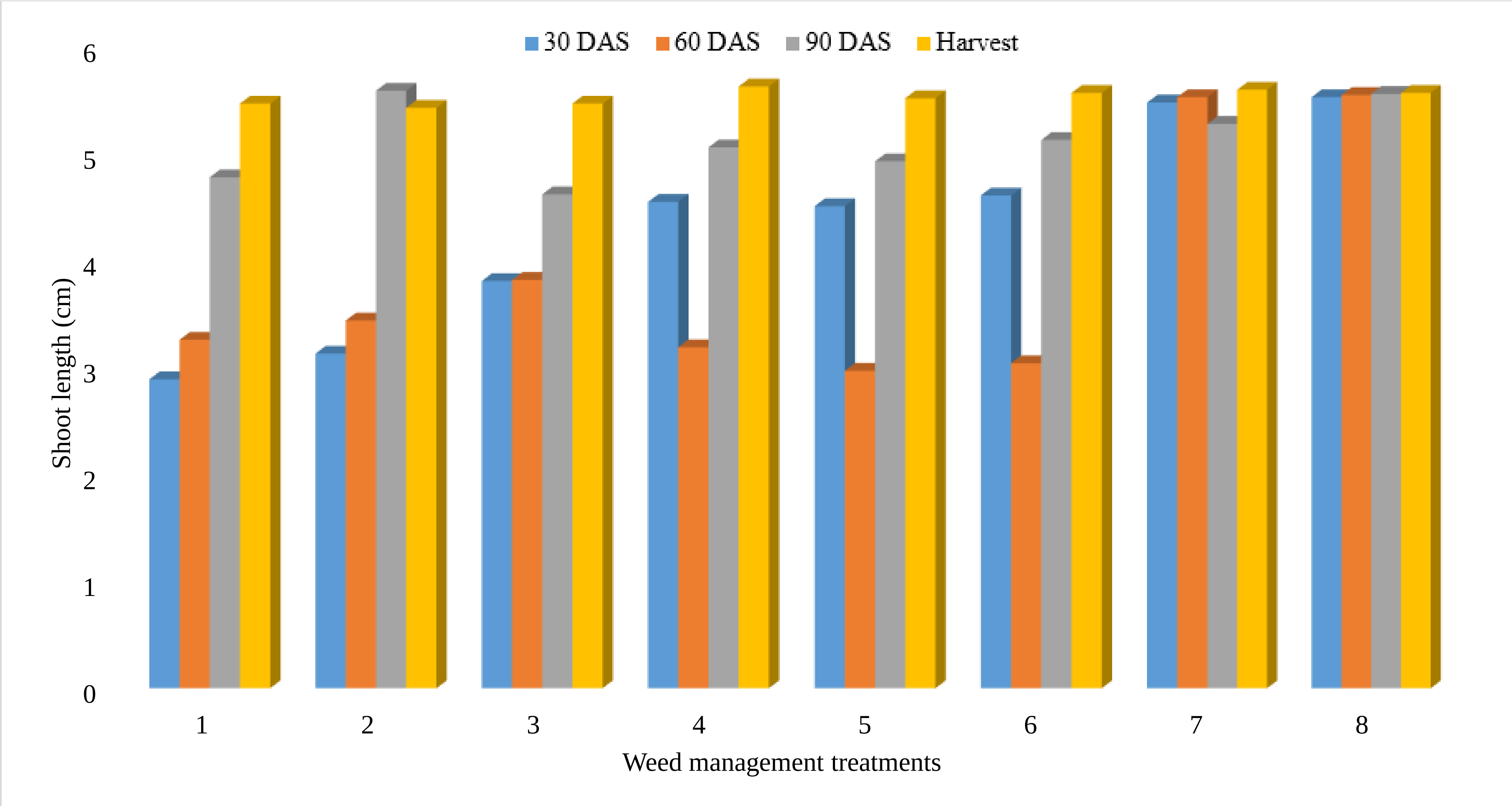


Fig 4.38 Effect of herbicide residues on shoot length (cm) of Oat at 10 DAS. (Pooled data 2021 and 2022)

4.4 Weed observations in cowpea

4.4.1 Weed Flora observed in the Field

The data concerning the field's weed flora included the following types, which recorded in order of dominance: At all crop growth phases, it was the most common weed species.

Chart 4.41 Weed flora found in experimental location (2021 and 2022).

Sr. No.	Common Name	Botanical Name	Family
A	**Monocot**		
1.	Tropical spiderwort	*Commelina benghalensis* L.	Commelinaceae
2.	Bermuda grass	*Cynodon dactylon* L Pers.	Poaceae
B	**Sedges**		
3.	Purple nutsedage	*Cyperus rotundus* L.	Cyperaceae
C	**Dicot**		
4.	Erect spiderling	*Boerhavia erecta* L.	Fabaceae
5.	Congress grass	*Parthenium hysterophorus* L	Asteraceae

Chart 4.42 Weed flora observed in experimental area. (2021 and 2022)

Sr. No.	Weed species	20 DAS	40 DAS	60 DAS
1.	*Commelina benghalensis* L.	✓	✓	✓
2.	*Cynodon dactylon* L.	✓	✓	✓
3.	*Cyperus rotundus* L.	✓	✓	✓
4.	*Boerhavia erecta* L.	✓	✓	✓
5.	*Parthenium hysterophorus* L.	✓	✓	✓

✓ Represent presence of weeds

The major, weed types detected in the investigational field remained *Commelina bengalensis*, *Cynodon dactylon* among Monocot and *Cyperus rotundus* and *Boerhavia erecta* L. *Parthenium hysterophorus* L among dicots between all the 3 weed sets, all the weed types detected was most predominant in the field throughout both years. Comparable weed flora was similarly discovered by Taramani Yadav (2017), Tripathi and Singh, (2001 and Sunday and Udensi, (2013).

Weed count

Chart 4.43 Influnce of herbicides on count of *Commelina benghalensis* L. in cowpea. (2021-2022)

Treatments	20 DAS (2021)	20 DAS (2022)	Pooled data	40 DAS (2021)	40 DAS (2022)	Pooled data	60 DAS (2021)	60 DAS (2022)	Pooled data	Harvest (2021)	Harvest (2022)	Pooled data
T_1	1.14*	1.15	1.14	1.30	1.31	1.31	1.37	1.40	1.41	1.34	1.35	1.34
	(1.30)**	**(1.34)**	**(1.32)**	**(1.70)**	**(1.74)**	**(1.72)**	**(1.91)**	**(1.97)**	**(1.94)**	**(1.82)**	**(1.84)**	**(1.82)**
T_2	1.0	1.01	1.00	1.05	1.05	1.05	1.0	1.00	1.00	0.97	1.02	0.99
	(1.00)	**(1.04)**	**(1.02)**	**(1.10)**	**(1.12)**	**(1.11)**	**(1.00)**	**(1.02)**	**(1.01)**	**(0.94)**	**(1.04)**	**(0.99)**
T_3	2.07	2.24	2.24	1.73	1.75	1.74	1.79	1.80	1.79	1.76	1.78	1.77
	(5.00)	**(5.03)**	**(5.02)**	**(3.00)**	**(3.09)**	**(3.04)**	**(3.25)**	**(3.26)**	**(3.23)**	**(3.10)**	**(3.17)**	**(3.15)**
T_4	2.02	2.02	20.2	1.70	1.72	1.71	1.73	1.75	1.74	1.72	1.73	1.73
	(4.10)	**(4.12)**	**(4.11)**	**(2.90)**	**(2.97)**	**(2.94)**	**(3.05)**	**(3.07)**	**(3.04)**	**(2.96)**	**(3.00)**	**(2.98)**
T_5	2.0	2.01	2.00	1.57	1.60	1.59	1.41	1.45	1.43	1.39	1.42	1.41
	(4.00)	**(4.05)**	**(4.03)**	**(2.50)**	**(2.58)**	**(2.54)**	**(2.00)**	**(2.12)**	**(2.06)**	**(1.99)**	**(2.02)**	**(2.00)**
T_6	2.21	2.21	2.21	1.30	1.32	1.31	1.09	1.13	1.11	1.08	1.10	1.09
	(4.90)	**(4.91)**	**(4.90)**	**(1.71)**	**(1.76)**	**(1.73)**	**(1.21)**	**(1.29)**	**(1.24)**	**(1.19)**	**(1.21)**	**(1.20)**
T_7	2.17	2.17	2.17	1.09	1.11	1.10	1.14	1.15	1.14	1.12	1.14	1.13
	(4.70)	**(4.73)**	**(4.72)**	**(1.23)**	**(1.24)**	**(1.22)**	**(1.38)**	**(1.34)**	**(1.32)**	**(1.26)**	**(1.30)**	**(1.28)**
T_8	2.31	2.36	2.13	2.69	2.81	2.77	2.87	2.88	2.87	2.85	2.86	2.85
	(5.50)	**(5.59)**	**(4.57)**	**(7.57)**	**(7.95)**	**(7.72)**	**(8.21)**	**(8.27)**	**(8.24)**	**(8.12)**	**(8.18)**	**(8.15)**
SEm (±)	**0.11**	**0.08**	**0.095**	**0.15**	**0.10**	**0.13**	**0.18**	**0.13**	**0.16**	**0.21**	**0.16**	**0.19**
CD (p=0.05)	**0.34**	**0.25**	**0.29**	**0.44**	**0.30**	**0.37**	**0.55**	**0.39**	**0.47**	**0.64**	**0.48**	**0.56**

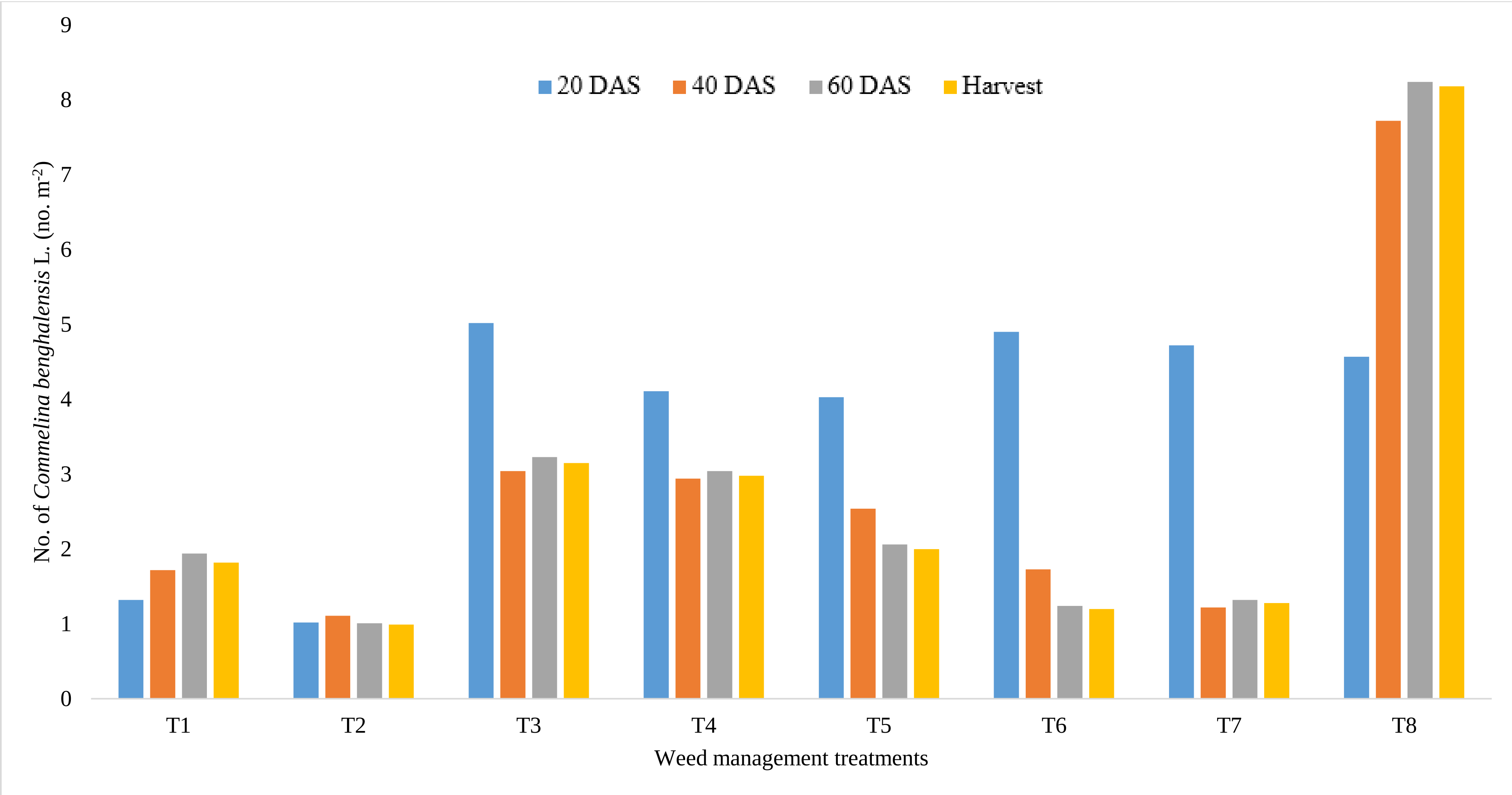
4.4.2 Species wise and total weed count

4.1.2.1 *Commelina benghalensis* L.

The data concerning the population of *Commelina benghalensis* L. in 2021 and 2022 as effect ofvarious weed control actions at all observational phases, as shown in chart 4.43, showed that weed control treatments affected the count of *Commelina benghalensis* L. at all observational stages.

Data from 2021 and 2022 on *Commelina benghalensis* L. showed that all weed management methods greatly reduced the population of this weed over the Un-weeded check. At 20 DAS PE treatment noted a minimum count of *Commelina benghalensis* L. as asociated to PoE treatment Pendimethalin 1.0 kg besides Pendimethalin 1.0 kg PE combination by HW at 20 DAS. Data on 40 DAS highest count of *Commelina benghalensis* L. in the use of Imazethapyr 20 DAS then Quizalofop-ethyl 20 DAS. Minimum count in Pendimethalin is PE in combination by HW at 20 DAS then HW at 20 & 40 DAS comparable observations were also reported by A Rajeshkumar (2017). Data on 60 DAS besides harvest same action was noted minimum in Pendimethalin 1.0 PE combination by HW at 20 DAS and HW at 20 & 40 DAS and greater in the count of *Commelina benghalensis* L. Imazethapyr 50 gPoE 20 DAS besides Quizalofop-ethyl 20 DAS as compare to the Un-weeded check.

The cumulative data shown in chart 4.43 then showed in graph 4.39 resulted at 20 DAS PE use of Pendimethalin 1.0 kg combination by HW at 20 DAS arrest the growth of *Commelina benghalensis* L. as compare to other treatment. Data on 40 DAS the minimum count was noted in Pre-emergent use of Pendimethalin PE combination by HW at 20 DAS and HW at 20 & 40 DAS and heighest in Imazethapyr 50 g PoE 20 DAS then Quizalofop-ethyl 20 DAS as compare to the un-weeded.



Graph 4.39 Influnce of herbicides on count of *Commelina benghalensis* L. in cowpea. (2021-2022)

Chart 4.44 Influnce of herbicides on count of *Cynodon dactylon* L. in cowpea. (2021 and 2022)

Treatments	20 DAS (2021)	20 DAS (2022)	Pooled data	40 DAS (2021)	40 DAS (2022)	Pooled data	60 DAS (2021)	60 DAS (2022)	Pooled data	Harvest (2021)	Harvest (2022)	Pooled data
T_1	1.41* **(2.00)****	1.42 **(2.03)**	1.46 **(2.15)**	1.52 **(2.31)**	1.54 **(2.39)**	1.52 **(2.34)**	1.58 **(2.53)**	1.60 **(2.59)**	1.59 **(2.54)**	1.58 **(2.51)**	1.60 **(2.57)**	1.59 **(2.53)**
T_2	1.26 **(1.62)**	1.30 **(1.69)**	1.28 **(1.64)**	1.0 **(1.05)**	1.01 **(1.03)**	1.07 **(1.15)**	1.0 **(1.00)**	1.1 **(1.04)**	1.0 **(1.02)**	0.99 **(0.99)**	1.00 **(1.00)**	1.00 **(1.00)**
T_3	1.73 **(3.07)**	1.74 **(3.05)**	1.73 **(3.02)**	1.69 **(2.85)**	1.69 **(2.88)**	1.69 **(2.86)**	1.70 **(2.91)**	1.71 **(2.95)**	1.71 **(2.93)**	1.70 **(2.93)**	1.71 **(2.94)**	1.70 **(2.92)**
T_4	1.69 **(2.91)**	1.70 **(2.91)**	1.70 **(2.90)**	1.61 **(2.67)**	1.63 **(2.67)**	1.62 **(2.64)**	1.58 **(2.54)**	1.59 **(2.55)**	1.58 **(2.52)**	1.57 **(2.48)**	1.58 **(2.52)**	1.58 **(2.50)**
T_5	1.52 **(2.32)**	1.52 **(2.34)**	1.52 **(2.32)**	1.38 **(1.91)**	1.39 **(1.94)**	1.38 **(1.92)**	1.04 **(1.13)**	1.06 **(1.13)**	1.05 **(1.12)**	1.00 **(1.00)**	1.02 **(1.05)**	1.00 **(1.02)**
T_6	1.64 **(2.79)**	**1.65** **(2.73)**	1.64 **(2.71)**	1.22 **(1.50)**	1.25 **(1.58)**	1.24 **(1.54)**	1.0 **(1.07)**	1.01 **(1.03)**	1.00 **(1.01)**	0.98 **(0.98)**	0.99 **(0.99)**	0.99 **(0.99)**
T_7	1.55 **(2.41)**	1.56 **(2.44)**	1.55 **(2.42)**	1.15 **(1.32)**	1.17 **(1.37)**	1.15 **(1.34)**	1.05 **(1.11)**	1.07 **(1.16)**	1.06 **(1.13)**	1.05 **(1.10)**	1.03 **(1.07)**	1.03 **(1.07)**
T_8	1.79 **(3.32)**	1.83 **(3.37)**	1.82 **(3.33)**	2.16 **(4.67)**	2.19 **(4.79)**	2.17 **(4.73)**	2.23 **(4.97)**	2.24 **(5.03)**	2.24 **(5.00)**	2.21 **(4.89)**	2.22 **(4.95)**	2.22 **(4.92)**
SEm (±)	**0.10**	**0.09**	**0.09**	**0.12**	**0.10**	**0.11**	**0.18**	**0.14**	**0.16**	**0.21**	**0.15**	**0.19**
CD (p=0.05)	**0.31**	**0.26**	**0.29**	**0.37**	**0.31**	**0.34**	**0.53**	**0.41**	**0.47**	**0.65**	**0.45**	**0.61**

4.1.2.2 *Cynodon dactylon* L.

The data concerning the population of *Cynodon dactylon* L., as effect ofseveral weed control actions at all stages of observations. This revealed that weed control actions had a substantial impact on the count of *Cynodon dactylon* L. at all phases of observation.

The total population of *Cynodon dactylon* L. was controlled by all weed management methods over the unweeded, according to data from 2021 and 2022 on the species. Data on 20 DAS PE treatment noted a minimum count of *Cynodon dactylon* L. as associated by Pendimethalin 1.0 kg usage and Pendimethalin 1.0 kg combination by HW at 20 DAS. Data on 40 DAS showed the highest count of *Cynodon dactylon* L. in the use of Imazethapyr 50 g for 20 DAS and Quizalofop-ethyl 50 g for 20 DAS. Then the minimum count of pendimethalin is 1.0 kg in combination by HW at 20 DAS and HW at 20 and 40 DAS. Data on 60 days between sowing and harvest for the same treatment was noted as the minimum in the Pendimethalin 1.0 kg combination by HW at 20 DAS and HW at 20 and 40 DAS. Imazethapyr 50 g 20 DAS and Quizalofop-ethyl 50 g 20 DAS as compared to the unweeded

The information displayed in chart 4.44 and represented in graph 4.40 showed that a PE use of Pendimethalin 1.0 kg at 20 DAS, subsequent to a Pendimethalin 1.0 kg mixture by manually weeding at 20 days during seeding, substantially retarded the growth rate of *Cynodon dactylon* L. when compared to other treatments. Data on 20 DAS shows that all the herbicidal actions ensued from the minimum count of *Cynodon dactylon* L. over the unweeded. On 40 DAS, the minimum count was noted in the pre-emergent use of pendimethalin 1.0 kg arrangement by HW at 20 DAS and HW at 20 and 40 DAS, and the heaviest in Imazethapyr 50 g 20 DAS next to Quizalofop-ethyl 50 g 20 DAS as compared to the un-weeded.

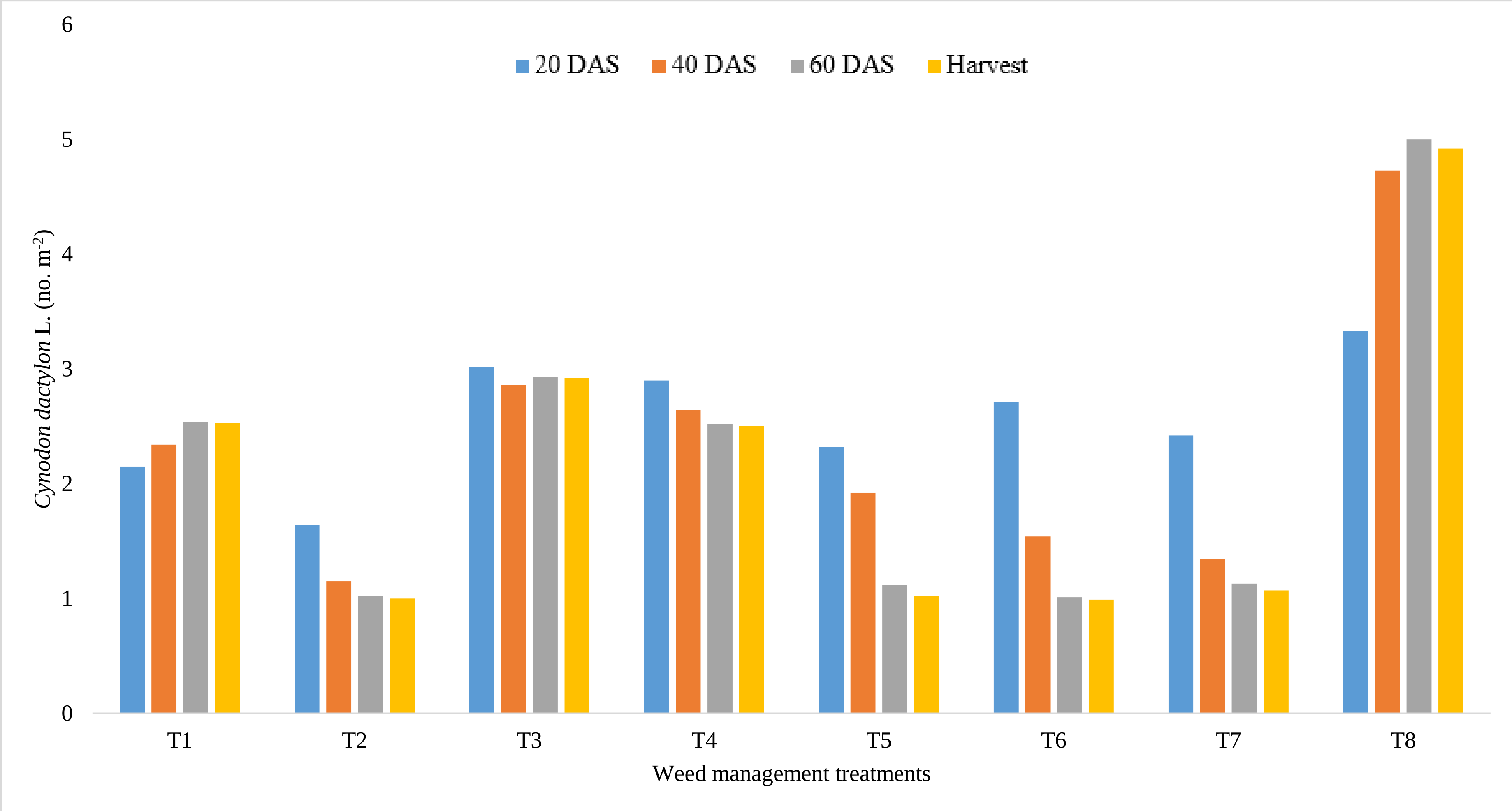


Fig 4.40 Influnce of herbicides on count of *Cynodon dactylon* L. in cowpea. (2021 and 2022)

Chart 4.45 Influnce of herbicides on count of *Cyperus rotundus* L. in cowpea. (2021 and 2022)

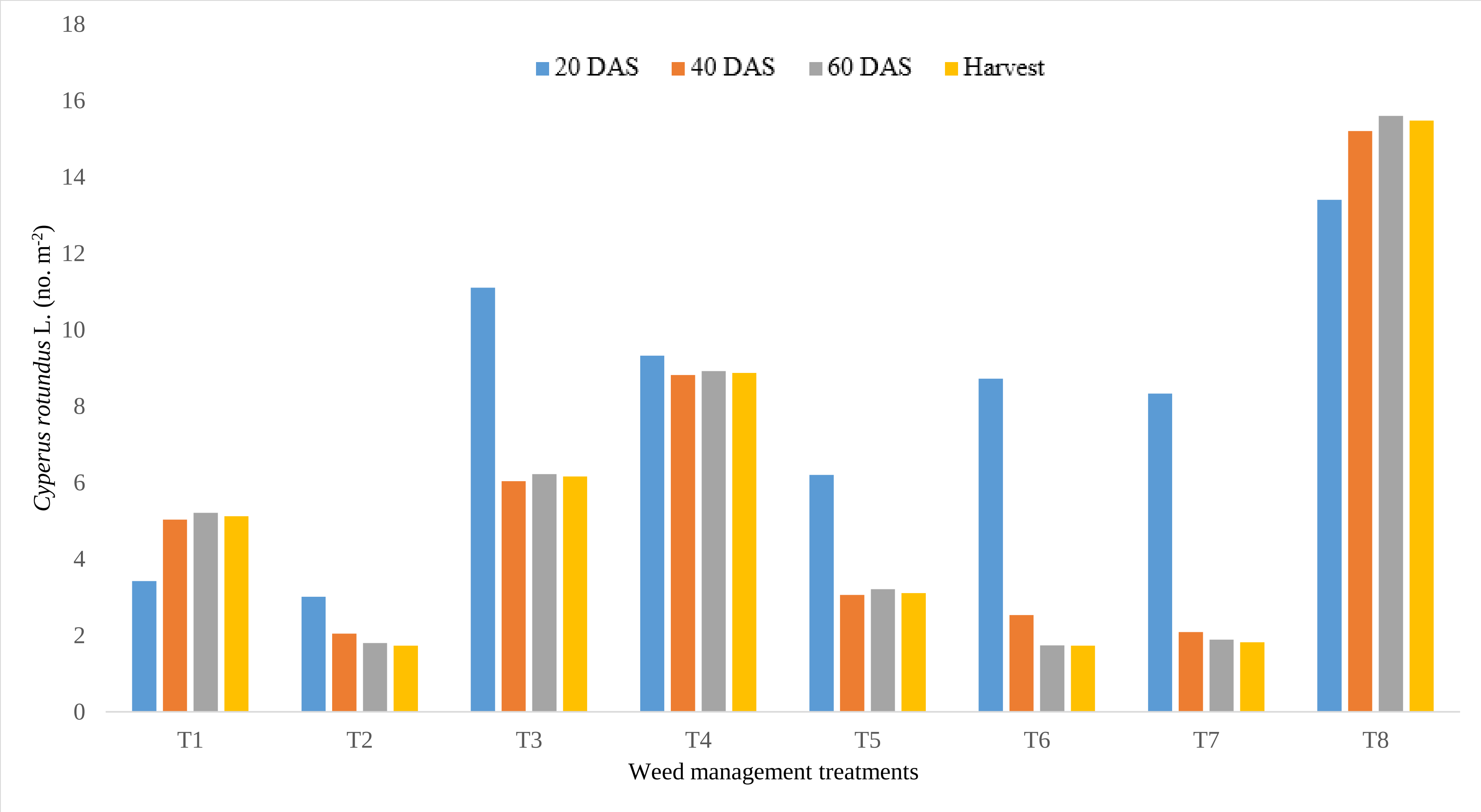
Treatments	20 DAS (2021)	20 DAS (2022)	Pooled data	40 DAS (2021)	40 DAS (2022)	Pooled data	60 DAS (2021)	60 DAS (2022)	Pooled data	Harvest (2021)	Harvest (2022)	Pooled data
T_1	1.84* (3.43)**	1.85 (3.44)	1.84 (3.42)	2.24 (5.01)	2.25 (5.07)	2.24 (5.03)	2.28 (5.2)	2.28 (5.23)	2.28 (5.21)	2.26 (5.12)	2.26 (5.14)	2.26 (5.12)
T_2	1.73 (3.01)	1.74 (3.03)	1.73 (3.01)	1.41 (2.03)	1.45 (2.11)	1.43 (2.05)	1.33 (1.8)	1.34 (1.81)	1.34 (1.80)	1.30 (1.74)	1.32 (1.76)	1.33 (1.73)
T_3	3.32 (11.03)	3.31 (11.02)	3.33 (11.1)	2.45 (6.09)	1.46 (6.09)	2.45 (6.04)	2.49 (6.2)	1.49 (6.24)	2.49 (6.22)	2.47 (6.11)	2.49 (6.21)	2.48 (6.16)
T_4	3.00 (9.07)	3.00 (9.06)	3.04 (9.32)	2.97 (8.88)	2.97 (8.84)	2.96 (8.82)	2.98 (8.9)	2.98 (8.94)	2.98 (8.92)	2.97 (8.82)	2.99 (8.92)	2.98 (8.87)
T_5	2.45 (6.06)	2.45 (6.04)	2.48 (6.20)	1.73 (3.06)	1.76 (3.13)	1.4 (3.06)	1.78 (3.2)	1.79 (3.22)	1.79 (3.21)	1.76 (3.18)	1.76 (3.12)	1.76 (3.11)
T_6	2.95 (8.72)	2.95 (8.74)	2.95 (8.72)	1.58 (2.57)	1.60 (2.57)	1.59 (2.53)	1.30 (1.7)	1.33 (1.78)	1.31 (1.74)	1.30 (1.70)	1.33 (1.77)	1.31 (1.73)
T_7	2.49 (6.28)	2.49 (6.23)	2.49 (6.21)	1.41 (2.03)	1.47 (2.19)	1.44 (2.09)	1.35 (1.88)	1.38 (1.91)	1.37 (1.89)	1.34 (1.80)	1.36 (1.85)	1.34 (1.82)
T_8	3.63 (13.26)	3.68 (13.60)	3.66 (13.40)	3.89 (15.13)	3.91 (15.27)	3.90 (15.20)	3.94 (15.51)	3.96 (15.69)	3.95 (15.60)	3.93 (15.41)	3.94 (15.55)	3.93 (15.48)
SE(m±)	**0.06**	**0.07**	**0.07**	**0.11**	**0.12**	**0.11**	**0.16**	**0.15**	**0.15**	**0.19**	**0.18**	**0.19**
CD (p=0.05)	**0.18**	**0.21**	**0.19**	**0.33**	**0.35**	**0.34**	**0.47**	**0.45**	**0.46**	**0.57**	**0.54**	**0.58**

4.1.2.3 *Cyperus rotundus* L.

The data concerning the population of *Cyperus rotundus* L. as effect ofseveral weed control actions at all phases of observations in the years 2021 and 2022, as existed in chart 4.45 and illustrated in graphic 4.41, showed that overall weed control actions had a substantial impact on the count of *Cyperus rotundus* L. at all phases of observation.

Data on the number of species of *Cyperus rotundus* L. for 2021 and 2022 Designated that the population of *Cyperus rotundus* L. is severely reduced by all weed management methods across the weedy check. Data taken on 20 DAS showed that PE treatment reduced the minimum count of *Cyperus rotundus* L. as compared to PoE treatment by Pendimethalin 1.0 kg PE in combination by HW at 20 DAS. At 40 DAS, the highest count of *Cyperus rotundus L. was observed* in the use of Quizalofop-ethyl 50 g 20 DAS and Imazethapyr 50 g 20 DAS. The minimum count in Pendimethalin is 1.0 kg in combination by physical weeding at 20 DAS and HW at 20 and 40 DAS. On 60 DAS, then at harvest, the same treatment is noted as minimum in the Pendimethalin 1.0 kg arrangement by HW at 20 DAS and HW at 20 and 40 DAS and higher in the count of *Cyperus rotundus* L. Quizalofop-ethyl 50 g 20 DAS, then Imazethapyr 50 g 20 DAS, as compared to un-weeded.

The cumulative data shown in chart 4.45 and shown in fig. 4.41 showed that at 20 DAS, PE use of Pendimethalin 1 kg PE and Pendimethalin 1 kg PE combination by HW at 20 DAS arrested the growth of *Cyperus rotundus* L. as compared to other treatments. At 20 DAS, all the herbicidal treatments resulted in a minimum count of *Cyperus rotundus* L. over the un-weeded check. On 40 DAS, the minimum count was noted in PE Pendimethalin 1.0 kg combination by HW at 20 DAS and HW at 20 and 40 DAS, and the heaviest in Quizalofop-ethyl 50 g 20 DAS and Imazethapyr 50 g 20 DAS as compared to check. At 60 DAS, then at harvest, the same management noted a higher count of *Cyperus rotundus* L. as equated to un-weeded.



Graph 4.41 Influnce of herbicides on count of *Cyperus rotundus* L. in cowpea. (2021 and 2022)

Chart 4.46 Influnce of herbicides on count of *Boerhavia erecta* L. in cowpea. (2021 and 2022)

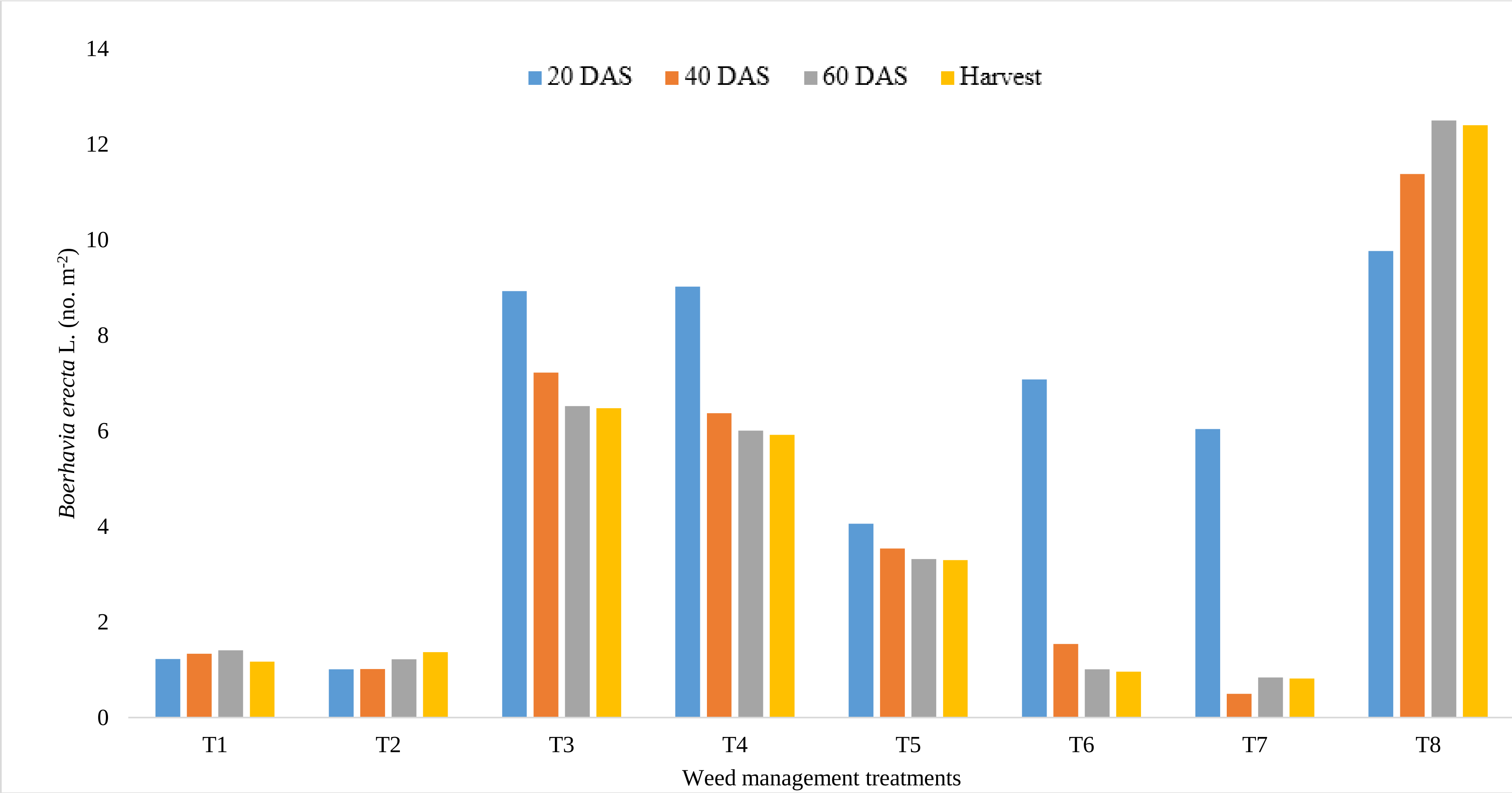
Treatments	20 DAS (2021)	20 DAS (2022)	Pooled data	40 DAS (2021)	40 DAS (2022)	Pooled data	60 DAS (2021)	60 DAS (2022)	Pooled data	Harvest (2021)	Harvest (2022)	Pooled data
T_1	1.09* **(1.2)****	1.12 **(1.26)**	1.10 **(1.23)**	1.3 **(1.3)**	1.17 **(1.39)**	1.15 **(1.34)**	1.18 **(1.40)**	1.91 **(1.42)**	1.81 **(1.41)**	1.16 **(1.34)**	1.18 **(1.40)**	1.17 **(1.37)**
T_2	1.0 **(1.00)**	1.01 **(1.03)**	1.00 **(1.01)**	1.0 **(1.00)**	1.01 **(1.04)**	1.00 **(1.02)**	1.09 **(1.23)**	1.11 **(1.24)**	1.10 **(1.22)**	1.06 **(1.13)**	1.10 **(1.21)**	1.08 **(1.17)**
T_3	2.98 **(8.9)**	2.99 **(8.96)**	2.98 **(8.93)**	2.68 **(7.2)**	2.69 **(7.24)**	2.68 **(7.22)**	2.55 **(6.52)**	2.55 **(6.54)**	2.55 **(6.52)**	2.54 **(6.44)**	2.55 **(6.52)**	2.55 **(6.48)**
T_4	3.04 **(9.0)**	3.00 **(9.05)**	3.00 **(9.02)**	2.58 **(6.7)**	2.59 **(6.74)**	1.52 **(6.37)**	2.45 **(6.08)**	2.45 **(6.03)**	2.45 **(6.01)**	2.43 **(5.89)**	2.44 **(5.95)**	2.43 **(5.92)**
T_5	2.0 **(4.00)**	2.02 **(4.12)**	2.01 **(4.06)**	1.87 **(3.5)**	1.89 **(3.59)**	1.88 **(3.54)**	1.81 **(3.36)**	1.83 **(3.35)**	1.82 **(3.32)**	1.81 **(3.28)**	1.81 **(3.32)**	1.82 **(3.30)**
T_6	2.66 **(7.0)**	2.67 **(7.16)**	2.66 **(7.08)**	1.22 **(1.5)**	1.25 **(1.58)**	1.24 **(1.54)**	1.0 **(1.00)**	1.01 **(1.03)**	1.00 **(1.01)**	0.95 **(0.90)**	1.01 **(1.02)**	0.98 **(0.96)**
T_7	2.45 **(6.0)**	2.46 **(6.09)**	2.45 **(6.04)**	0.69 **(0.50)**	0.71 **(0.51)**	0.70 **(0.50)**	0.89 **(0.80)**	0.94 **(0.89)**	0.91 **(0.84)**	0.89 **(0.79)**	0.92 **(0.85)**	0.91 **(0.82)**
T_8	3.11 **(9.7)**	3.13 **(9.85)**	3.12 **(9.77)**	3.30 **(11.0)**	3.32 **(11.07)**	3.37 **(11.38)**	3.53 **(12.44)**	3.54 **(12.56)**	3.54 **(12.50)**	3.51 **(12.30)**	3.54 **(12.50)**	3.52 **(12.40)**
SEm (±)	**0.09**	**0.10**	**0.10**	**0.12**	**0.11**	**0.12**	**0.15**	**0.15**	**0.15**	**0.19**	**0.14**	**0.18**
CD (p=0.05)	**0.27**	**0.30**	**0.28**	**0.38**	**0.33**	**0.35**	**0.45**	**0.46**	**0.45**	**0.58**	**0.42**	**0.51**

4.1.2.4 ***Boerhavia erecta* L.**

The data concerning the population of *Boerhavia erecta* L. as effect ofseveral weed control treatments at all phases of observations in the years 2021 and 2022, as showed in chart 4.46 and illustrated in graph. 4.42, showed that weed control actions had important impact on the count of *Boerhavia erecta* L. at all phases of observation.

Data 2021 and 2022 on the inhabitants of *Boerhavia erecta* L. designated that all weed control actions suggestively switch the population of *Boerhavia erecta* L. over the Un-weeded. Data on 20 DAS PE action noted a minimum count of *Boerhavia erecta* L. As asociated to PoE treatment by Pendimethalin 1.0 kg combination by HW at 20 DAS. Data on 40 DAS highest count of *Boerhavia erecta* L. in the use of Quizalofop-ethyl 50 g 20 DAS subsiquently Imazethapyr 50 g 20 DAS. The minimum count in HW at 20 plus 40 DAS subsiquently Pendimethalin 1.0 kg combination by HW at 20 DAS. Data on 60 DAS subsiquently harvest same treatment was noted minimum in HW at 20 plus 40 DAS subsiquently Quizalofop-ethyl 40 g 20 DAS Parallel comments were also reported by Taramani Yadav (2015). The higher count of *Boerhavia erecta* L. Imazethapyr 50 g 20 DAS next to Quizalofop-ethyl 50 g 20 DAS as associated to the Un-weeded.

The cumulative data shown in chart 4.46 subsiquently showed in graph 4.42 resulted at 20 DAS pre-emergent use of Pendimethalin 1 kg subsiquently Pendimethalin 1 kg mixture by HW at 20 DAS arrest the growth of *Boerhavia erecta* L. as compare to other treatment. Data on 20 DAS all the herbicidal actions resulted in a smallest count of *Boerhavia erecta* L. over the check. Data on 60 DAS subsiquently harvest same treatment was noted heighest in the count of *Boerhavia erecta* L. as associated to the check.



Graph 4.42 Influnce of herbicides on count of *Boerhavia erecta* L. in cowpea. (2021 and 2022)

Chart 4.47 Influnce of herbicides on count of *Parthenium hysterophorus* L. in cowpea at 20 days intervals. (2021 and 2022)

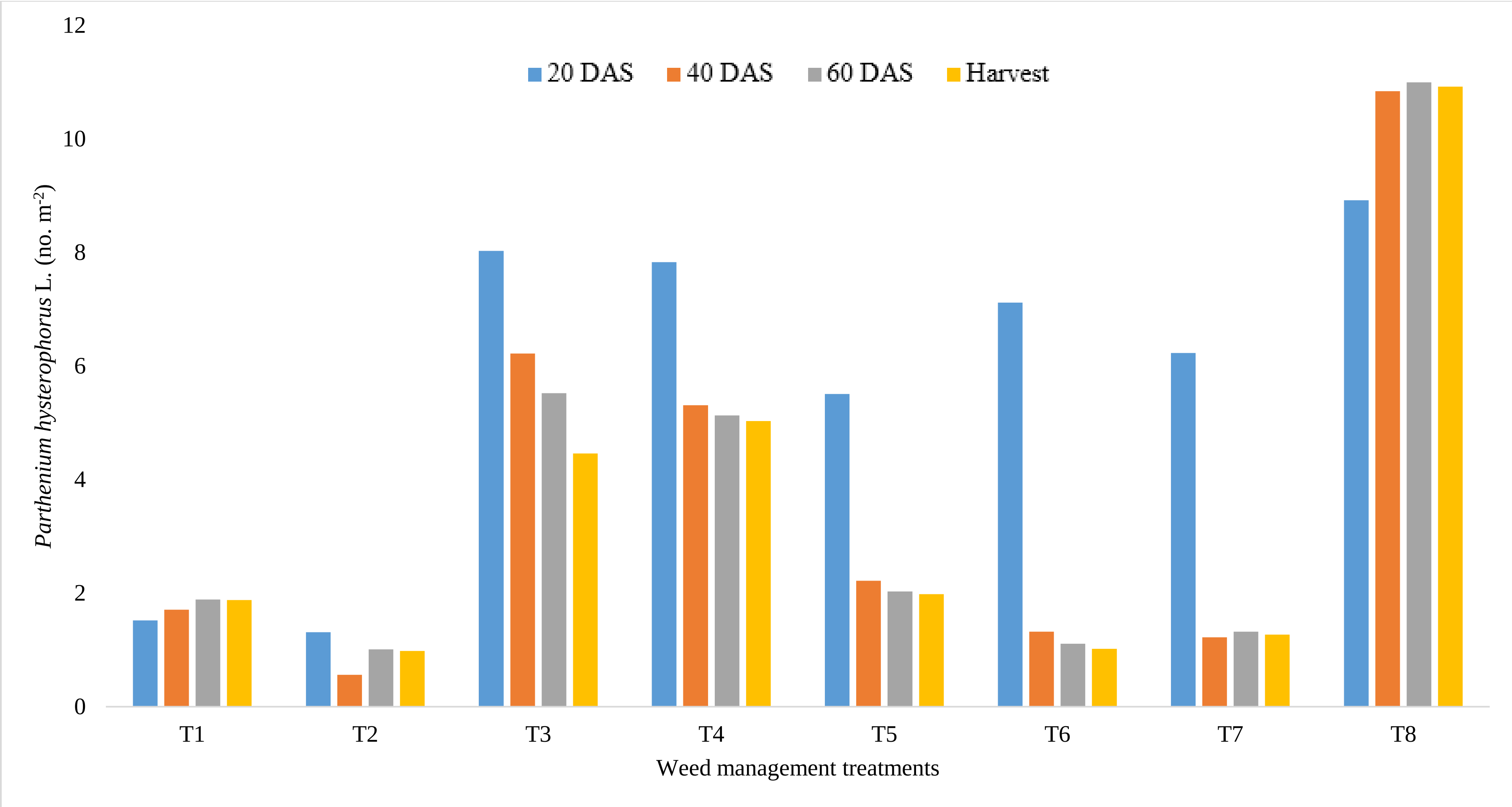
Treatments	20 DAS (2021)	20 DAS (2022)	Pooled data	40 DAS (2021)	40 DAS (2022)	Pooled data	60 DAS (2021)	60 DAS (2022)	Pooled data	Harvest (2021)	Harvest (2022)	Pooled data
T_1	1.22* **(1.5)****	1.24 **(1.54)**	1.23 **(1.52)**	1.30 **(1.7)**	1.31 **(1.73)**	1.30 **(1.71)**	1.37 **(1.88)**	1.38 **(1.91)**	1.37 **(1.89)**	1.37 **(1.87)**	1.37 **(1.89)**	1.7 **(1.88)**
T_2	1.14 **(1.3)**	1.14 **(1.32)**	1.14 **(1.31)**	0.74 **(0.55)**	0.76 **(0.58)**	0.74 **(0.56)**	1.0 **(1.00)**	1.01 **(1.03)**	1.00 **(1.01)**	0.97 **(0.95)**	1.00 **(1.01)**	0.99 **(0.98)**
T_3	2.83 **(8.0)**	2.83 **(8.06)**	2.83 **(8.03)**	2.49 **(6.2)**	2.49 **(6.24)**	2.49 **(6.22)**	2.34 **(5.5)**	2.35 **(5.54)**	2.34 **(5.52)**	2.32 **(5.40)**	2.35 **(5.52)**	2.34 **(5.46)**
T_4	2.79 **(7.8)**	2.80 **(7.87)**	2.79 **(7.83)**	2.30 **(5.3)**	2.30 **(5.33)**	2.30 **(5.31)**	2.26 **(5.1)**	2.27 **(5.16)**	2.26 **(5.13)**	2.24 **(5.00)**	2.25 **(5.07)**	2.24 **(5.03)**
T_5	2.34 **(5.5)**	2.34 **(5.52)**	2.34 **(5.51)**	1.48 **(2.2)**	1.50 **(2.25)**	1.48 **(2.22)**	1.41 **(2.0)**	1.43 **(2.06)**	1.42 **(2.03)**	1.39 **(1.97)**	1.41 **(2.00)**	1.40 **(1.98)**
T_6	2.66 **(7.1)**	2.67 **(7.14)**	2.66 **(7.12)**	1.13 **(1.3)**	1.15 **(1.34)**	1.14 **(1.32)**	1.05 **(1.1)**	1.06 **(1.13)**	1.05 **(1.11)**	0.99 **(1.00)**	1.01 **(1.04)**	1.00 **(1.02)**
T_7	2.49 **(6.2)**	2.50 **(6.26)**	2.49 **(6.23)**	1.09 **(1.2)**	1.10 **(1.23)**	1.10 **(1.22)**	1.14 **(1.3)**	1.15 **(1.34)**	1.14 **(1.32)**	1.11 **(1.24)**	1.14 **(1.30)**	1.13 **(1.27)**
T_8	2.98 **(8.9)**	2.98 **(8.94)**	2.98 **(8.92)**	3.26 **(10.8)**	3.30 **(10.89)**	3.29 **(10.84)**	3.30 **(10.88)**	3.33 **(11.12)**	3.32 **(11.00)**	3.30 **(10.88)**	3.31 **(10.96)**	3.30 **(10.92)**
SE(m±)	**0.07**	**0.09**	**0.08**	**0.13**	**0.12**	**0.12**	**0.17**	**0.14**	**0.15**	**0.20**	**0.16**	**0.18**
CD (p=0.05)	**0.23**	**0.28**	**0.25**	**0.40**	**0.36**	**0.38**	**0.51**	**0.44**	**0.49**	**0.59**	**0.49**	**0.54**

4.1.2.5 ***Parthenium hysterophorus* L.**

The data concerning the population of *Parthenium hysterophorus* L. as effect ofseveral weed control actions at all phases of observations in the years 2021 and 2022, as accessible in chart 4.47 and illustrated in graph. 4.43, at all phases of investigation, weed control applications had major effects on the overall number of *Parthenium hysterophorus* L.

Data from 2021 and 2022 on the *Parthenium hysterophorus* L. population showed that all weed management methods considerably reduced the population of this plant likened to the check. Data logged by 20 DAS pre-emergent action noted a lowest amount of *Parthenium hysterophorus* L. as asociated to post-emergent action. Data logged 40 DAS highest count of *Parthenium hysterophorus* L. in the use of PoE Imazethapyr 50 g 20 DAS then Quizalofop-ethyl 50 g 20 DAS. Minimum count in Pendimethalin PE in arrangement by HW at 20 DAS then HW at 20 plus 40 DAS. Data on 60 DAS and harvest same treatment was noted minimum in Pendimethalin 1.0 kg PE combination by HW on 20 DAS then HW on 20 then 40 DAS compare to the Un-weeded check. Related observations were also stated by A Rajeshkumar (2017) and Priyanka (2018).

The overall results displayed in chart 4.47 and implied in graph 4.43 showed that at 20 DAS, prior to emergence use of Pendimethalin 1 kg while Pendimethalin 1 kg PE in conjunction by HW gently arrest the growth of Boerhavia erecta L. as opposed to other treatments. Around 40 DAS, a lower quantity was observed during the PE usage of Pendimethalin PE combination by HW in 20 DAS and physical weeding in 20 as well as 40 DAS, and the greatest count was observed in Imazethapyr 50 g 20 DAS and Quizalofop-ethyl 50 g 20 DAS as compared to the control. Data on 60 DAS and harvest same treatment was noted heighest in the count of *Parthenium hysterophorus* L. The count in minimum Pendimethalin combination by Quizalofop-ethyl 20 DAS as associate to check.



Graph 4.43 Influnce of herbicides on count of *Parthenium hysterophorus* L. in cowpea at 20 days intervals. (2021 and 2022)

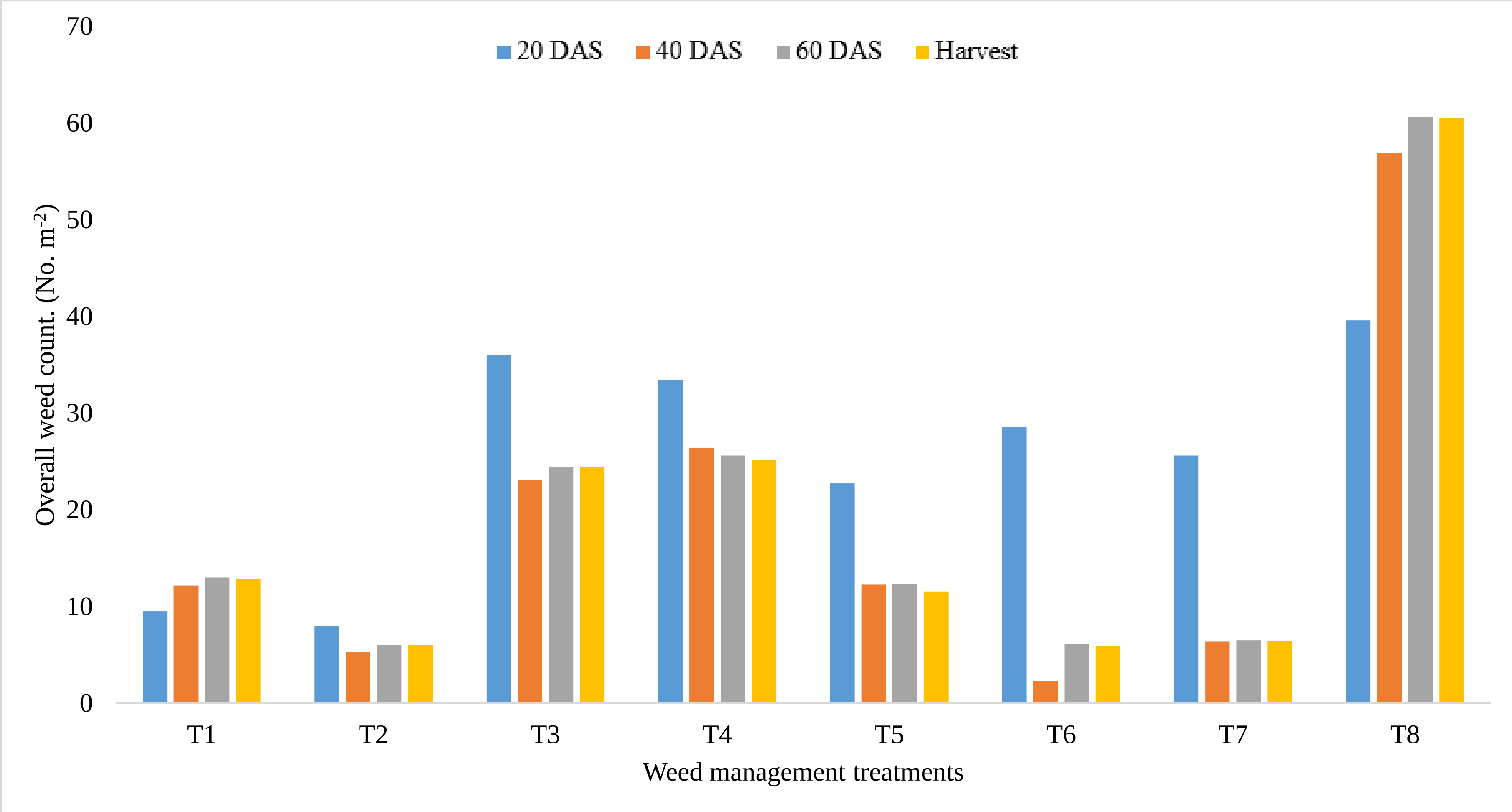
Chart 4.48 Influnce of herbicides **on count of total weed population in cowpea at 20 days intervals. (2021 and 2022)**

Treatments	20 DAS (2021)	20 DAS (2022)	Pooled data	40 DAS (2021)	40 DAS (2022)	Pooled data	60 DAS (2021)	60 DAS (2022)	Pooled data	Harvest (2021)	Harvest (2022)	Pooled data
T_1	3.06* **(9.4)****	3.10 **(9.61)**	3.08 **(9.50)**	3.46 **(12.00)**	3.50 **(12.32)**	3.48 **(12.16)**	3.59 **(12.88)**	3.62 **(13.12)**	3.60 **(13.00)**	3.58 **(12.8)**	3.69 **(12.94)**	3.58 **(12.87)**
T_2	2.81 **(7.9)**	2.84 **(8.11)**	2.82 **(8.00)**	2.15 **(4.65)**	3.42 **(5.88)**	2.29 **(5.26)**	2.45 **(6.0)**	2.46 **(6.08)**	2.45 **(6.04)**	2.45 **(6.00)**	2.46 **(6.09)**	2.45 **(6.03)**
T_3	5.99 **(35.9)**	6.00 **(36.12)**	6.00 **(36.01)**	5.02 **(25.25)**	5.05 **(25.57)**	5.04 **(25.41)**	4.93 **(24.31)**	4.95 **(24.53)**	4.94 **(24.42)**	4.93 **(24.30)**	4.95 **(24.48)**	4.94 **(24.39)**
T_4	5.81 **(33.8)**	5.74 **(33.01)**	5.77 **(33.40)**	5.13 **(26.3)**	5.15 **(26.55)**	5.14 **(26.42)**	5.04 **(25.5)**	5.07 **(25.75)**	5.06 **(25.62)**	5.02 **(25.16)**	5.02 **(25.24)**	5.02 **(25.20)**
T_5	4.67 **(21.8)**	4.68 **(23.69)**	4.76 **(22.74)**	3.33 **(11.1)**	3.67 **(13.49)**	3.50 **(12.30)**	3.40 **(11.6)**	3.44 **(11.88)**	3.42 **(11.74)**	3.40 **(11.6)**	3.39 **(11.51)**	3.39 **(11.55)**
T_6	5.14 **(26.4)**	5.53 **(30.68)**	5.34 **(28.54)**	2.91 **(8.5)**	2.97 **(8.83)**	2.88 **(8.31)**	2.44 **(6.0)**	2.50 **(6.26)**	2.47 **(6.13)**	2.40 **(5.85)**	2.45 **(6.01)**	2.43 **(5.93)**
T_7	5.05 **(25.5)**	5.07 **(25.75)**	5.06 **(25.62)**	2.49 **(6.22)**	2.55 **(6.54)**	2.52 **(6.38)**	2.52 **(6.39)**	2.57 **(6.64)**	2.55 **(6.51)**	2.53 **(6.40)**	2.55 **(6.52)**	2.54 **(6.46)**
T_8	5.33 **(38.51)**	5.89 **(40.71)**	5.62 **(39.61)**	7.50 **(56.47)**	7.57 **(57.38)**	7.54 **(56.92)**	7.78 **(60.52)**	7.79 **(60.64)**	7.78 **(60.58)**	7.78 **(60.46)**	7.78 **(60.58)**	7.78 **(60.52)**
SEm (±)	**0.11**	**0.08**	**0.09**	**0.14**	**0.11**	**0.13**	**0.14**	**0.14**	**0.14**	**0.17**	**0.15**	**0.16**
CD (p=0.05)	**0.34**	**0.24**	**0.28**	**0.41**	**0.32**	**0.36**	**0.44**	**0.42**	**0.43**	**0.51**	**0.44**	**0.48**

4.1.2.6 Population of total weed spp.

The data concerning the population of total weed species effect ofvarious weed control methods at all observational stages in the years 2021 and 2022, as existede in chart 4.48 then illustrated in graph. 4.44, showed that weed control methods affected the count of the overall weed species at all observational methods.

The population of total weeds is considerably controlled by all weed management measures over the Un-weeded, according to data from 2021 and 2022 on the population of total weeds. In 20 DAS suggestively pre-emergent action noted a minimum count of total weed population as asociated to post-emergent action Pendimethalin PE besides Pendimethalin PE combination by HW in 20 DAS. Data on 40 DAS highest count of over all weed specimens in the use of Imazethapyr PoE 20 DAS then Quizalofop-ethyl PoE 20 DAS. However, as evidenced by the weed density at 20 DAS, delaying weed emergence, Pendimethalin PE only efficiently controls weeds at late stages of crop growth. When Pendimethalin plus HW were used composed, there was a significant decrease in weed thickness. Lesser weed density plus dry matter have been detected as a result of HW, other intercultural processes, post-emergent and pre-emergent herbicide applications, and various crop durations. As a result of effective weed control, cowpea can use resources more effectively, which is also responsible for this by those treatment the outcomes follow to the findings of Pravindra Kumar *et al.,* (2017), G. Mekonnen *et al.,* (2016) and J.K. Sinchana (*et al.,* 2020), and Gupta *et al.,* (2013).



Graph 4.44 Influnce of herbicides on count of total weed population in cowpea at 20 days intervals. (2021 and 2022)

Chart 4.49 Influnce of herbicides on weed dry weightof *Commelina benghalensis* L. in cowpea at 20 days intervals. (2021 and 2022)

Treatments	20 DAS (2021)	20 DAS (2022)	Pooled data	40 DAS (2021)	40 DAS (2022)	Pooled data	60 DAS (2021)	60 DAS (2022)	Pooled data	Harvest (2021)	Harvest (2022)	Pooled data
T_1	0.23* **(0.055)****	0.24 **(0.059)**	0.23 **(0.057)**	0.27 **(0.075)**	0.28 **(0.080)**	0.27 **(0.077)**	0.33 **(0.11)**	0.34 **(0.117)**	0.33 **(0.114)**	0.37 **(0.14)**	0.34 **(0.12)**	0.36 **(0.13)**
T_2	0.22 **(0.050)**	0.22 **(0.052)**	0.22 **(0.051)**	0.26 **(0.070)**	0.27 **(0.074)**	0.26 **(0.072)**	0.35 **(0.12)**	0.35 **(0.126)**	0.35 **(0.123)**	0.41 **(0.17)**	0.38 **(0.15)**	0.40 **(0.16)**
T_3	0.48 **(0.23)**	0.48 **(0.235)**	0.48 **(0.24)**	0.36 **(0.13)**	0.36 **(0.134)**	0.36 **(0.132)**	0.41 **(0.17)**	0.42 **(0.181)**	0.34 **(0.117)**	0.40 **(0.16)**	0.37 **(0.14)**	0.38 **(0.15)**
T_4	0.46 **(0.21)**	0.46 **(0.217)**	0.45 **(0.21)**	0.32 **(0.10)**	0.32 **(0.106)**	0.32 **(0.103)**	0.37 **(0.135)**	0.37 **(0.141)**	0.37 **(0.138)**	0.43 **(0.19)**	0.41 **(0.17)**	0.42 **(0.18)**
T_5	0.46 **(0.212)**	0.46 **(0.215)**	0.36 **(0.13)**	0.29 **(0.085)**	0.29 **(0.089)**	0.29 **(0.087)**	0.35 **(0.120)**	0.35 **(0.129)**	0.35 **(0.124)**	0.46 **(0.22)**	0.42 **(0.18)**	0.44 **(0.20)**
T_6	0.44 **(0.200)**	0.46 **(0.216)**	0.45 **(0.208)**	0.30 **(0.090)**	0.30 **(0.094)**	0.30 **(0.092)**	0.32 **(0.10)**	0.32 **(0.106)**	0.32 **(0.103)**	0.36 **(0.13)**	0.33 **(0.11)**	0.34 **(0.12)**
T_7	0.43 **(0.19)**	0.44 **(0.200)**	0.44 **(0.200)**	00.27 **(0.072)**	0.27 **(0.077)**	0.27 **(0.074)**	0.10 **(0.29)**	0.54 **(0.298)**	0.54 **(0.294)**	0.10 **(0.31)**	0.56 **(0.317)**	0.55 **(0.313)**
T_8	0.60 **(0.36)**	0.63 **(0.400)**	0.61 **(0.38)**	0.66 **(0.450)**	0.71 **(0.510)**	0.69 **(0.48)**	0.65 **(0.80)**	0.94 **(0.895)**	0.91 **(0.84)**	0.92 **(0.85)**	0.97 **(0.95)**	0.94 **(0.90)**
SE(m±)	**0.03**	**0.04**	**0.04**	**0.03**	**0.03**	**0.03**	**0.05**	**0.06**	**0.06**	**0.05**	**0.04**	**0.5**
CD (p=0.05)	**0.10**	**0.11**	**0.11**	**0.10**	**0.08**	**0.09**	**0.15**	**0.17**	**0.16**	**0.15**	**0.11**	**0.13**

4.4.3 Species wise and total dried matter producton of weeds

The data concerning dry matter of weeds at 20, 40, 60, and the time of harvest, influenced by weeed management prctices.

4.4.3.1 *Commelina benghalensis* L.

The data concerning the dry matter of weeds shown in chart. 4.45 and graph 4.49, the results on *Commelina benghalensis* L. influenced by various weed control treatments at all observational stages revealed that weed control treatments affected *Commelina benghalensis* L. dry weightat all qualitative stages in the years 2021 and 2022.

In comparison to other herbicidal treatments, the treatment of pendimethalin PE combo by HW in 20 DAS caused in the lowest dry weightof *Commelina benghalensis* L. in the years 2021 and 2022, according to the data shown in chart 4.49 and illustrated in graph. 4.45. Data obtained in 40 DAS minimum dry weightof *Commelina benghalensis* L. was noted in Pendimethalin combination by HW in 20 DAS subsequently 2 HW (20 & 40 DAS) then higher in Imazethapyr 20 DAS also Quizalofop-ethyl 20 DAS. Data on 60 DAS and harvest Quizalofop-ethyl 20 DAS next to Pendimethalin combination by HW in 20 DAS noted minimum dry weightof *Commelina benghalensis* L. as asociated to other herbicidal treatments, over un-weeded.

Cumulative data shown in chart 4.49 then depicted in graph 4.45 in 20 DAS minimum dry weightis noted in PE herbicidal actions as asociated to post-emergent actions. Minimal dry weightof *Commelina benghalensis* L. was noted at 40 days later seeding in Pendimethalin conjunction by HW at 20 days later seeding, next to weeding by hand two times (20 as well as 40 days later seeding) while greatest in Imazethapyr 20 days later seeding along by Quizalofop-ethyl PoE 20 days later seeding. The minimum dry weightof *Commelina benghalensis* L. was found at 60 DAS to harvest under Quizalofop-ethyl PoE 20 days after seeding next to Pendimethalin as compared to other herbicidal treatments beyond the un-weeded.

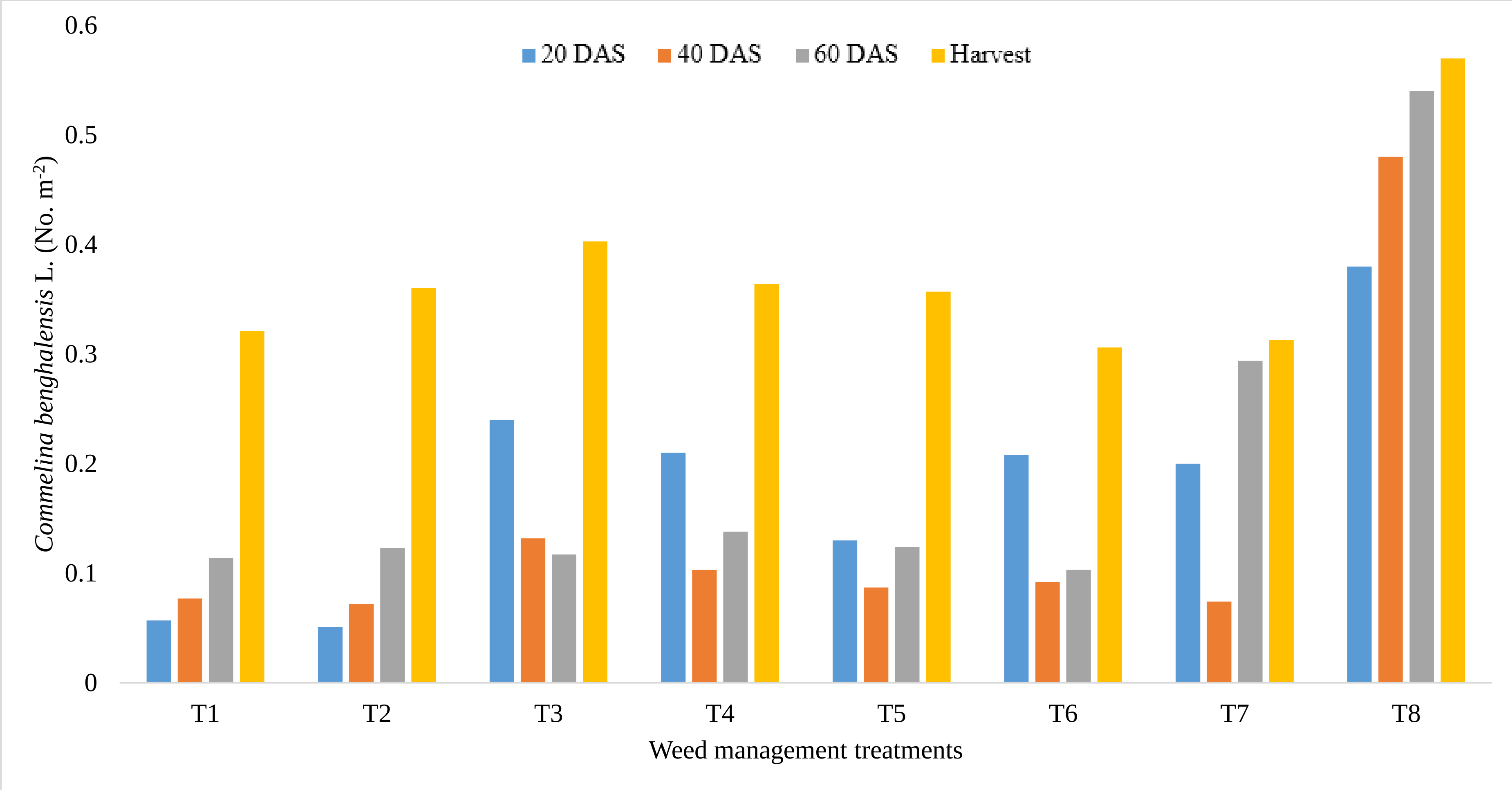


Chart 4.45. Influnce of herbicides on weed dry weightof *Commelina benghalensis* L. in cowpea at 20 days intervals. (2021 and 2022)

Chart 4.50 Influnce of herbicides on weed dry weightof *Cynodon dactylon* L. in cowpea at 20 days intervals. (2021 and 2022)

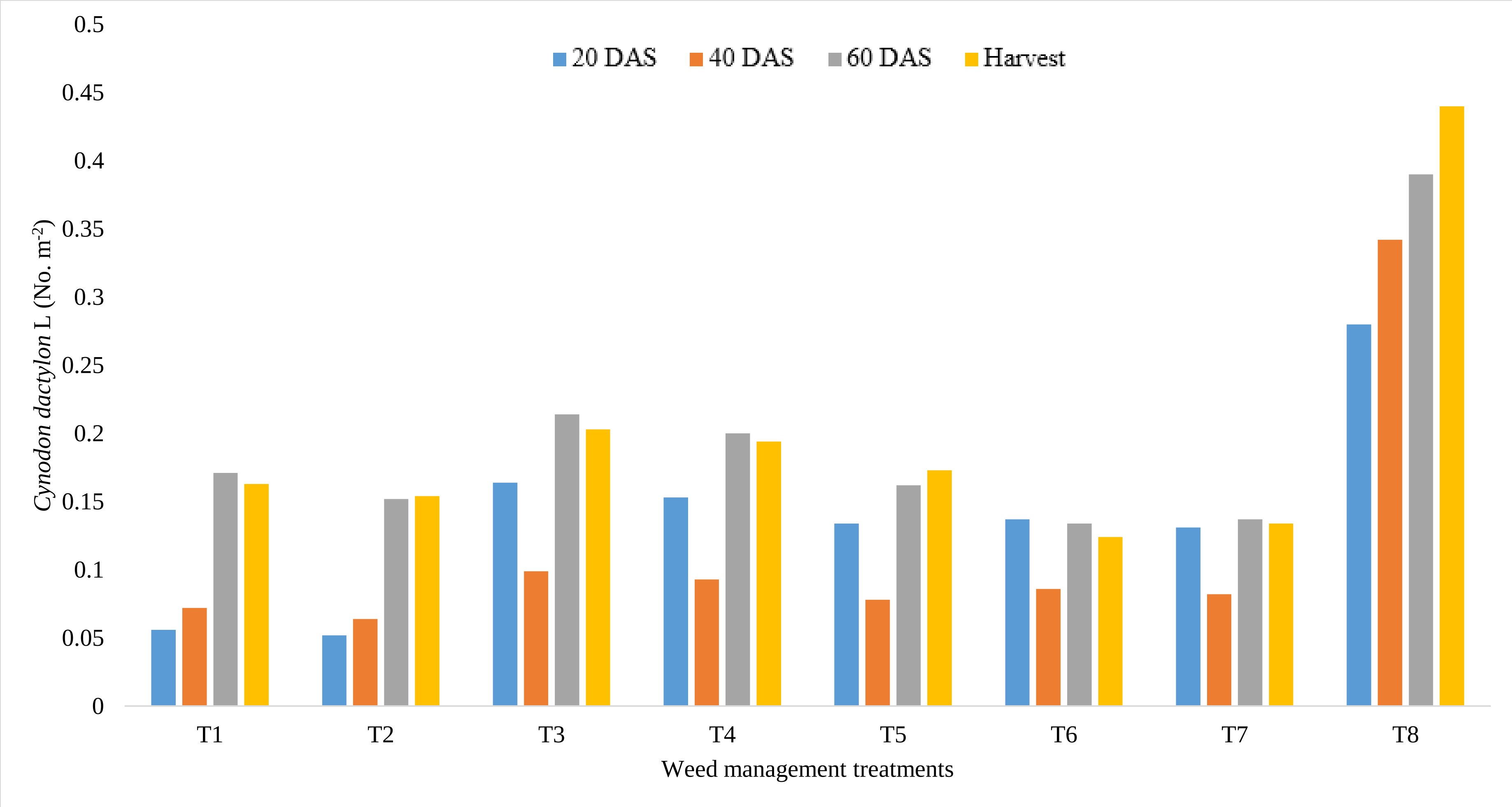
Treatments	20 DAS (2021)	20 DAS (2022)	Pooled data	40 DAS (2021)	40 DAS (2022)	Pooled data	60 DAS (2021)	60 DAS (2022)	Pooled data	Harvest (2021)	Harvest (2022)	Pooled data
T_1	0.23* (0.052)**	0.24 (0.061)	0.23 (0.056)	0.26 (0.069)	0.27 (0.075)	0.26 (0.072)	0.41 (0.17)	0.41 (0.172)	0.41 (0.171)	0.47 (0.23)	0.43 (0.19)	0.45 (0.21)
T_2	0.22 (0.048)	0.23 (0.054)	0.22 (0.052)	0.24 (0.020)	0.26 (0.029)	0.25 (0.025)	0.39 (0.031)	0.39 (0.037)	0.39 (0.034)	0.39 (0.037)	0.39 (0.039)	0.39 (0.038)
T_3	0.40 (0.16)	0.41 (0.169)	0.40 (0.164)	0.31 (0.098)	0.31 (0.10)	0.31 (0.099)	0.45 (0.21)	0.46 (0.219)	0.45 (0.214)	0.54 (0.30)	0.50 (0.26)	0.52 (0.28)
T_4	0.39 (0.15)	0.39 (0.157)	0.39 (0.153)	0.30 (0.090)	0.30 (0.096)	0.30 (0.093)	0.44 (0.19)	0.45 (0.21)	0.45 (0.20)	0.51 (0.27)	0.47 (0.23)	0.50 (0.25)
T_5	0.36 (0.13)	0.37 (0.138)	0.36 (0.134)	0.27 (0.075)	0.28 (0.081)	0.27 (0.078)	0.40 (0.16)	0.41 (0.165)	0.40 (0.162)	0.41 (0.17)	0.42 (0.177)	0.41 (0.173)
T_6	0.37 (0.135)	0.37 (0.139)	0.37 (0.137)	0.29 (0.084)	0.29 (0.089)	0.29 (0.086)	0.36 (0.13)	0.37 (0.138)	0.36 (0.134)	0.40 (0.16)	0.37 (0.14)	0.38 (0.15)
T_7	0.36 (0.129)	0.36 (0.134)	0.36 (0.131)	0.28 (0.026)	0.28 (0.029)	0.28 (0.027)	0.37 (0.016)	0.37 (0.021)	0.37 (0.018)	0.36 (0.020)	0.37 (0.022)	0.36 (0.021)
T_8	0.50 (0.25)	0.55 (0.310)	0.52 (0.28)	0.56 (0.32)	0.60 (0.364)	0.58 (0.342)	0.86 (0.75)	0.88 (0.790)	0.87 (0.77)	0.88 (0.78)	0.90 (0.82)	0.92 (0.80)
SEm (±)	**0.01**	**0.02**	**0.02**	**0.02**	**0.02**	**0.02**	**0.04**	**0.03**	**0.04**	**0.04**	**0.04**	**0.04**
CD (p=0.05)	**0.03**	**0.06**	**0.04**	**0.07**	**0.07**	**0.07**	**0.12**	**0.08**	**0.10**	**0.12**	**0.11**	**0.10**

4.4.3.2 *Cynodon dactylon* L.

The data concerning the dry matter of weeds *Cynodon dactylon* L. as influenced by different weed control methods at all phases of assessment in the years 2021 and 2022, as displayed in chart 4.50 and shown in graph 4.46, demonstrated that weed control treatments had a major effect on *Cynodon dactylon* L. dry weightat all phases of observations.

When using PE Pendimethalin in combination by HW on 20 DAS then Pendimethalin in comparison to other herbicidal actions, the minimum dry weight of *Cynodon dactylon* L. was noted in the years 2021 and 2022, according to the data shown in chart 4.50 then shown in fig. 4.46. Data on 40 DAS minimum dry weightof *Cynodon dactylon* L. was noted in HW at 20 and 40 DAS next to Pendimethalin mixture by HW at 20 DAS and superior in Imazethapyr 20 DAS then Quizalofop-ethyl 20 DAS. Data took on 60 DAS then at harvest HW at 20 and 40 DAS subsequently Pendimethalin combination by HW in 20 DAS noted minimum dried weight of *Cynodon dactylon* L. A comparable result was recorded by Yaduraju *et al*., (2002) and Mishra *et al*., (2005).

Cumulative data shown in chart 4.50 and depicted in graph 4.46 at 20 DAS minimum dried weight is noted in PE herbicidal treatments as asociated to PoE treatments. Data taken on 40 DAS minimum dry weight of *Cynodon dactylon* L. was noted in Pendimethalin combination through HW at 20 DAS subsequently Pendimethalin then superior in Imazethapyr 20 DAS and Quizalofop-ethyl 20 DAS. Data on 60 DAS also harvest the minimum dry weightof *Cynodon dactylon* L. was noted in the treatment of Quizalofop-ethyl 40 gPoE 20 DAS tracked by HW (20 and 40 DAS) and superior in Imazethapyr 20 DAS then Quizalofop-ethyl 20 DAS as compare to other herbicidal actions over the Un-weeded.



Graph 4.46 Influnce of herbicides on weed dry weightof *Cynodon dactylon* L. in cowpea at 20 days intervals. (2021 and 2022)

Chart 4.51 Influnce of herbicides on weed dry weightof *Cyperus rotundus* L. in cowpea at 20 days intervals. (2021 and 2022)

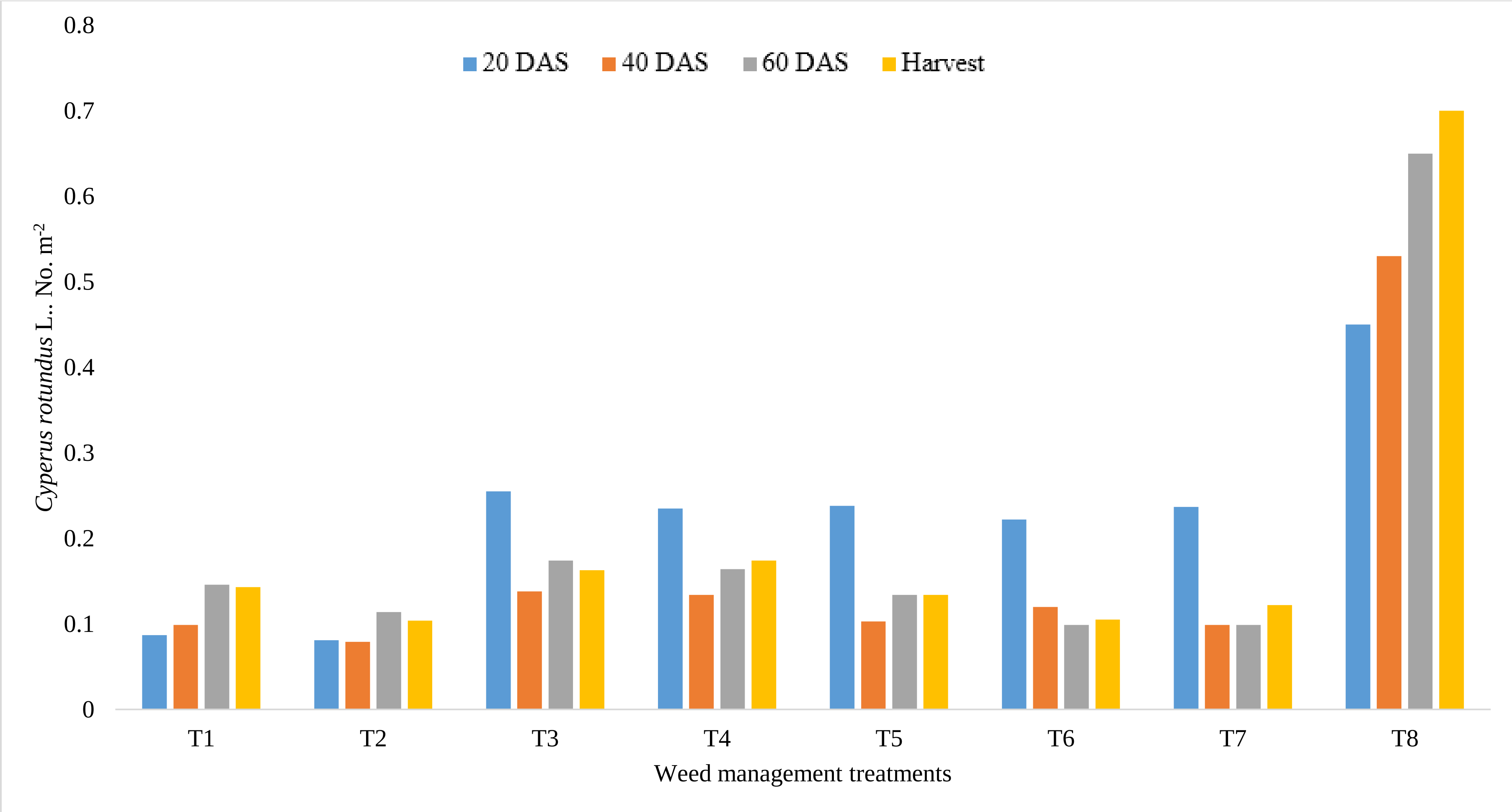
Treatments	20 DAS (2021)	20 DAS (2022)	Pooled data	40 DAS (2021)	40 DAS (2022)	Pooled data	60 DAS (2021)	60 DAS (2022)	Pooled data	Harvest (2021)	Harvest (2022)	Pooled data
T_1	0.29* **(0.085)****	0.30 **(0.091)**	0.93 **(0.087)**	0.31 **(0.098)**	0.31 **(0.10)**	0.99 **(0.99)**	0.37 **(0.14)**	0.39 **(0.153)**	0.38 **(0.146)**	0.41 **(0.17)**	0.38 **(0.15)**	0.40 **(0.16)**
T_2	0.28 **(0.08)**	0.28 **(0.082)**	0.90 **(0.081)**	0.27 **(0.076)**	0.28 **(0.084)**	0.28 **(0.079)**	0.33 **(0.11)**	0.34 **(0.119)**	0.33 **(0.114)**	0.34 **(0.12)**	0.37 **(0.14)**	0.36 **(0.13)**
T_3	0.50 **(0.25)**	0.51 **(0.261)**	0.50 **(0.255)**	0.37 **(0.135)**	0.39 **(0.141)**	0.37 **(0.138)**	0.41 **(0.17)**	0.42 **(0.178)**	0.41 **(0.174)**	0.42 **(0.18)**	0.46 **(0.22)**	0.44 **(0.20)**
T_4	0.47 **(0.22)**	0.50 **(0.254)**	0.48 **(0.235)**	0.36 **(0.13)**	0.38 **(0.139)**	0.36 **(0.134)**	0.40 **(0.16)**	0.41 **(0.169)**	0.40 **(0.164)**	0.41 **(0.17)**	0.42 **(0.178)**	0.41 **(0.174)**
T_5	0.49 **(0.24)**	0.48 **(0.237)**	0.48 **(0.238)**	0.32 **(0.10)**	0.33 **(0.107)**	0.32 **(0.103)**	0.36 **(0.13)**	0.37 **(0.138)**	0.36 **(0.134)**	0.37 **(0.14)**	0.41 **(0.16)**	0.38 **(0.15)**
T_6	0.46 **(0.215)**	0.47 **(0.229)**	0.47 **(0.222)**	0.33 **(0.112)**	0.45 **(0.129)**	0.34 **(0.120)**	0.30 **(0.09)**	0.31 **(0.100)**	0.31 **(0.099)**	0.31 **(0.1)**	0.33 **(0.110)**	0.32 **(0.105)**
T_7	0.48 **(0.23)**	0.49 **(0.244)**	0.48 **(0.237)**	0.31 **(0.098)**	0.31 **(0.099)**	0.31 **(0.099)**	0.31 **(0.098)**	0.31 **(0.099)**	0.31 **(0.099)**	0.32 **(0.12)**	0.35 **(0.124)**	0.34 **(0.122)**
T_8	0.63 **(0.40)**	0.71 **(0.51)**	0.67 **(0.45)**	0.66 **(0.44)**	0.72 **(0.52)**	0.69 **(0.48)**	0.77 **(0.60)**	0.84 **(0.71)**	0.80 **(0.65)**	0.79 **(0.65)**	0.87 **(0.76)**	0.83 **(0.700)**
SEm (±)	**0.01**	**0.02**	**0.02**	**0.02**	**0.03**	**0.02**	**0.03**	**0.03**	**0.03**	**0.05**	**0.04**	**0.05**
CD (p=0.05)	**0.04**	**0.07**	**0.05**	**0.07**	**0.08**	**0.08**	**0.10**	**0.08**	**0.09**	**0.14**	**0.12**	**0.13**

4.4.3.3 *Cyperus rotundus* L.

The data concerning the dry matter of *Cyperus rotundus* L. effect ofdifferent weed control treatments at all phases of observation in the years 2021 and 2022, as shown in chart 4.51 and shown in graph. 4.47, indicated that weed control therapies had a major effect on the dry weightof *Cyperus rotundus* L. at all phases of observation.

In the years 2021 and 2022 the data shown in 4.51 and depicted in fig 4.47 at 20 DAS the minimum dry weightof *Cyperus rotundus* L. was recorded in Pendimethalin arrangement by HW at 20 DAS and Pendimethalin as compare to other herbicidal treatments. Data on 40 DAS lowest dry weightof *Cyperus rotundus* L. was noted in the treatment of Pendimethalin arrangement through HW in 20 DAS shadowed by HW (20 and 40 DAS) also superior in Imazethapyr 50 gPoE 20 DAS and Quizalofop-ethyl 50 gPoE 20 DAS. Dats on 60 DAS then harvest Quizalofop-ethyl 20 DAS tailed by HW (20 and 40 DAS) noted minimum deied weight of *Cyperus rotundus* L. as asociated to further herbicidal treatments. Greater dry weight is noted in Imazethapyr 20 DAS and Quizalofop-ethyl 20 DAS.

Cumulative data shown in chart 4.51 and depicted in graph 4.47 in 20 DAS minimum dried weight is noted in PE herbicidal treatments as associated to PoE treatments. At 40 DAS lowest dry weightof *Cyperus rotundus* L. was noted in Pendimethalin combination by HW at 20 DAS subsequently Pendimethalin then heighest in Imazethapyr 20 DAS and Quizalofop-ethyl 20 DAS. Data on 60 DAS then harvest the lowest dry weightof *Cyperus rotundus* L. was noted in the treatment of Pendimethalin arrangement by HW at 20 DAS by HW (20 also 40 DAS) and superior in Imazethapyr 20 DAS and Quizalofop-ethyl 20 DAS as compare to other herbicidal treatments over the uFn-weeded.



Graph 4.47 Influnce of herbicides on weed dry weightof *Cyperus rotundus* L. in cowpea at 20 days intervals. (2021 and 2022)

Chart 4.52 Influnce of herbicides on weed dry weightof *Boerhavia erecta* L. in cowpea at 20 days intervals. (2021 and 2022)

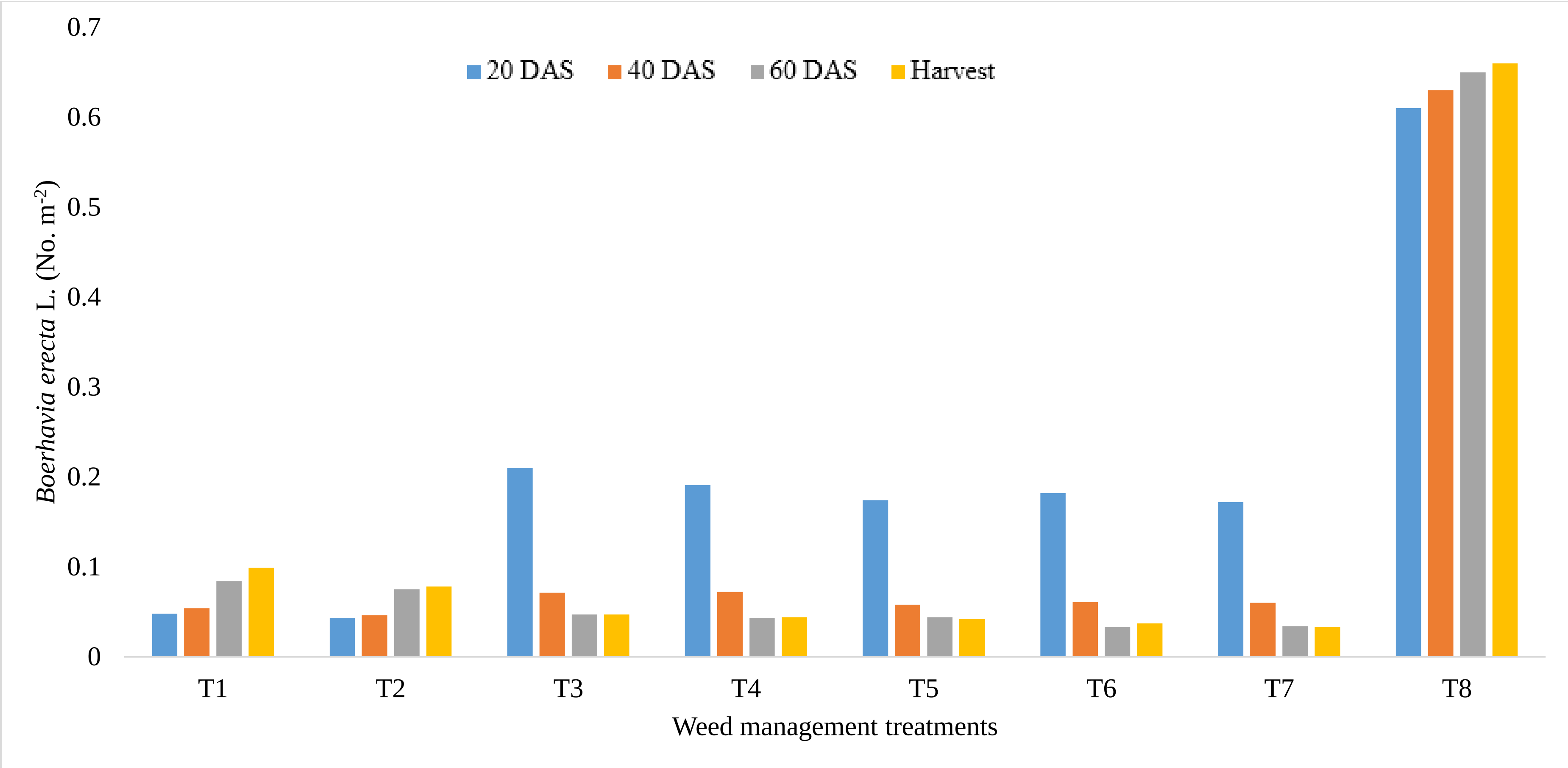
Treatments	20 DAS (2021)	20 DAS (2022)	Pooled data	40 DAS (2021)	40 DAS (2022)	Pooled data	60 DAS (2021)	60 DAS (2022)	Pooled data	Harvest (2021)	Harvest (2022)	Pooled data
T_1	0.20* **(0.042)****	0.22 **(0.052)**	0.21 **(0.048)**	0.22 **(0.049)**	0.24 **(0.059)**	0.23 **(0.054)**	0.28 **(0.08)**	0.29 **(0.089)**	0.28 **(0.084)**	0.30 **(0.09)**	0.31 **(0.099)**	0.31 **(0.099)**
T_2	0.19 **(0.038)**	0.21 **(0.0480)**	0.20 **(0.043)**	0.20 **(0.040)**	0.22 **(0.052)**	0.21 **(0.046)**	0.27 **(0.071)**	0.28 **(0.079)**	0.27 **(0.075)**	0.27 **(0.075)**	0.28 **(0.080)**	0.27 **(0.078)**
T_3	0.40 **(0.16)**	0.51 **(0.261)**	0.45 **(0.210)**	0.25 **(0.065)**	0.27 **(0.076)**	0.26 **(0.071)**	0.21 **(0.044)**	0.22 **(0.049)**	0.23 **(0.047)**	0.22 **(0.051)**	0.23 **(0.053)**	0.22 **(0.052)**
T_4	0.37 **(0.14)**	0.49 **(0.242)**	0.43 **(0.191)**	0.24 **(0.060)**	0.26 **(0.071)**	0.26 **(0.072)**	0.20 **(0.040)**	0.21 **(0.046)**	0.20 **(0.043)**	0.20 **(0.042)**	0.21 **(0.048)**	0.20 **(0.044)**
T_5	0.35 **(0.12)**	0.47 **(0.228)**	0.41 **(0.174)**	0.23 **(0.052)**	0.25 **(0.064)**	0.24 **(0.058)**	0.20 **(0.041)**	0.21 **(0.048)**	0.21 **(0.044)**	0.31 **(0.10)**	0.28 **(0.08)**	0.30 **(0.09)**
T_6	0.36 **(0.13)**	0.48 **(0.234)**	0.42 **(0.182)**	0.24 **(0.056)**	0.25 **(0.067)**	0.24 **(0.061)**	0.17 **(0.030)**	0.18 **(0.036)**	0.19 **(0.033)**	0.19 **(0.035)**	0.19 **(0.039)**	0.19 **(0.037)**
T_7	0.34 **(0.117)**	0.47 **(0.227)**	0.41 **(0.172)**	0.23 **(0.053)**	0.26 **(0.068)**	0.23 **(0.060)**	0.18 **(0.033)**	0.18 **(0.034)**	0.19 **(0.034)**	0.24 **(0.06)**	0.20 **(0.04)**	0.22 **(0.05)**
T_8	0.68 **(0.47)**	0.75 **(0.570)**	0.78 **(0.61)**	0.70 **(0.50)**	0.77 **(0.60)**	0.74 **(0.55)**	0.74 **(0.56)**	0.79 **(0.63)**	0.76 **(0.59)**	0.80 **(0.64)**	0.78 **(0.62)**	0.79 **(0.63)**
SEm (±)	**0.02**	**0.02**	**0.02**	**0.03**	**0.03**	**0.03**	**0.03**	**0.03**	**0.03**	**0.03**	**0.03**	**0.03**
CD (p=0.05)	**0.07**	**0.07**	**0.07**	**0.08**	**0.09**	**0.09**	**0.08**	**0.08**	**0.08**	**0.10**	**0.10**	**0.10**

4.4.3.4 *Boerhavia erecta* L.

The data concerning the dry matter of *Boerhavia erecta* L. effect ofvarious weed control treatments at all phases of observations in the years 2021 and 2022, as showed in chart 4.52 and illustrated in graph. 4.48, showed that weed control treatments had a substantial impact on the dry weightof *Boerhavia erecta* L. at all phases of observation.

In the years 2021 and 2022 the data shown in chart 4.52 and showed in graph 4.48 at 20 DAS the minimum dry weight of *Boerhavia erecta* L. was noted in the PE action of Pendimethalin mixture by manul weeding at 20 DAS then PE Pendimethalin as compare to other herbicidal treatments. Data took on 40 DAS minimum dry weight of *Boerhavia erecta* L. was noted in the treatment of Pendimethalin mixture by manul weeding in 20 DAS subsequently Pendimethalin then higher in Imazethapyr 20 DAS also Quizalofop-ethyl 20 DAS. Observations on 60 DAS then harvest Quizalofop-ethyl 20 DAS mixture by manul weeding (20 and 40 DAS) noted minimum dried weight of *Boerhavia erecta* L. as asociated to other herbicidal actions.

Cumulative data shown in 4.52 and depicted in graph 4.48 in 20 DAS minimum dried weight is noted in pre-emergent herbicidal actions as asociated to post-emergent actions. Data on 40 DAS minimum dried weight of *Boerhavia erecta* L. was noted in Pendimethalin mixture by manul weeding at 20 DAS Pendimethalin also heighest in Imazethapyr 20 DAS and Quizalofop-ethyl 20 DAS. Data on 60 DAS then harvest the lowest dry weightof *Boerhavia erecta* L. was noted in the usage Quizalofop-ethyl 20 DAS HW (20 and 40 DAS) then higher in Imazethapyr 20 DAS also Pendimethalin mixture by manul weeding at 20 DAS as compare to other herbicidal treatments over the Un-weeded.



Graph 4.48. Influnce of herbicides on weed dry weightof *Boerhavia erecta* L. in cowpea at 20 days intervals. (2021 and 2022)

Chart 4.53 Influnce of herbicides on weed dry weightof *Parthenium hysterophorus* L. in cowpea at 20 days intervals. (2021 and 2022)

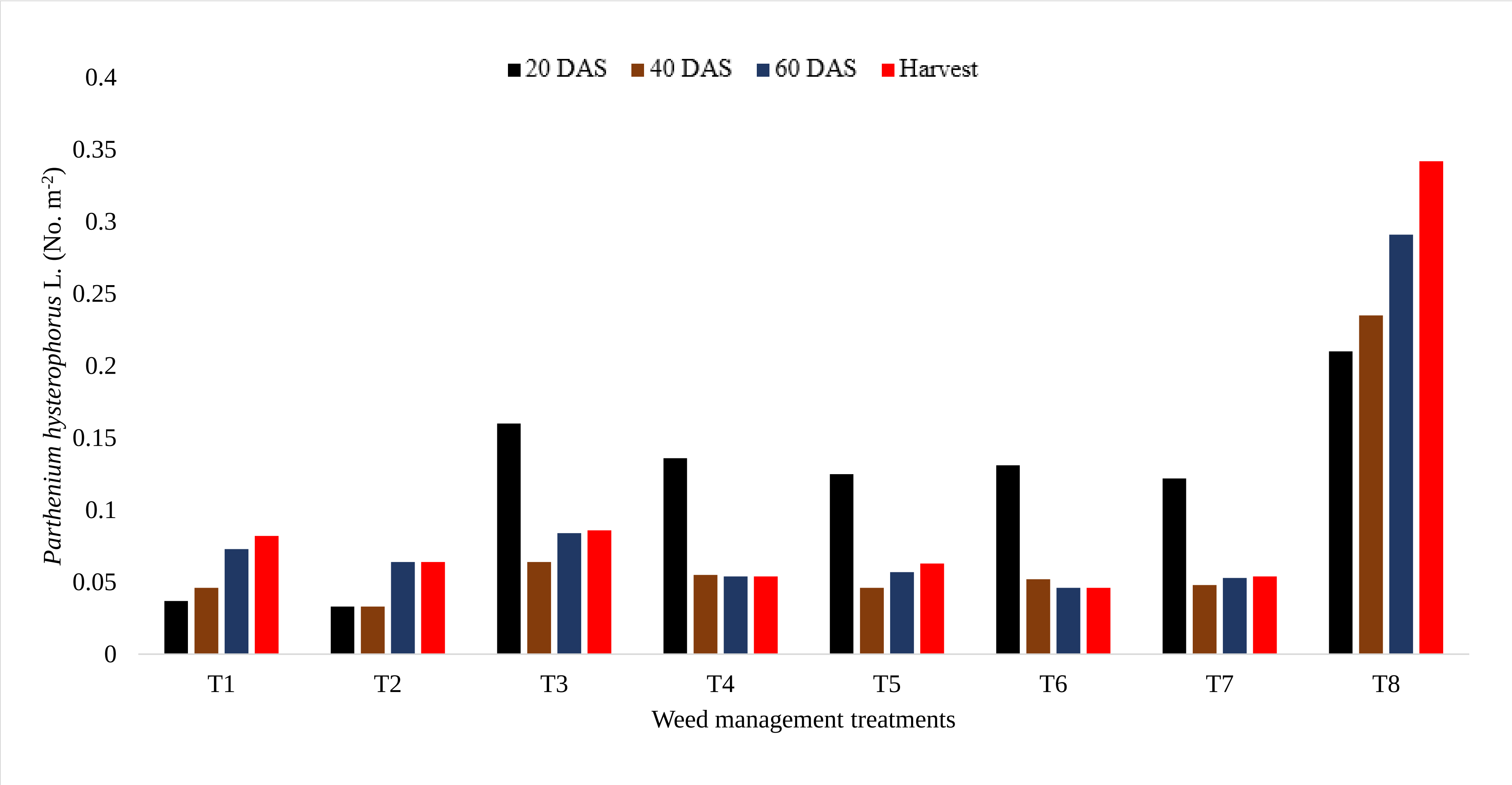
Treatments	20 DAS (2021)	20 DAS (2022)	Pooled data	40 DAS (2021)	40 DAS (2022)	Pooled data	60 DAS (2021)	60 DAS (2022)	Pooled data	Harvest (2021)	Harvest (2022)	Pooled data
T_1	0.18* **(0.036)****	0.19 **(0.039)**	0.19 **(0.037)**	0.21 **(0.043)**	0.21 **(0.048)**	0.21 **(0.046)**	0.26 **(0.07)**	0.27 **(0.076)**	0.27 **(0.073)**	0.28 **(0.08)**	0.28 **(0.084)**	0.28 **(0.082)**
T_2	0.18 **(0.031)**	0.18 **(0.035)**	0.18 **(0.033)**	0.18 **(0.032)**	0.18 **(0.036)**	0.18 **(0.033)**	0.26 **(0.066)**	0.26 **(0.069)**	0.25 **(0.067)**	0.31 **(0.10)**	0.28 **(0.08)**	0.30 **(0.09)**
T_3	0.37 **(0.14)**	0.43 **(0.19)**	0.40 **(0.16)**	0.24 **(0.060)**	0.26 **(0.068)**	0.25 **(0.064)**	0.28 **(0.08)**	0.29 **(0.088)**	0.27 **(0.084)**	0.29 **(0.084)**	0.29 **(0.089)**	0.29 **(0.086)**
T_4	0.37 **(0.135)**	0.37 **(0.137)**	0.36 **(0.136)**	0.23 **(0.053)**	0.23 **(0.057)**	0.23 **(0.055)**	0.22 **(0.05)**	0.23 **(0.057)**	0.23 **(0.054)**	0.24 **(0.06)**	0.28 **(0.08)**	0.26 **(0.07)**
T_5	0.35 **(0.123)**	0.35 **(0.128)**	0.35 **(0.125)**	0.21 **(0.044)**	0.22 **(0.049)**	0.21 **(0.046)**	0.23 **(0.055)**	0.24 **(0.059)**	0.23 **(0.057)**	0.24 **(0.06)**	0.25 **(0.066)**	0.25 **(0.063)**
T_6	0.36 **(0.13)**	0.36 **(0.132)**	0.36 **(0.131)**	0.22 **(0.050)**	0.22 **(0.053)**	0.22 **(0.052)**	0.21 **(0.044)**	0.22 **(0.049)**	0.21 **(0.046)**	0.22 **(0.05)**	0.26 **(0.07)**	0.24 **(0.06)**
T_7	0.35 **(0.12)**	0.35 **(0.124)**	0.34 **(0.122)**	0.21 **(0.046)**	0.23 **(0.050)**	0.21 **(0.048)**	0.23 **(0.052)**	0.23 **(0.053)**	0.23 **(0.053)**	0.22 **(0.05)**	0.23 **(0.057)**	0.23 **(0.054)**
T_8	0.44 **(0.20)**	0.46 **(0.22)**	0.45 **(0.21)**	0.47 **(0.23)**	0.48 **(0.240)**	0.48 **(0.235)**	0.53 **(0.29)**	0.54 **(0.30)**	0.53 **(0.291)**	0.53 **(0.30)**	0.62 **(0.39)**	0.58 **(0.342)**
SEm (±)	**0.02**	**0.02**	**0.02**	**0.02**	**0.02**	**0.02**	**0.03**	**0.03**	**0.03**	**0.03**	**0.03**	**0.03**
CD (p=0.05)	**0.06**	**0.05**	**0.06**	**0.07**	**0.05**	**0.06**	**0.09**	**0.08**	**0.09**	**0.10**	**0.10**	**0.10**

4.4.3.5 *Parthenium hysterophorus* L.

The data concerning the dry matter of *Parthenium hysterophorus* L. as influenced by different weed control therapies at all points during observations in the years 2021 and 2022, as shown in chart 4.51 and illustrated in the graph. 4.47, demonstrated that weed control practices had a substantial effect on *Parthenium hysterophorus* L. dry weightat all periods of observing.

As shown in chart. 4.49 And graph 4.53, the minimum dry weightof *P. hysterophorus* L. was noted at 20 DAS pendimethalin together by HW in 20 DAS and pendimethalin as asociated to other herbicidal actions. Data on 40 DAS minimum dry weight of *P. hysterophorus* L. was noted in the usage of Pendimethalin combination by HW in 20 DAS next to Pendimethalin also higher in Imazethapyr 20 DAS also Quizalofop-ethyl 20 DAS. Observed data by 60 DAS and harvest Quizalofop-ethyl 20 DAS subsequently Quizalofop-ethyl 20 DAS noted minimum dry weightof *P. hysterophorus* L. as asociated to other herbicidal actions. Higher dry weight is noted in Imazethapyr 50 gPoE 20 DAS besides Pendimethalin combination by manual clearing in 20 DAS as likened to the check.

Cumulative data shown in chart 4.53 and depicted in graph 4.49 in 20 DAS minimum dried weight is noted in PE herbicidal actions as asociated to PoE actions. Data on 40 DAS minimum dried weight of *Parthenium* was noted in Pendimethalin combination by HW in 20 DAS subsequently Pendimethalin also higher in Imazethapyr 20 DAS and Quizalofop-ethyl. In 60 DAS then harvest, lowermost dry weightwas noted in the treatment of Quizalofop-ethyl 20 DAS tracked by HW (20 and 40 DAS) also superior in Imazethapyr 20 DAS and Pendimethalin combination by HWs in 20 DAS as compare to other herbicidal treatments over the Un-weeded.



Graph 4.49 Influnce of herbicides on weed dry weightof *Parthenium hysterophorus* L. in cowpea at 20 days intervals. (2021 and 2022)

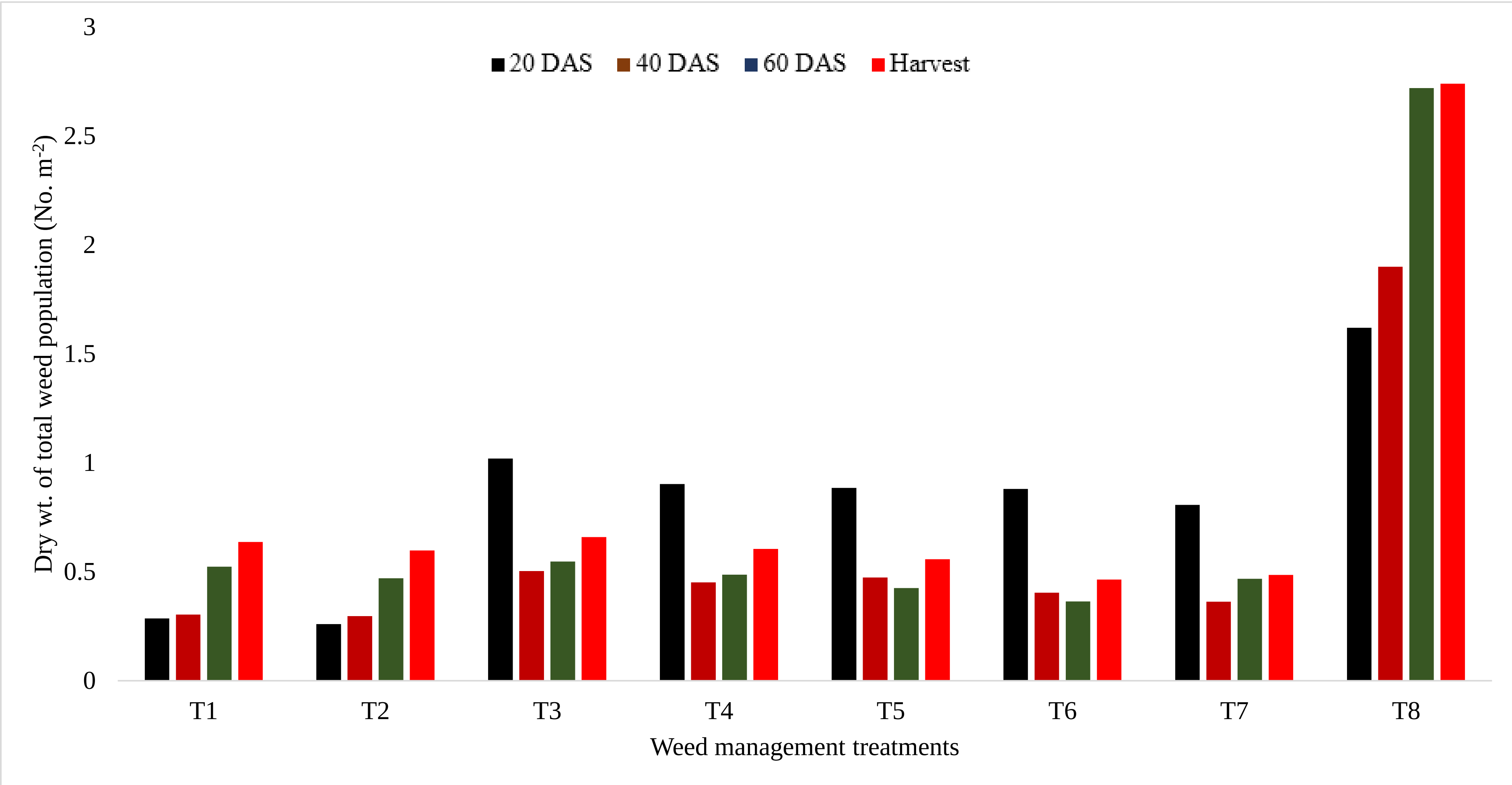
Chart 4.54 Influnce of herbicides on weed dry weightof total weed population in cowpea at 20 days intervals. (2021 and 2022

Treatments	20 DAS (2021)	20 DAS (2022)	Pooled data	40 DAS (2021)	40 DAS (2022)	Pooled data	60 DAS (2021)	60 DAS (2022)	Pooled data	Harvest (2021)	Harvest (2022)	Pooled data
T_1	0.52* **(0.27)****	0.54 **(0.302)**	0.53 **(0.286)**	0.58 **(0.334)**	0.52 **(0.272)**	0.55 **(0.303)**	0.66 **(0.44)**	0.77 **(0.607)**	0.72 **(0.523)**	0.21 **(0.45)**	0.90 **(0.823)**	0.79 **(0.636)**
T_2	0.50 **(0.247)**	0.52 **(0.271)**	0.50 **(0.259)**	0.52 **(0.278)**	0.56 **(0.315)**	0.54 **(0.296)**	0.63 **(0.40)**	0.74 **(0.55)**	0.68 **(0.47)**	0.20 **(0.41)**	0.88 **(0.786)**	0.77 **(0.598)**
T_3	0.97 **(0.940)**	1.05 **(1.11)**	1.00 **(1.02)**	0.70 **(0.488)**	0.72 **(0.519)**	0.70 **(0.503)**	0.61 **(0.38)**	0.84 **(0.715)**	0.73 **(0.547)**	0.20 **(0.4)**	0.85 **(0.918)**	0.81 **(0.659)**
T_4	0.92 **(0.855)**	1.00 **(1.00)**	0.96 **(0.927)**	0.66 **(0.433)**	0.68 **(0.469)**	0.67 **(0.451)**	0.59 **(0.35)**	0.79 **(0.625)**	0.69 **(0.487)**	0.19 **(0.36)**	0.92 **(0.850)**	0.77 **(0.605)**
T_5	0.91 **(0.825)**	0.97 **(0.946)**	0.94 **(0.885)**	0.59 **(0.356)**	0.62 **(0.390)**	0.68 **(0.473)**	0.56 **(0.32)**	0.73 **(0.535)**	0.65 **(0.425)**	0.18 **(0.33)**	0.88 **(0.784)**	0.74 **(0.557)**
T_6	0.90 **(0.810)**	0.96 **(0.950)**	0.93 **(0.88)**	0.62 **(0.392)**	0.64 **(0.416)**	0.63 **(0.404)**	0.55 **(0.30)**	0.64 **(0.429)**	0.60 **(0.364)**	0.54 **(0.29)**	0.79 **(0.638)**	0.68 **(0.464)**
T_7	0.88 **(0.786)**	0.91 **(0.829)**	0.89 **(0.807)**	0.59 **(0.349)**	0.61 **(0.376)**	0.60 **(0.362)**	0.56 **(0.31)**	0.78 **(0.624)**	0.68 **(0.467)**	0.55 **(0.30)**	0.81 **(0.670)**	0.69 **(0.485)**
T_8	1.19 **(1.43)**	1.34 **(1.81)**	1.27 **(1.62)**	1.27 **(1.66)**	0.46 **(2.15)**	1.37 **(1.90)**	1.42 **(2.12)**	1.82 **(3.32)**	1.64 **(2.72)**	1.44 **(2.15)**	1.82 **(3.33)**	1.65 **(2.74)**
SE(m±)	**0.05**	**0.05**	**0.05**	**0.07**	**0.05**	**0.06**	**0.09**	**0.08**	**0.09**	**0.08**	**0.07**	**0.08**
CD (p=0.05)	**0.14**	**0.16**	**0.15**	**0.20**	**0.14**	**0.17**	**0.27**	**0.24**	**0.26**	**0.23**	**0.22**	**0.23**

4.4.3.6 Dry matter of total weed species

The data concerning the dry matter of total weed population effect ofvarious weed control methods at all observational stages in the years 2021 and 2022, as obtainable in chart 4.54 also illustrated in graph 4.50, showed that weed control methods affected dry weightof the total weed population at all observational methods.

In comparison to other herbicidal treatments, the treatment of pendimethalin in combination by HW in 20 DAS noted the lowest dry weightof the total weed population in the years 2021 and 2022, according to the data in chart 54 and illustrated in graph 4.50. Data on 40 DAS minimum dry weightof overall weed population was noted in Pendimethalin by HW at 20 DAS, sImazethapyr 20 DAS and Quizalofop-ethyl 20 DAS. Similar studies were conducted by Yaduraju *et al*., 2002, and Mishra *et al*., (2005), then the lowest dry weight of the whole weed population was observed at 60 Days later seeding and harvest Quizalofop-ethyl 20 Days later seeding, HW scraped the soil's surface to control late emergent blushes while Pendimethalin controlling the early flushes of weeds for a longer period of time. As a result, the weed density was reduced. Which shown that weeds appearing early in the season could be successfully managed by PE herbicide application, and weeds emerging later in the season could be successfully managed by PoE herbicides, which was comparable to two HW done 20 and 40 Days later seeding. Due to the varying application time of the various weed controlling strategies, both independently and together, at different times of the year, there were variations in weed density. The crop's capacity to effectively absorb water and nutrients may be the cause of the weed density consistently increasing, as seen by the weedy check subsequently HWs (20 and 40 Days later seeding). These discoveries agreed by Gupta *et al*., (2013).



Graph 4.50 Influnce of herbicides on weed dry weight of total weed population in cowpea at 20 days intervals. (2021 and 2022

Chart 4.55 Influnce of herbicides on WCE of *Commelina benghalensis* L. in cowpea at 20 days intervals. (2021 and 2022)

Treatments	20 DAS (2021)	20 DAS (2022)	Pooled data	40 DAS (2021)	40 DAS (2022)	Pooled data	60 DAS (2021)	60 DAS (2022)	Pooled data	Harvest (2021)	Harvest (2022)	Pooled data
T_1	84.72	85.25	84.99	83.33	84.31	83.82	83.07	86.85	84.96	83.53	83.37	83.45
T_2	86.11	87.00	86.56	84.44	85.49	84.97	81.53	85.84	83.69	80.00	84.21	82.11
T_3	36.11	41.25	38.68	71.11	73.72	72.42	73.84	79.66	76.75	72.18	73.26	73.22
T_4	41.66	45.75	43.71	77.77	79.21	78.49	79.23	84.15	81.69	77.65	82.11	79.88
T_5	41.11	46.25	43.68	81.11	82.54	81.83	81.53	85.50	83.52	74.12	81.05	77.59
T_6	44.44	46.00	45.22	80.00	81.56	80.78	84.61	88.08	86.35	84.71	86.42	85.56
T_7	47.22	15.00	31.11	84.00	84.90	84.45	84.60	66.51	75.56	63.53	67.37	65.45
T_8	-	-	-	-	-	-	-	-	-	-	-	-

4.4.4 WCE (%)

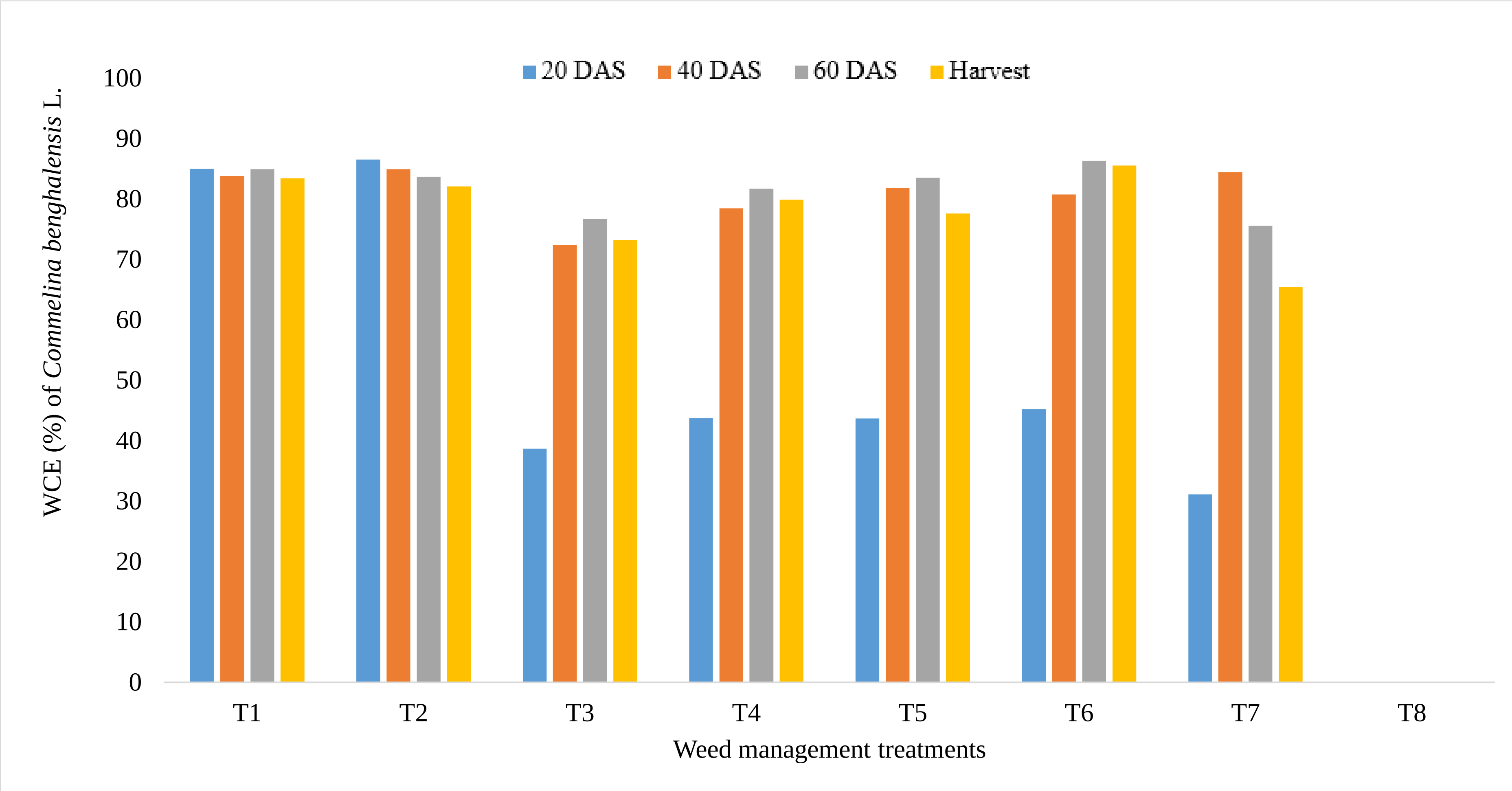
The data concerning the WCE species-wised and total influenced by weed management practices at 20, 40, 60, and harvest.

4.4.4.1 *Commelina Spp* L.

The data concerning the WCE *Commelina Spp* L. effect ofseveral weed control activities at all steps of observations in the years 2021 and 2022, as existing in chart 4.53 then illustrated in graph. 4.49, showed weed control treatments had a momentous impact on the WCE of *Comme lina benghalensis* L. at all phases of observation.

In the years 2021 and 2022 data show in chart 4.55 and represented in graph 4.51 in 20 Days later seeding greater weed control efficiency was observed in Pendimethalin mixture by HW in 20 Days later seeding and Pendimethalin as compare to PoE treatments. At 40 Days later seeding extreme weed control efficiency was noted Pendimethalin combination by HW in 20 Days later seeding and 2 HW (20 then 40 Days later seeding). The lowest weed control efficiency was noted in the treatment of Imazethapyr 20 Days later seeding and Quizalofop-ethyl 20 Days later seeding. In 60 Days later seeding then harvest higher weed control efficiency was noted Quizalofop-ethyl 20 Days later seeding and 2 HW (20 then 40 Days later seeding). The smallest weed control efficiency of *Commelina benghalensis* L. was logged in a check. These outcomes were in concurrence by the judgements of Madukwe *et al.*, (2012).

Cumulative data in the years 2021 and 2022 shown in chart 4.55 and showed in graph 4.51 exposed that Pendimethalin in conjunction by HW twice (20 then 40 Days later seeding) over the Un-weeded ensued in the highest weed control effectiveness. Pendimethalin in conjunction by 2 HW (20 and 40 Days later seeding) and at 20 Days later seeding had a greater 40 Days later seeding efficacy of weed control than other herbicidal treatments. Data on 60 Days later seeding and harvest, Imazethapyr 20 Days later seeding and Quizalofop-ethyl 20 Days later seeding had the lowest weed control efficacy, while Quizalofop-ethyl 20 Days later seeding had the efficacy of highest weed control, which was subsequently 2 HW (20 & 40 Days later seeding) over the un-weeded.



Graph 4.51 Influnce of herbicides on WCE of *Commelina benghalensis* L. in cowpea at 20 days intervals. (2021 and 2022)

Chart 4.56 Influnce of herbicides on WCE of *Cynodon dactylon* L. in cowpea at 20 days intervals. (2021 and 2022)

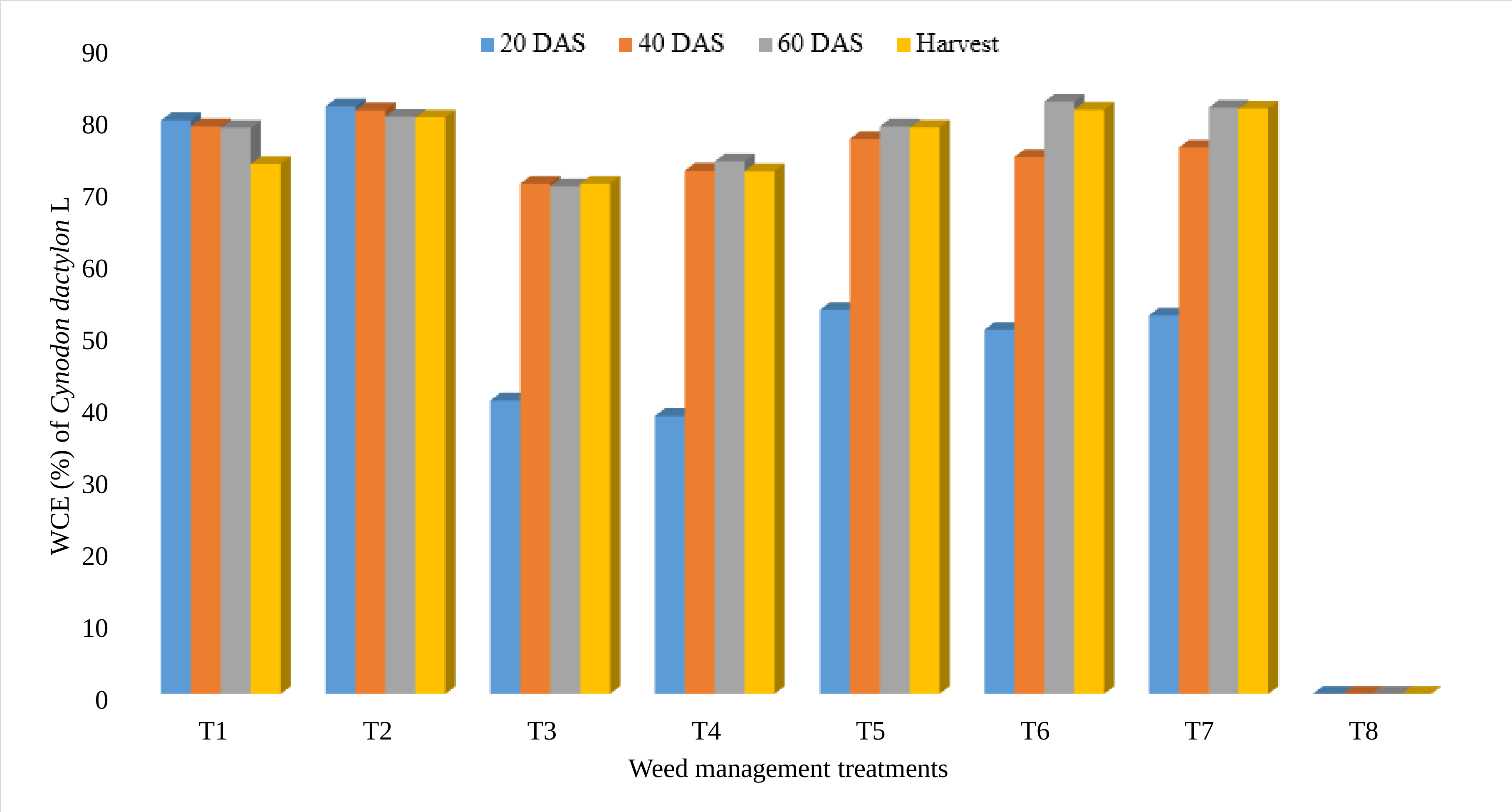
Treatments	20 DAS (2021)	20 DAS (2022)	Pooled data	40 DAS (2021)	40 DAS (2022)	Pooled data	60 DAS (2021)	60 DAS (2022)	Pooled data	Harvest (2021)	Harvest (2022)	Pooled data
T_1	79.20	80.32	79.76	78.43	79.39	78.91	79.20	78.22	78.71	70.51	76.83	73.67
T_2	80.80	82.58	81.69	81.25	81.04	81.14	80.00	80.50	80.25	79.30	80.00	80.15
T_3	36.00	45.48	40.74	69.37	72.52	70.94	72.00	72.27	72.13	71.54	69.29	70.92
T_4	40.00	37.19	38.59	71.87	73.62	72.74	74.65	73.41	74.03	72.38	71.95	72.67
T_5	48.00	58.70	53.35	76.56	77.74	77.15	78.66	79.11	78.88	78.21	79.27	78.74
T_6	46.00	55.16	50.58	73.75	75.54	74.64	82.13	82.53	82.33	79.49	82.93	81.21
T_7	48.40	56.77	52.58	75.00	76.92	75.96	82.00	81.01	81.50	79.89	80.32	81.38
T_8	-	-	-	-	-	-	-	-	-	-	-	-

4.4.4.2 *Cynodon dactylon* L.

The data concerning the WCE *Cynodon dactylon* L. effect ofvarious weed control activities at all observational steps, as existing in chart 4.56 then illustrated in graph 4.52, showed that several weed treatments had a major impact on *Cynodon dactylon* L. weed control efficiency at all observational points in the years 2021 and 2022.

In the years 2021 and 2022 data show in chart 4.56 and represented in graph 4.52 at 20 days later seeding greater weed control efficiency was observed in Pendimethalin by manual clearing at 20 days later seeding and Pendimethalin as compare to PoE treatments. Data on 40 days later seeding supreme efficacy of weed control was noted in Pendimethalin by HW in 20 days later seeding. The minimum weed control efficiency was noted in the treatment of Imazethapyr 20 days later seeding and Quizalofop-ethyl 20 days later seeding. Data on 60 days later seeding then harvest higher weed control efficiency was noted 2 HW (20 then 40 days later seeding) and Quizalofop-ethyl 20 days later seeding. The minimum weed control efficiency of *Cynodon dactylon* L. was noted in Un-weeded. The outcomes conform to the results of Sasode *et al.*, (2020) and Radhey Shyam *et al*., (2014).

According to cumulative data for the years 2021 and 2022 given in chart 4.56 and shown in graph 4.52, Pendimethalin by HW twice (20 then 40 days later seeding) over the check, caused in the utmost WCE. Data on 40 days later seeding higher weed control efficiency was noted in Pendimethalin combination by HWs in 20 days later seeding plus Pendimethalin as asociated to other herbicidal treatments. Data noted in 60 days later seeding then harvest, Imazethapyr then Quizalofop-ethyl noted the lowest weed control effectiveness, while Quizalofop-ethyl noted the supreme weed control effectiveness, which was subsequently HW twice (20 then 40 days later seeding) over the Un-weeded.



Graph 4.52 Influnce of herbicides on WCE of *Cynodon dactylon* L. in cowpea at 20 days intervals. (2021 and 2022)

Chart 4.57 Influnce of herbicides on WCE of *Cyperus rotundus* L. in cowpea at 20 days intervals. (2021 and 2022)

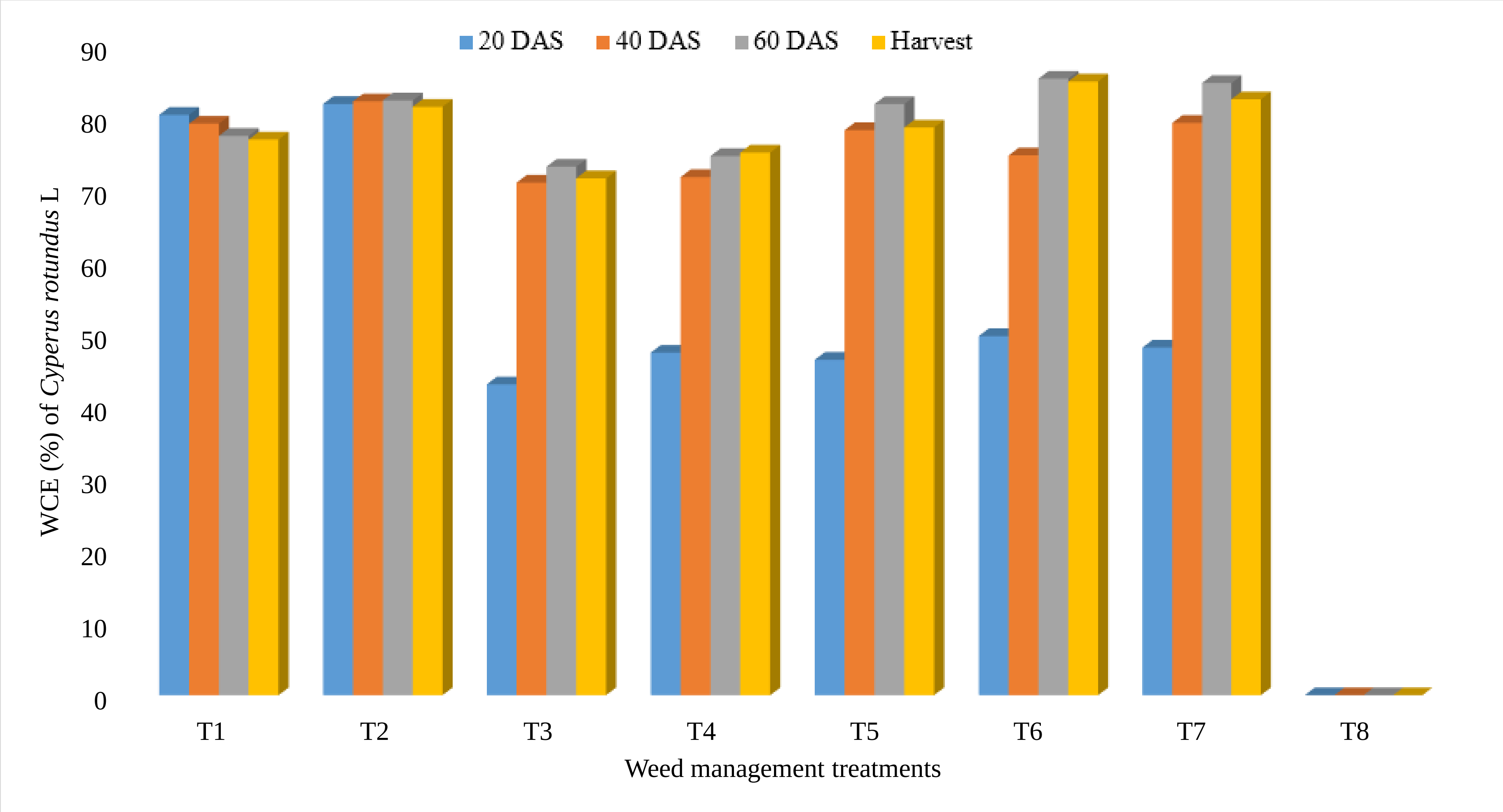
Treatments	20 DAS (2021)	20 DAS (2022)	Pooled data	40 DAS (2021)	40 DAS (2022)	Pooled data	60 DAS (2021)	60 DAS (2022)	Pooled data	Harvest (2021)	Harvest (2022)	Pooled data
T_1	78.75	82.15	80.45	77.72	80.76	79.24	76.66	78.45	77.55	73.85	80.26	77.05
T_2	80.00	83.92	81.96	82.72	81.92	82.32	81.66	83.23	82.44	81.54	81.58	81.56
T_3	37.50	48.82	43.16	69.31	72.88	71.09	71.66	74.92	73.29	72.31	71.05	71.68
T_4	45.00	50.19	47.59	70.45	73.26	71.85	73.33	76.19	74.76	73.84	76.65	75.24
T_5	40.00	53.22	46.61	77.27	79.42	78.34	83.33	80.56	81.94	78.46	78.95	78.70
T_6	46.25	53.52	49.88	74.54	75.19	74.86	85.00	85.91	85.45	84.61	85.52	85.06
T_7	42.50	54.11	48.30	77.72	80.96	79.34	83.66	86.05	84.85	81.53	83.68	82.60
T_8	-	-	-	-	-	-	-	-	-	-	-	-

4.4.4.3 *Cyperus rotundus* L.

The data concerning the WCE *Cyperus rotundus* L. effect ofvarious weed control actions at all observational points, as accessible in chart 4.57 then illustrated in graph 4.53, showed that weed control actions had a substantial impact on *Cyperus rotundus* L. weed control efficiency at all observational phases in the years 2021 then 2022.

In the years 2021 and 2022 data show in chart 4.57 data on 20 Days later seeding higher WCE of *Cyperus rotundus* L. was observed in Pendimethalin by HW in 20 days later seeding then Pendimethalin as associate to post-emergent actions. Data on 40 days later seeding higher WCE was noted in Pendimethalin by HW in 20 days later seeding. The lowest weed control efficiency was noted in the treatment of Imazethapyr 20 days later seeding and Quizalofop-ethyl 20 days later seeding. Data on 60 days later seeding and harvest superior weed control efficiency was noted Quizalofop-ethyl 20 days later seeding then2 HW (20 then 40 Days later seeding). The minimum weed control efficiency of *Cyperus rotundus* L. was noted in a check. Alike observations were also informed by Madikwe *et al*., (2012).

Cumulative data in the years 2021 and 2022 shown in chart 4.57 then portrayed in fig 4.53 discovered that heighest weed control efficiency of *Cyperus rotundus* L. has been noted in Pendimethalin combination by HW in 20 days later seeding and HW twice (20 then 40 days later seeding) over the Un-weeded. Data on 40 days later seeding higher weed control efficacy was noted in Pendimethalin combination by HW in 20 days later seeding then Pendimethalin as asociated to other herbicidal actions and minimum Imazethapyr 20 days later seeding and Quizalofop-ethyl 20 days later seeding. Data on 60 days later seeding and harvest minimum WCE was noted in Imazethapyr 20 days later seeding then Quizalofop-ethyl 20 days later seeding then higher weed control efficacy was noted in Quizalofop-ethyl 20 days later seeding next 2 HW (20 & 40 days later seeding) over the Un-weeded.



Graph 4.53 Influnce of herbicides on WCE of *Cyperus rotundus* L. in cowpea at 20 days intervals. (2021 and 2022)

Chart 4.58 Influnce of herbicides on WCE of *Boerhavia erecta* L. in cowpea at 20 days intervals. (2021 and 2022)

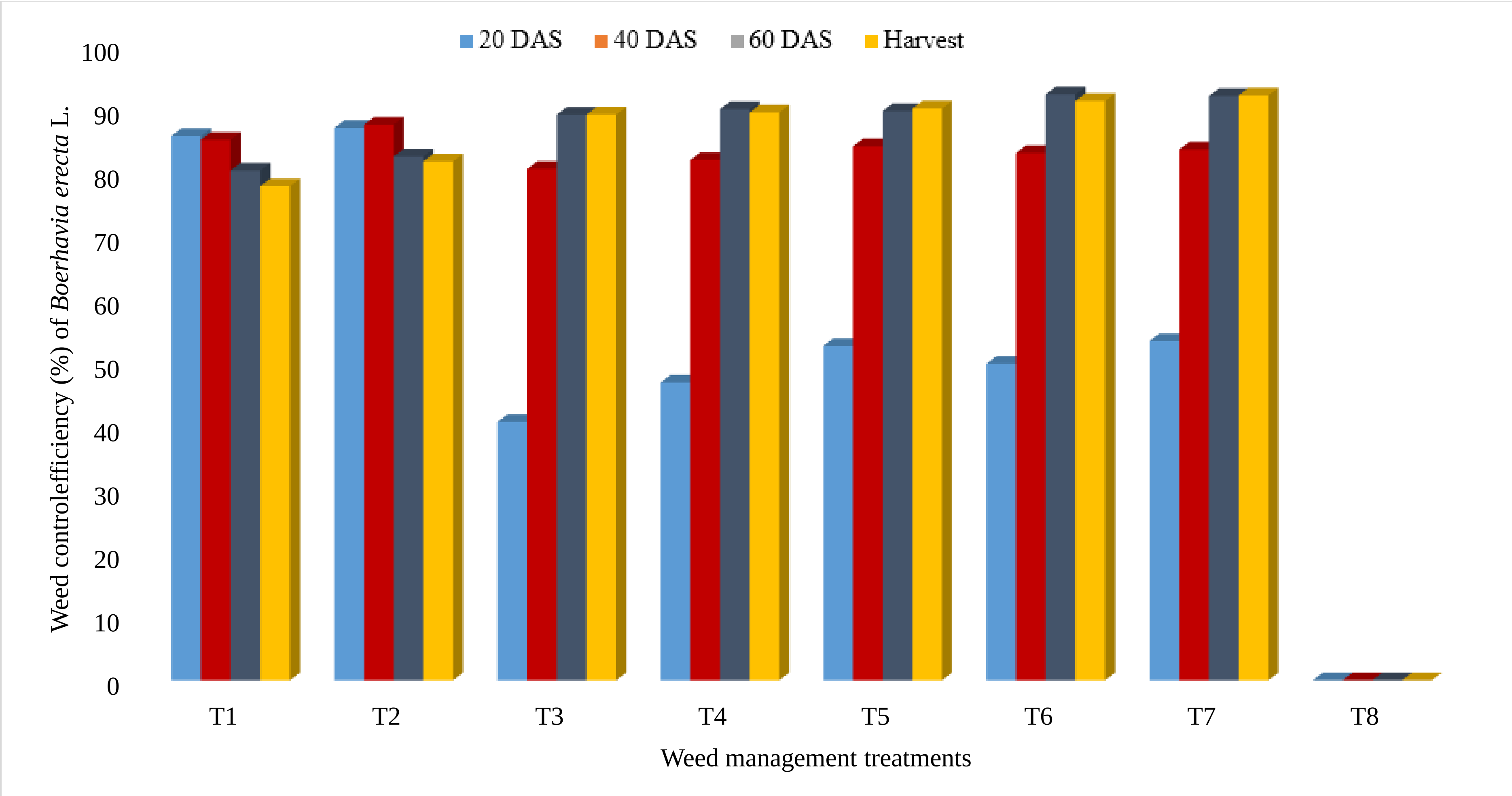
Treatments	20 DAS (2021)	20 DAS (2022)	Pooled data	40 DAS (2021)	40 DAS (2022)	Pooled data	60 DAS (2021)	60 DAS (2022)	Pooled data	Harvest (2021)	Harvest (2022)	Pooled data
T_1	80.90	90.87	85.88	80.40	90.16	85.28	75.00	85.87	80.43	74.97	85.62	80.30
T_2	82.72	91.57	87.14	84.00	91.33	87.66	77.81	87.46	82.63	77.68	87.31	82.50
T_3	27.27	54.21	40.74	74.00	87.33	80.66	86.25	92.22	89.23	86.12	91.76	88.94
T_4	36.36	57.54	46.95	76.00	88.16	82.08	87.50	92.69	90.09	86.65	89.97	88.31
T_5	45.45	60.00	52.72	79.20	89.33	84.26	87.18	92.38	89.78	84.38	87.1	85.74
T_6	40.90	58.94	49.92	77.60	88.83	83.21	90.62	94.28	92.45	90.6	94.03	92.32
T_7	46.81	60.17	53.49	78.8	88.66	83.73	89.68	94.60	92.14	90.63	93.55	92.09
T_8	-	-	-	-	-	-	-	-	-	-	-	-

4.4.4.4 ***Boerhavia erecta* L.**

The data concerning the WCE *Boerhavia erecta* L effect ofvarious weed control actions at all observational phases, as accessible in chart 4.58 and illustrated in graph 4.54, showed that weed control actions had important effect on *Boerhavia erecta* L. weed control efficiency at all observational phases in years 2021 and 2022.

In the years 2021 and 2022 data show in chart 4.58 and described in graph 4.54 in 20 Days later seeding higher WCE of *Boerhavia erecta* L. was observed in Pendimethalin mixture by HW in 20 days later seeding then Pendimethalin as compare to post-emergent actions. Data on 40 days later seeding higher efficiency of weed cntrolling was noted in Pendimethalin by HW in 20 days later seeding. The minimum weed control efficiency was noted in Imazethapyr 20 days later seeding then Quizalofop-ethyl 20 days later seeding. Data on 60 days later seeding and harvest supreme weed control efficiency was noted Quizalofop-ethyl 20 days later seeding and 2 HW (20 then 40 days later seeding). The minimum WCE of *Boerhavia erecta* L. has been noted in single PE use of Pendimethalin then Pendimethalin combination by HW at 20 days later seeding as paralleled to the check.

Cumulative data in the years 2021 and 2022 shown in chart 4.58 and showed in fig 4.54 exposed that higher WCE of *Boerhavia erecta* L. has been noted in Pendimethalin by HW at 20 Days later seeding then 2 HW (20 then 40 days later seeding) over the Un-weeded. Data on 40 days later seeding heighest WCE was noted in Pendimethalin combination by HW on 20 days later seeding. Data on 60 days later seeding also harvest minimum weed control efficiency was noted in Pendimethalin then Pendimethalin by HW at 20 days later seeding and higher weed control efficiency was noted in Quizalofop-ethyl 20 days later seeding subsequently 2 HW (20 then 40 days later seeding) over the Un-weeded.



Graph 4.53. Influnce of herbicides on WCE of *Boerhavia erecta* L. in cowpea at 20 days intervals. (2021 and 2022)

Chart 4.59 Influnce of herbicides on WCE of *Parthenium hysterophorus* L. in cowpea at 20 days intervals. (2021 and 2022)

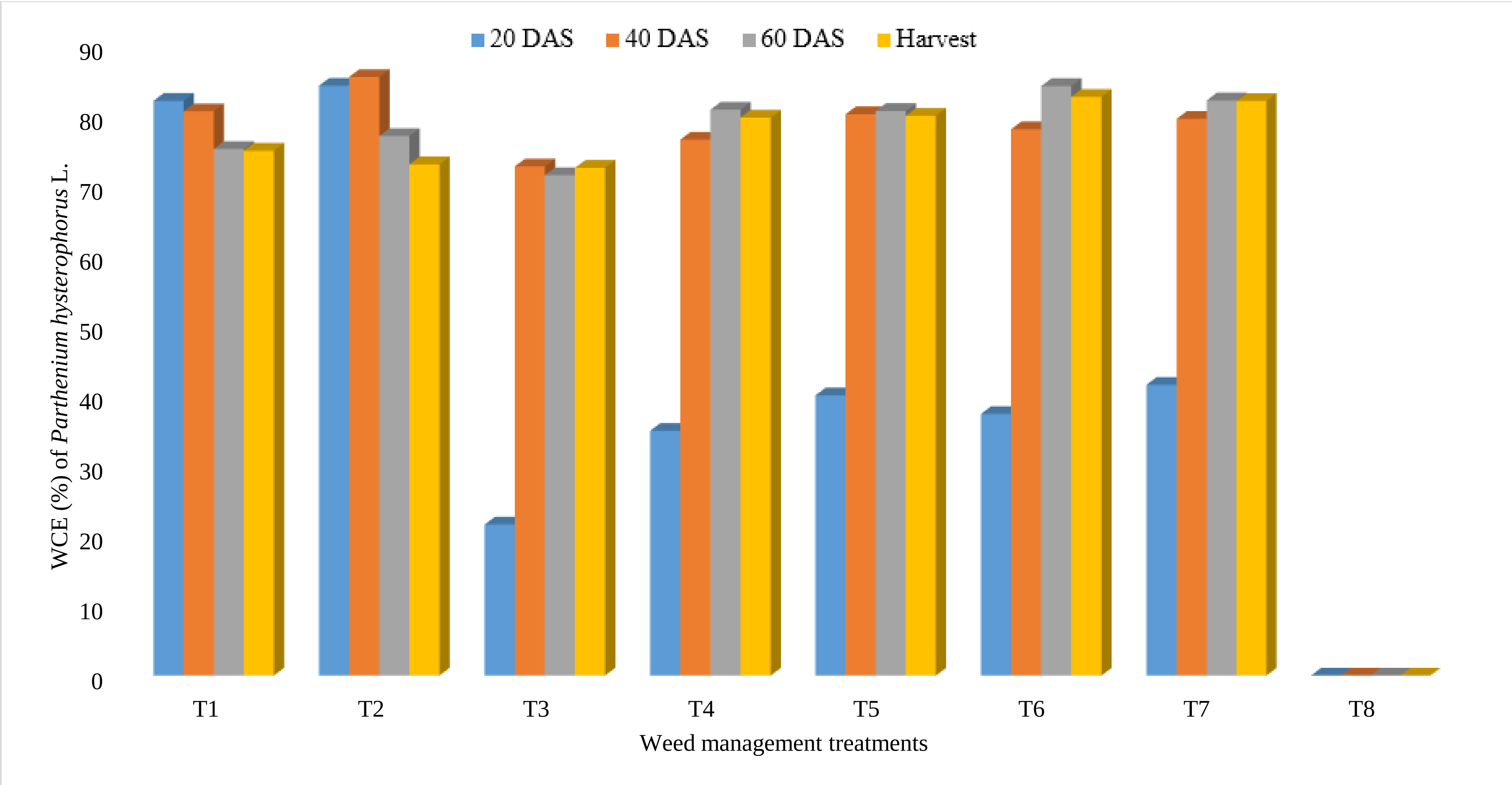
Treatments	20 DAS (2021)	20 DAS (2022)	Pooled data	40 DAS (2021)	40 DAS (2022)	Pooled data	60 DAS (2021)	60 DAS (2022)	Pooled data	Harvest (2021)	Harvest (2022)	Pooled data
T_1	82.00	82.27	82.13	81.30	80.00	80.65	75.86	74.66	75.26	73.33	78.46	75.02
T_2	84.50	84.09	84.29	86.08	85.00	85.54	77.24	77.00	77.12	66.67	79.49	73.08
T_3	30.00	13.36	21.68	73.91	71.66	72.78	72.41	70.66	71.53	72.00	71.17	72.58
T_4	32.50	37.72	35.11	76.95	76.25	76.60	82.75	81.00	81.87	80.00	79.49	79.74
T_5	38.50	41.81	40.15	80.86	79.58	80.22	81.03	80.33	80.68	80.00	83.07	80.00
T_6	35.00	40.00	37.50	78.26	77.91	78.08	84.82	83.66	84.24	83.33	82.05	82.69
T_7	40.00	43.36	41.68	80.00	79.16	79.58	82.06	82.33	82.19	83.33	81.34	82.12
T_8	-	-	-	-	-	-	-	-	--	-	-	-

4.4.4.5 *Parthenium hysterophorus* L.

The data concerning the WCE *Parthenium hysterophorus* L. effect ofvarious weed control methods at all observation phases in the years 2021 and 2022, as displayed in chart 4.59 while presented in graph 4.55, proved that weed control procedures had a major impact on WCE of *Parthenium hysterophorus* L. at all evaluation phases.

In the years 2021 and 2022 data show in chart 4.59 also showed in graph 4.55 at 20 days later seeding higher WCE of *Parthenium hysterophorus* L. was observed in Pendimethalin combination through HWs on 20 days later seeding besides Pendimethalin as compare to post-emergent usages. Data on 40 days later seeding heighest WCE was noted in Pendimethalin combination by HW at 20 days later seeding. While minimum WCE was noted in Imazethapyr 20 days later seeding then Quizalofop-ethyl 20 days later seeding. Data shown in 60 days later seeding further harvest higher WCE was noted Quizalofop-ethyl 20 days later seeding then 2 HW (20 then 40 days later seeding). Minimum WCE of *Parthenium* was noted in Un-weeded. Alike observations were also reported by Madukwe *et al*., (2012).

Cumulative data in the years 2021 and 2022 shown in chart 4.59 and depicted in geaaph 4.55 discovered that extreme WCE of *Parthenium* has been noted in Pendimethalin combination by HW on 20 days later seeding then HW twice (20 then 40 days later seeding) over the Un-weeded. data on 40, 60 also harvest higher WCE was noted in Pendimethalin combination by HW at 20 days later seeding then Pendimethalin asociated to other herbicidal treatments and minimum Imazethapyr 20 days later seeding then Quizalofop-ethyl 20 days later seeding over the Un-weeded.



Graph 4.55 Influnce of herbicides on WCE of *Parthenium hysterophorus* L. in cowpea at 20 days intervals. (2021 and 2022)

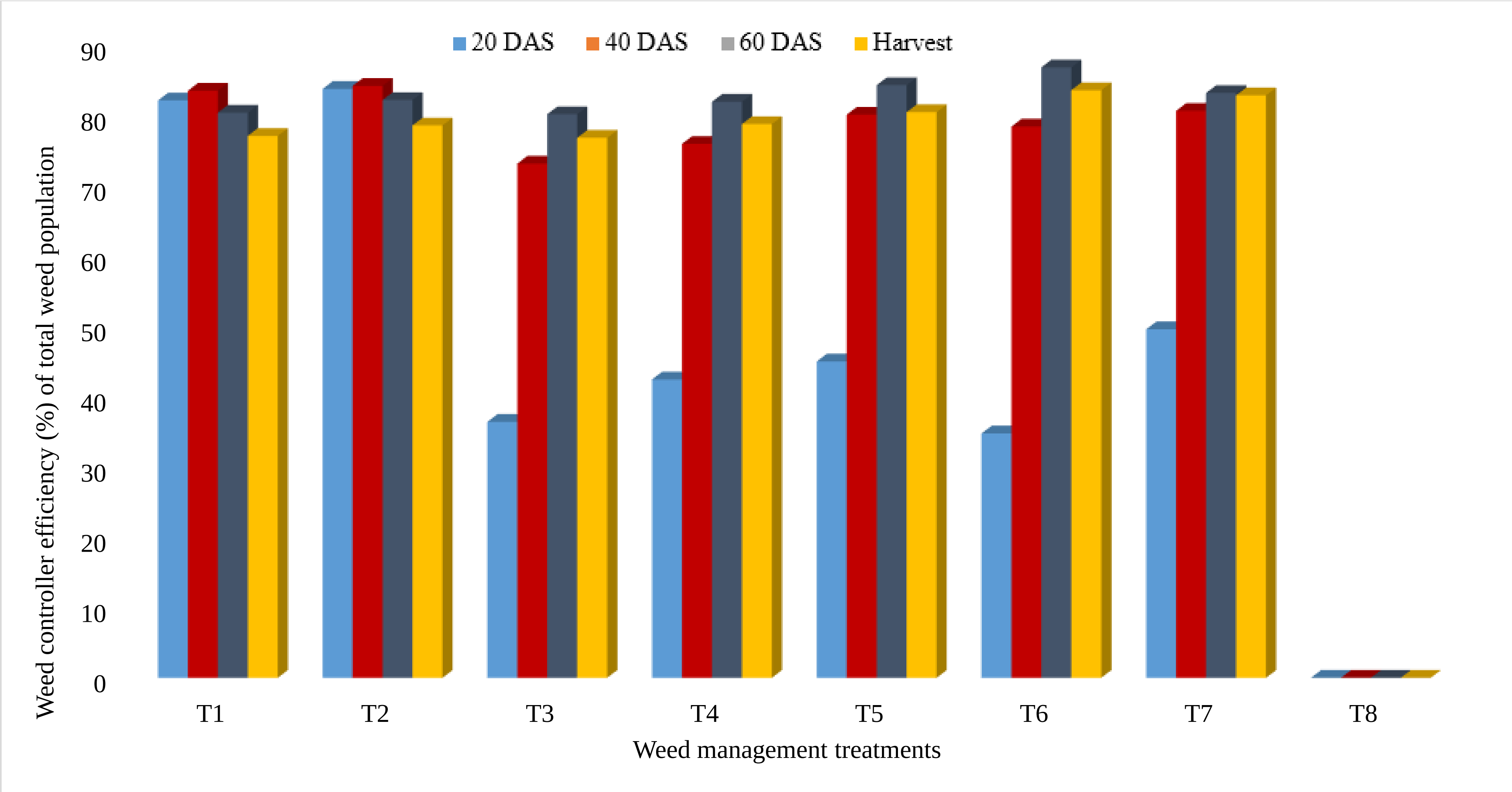
Chart 4.60 Influnce of herbicides on WCE of total weed population in cowpea at 20 days intervals. (2021 and 2022)

Treatments	20 DAS (2021)	20 DAS (2022)	Pooled data	40 DAS (2021)	40 DAS (2022)	Pooled data	60 DAS (2021)	60 DAS (2022)	Pooled data	Harvest (2021)	Harvest (2022)	Pooled data
T_1	81.11	83.33	82.22	79.87	87.34	83.60	79.24	81.71	80.47	79.06	75.28	77.17
T_2	82.72	85.02	83.87	83.25	85.34	84.29	81.13	83.43	82.28	80.93	76.39	78.66
T_3	34.26	38.67	36.46	70.60	75.86	73.23	82.07	78.46	80.26	81.39	72.43	76.91
T_4	40.20	44.75	42.47	73.91	78.18	76.04	83.49	80.57	82.03	83.25	74.47	78.86
T_5	42.30	47.77	45.03	78.55	81.86	80.20	84.90	83.38	84.39	84.65	76.45	80.55
T_6	43.35	26.25	34.80	76.38	80.65	78.51	85.84	87.98	86.91	86.51	80.84	83.67
T_7	45.03	54.19	49.61	78.97	82.51	80.74	85.37	81.20	83.28	86.04	79.87	82.95
T_8	-	-	-	-	-	-	-	-	-	-	-	-

4.4.4.6 Total WCE

The data concerning the WCE for total weed population effect ofvarious weed control procedures at all phases of observation in the years 2021 and 2022, as shown in chart 4.60 along by illustrated in fig 4.56, revealed that weed control procedures had an enormous impact on WCE of overall weed population at all assertion steps.

In the years 2021 and 2022 data show in chart 4.60 and depicted in graph 4.56 at 20 Days later seeding higher WCE of overall weed population was observed in Pendimethalin combination by HW on 20 days later seeding and Pendimethalin as compare to PoE actions. Data on 40 days later seeding extreme WCE was noted in Pendimethalin combination by HW on 20 days later seeding. While lowest WCE was noted in the treatment of Imazethapyr 20 days later seeding and Quizalofop-ethyl 20 days later seeding. Data on 60 days later seeding then harvest extreme WCE noted Quizalofop-ethyl 20 days later seeding then 2 HW (20 then 40 Days later seeding). In pre- emergence treatments at 20 days later seeding recorded higher weed control efficacy in comparison to post emergence treatments. The dry weightof weeds in treated plots compared to weedy control plots, reported as a percentage, is the foundation for determining the efficiency of weed management. At 40 days later seeding WCE is highest Pendimethalin 0.700 kg/ha PE + HW because this treatment arrest weed species at early and later stage of crop growth resulted lowest weed dry biomass Such an notes were also stated by Madukwe *et al*., (2012) and Madukwe *et al*., (2012).



Graph 4.56 Influnce of herbicides on WCE of total weed population in cowpea at 20 days intervals. (2021 and 2022)

Chart 4.61 Effect of herbicide residues on germination percentage of Cucumber (days after treatment) (2021 and 2022)

Treatments	30 DAT (2021)	30 DAT (2022)	Pooled data	60 DAT (2021)	60 DAT (2022)	Pooled data	Harvest 2021	Harvest 2022	Pooled data
T_1	48.46	49.16	48.81	61.22	62.14	61.68	74.24	75.44	74.84
T_2	45.26	46.22	45.74	64.76	65.46	65.11	76.31	77.29	76.80
T_3	80.20	81.13	80.67	49.22	50.54	49.88	65.71	67.18	66.45
T_4	81.44	82.27	81.86	45.32	46.38	45.85	67.33	70.44	68.89
T_5	46.12	47.29	46.71	74.57	76.64	75.61	81.39	82.18	81.79
T_6	80.44	80.22	80.33	48.12	50.52	49.32	62.84	63.46	63.15
T_7	85.70	86.23	85.97	84.71	85.89	85.30	85.61	86.29	85.95
T_8	85.80	86.46	86.13	86.21	86.77	86.49	87.23	87.54	87.39
SEm (±)	**0.61**	**0.83**	**0.72**	**0.75**	**0.94**	**0.85**	**0.90**	**0.89**	**0.90**
CD (p=0.05)	**1.84**	**2.51**	**2.51**	**2.29**	**2.84**	**2.57**	**2.72**	**2.71**	**2.72**

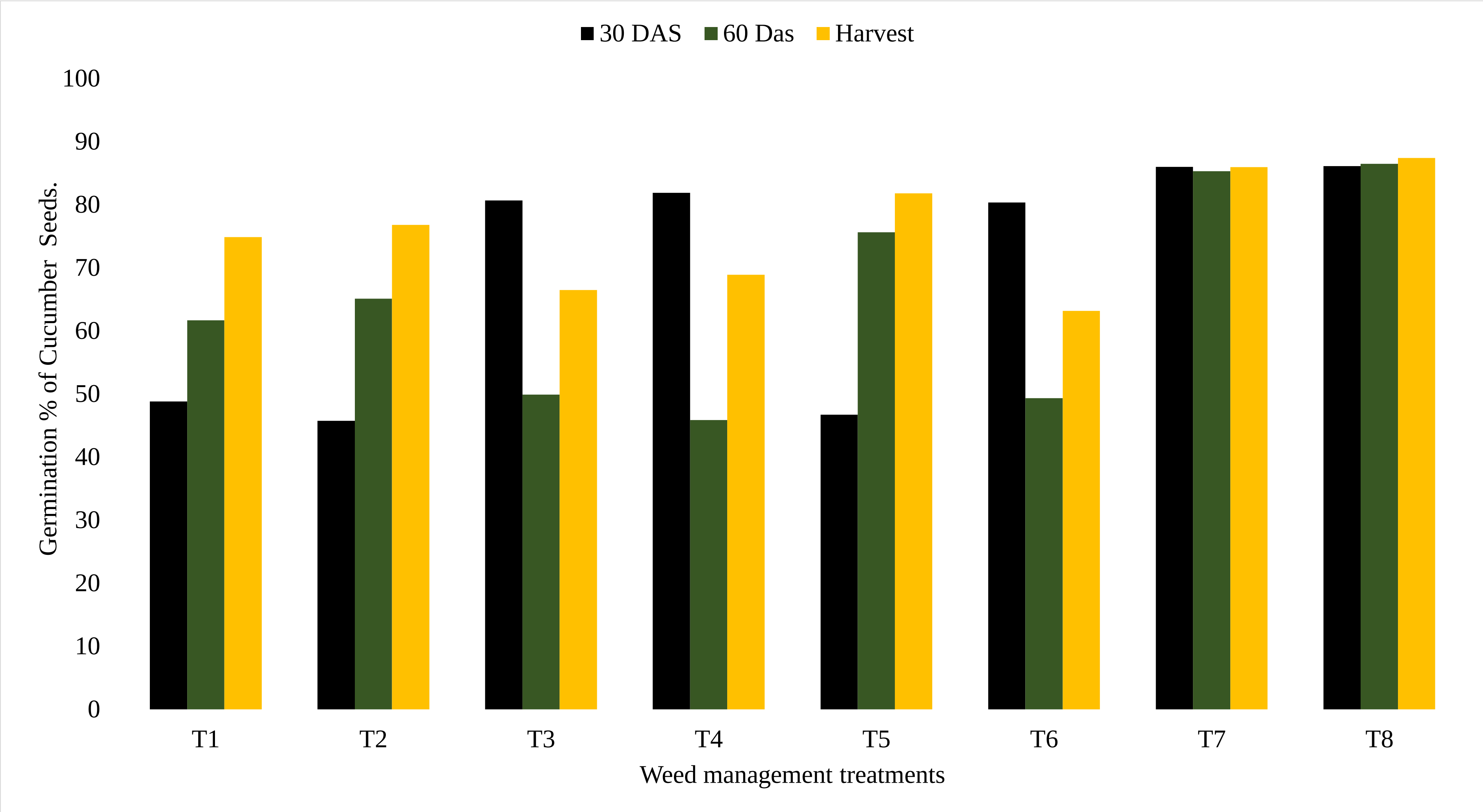
4.4. Herbicide persistence study

4.4.4.7 Germination percentage of cucumber seeds

The data concerning the germination percentage of cucumber effect ofdissimilar weed control treatments at all phases of observations are shown in charts 4.61 and 4.57.

In the years 2021 and 2022, the data shown in chart 4.61 and graph 4.57 at 30 days later seeding indicated that the minimum germination percentage of cucumber seeds was noted in the pre-emergent use of pendimethalin and then pendimethalin combination by HW at 20 days later seeding. The higher germination percentage of cucumber seeds was noted in PoE treatments. 60 days after seeding, the highest germination percentage of cucumber seeds was noted in HW as being associated by herbicidal actions. Among the PoE herbicidal treatments noted, a minimum germination percentage was noted because of herbicidal residue active in the soil. At harvest, all herbicidal treatments noted an average germination percentage of cucumber seeds. The minimum germination percentage observed in Imazethapyr 20 days later seeding and subsequently in Quizalofop-ethyl 20 days later seeding was associated by further treatments.

Cumulative data shown in the years 2021 and 2022 shown in charts 4.61 and 4.57 indicated that the 30 days later seeding PE herbicides highly remain active in soil, resulting in a minimum germination percentage of cucumber seed over another treatment. 60 days later, the minimum germination percentage of cucumber seeds was noted in the PoE treatment as compared to the PE treatment. The highest germination percentage was noted in hand-weeding and un-weeding. At harvest, a lower average germination percentage was observed in all chemical treatments because of the lower herbicidal concentration present in the soil.



Graph 4.57 Effect of herbicide residues on germination percentage of Cucumber (days after treatment) (Pooled data 2021 and 2022)

Chart 4.62 Effect of herbicide residues on root length (cm) of Cucumber at 10 DAS. (2021 and 2022)

Treatments	30 DAT (2021)	30 DAT (2022)	Pooled data	60 DAT (2021)	60 DAT (2022)	Pooled data	Harvest 2021	Harvest 2022	Pooled data
T_1	3.47	3.52	3.50	4.86	4.76	4.81	4.94	4.89	4.92
T_2	3.22	3.29	3.26	4.91	4.85	4.88	4.95	4.92	4.94
T_3	5.80	5.86	5.83	3.77	3.71	3.74	4.60	4.63	4.62
T_4	5.44	5.51	5.48	3.54	3.57	3.56	4.77	4.72	4.75
T_5	3.39	3.42	3.41	4.72	4.74	4.73	4.91	4.87	4.89
T_6	5.57	5.61	5.59	3.94	3.90	3.92	4.68	4.70	4.69
T_7	5.78	5.85	5.82	5.80	5.76	5.78	5.93	5.86	5.90
T_8	5.86	5.88	5.87	5.86	5.89	5.88	5.96	5.91	5.94
SE(m±)	**0.62**	**0.40**	**0.51**	**0.69**	**0.50**	**0.60**	**0.73**	**0.54**	**0.64**
CD (p=0.05)	**1.87**	**1.21**	**1.54**	**2.10**	**1.53**	**1.82**	**2.21**	**1.63**	**1.92**

4.4.4.4.7 Root length (cm) of Cucumber

The data concerning the root length was effect ofdissimilar weed control actions at all stages of observations, as accessible in charts 4.62 and 4.58.

In the years 2021 and 2022, the data shown in charts 4.62 and 4.58 at 30 days later seeding specified that the minimum root length of cucumber seeds was logged in the PE use of pendimethalin and pendimethalin combination by HW at 20 days later seeding. The higher root length of cucumber seeds was noted in PoE treatments. 60 days after seeding, the heaviest root length of cucumber seeds was noted in HW as associated by herbicidal treatments. Among the PoE herbicidal actions noted, minimum root length was noted because of herbicidal residue active in the soil. At harvest, all herbicidal treatments noted the average root length of cucumber seeds. The minimum root length observed in Imazethapyr 20 days later seeding and subsequently Quizalofop-ethyl 20 days later seeding as associated by other treatments

Cumulative data shown in the years 2021 and 2022 shown in charts 4.62 and 4.58 indicated that the 30 days later seeding PE herbicides highly remain active in soil, resulting in minimum root length of cucumber seed in Pendimethalin, then Pendimethalin combination by HW at 20 days later seeding over another treatment. At 60 days later seeding, the minimum root length of cucumber seeds was noted in the PoE treatment Imazethapyr (20 days later seeding), subsequently Quizalofop-ethyl 50 (20 days later seeding), and Quizalofop-ethyl 40 (20 days later seeding) as compared to PE treatments. The superior root length was noted in hand-weeding and un-weeding. At harvest, a shorter average root length was observed in all chemical treatments due to the lower herbicidal concentration present in the soil.

.

Graph 4.58 effect of herbicide residues on germination percentage of Cucumber (cm) of Cucumber at 10 DAS. (Pooled data 2021 and 2022)

Chart 4.63 Effect of herbicide residues on shoot length (cm) of Cucumber at 10 DAS. (2021 and 2022)

Treatments	30 DAT (2021)	30 DAT (2022)	Pooled data	60 DAT (2021)	60 DAT (2022)	Pooled data	Harvest 2021	Harvest 2022	Pooled data
T_1	2.87	2.85	2.86	3.78	3.75	3.77	4.33	4.38	4.36
T_2	2.71	2.69	2.70	3.89	3.85	3.87	4.42	4.40	4.41
T_3	5.37	5.35	5.36	2.88	2.91	2.90	3.95	3.91	3.93
T_4	4.37	4.66	4.52	2.56	2.60	2.58	3.99	4.01	4.00
T_5	3.81	3.82	3.82	4.77	4.79	4.78	4.81	4.77	4.79
T_6	4.76	4.77	4.77	2.96	2.99	2.98	4.27	4.32	4.30
T_7	4.85	4.80	4.83	4.76	4.85	4.81	4.79	4.84	4.82
T_8	4.91	4.87	4.89	4.96	4.94	4.95	4.98	4.85	4.92
SE(m±)	**0.37**	**0.45**	**0.41**	**0.42**	**0.65**	**0.54**	**0.58**	**0.62**	**0.60**
CD (p=0.05)	**1.13**	**1.36**	**1.25**	**1.28**	**1.97**	**1.63**	**1.77**	**1.87**	**1.82**

.

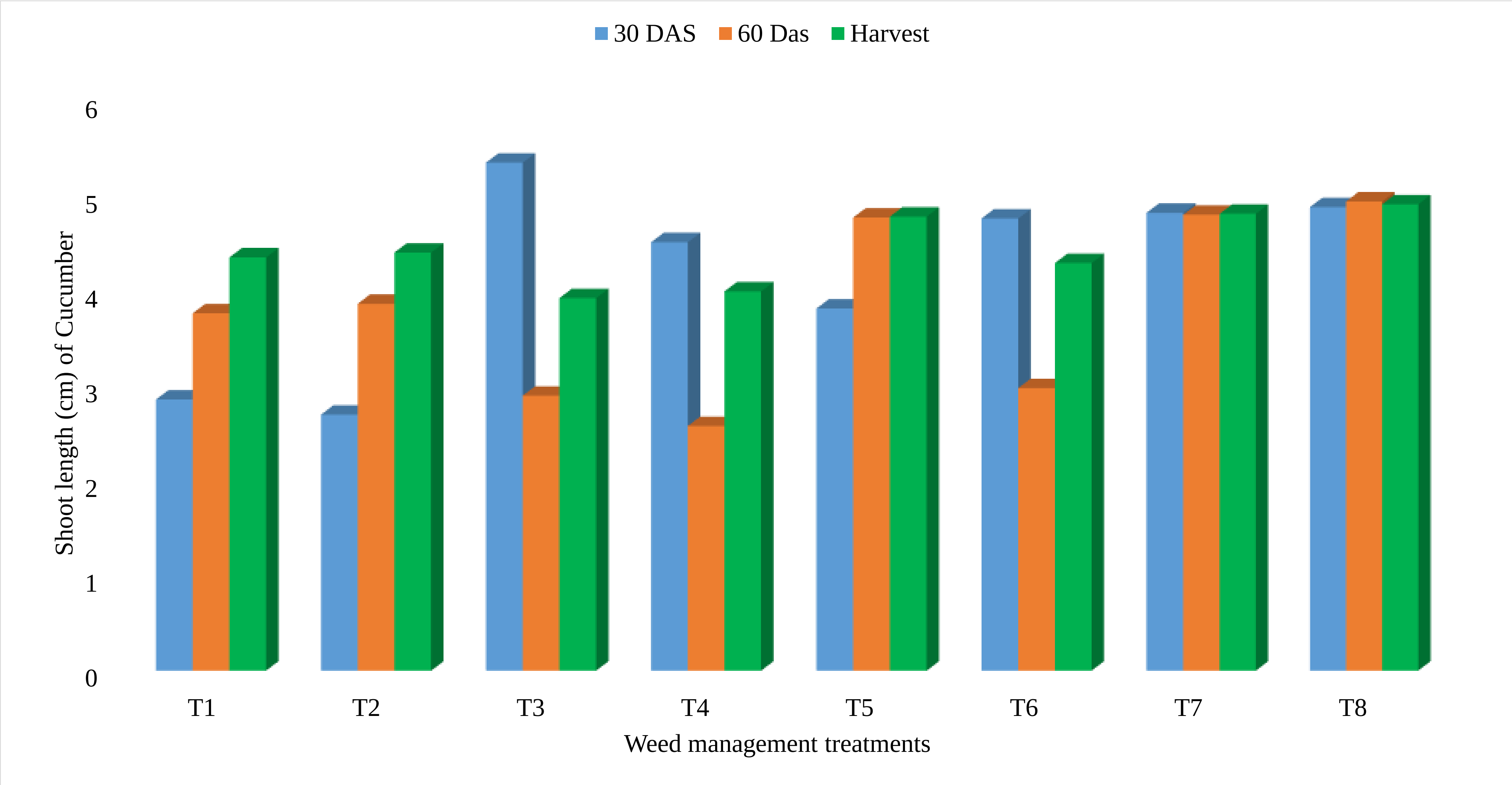
4.4.4.8 Stem length (cm) of Cucumber

The data concerning the shoot length was subjective due to dissimilar weed control actions at all stages of observations, as accessible in charts 4.63 and 4.59.

In the years 2021 and 2022, the data shown in charts 4.63 and 4.59 at 30 days later seeding showed that the minimum shoot length of cucumber seeds was noted in the PE use of pendimethalin, followed by a pendimethalin mixture by HW at 20 days later seeding. The higher shoot length of cucumber seeds was noted in PoE treatments. 60 days after seeding, the heaviest shoot length of cucumber seeds was noted in HW as associated by herbicidal treatments. Among the PoE herbicidal actions, a minimum shoot length was noted because of herbicidal residue active in the soil. At harvest, all herbicidal treatments noted the average shoot length of cucumber seeds. The minimum shoot length observed in Imazethapyr 20 days later after seeding subsequently Quizalofop-ethyl 20 days later, seeding was associated by further treatments.

Cumulative data shown in the years 2021 and 2022 shown in chart 4.63 and graph 4.59 indicated that the 30 days later seeding PE herbicides highly remain active in soil, resulting in minimum shoot length of cucumber seed in Pendimethalin, then Pendimethalin combination by HW at 20 days later seeding over another treatment. At 60 days later seeding, the minimum shoot length of cucumber seeds was noted in the PoE treatment Imazethapyr (20 days later seeding), subsequently Quizalofop-ethyl (20 days later seeding), and Quizalofop-ethyl (20 days later seeding) as compared to PE treatments. The higher shoot length was noted in hand-weeding and un-weeding. At harvest, a lower average shoot length was observed in all chemical treatments because of the lower herbicidal concentration present in the soil.

.



Graph 4.59 Effect of herbicide residues on germination percentage of Cucumber (cm) of Cucumber at 10 DAS. (Pooled data 2021 and 2022)

Chart 4.64. Influnce of herbicides on plant count of cowpea (m^2) at 30 days. (2021 and 2022)

Treatments	30 DAS (2021)	30 DAS (2022)	Pooled data
T_1	29	29	29
T_2	29	28	28.5
T_3	29	29	29
T_4	27	27	27
T_5	27	25	26
T_6	28	29	28.5
T_7	28	28	28
T_8	27	29	28
SEm (±)	**0.36**	**1.12**	**0.74**
CD (p=0.05)	**1.08**	**3.40**	**2.24**

4.5 Study on Cowpea

4.5.1 Plant population

The data concerning the crop stand of cowpea is shown in Chart 4.64 and Picture 4.60, as influenced by various weed control treatments that considerably enhance the crop stand of cowpea above the un-weeded. Weed control practices had no effect on plant populations from germination to harvest.

The cumulative data for 2021 and 2022 is shown in charts 4.64 and 4.60. A heaviest crop stand (m^2) was noted in PE treatment because of the arrest of the weeds at the initial growth stage as associated by PoE herbicide over the un-weeded.

.

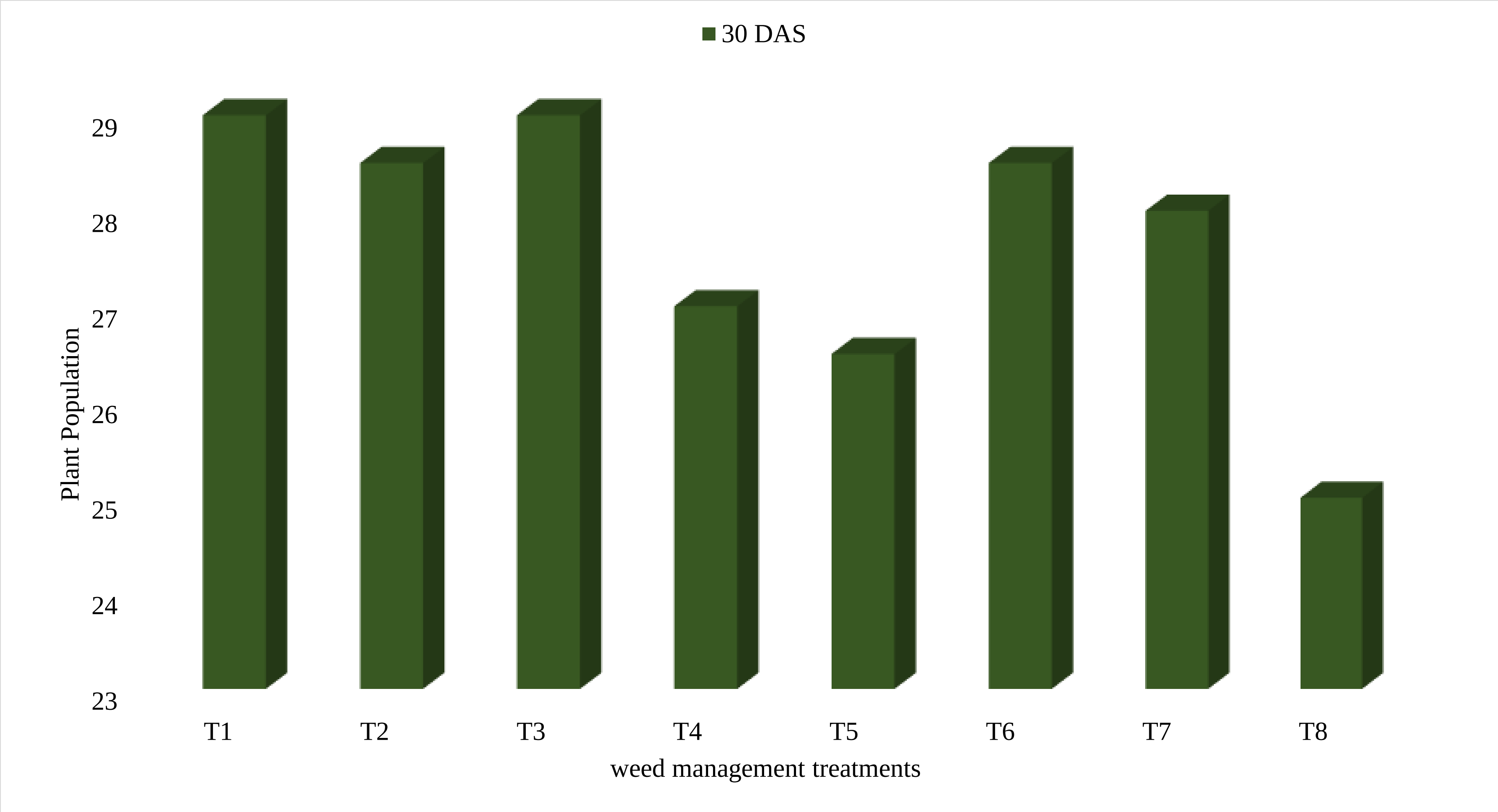


Fig 4.60 Influnce of herbicides on plant count of cowpea (m^2) at 30 days. (2021 and 2022)

Chart 4.65 Influnce of herbicides on Plant height of cowpea at 20 days intervals. (2021 and 2022).

Treatments	20 DAS (2021)	20 DAS (2022)	Pooled data	40 DAS (2021)	40 DAS (2022)	Pooled data	60 DAS (2021)	60 DAS (2022)	Pooled data	Harvest (2021)	Harvest (2022)	Pooled data
T_1	34.7	35.12	34.91	52.80	53.24	53.02	58.22	59.24	58.73	59.00	59.35	59.18
T_2	35.2	36.10	35.65	53.70	54.17	53.93	60.16	60.76	60.46	60.50	60.79	60.65
T_3	30.3	30.40	30.35	48.00	49.10	48.55	51.44	51.59	51.51	52.55	51.64	52.10
T_4	30.55	30.60	30.57	49.40	49.60	49.50	56.14	56.27	56.20	56.21	56.31	56.26
T_5	33.10	33.12	33.11	51.30	51.68	51.49	58.12	58.21	58.16	58.17	58.28	58.23
T_6	32.20	32.41	32.30	50.20	50.77	50.48	55.47	56.13	55.8	55.13	56.24	55.69
T_7	33.00	33.24	33.12	50.42	50.52	50.47	56.66	56.76	56.71	56.79	56.79	56.79
T_8	26.50	27.41	26.95	44.10	45.31	44.70	48.13	49.18	48.65	51.11	50.44	50.78
SEm (±)	**0.43**	**0.45**	**0.44**	**0.49**	**0.72**	**0.60**	**0.64**	**0.66**	**0.65**	**0.77**	**0.69**	**0.73**
CD (p=0.05)	**1.29**	**1.38**	**1.34**	**1.48**	**2.18**	**1.83**	**1.95**	**2.00**	**1.98**	**2.34**	**2.11**	**2.23**

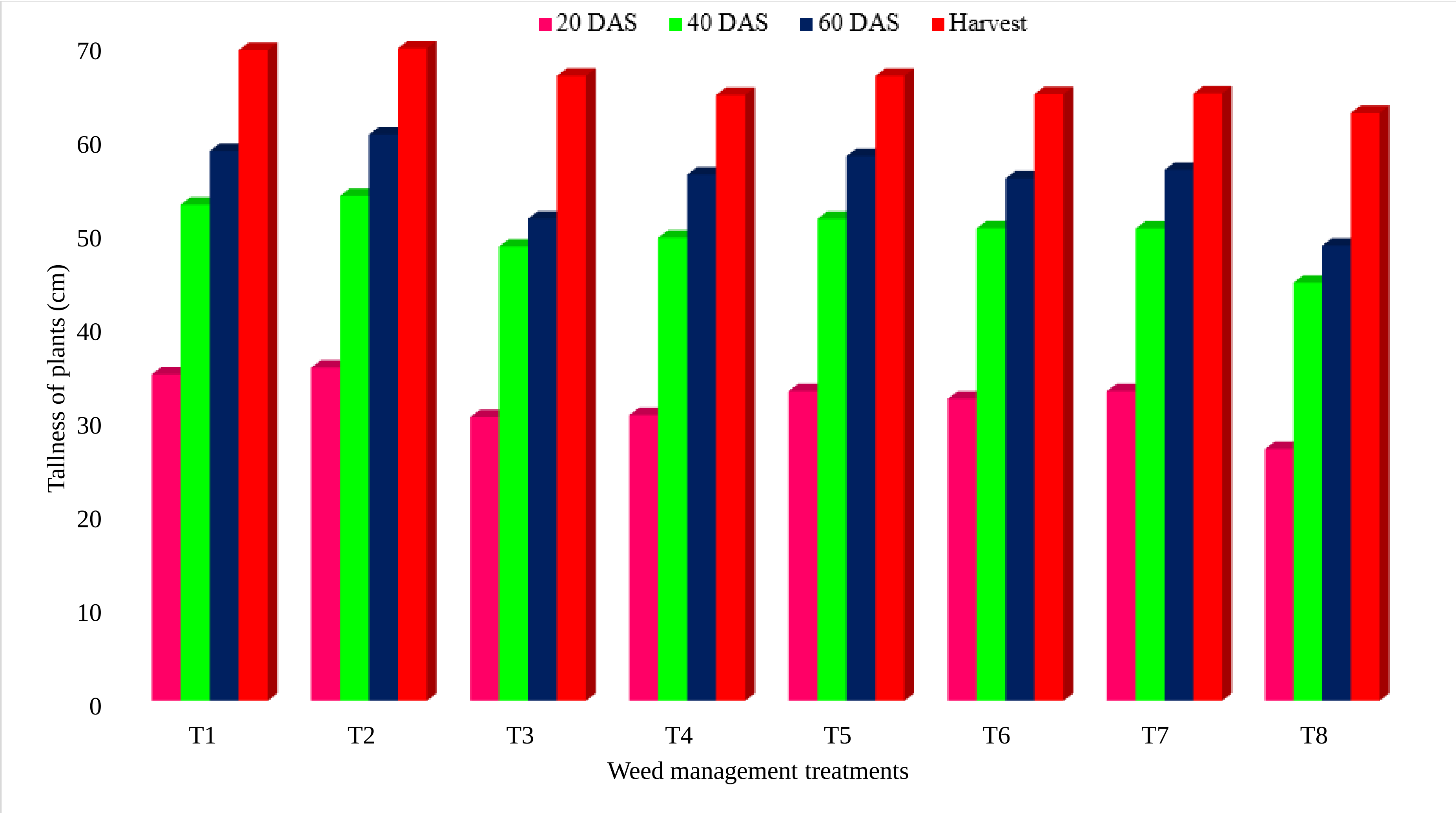
4.5.2 Plant height (cm)

Different weed management methods substantially impacted plant height data at all phases of observation, as shown in charts 4.65 and 4.61.

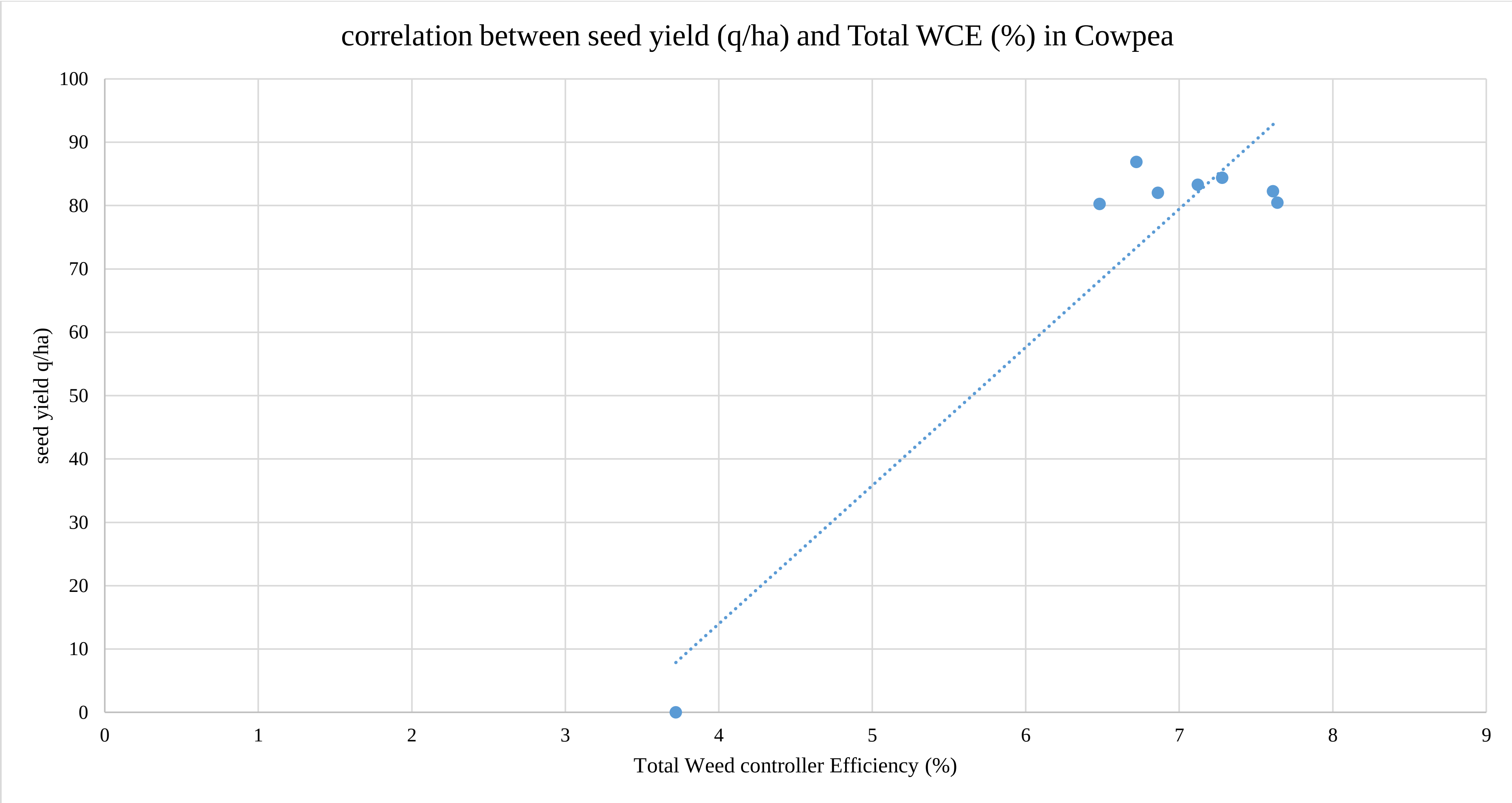
In the years 2021 and 2022, the data shown in charts 4.65 and 4.61 at 20 days later seeding Plant height at several stages of crop growth exposed that all the weed management observations suggestively increased the plant height compared to un-weeded. taller plants were observed in the pre-emergent use of pendimethalin at that time, and the pendimethalin mixture by HW on 20 days later seeding was associated by the repose of the actions above un-weeded. Data on 40 days later seeding showed higher plant height in the pendimethalin arrangement by HW on 20 days later seeding. Data on 60-day later seeding and harvest showed minimum plant height was noted in Imazethapyr 20-day later seeding and Quizalofop-ethyl 20-day later seeding. Similar opinions were similarly stated by Madukwe *et al.* (2012) and Sasode *et al*. (2020).

The cumulative data shown in the years 2021 and 2022 shown in charts 4.65 and 4.61 indicated that at 30 days after seeding, extreme plant height was noted in PE usage as associated by post-emergent treatment. In the presented data on 40-day later seeding, the minimum plant height was noted in Imazethapyr (20-day later seeding) and Quizalofop-ethyl (20-day later seeding). Data on 60-day later seeding also showed significant harvest for all herbicidal treatments noted average plant height by pendimethalin combination by HW at 20-day later seeding. Such minimum plant height was noted in Imazethapyr 20 days later seeding plus Quizalofop-ethyl 20 days later seeding over the un-weeded.

.



Graph 4.61 Influnce of herbicides on Plant height of cowpea at 20 days intervals. (2021 and 2022).



r=0.98

Fig: 4.61 (a) Correlation between seed yield (q/h) and Total WCE (%) In Cowpea

Chart 4.66 Influnce of herbicides on branches/plant of cowpea at 20 days intervals. (2021 and 2022)

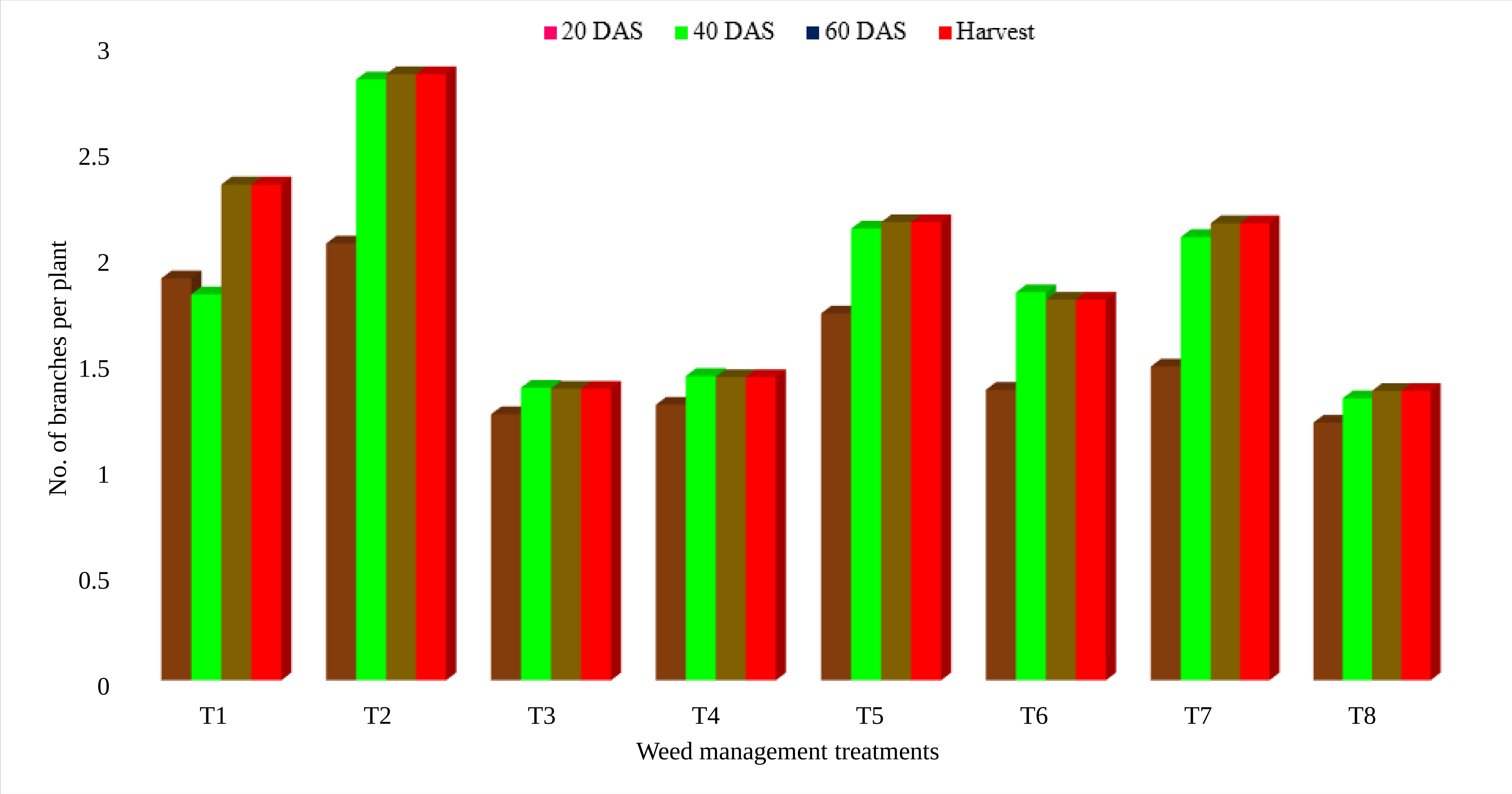
Treatments	20 DAS (2021)	20 DAS (2022)	Pooled data	40 DAS (2021)	40 DAS (2022)	Pooled data	60 DAS (2021)	60 DAS (2022)	Pooled data	Harvest (2021)	Harvest (2022)	Pooled data
T_1	1.88	1.91	1.89	2.30	1.34	1.82	2.33	2.35	2.34	2.33	2.37	2.34
T_2	2.00	2.12	2.06	2.80	2.87	2.83	2.84	2.88	2.86	2.84	2.86	2.86
T_3	1.24	1.27	1.25	1.35	1.41	1.38	1.36	1.39	1.37	1.36	2.37	1.37
T_4	1.29	1.31	1.3	1.40	1.47	1.43	1.44	1.42	1.43	1.44	1.47	1.43
T_5	1.70	1.76	1.73	2.10	2.16	2.13	2.13	2.19	2.16	2.12	2.17	2.16
T_6	1.35	1.39	1.37	1.77	1.89	1.83	1.79	1.80	1.79	1.78	1.76	1.79
T_7	1.46	1.50	1.48	2.00	2.18	2.09	2.12	2.19	2.15	2.14	2.20	2.15
T_8	1.20	1.23	1.215	1.32	1.34	1.33	1.35	1.38	1.36	1.35	1.41	1.36
SEm (±)	**0.16**	**0.11**	**0.14**	**0.23**	**0.20**	**0.22**	**0.22**	**0.24**	**0.23**	**0.25**	**0.22**	**0.24**
CD (p=0.05)	**0.49**	**0.35**	**0.42**	**0.69**	**0.60**	**0.65**	**0.66**	**0.74**	**0.70**	**0.76**	**0.66**	**0.71**

4.5.3 No. of branches per plant

The data concerning branching per plant is associated by different weed control treatments at the overall stages of observations in charts 4.66 and 4.62.

In the years 2021 and 2022, the data shown in charts 4.66 and 4.62 on 20 and 40 days later seeding showed the maximum number of branches per plant in Pendimethalin combination by HW at 20 days later seeding than Pendimethalin. Also, minimum branching in every plant was noted in the use of Imazethapyr 20 days later seeding and Quizalofop-ethyl 20 days later seeding as associated by the un-weeded. Data on 60 days later seeding plus harvesting the minimum branches of every plant was renowned in Imazethapyr 20 days later seeding, then Quizalofop-ethyl 20 days later seeding, then the heaviest was noted in Pendimethalin combination by HW at 20 days later seeding over the weedy. The consequences imitate the outcomes of Radhey Shyam *et al*. (2014).

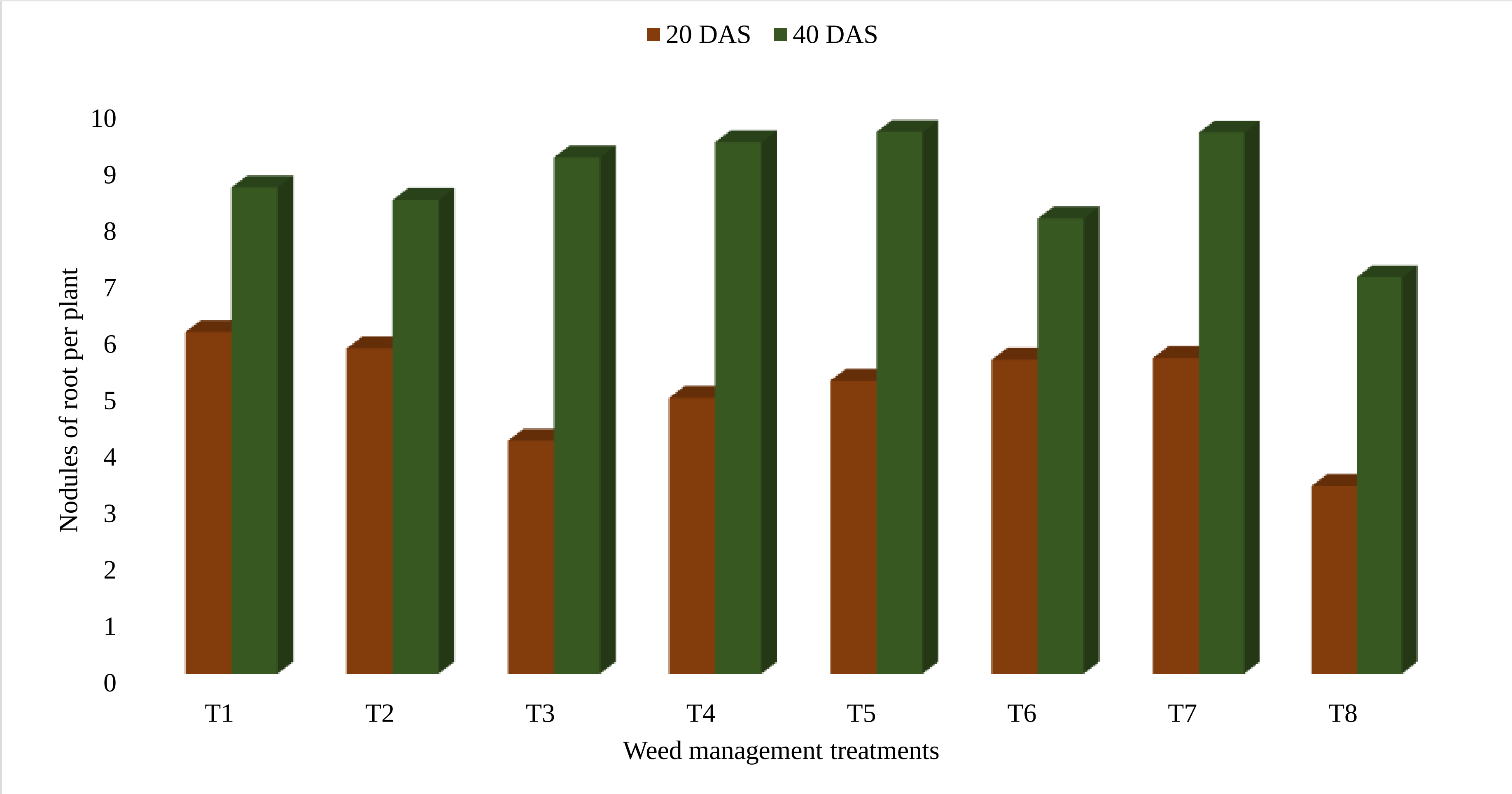
The cumulative data shown in the years 2021 and 2022 shown in charts 4.66 and 4.62 indicated that at 20 days after seeding, the heaviest branches per plant were noted in PE treatment as associated by PoE action. Data on 40-day later seeding showed that the minimum number of branches per plant was noted in Imazethapyr 20-day later seeding and Quizalofop-ethyl 20-day later seeding. Higher branching per plant was noted in Pendimethalin combination by HW on 20 days later seeding and HW (20 and 40 days later seeding). Data on 60 days later seeding and harvesting all herbicidal usages noted number of branches per plant Pendimethalin combination by HW at 20 days later seeding and Pendimethalin. The minimal number of branches per plant was noted in Imazethapyr 20 days later seeding and Quizalofop-ethyl 20 days later seeding over the unweeded.



Graph 4.62 Influnce of herbicides on branches/plant of cowpea at 20 days intervals. (2021 and 2022).)

Chart 4.67 Influnce of herbicides on nodules /plant of cowpea at 20 and 40 days intervals. (2021 and 2022)

Treatments	20 DAS (2021)	20 DAS (2022)	Pooled data	40 DAS (2021)	40 DAS (2022)	Pooled data
T_1	5.78	6.32	6.05	8.60	8.62	8.61
T_2	6.11	5.41	5.76	8.41	8.36	8.39
T_3	4.00	4.24	4.12	9.10	9.17	9.14
T_4	4.44	5.32	4.88	9.40	9.42	9.41
T_5	5.19	5.19	5.19	9.70	9.48	9.59
T_6	5.00	6.12	5.56	8.00	8.12	8.06
T_7	5.50	5.67	5.59	9.30	9.86	9.58
T_8	3.20	3.44	3.32	7.00	7.03	7.02
SEm (±)	**0.32**	**0.30**	**0.31**	**0.35**	**0.44**	**0.40**
CD (p=0.05)	**0.98**	**0.92**	**0.95**	**1.06**	**1.34**	**1.20**



Graph 4.63 Influnce of herbicides on root nodules /plant of cowpea at 20 and 40 days intervals. (2021 and 2022)

4.5.4 Nodulations of root/plant

The data concerning the root nodules and plant is influenced by different weed control actions at all phases of observations in charts 4.67 and 4.63.

In the years 2021 and 2022, the data shown in chart 4.67 and graph 4.63 at 20 days later seeding show a significant number of root nodules per plant observed in the pre-emergent use of pendimethalin in combination by HW on 20 days later seeding and pendimethalin as associated by the next treatments over the unweeded. Data on 40 days later seeding showed a higher number of root nodules per plant in Pendimethalin combination by HW on 20 days later seeding plus single use of Pendimethalin. The minimum number of root nodules per plant was noted by the use of Imazethapyr 20 days after seeding. Higher nodules in Pendimethalin in combination by HW 40 days later after seeding may be due to weed suppression for a longer period, better soil aeration, and soil structural manipulation. Subsequently, for pure weed control by hand measures, pendimethalin was the best-performing medication. Herbicides also reduced symbiotic activity in lentils, according to Ahemad and Khan et al. (2010). Related outcomes were found by Silva et al. (2003) and Chatta et al. (2007).

The cumulative data shown in the years 2021 and 2022 shown in chart 4.67 and graph 4.63 indicated that at 20 days later seeding, the highest root nodules per plant were noted in PE treatment by pendimethalin in combination by HW on 20 days later seeding and pendimethalin as compared to post-emergent action. Data on 40 days later seeding showed that the minimum number of root nodules per plant was noted in Imazethapyr 20 days later seeding. The heaviest number of root nodules per plant was noted in pendimethalin combination by HW at 20 days after seeding over the check.

Chart 4.68 Influnce of herbicides on leaf area index of cowpea at 20 days intervals. (2021 and 2022)

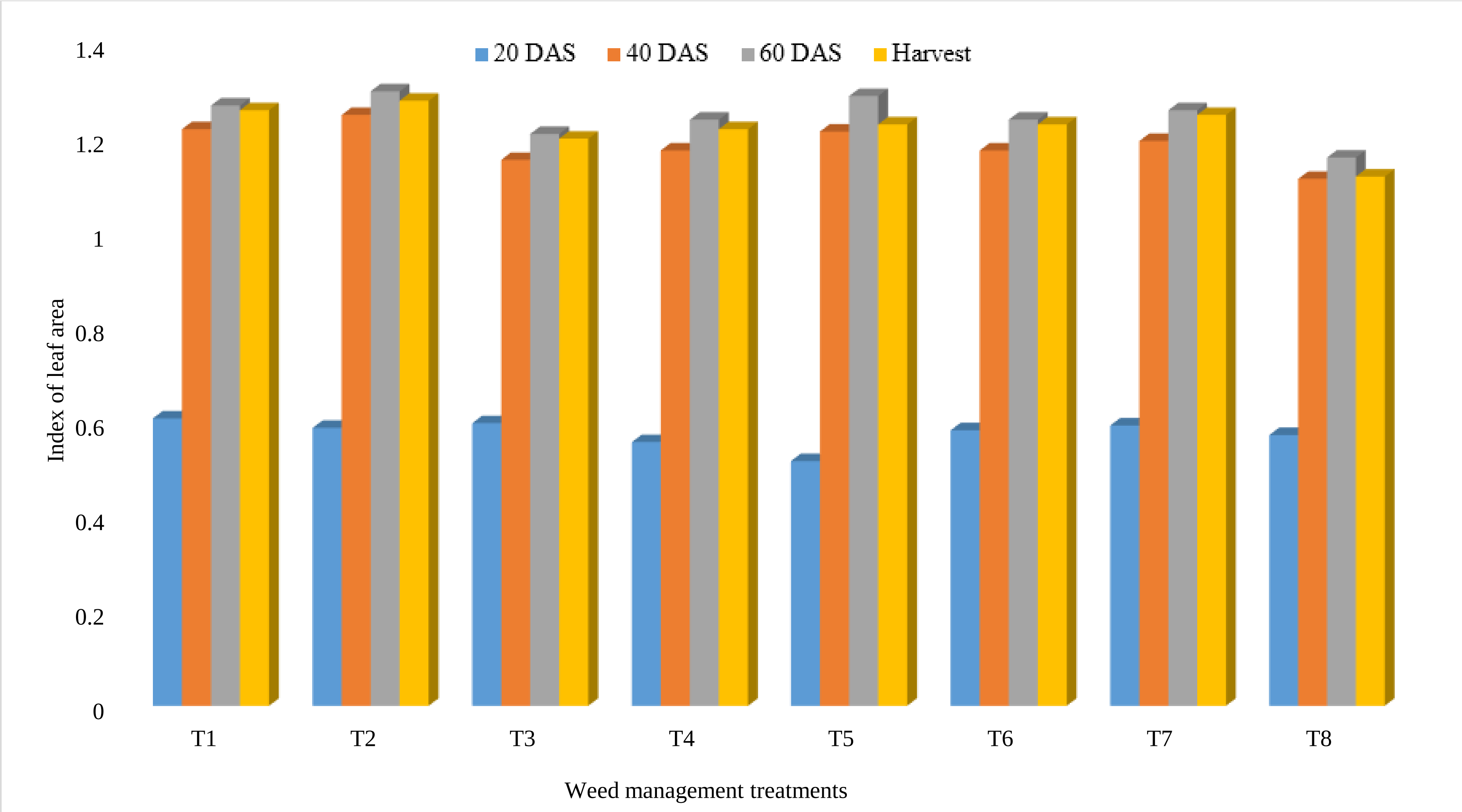
Treatments	20 DAS (2021)	20 DAS (2022)	Pooled data	40 DAS (2021)	40 DAS (2022)	Pooled data	60 DAS (2021)	60 DAS (2022)	Pooled data	Harvest (2021)	Harvest (2022)	Pooled data
T_1	0.60	0.62	0.61	1.20	1.24	1.22	1.26	1.28	1.27	1.24	1.27	1.26
T_2	0.58	0.60	0.59	1.24	1.26	1.25	1.30	1.30	1.30	1.29	1.27	1.28
T_3	0.59	0.61	0.6	1.14	1.17	1.15	1.19	1.23	1.21	1.17	1.22	1.20
T_4	0.55	0.57	0.56	1.16	1.19	1.17	1.22	1.25	1.24	1.20	1.24	1.22
T_5	0.51	0.53	0.52	1.21	1.22	1.21	1.28	1.29	1.29	1.19	1.26	1.23
T_6	0.57	0.60	0.58	1.17	1.18	1.17	1.23	1.24	1.24	1.22	1.23	1.23
T_7	0.58	0.61	0.59	1.19	1.20	1.19	1.25	1.26	1.26	1.24	1.25	1.25
T_8	0.57	0.58	0.57	1.11	1.12	1.11	1.14	1.17	1.16	1.12	1.11	1.12
SEm (±)	**0.04**	**0.03**	**0.04**	**0.18**	**0.11**	**0.15**	**0.26**	**0.16**	**0.21**	**0.29**	**0.17**	**0.23**
CD (p=0.05)	**0.11**	**0.10**	**0.11**	**0.55**	**0.33**	**0.44**	**0.79**	**0.48**	**0.64**	**0.88**	**0.53**	**0.71**

4.5.5 (LAI) Leaf area Index

The data concerning the leaf area index is effect ofdifferent weed control actions at all phases of observations in charts 4.68 and 4.64.

In the years 2021 and 2022, the data shown in charts 4.68 and 4.64 on 20-day later seeding show a substantial index of leaf area observed in the PE Pendimethalin and Imazethapyr 20-day later seeding as compared to other treatments over the un-weeded. On 40 days later seeding, the highest index of leaf area was noted in Pendimethalin combination by HW on 20 days later seeding, followed by Metolachlor combined by HW on 20 days later seeding. A higher index of leaf area was noted in the use of Imazethapyr 20 days later seeding than Quizalofop-ethyl 20 days later seeding as associated by the un-weeded. Data on 60 days later seeding and harvest showed that the minimum index of leaf area was noted in Imazethapyr 20 days later seeding and Quizalofop-ethyl 20 days later seeding, and the heaviest index of leaf area was noted in Pendimethalin combination by HW on 20 days later seeding over the check.

The cumulative data shown in the years 2021 and 2022 shown in chart 4.68 and graph 4.64 indicated that on 20 days later seeding, the extreme index of leaf area was noted in pre-emergent action as associated by PoE treatment, and after 40 days later seeding, the minimum index of leaf area was noted in Imazethapyr 20 days later seeding and Quizalofop-ethyl 20 days later seeding. The heaviest index of leaf area was noted in Pendimethalin combination by HW on 20 days after seeding, then Pendimethalin, then data on 60 days after seeding and harvest. all herbicidal treatments noted an average leaf area index next to un-weeded.



Graph 4.64 Influnce of herbicides on leaf area index of cowpea at 20 days intervals. (2021 and 2022))

Chart 4.69 Influnce of herbicides on fresh weight of plant of cowpea at 20 days intervals. (2021 and 2022).

Treatments	20 DAS (2021)	20 DAS (2022)	Pooled data	40 DAS (2021)	40 DAS (2022)	Pooled data	60 DAS (2021)	60 DAS (2022)	Pooled data	Harvest (2021)	Harvest (2022)	Pooled data
T_1	30.12	30.44	30.28	69.30	69.37	69.33	86.12	87.24	86.68	86.21	87.26	86.74
T_2	31.40	31.61	31.50	70.20	70.27	70.23	86.37	87.38	86.875	86.39	87.41	86.90
T_3	24.12	24.44	24.28	60.25	60.33	60.29	79.13	80.17	79.65	79.13	80.17	79.65
T_4	25.70	25.72	25.71	61.40	61.51	61.45	80.17	80.26	80.21	80.19	80.28	80.24
T_5	29.60	29.74	29.67	65.80	66.01	65.90	81.20	82.12	81.66	81.20	82.1	81.65
T_6	27.40	27.48	27.44	62.40	62.58	62.49	76.44	77.49	76.96	76.45	77.42	76.94
T_7	29.20	29.36	29.28	64.30	65.24	64.77	78.83	79.13	78.98	78.86	79.11	78.99
T_8	21.79	21.82	21.805	58.45	59.18	58.81	69.13	70.67	69.9	69.1	70.62	69.86
SEm (±)	**0.36**	**0.54**	**0.45**	**0.42**	**0.53**	**0.48**	**0.56**	**0.57**	**0.48**	**0.68**	**0.65**	**0.67**
CD (p=0.05)	**1.10**	**1.63**	**1.37**	**1.28**	**1.60**	**1.44**	**1.71**	**1.74**	**1.44**	**2.07**	**1.96**	**2.02**

4.5.6 Fresh weight of plant

The data concerning the fresh weight of plants effect ofdifferent weed control treatments at all phases of observations are in charts 4.69 and 4.65.

In the years 2021 and 2022, as shown in charts 4.69 and 4.65, on 20 days later seeding, significant fresh weight of plant was observed in the PE use of pendimethalin in combination by HW on 20 days later seeding, followed by pendimethalin over the weedy check. Data on 40 days later seeding, extreme renewed weight of the plant was noted in Pendimethalin combination by HW on 20 days later seeding, and Pendimethalin data of minimum fresh weight of the plant was noted in the use of Imazethapyr 20 days later seeding and Quizalofop-ethyl 20 days later seeding as associated by the un-weeded check. Information on 60 days later seeding plus harvest: the minimum fresh weight of the plant was noted in Quizalofop-ethyl days later seeding and HW (20 then 40 days later seeding), then the heaviest fresh weight of the plant was noted in Pendimethalin combination by HW at 20 days later seeding over the un-weeded. Hanumanthappa *et al.* (2012)

The cumulative data shown in the years 2021 and 2022 shown in charts 4.69 and 4.65 indicated that the heaviest fresh weight of the plant was noted in the PE Pendimethalin combination by an arrow on the 20-day seeding treatment as compared to the PoE treatment. The minimum fresh weight of the plant 40 days after seeding was recorded in Imazethapyr 20 days after seeding, followed by Quizalofop-ethyl. 20 days later seeding, such as the heaviest fresh weight of the plant, was noted in Pendimethalin combination by HW on 20 days later seeding, then Pendimethalin. Current data on 60 DAS and harvest indicates that all herbicidal treatments noted an average fresh weight except check.

.

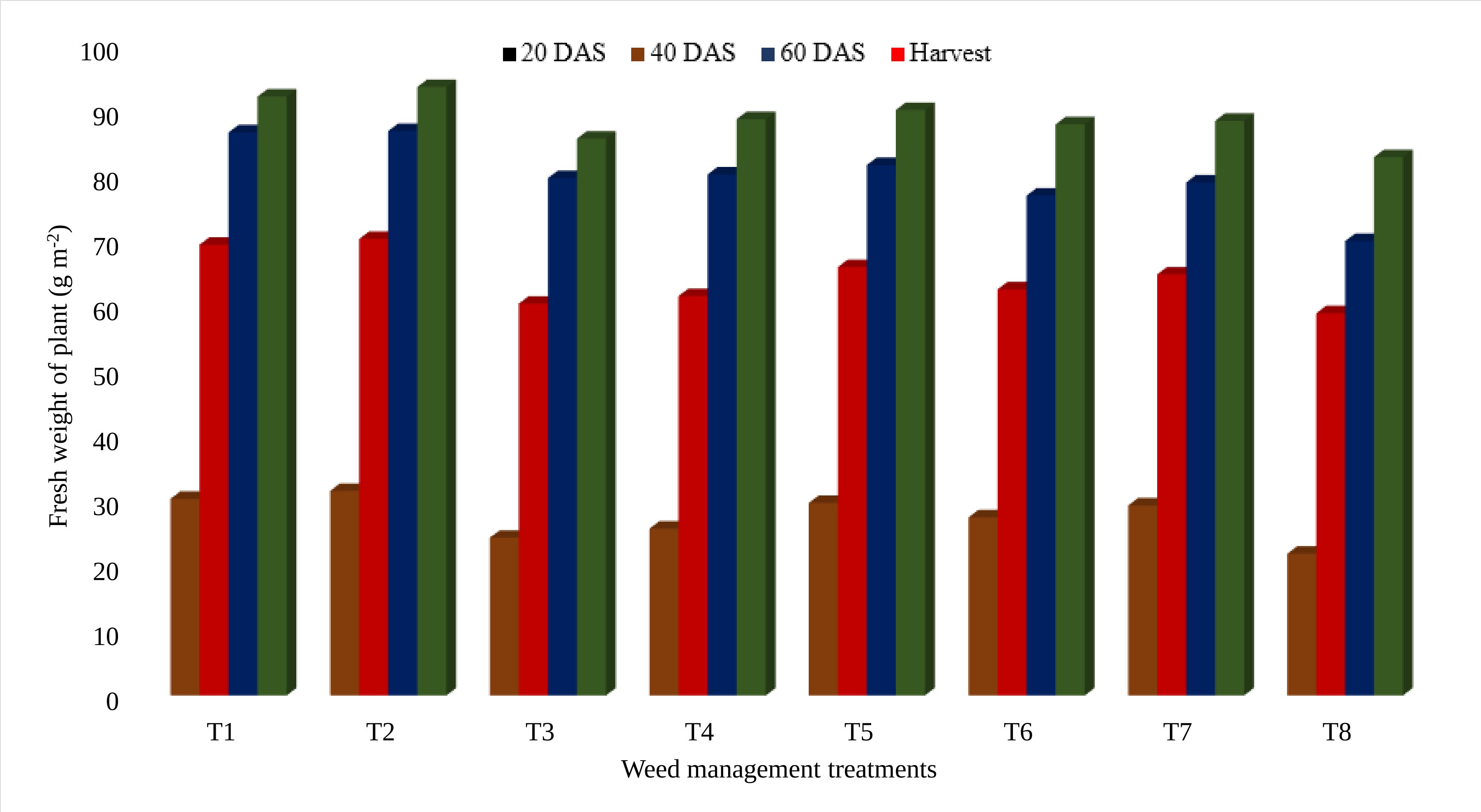


Fig 4.65 Influnce of herbicides on fresh weight of plant of cowpea at 20 days intervals. (2021 and 2022).

Chart 4.70 Influnce of herbicides on dry weight of plant of cowpea at 20 days intervals. (2021 and 2022)

Treatments	20 DAS (2021)	20 DAS (2022)	Pooled data	40 DAS (2021)	40 DAS (2022)	Pooled data	60 DAS (2021)	60 DAS (2022)	Pooled data	Harvest (2021)	Harvest (2022)	Pooled data
T_1	8.4	8.49	8.44	13.46	13.61	13.53	23.70	23.81	23.75	32.88	33.14	33.01
T_2	8.7	8.76	8.73	17.22	18.23	17.72	24.33	24.50	24.41	33.24	33.07	33.15
T_3	7.0	7.12	7.06	14.79	14.81	14.80	20.73	20.76	20.74	30.44	32.29	31.36
T_4	7.44	7.51	7.47	14.76	14.79	14.77	22.73	22.79	22.76	31.89	32.67	32.28
T_5	8.00	8.24	8.12	17.50	17.67	17.58	23.42	23.69	23.55	32.29	31.14	31.71
T_6	7.60	7.66	7.63	17.43	17.44	17.43	21.94	22.00	21.97	30.86	30.89	30.87
T_7	7.90	7.98	7.94	17.60	17.62	17.61	22.91	23.10	23.00	31.84	31.00	31.42
T_8	6.50	6.67	6.58	12.43	12.50	12.46	18.43	18.60	18.51	26.68	27.18	26.93
SEm (±)	**0.45**	**0.38**	**0.42**	**0.47**	**0.57**	**0.52**	**0.54**	**0.54**	**0.54**	**0.59**	**0.52**	**0.56**
CD (p=0.05)	**1.38**	**1.14**	**1.26**	**1.42**	**1.74**	**1.58**	**1.63**	**1.65**	**1.64**	**1.79**	**1.56**	**1.68**

4.5.7 Dry weight of plant

The data concerning the dry weight of plants effect ofdifferent weed control treatments at all phases of observations are accessible in charts 4.70 and 4.66.

In the years 2021 and 2022, the data shown in charts 4.70 and 4.66 at 20 days later seeding Substantial differences in dry weight accumulation were detected due to weed management at all phases of crop growth, suggesting dry weight of plants observed in the pre-emergent use of pendimethalin in combination by HW at 20 days after seeding and then Pendimethalin overcheck. Data on 40 days later seeding showed that supreme dry weight of the plant was noted in HW (20 then 40 days later seeding), then Metolachlor combined by HW at 20 days later seeding, and minimum dry weight of the plant was noted in Pendimethalin plus Imazethapyr at 20 days later seeding as associated by the un-weeded. Data on 60 days later seeding harvest shows that the minimum dry weight of the plant was noted in Imazethapyr 20 days later seeding, then Quizalofop-ethyl, and the heaviest dry weight of the plant was noted in Pendimethalin combination by HW on 20 days later seeding and Pendimethalin overcheck. The result was confirmed by Kumavat *et al.* (2017) and Rajeshkumar *et al.* (2017).

The cumulative data obtained in the years 2021 and 2022 shown in chart 4.70 and graph 4.66 indicated that the extreme dry weight of the plant was noted in PE Pendimethalin combination by HW on 20 days later seeding, and Pendimethalin as compared to PoE treatment, then the data on 40 days later seeding indicated that the minimum dry weight of the plant was noted in Pendimethalin, then Imazethapyr 20 days later seeding, and subsequently the heaviest dry weight of the plant was noted in Pendimethalin combination by HW on 20 DAS over the un-weeded

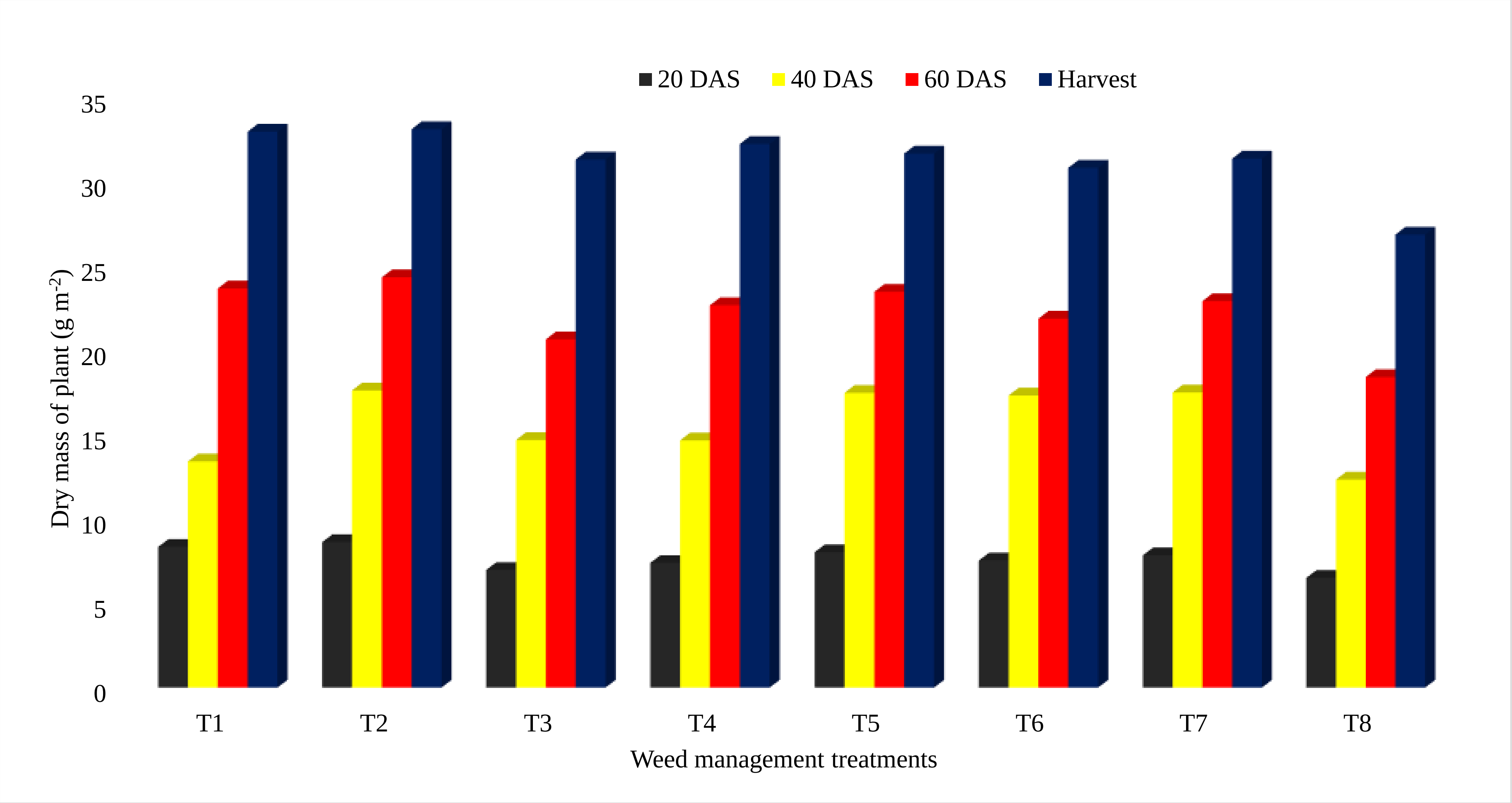


Fig 4.66 Influnce of herbicides on dry weight of plant of cowpea at 20 days intervals. (2021 and 2022)

Chart 4.71 Influnce of herbicides on Crop growth rate of cowpea at 20 days intervals. (2021 and 2022)

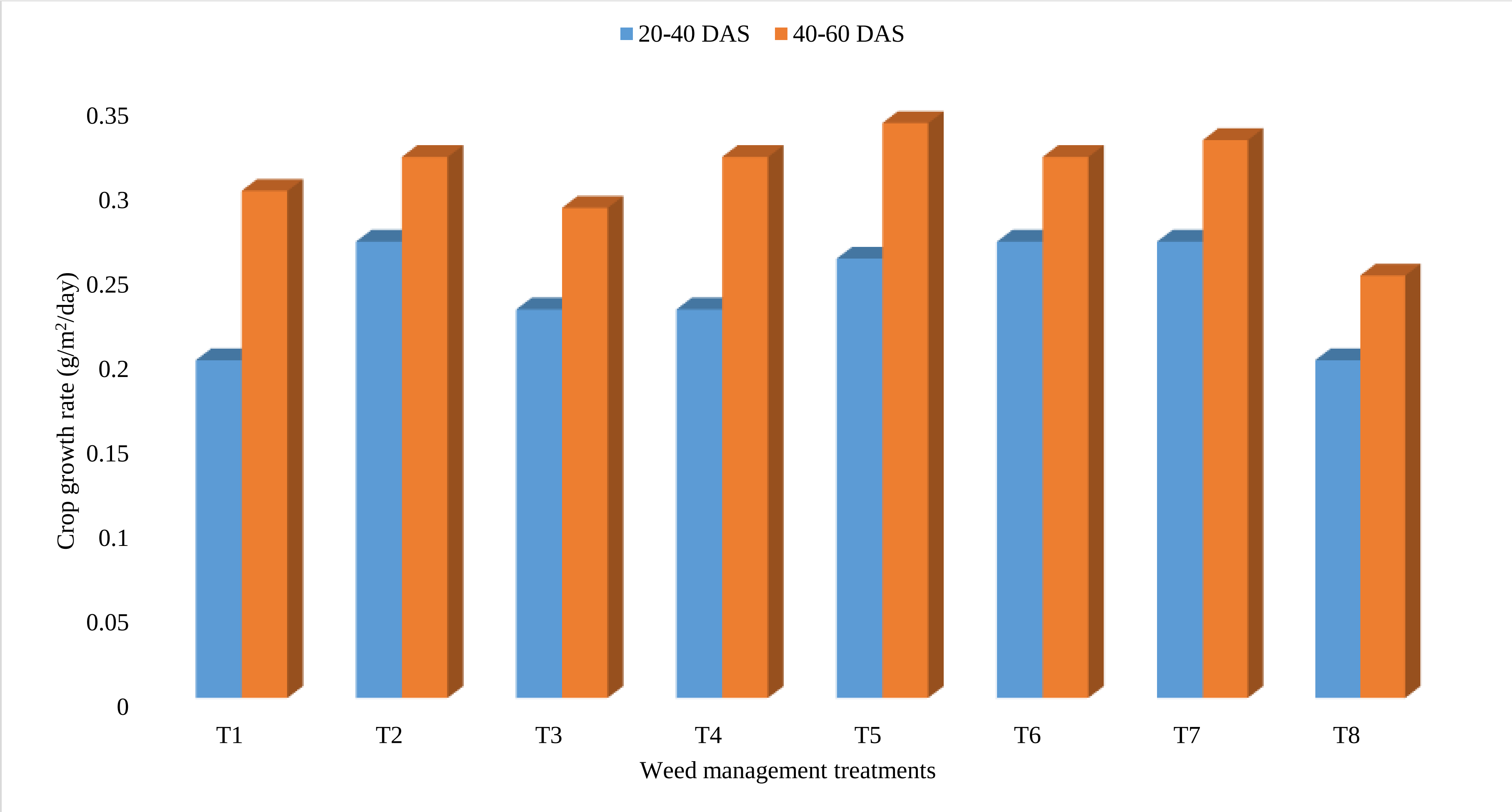
Treatments	20-40 DAS (2021)	20-40 DAS (2022)	Pooled data	40-60 DAS (2021)	40-60 DAS (2022)	Pooled data
T_1	0.22	0.17	0.20	0.25	0.34	0.30
T_2	0.22	0.31	0.27	0.42	0.21	0.32
T_3	0.20	0.25	0.23	0.37	0.20	0.29
T_4	0.21	0.24	0.23	0.36	0.27	0.32
T_5	0.21	0.31	0.26	0.47	0.20	0.34
T_6	0.21	0.32	0.27	0.48	0.15	0.32
T_7	0.21	0.32	0.27	0.48	0.18	0.33
T_8	0.19	0.19	0.20	0.29	0.20	0.25
SE(m±)	**0.08**	**0.09**	**0.09**	**0.10**	**0.11**	**0.11**
CD (p=0.05)	**0.24**	**0.27**	**0.30**	**0.31**	**0.30**	**0.34**

4.5.8 Crop growth rate (g/m2/day))

The data concerning the 4.5.8 crop growth rate shown in Chart 4.71 and Graph 4.67 as influenced by various weed control applications at all phases of observation

In the years 2021 and 2022, data shown in chart 4.71 and graph 4.67 on 40-20 Days later seeding significant higher rate of crop growth observed in the PE use of Pendimethalin combination by HW on 20 Days later seeding then Pendimethalin then minimum in Metolachlor combination by HW 20 Days later seeding Un-weeded. Data on 40–60 days after seeding the supreme rate of growth of the crop was noted in Quizalofop-ethyl. 20 days later seeding, then HW (20 and 40 days later seeding), the minimum rate of growth of the crop was noted in the use of pendimethalin and Quizalofop-ethyl (20 days later seeding) as associated by the check.

The cumulative data shown in the years 2021 and 2022, shown in chart 4.71 and graph 4.67, indicated that at 20–40 days after seeding, the higher rate of growth of the crop was noted in pre-emergent Pendimethalin combination by HW on 20 days after seding, then Quizalofop-ethyl on 20 days after seding, as compared to PoE treatment. Data on 60–40 days after seding indicated that the minimum rate of growth of the crop was noted in Pendimethalin and Imazethapyr days after seding. The supreme plant development rate was noted in Metolachlor combined by HW 20 days after seeding and HW (20 and 40 days after seding) over the un-weeded.



Graph 4.67 Influnce of herbicides on Crop growth rate of cowpea at 20 days intervals. (2021 and 2022)

Chart 4.72 Influnce of herbicides on relative growth rate of cowpea at 20 days intervals. (2021 and 2022)

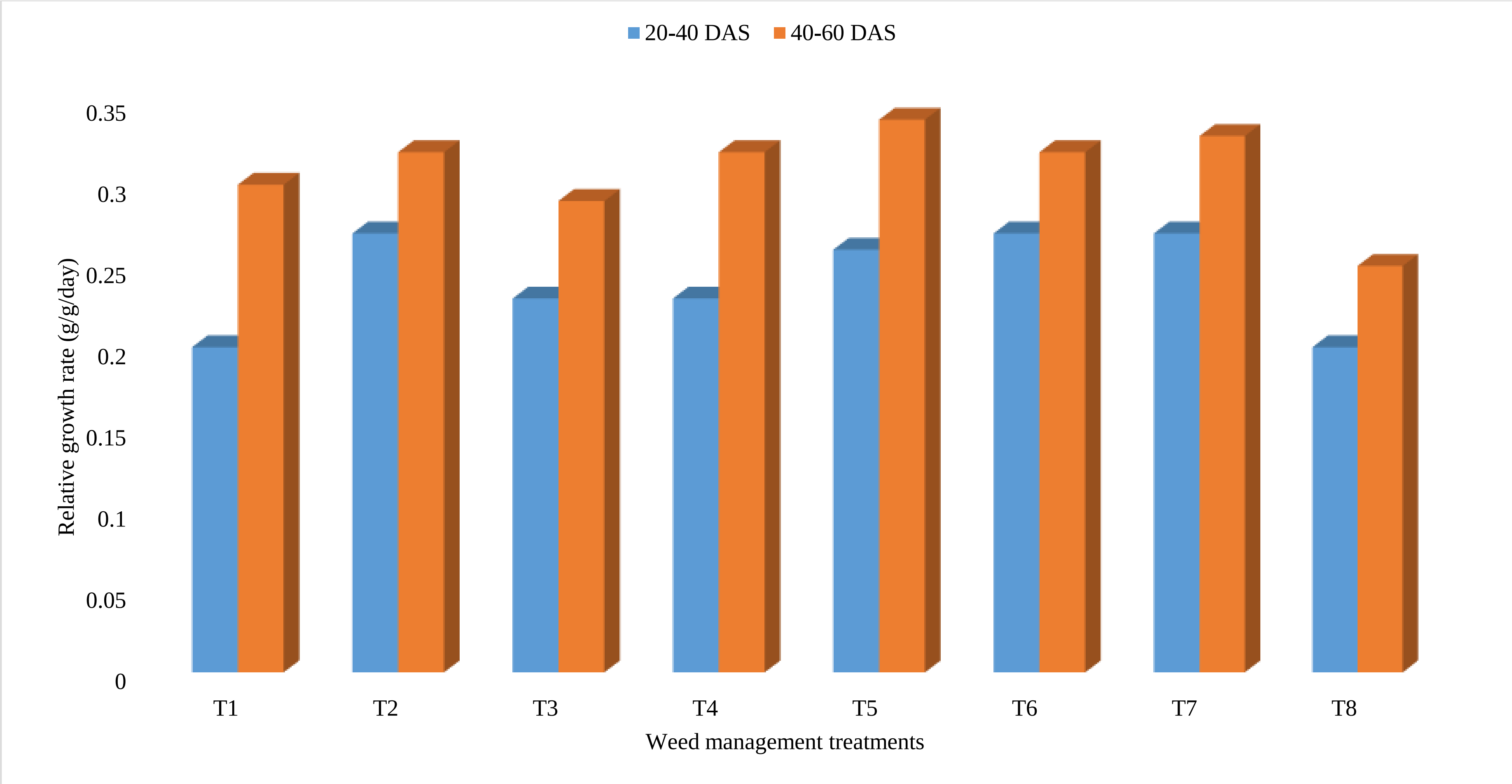
Treatments	20-40 DAS (2021)	20-40 DAS (2022)	Pooled data	40-60 DAS (2021)	40-60 DAS (2022)	Pooled data
T_1	0.37	0.24	0.31	0.23	0.10	0.62
T_2	0.36	0.37	0.37	0.34	0.10	0.68
T_3	0.42	0.37	0.40	0.37	0.09	0.67
T_4	0.42	0.34	0.38	0.34	0.09	0.67
T_5	0.37	0.38	0.38	0.39	0.10	0.70
T_6	0.41	0.41	0.41	0.41	0.09	0.70
T_7	0.40	0.40	0.40	0.40	0.10	0.70
T_8	0.46	0.31	0.39	0.32	0.09	0.63
SEm (±)	**0.06**	**0.07**	**0.07**	**0.08**	**0.08**	**0.08**
CD (p=0.05)	**0.18**	**0.21**	**0.23**	**0.23**	**0.24**	**0.25**

4.5.9 Relative growth rate (g/g/day)

The data concerning the rate of relative growth effect ofdifferent weed control actions at all phases of observations are available in charts 4.72 and 4.68.

In the years 2021 and 2022, the data shown in charts 4.72 and 4.68 at 40–20 DAS show the supreme relative growth rate observed in the PE use of Imazethapyr. Twenty days later, seeding was followed by Quizalofop-ethyl. 20 days later seeding, then minimum in Pendimethalin combination by HW on 20 days later seeding, and also in Metolachlor combination by HW 20 DAS. Data on 06-40, the day's latter seeding supreme rate of relative growth, was noted in Quizalofop-ethyl 20 days later seeding, then HW (20 and 40 days later seeding), the smallest relative growth rate was noted in pendimethalin plus pendimethalin in arrangement by HW on 20 associated by un-weeded.

The cumulative data shown in the years 2021 and 2022, shown in charts 4.72 and 4.68, indicated that at 40–20 days after seeding, the higher rate of relative growth was noted by Quizalofop-ethyl. 20 days later seeding, then HW (20 and 40 days later seeding), also minimum in pendimethalin, then pendimethalin combination by HW on 20 days later seeding as compared to the un-weeded. Then data on 60–40 days later seeding showed that the minimum rate of relative growth was noted in Pendimethalin and Imazethapyr at 20 days later seeding. The higher rate of relative development remained noted in Metolachlor combined by HW 20 days later seeding and HW (20 and 40 days later seeding) over check.



Graph 4.68 Influnce of herbicides on relative growth rate of cowpea at 20 days intervals. (2021 and 2022)

Chart 4.73 Influnce of herbicides on yield attributes of cowpea. (2021 and 2022)

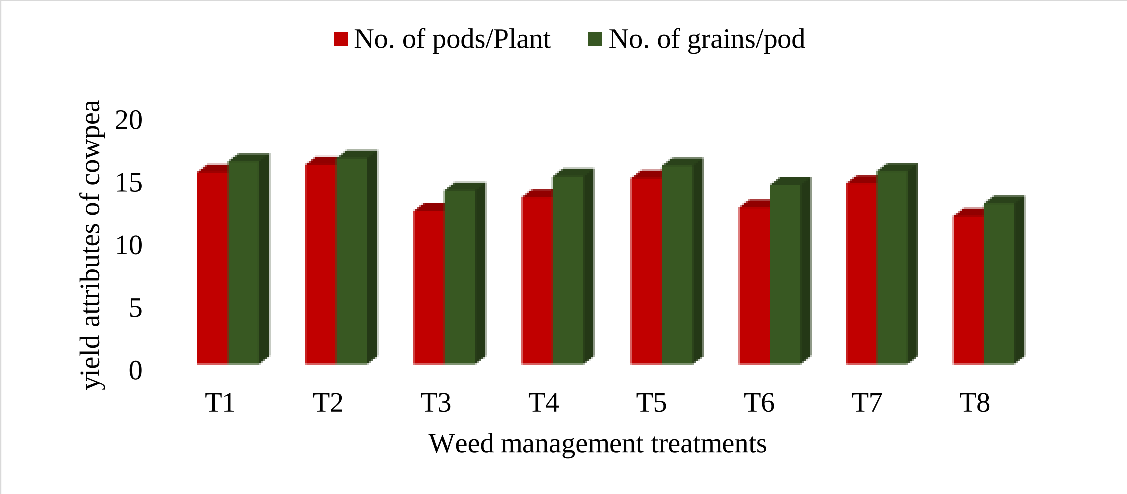
Treatments	No. of pods/ Plant 2021	No. of pods/ Plant 2022	Pooled data	No. of grains /pod 2021	No. of grains /pod 2022	Pooled data	Length of pods (cm) 2021	Length of pods (cm) 2022	Pooled data	Test weight (g) 2021	Test weight (g) 2022	Pooled data
T_1	15.2	15.29	15.24	16.07	16.17	16.12	20.19	20.30	20.245	85.32	85.29	85.30
T_2	15.8	15.90	15.85	16.30	16.44	16.37	20.84	20.86	20.85	85.68	85.72	85.7
T_3	12.1	12.24	12.17	13.72	13.91	13.81	17.32	17.44	17.38	82.36	82.40	82.38
T_4	13.2	13.33	13.27	14.86	14.97	14.91	18.73	18.91	18.82	83.12	83.10	83.11
T_5	14.70	14.86	14.78	15.74	15.81	15.77	19.33	19.45	19.39	84.67	84.65	84.66
T_6	12.44	12.49	12.46	14.19	14.30	14.24	18.10	18.16	18.13	82.89	82.90	82.89
T_7	14.10	14.67	14.38	15.29	15.41	15.35	18.85	18.97	18.91	83.29	83.30	83.29
T_8	11.21	12.30	11.75	12.44	13.10	12.77	15.89	16.12	16.005	81.38	80.17	80.77
SEm (±)	**0.40**	**0.56**	**0.48**	**0.52**	**0.63**	**0.58**	**0.43**	**0.60**	**0.52**	**0.42**	**0.68**	**0.55**
CD (p=0.05)	**1.20**	**1.70**	**1.45**	**1.57**	**1.92**	**1.75**	**1.31**	**1.83**	**1.57**	**1.28**	**2.07**	**1.68**

4.5.10 Yield features

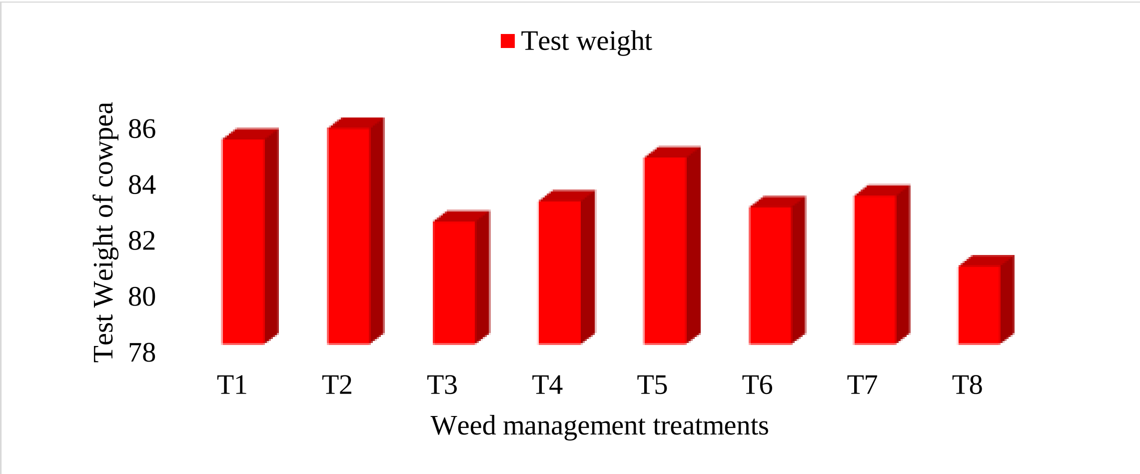
The data concerning the yield features effect ofdifferent weed control actions at all phases of observations are present in Chart 4.72 and represented in Graph 4.69.

In the years 2021 and 2022, the data shown in charts 4.72 and 4.69 at 40–20 days later seeding Yield features noted, such as pods per plant, grain per plant, size of the pod, and test weight (100 grain weight), were obviously pretentious by the weed controlling practices. highest pods/plant, grain/plant, pod length, and also test mass in the PE Pendimethalin + HW at 20 days after seeding, then Pendimethalin, then minimum in Imazethapyr 20 days later seeding, and Quizalofop-ethyl 20 days later seeding over the un-weeded. The various herbicide mixtures successfully inhibited weed growth for around 40 days, resulting in increased seed production. Weedy Check, which reported the lowest pod yield, would have otherwise led to a yield loss of nearly 80%. By analyzing the impact of weed biomass and density on cowpea production, it can be concluded that decreased weed biomass and density might efficiently lessen the rivalry for resources between the crop and weed, which has led to an increase in cowpea output. The outcomes are in agreement by those of A. Rajeshkumar *et al.* (2017), Taramani Yadav *et al.* (2015), and J.K. Sinchana *et al.* (2020).

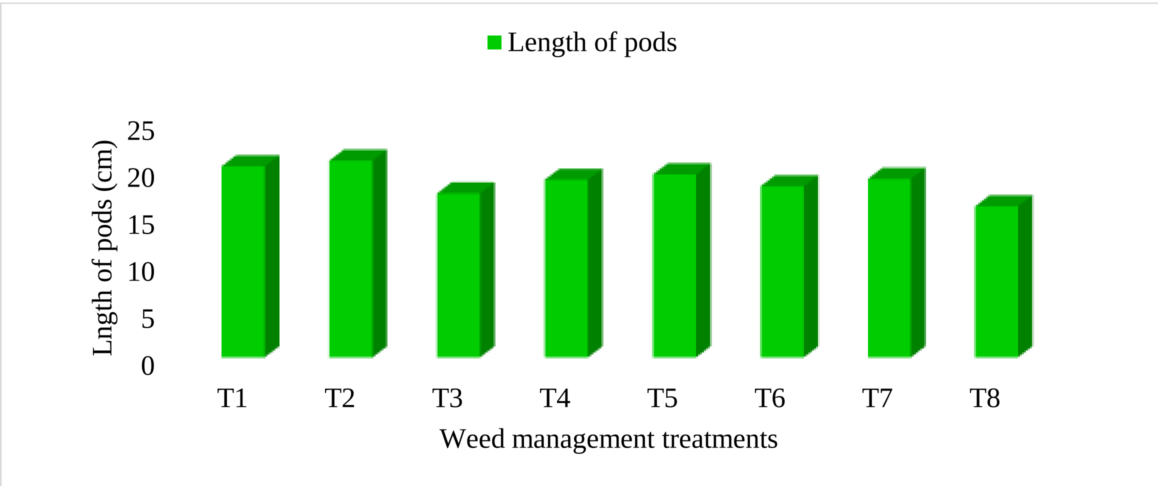
The cumulative data shown in the years 2021 and 2022, shown in charts 4.72 and 4.69, indicated that at 20–40 days later seeding lowest pods/plant, grain/plant, pod length, then test mass was noted. Imazethapyr was 20 days later seeded, then Quizalofop-ethyl 20 days later seeding, higher yield attributes were noted in the PE use of pendimethalin + HW at 20 days later seeding and pendi over the un-weeded.



Graph 4.69 (a) yield characters (2021 and 2022)



Graph 4.69 (b) yield attributes of cowpea (2021 and 2022).



Graph 4.69 (C) on yield attributes of cowpea (2021 and 2022)

Chart 4.74 Influnce of herbicides on yield characters of cowpea. (2021 and 2022)

Treatments	Seed yield (q/ha) (2021)	Seed yield (q/ha) (2022)	Pooled data	Straw yield (q/ha) (2021)	Straw yield (q/ha) (2022)	Pooled data	Harvest Index (%) (2021)	Harvest Index (%) (2022)	Pooled data	WI (%) (2021)	WI (%) (2022)	Pooled data
T_1	7.40	7.81	7.64	14.29	14.32	14.30	40.31	40.35	36.55	00.00	00.00	00.00
T_2	7.70	7.58	7.61	14.56	14.50	14.53	36.52	36.58	40.33	11.07	10.23	10.65
T_3	6.42	6.55	6.48	12.11	12.15	12.13	28.40	28.49	28.44	41.39	41.44	41.41
T_4	6.81	6.91	6.86	12.96	13.00	12.98	31.63	31.70	31.66	30.15	30.87	30.51
T_5	7.21	7.35	7.28	13.93	13.97	13.95	35.93	36.10	36.01	16.01	16.61	16.31
T_6	6.63	6.81	6.72	12.32	12.39	12.35	30.11	30.76	30.43	36.79	37.08	36.93
T_7	7.02	7.22	7.12	13.49	13.57	13.53	32.02	32.52	32.27	26.40	26.51	26.45
T_8	3.60	3.84	3.72	10.94	11.10	11.02	28.51	29.44	28.97	46.84	46.30	46.57
SEm (±)	**11.28**	**12.21**	**13.11**	**16.33**	**17.46**	**17.22**	**0.63**	**0.75**	**0.69**	**0.87**	**0.59**	**0.73**
CD (p=0.05)	**33.18**	**35.68**	**39.69**	**48.22**	**50.37**	**50.33**	**1.91**	**2.26**	**2.09**	**2.63**	**1.78**	**2.21**

4.5.11 Yield attributes

The data concerning the yield attributes as effect ofdifferent weed control actions at all phases of observations are available in chart 4.73 and shown in graph 4.69.

In the years 2021 and 2022, the data shown in charts 4.73 and 4.69 at 40–20 days later seeding showed the highest seed, straw yield, and harvesting index in the pre-emergent use of pendimethalin in combination by HW at 20 days later seeding. This could be attributed to the complete utilization of all growth factors by cowpea. Minimum in Imazethapyr 20 DAS and Quizalofop-ethyl 20 DAS over the un-weeded check next to the lowest WI was noted in PE use of pendimethalin combination by HW at 20 days later seeding, and pendimethalin was then heaviest in Imazethapyr 20 days later seeding and Quizalofop-ethyl 20 days later seeding. The smallest seed, yield of straw, and harvest index were noted in the unweeded check. PE herbicide combined by HW creates a weed-free environment that is conducive to crop growth. HW decreases weed growth and competition by crops from sowing to harvesting, increasing cowpea production. Effective weed control methods boost crop plant growth and development by enhancing photosynthetic activity and reducing crop weed competition, which increases cowpea seed output. These results are in agreement by the answers of Sinchana (2020), Mekonnen (2016), and Pravindra Kumar (2017).

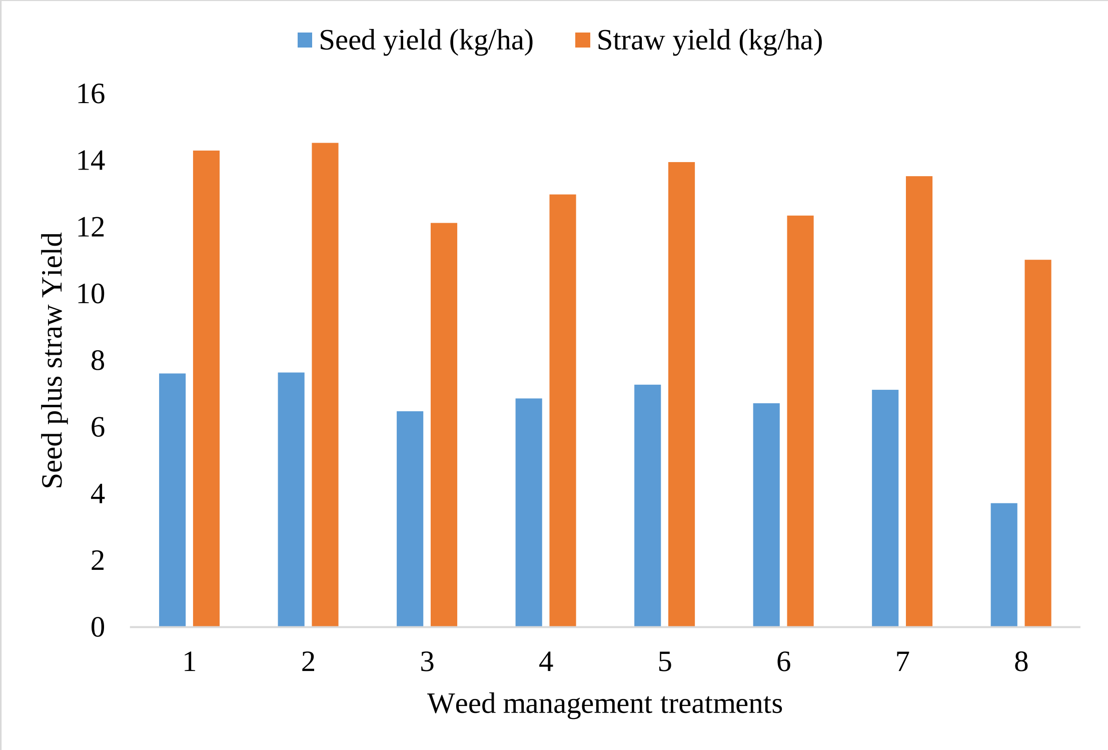


Fig 4.70 (a) yield characters of cowpea. (Pooled data 2021 and 2022)

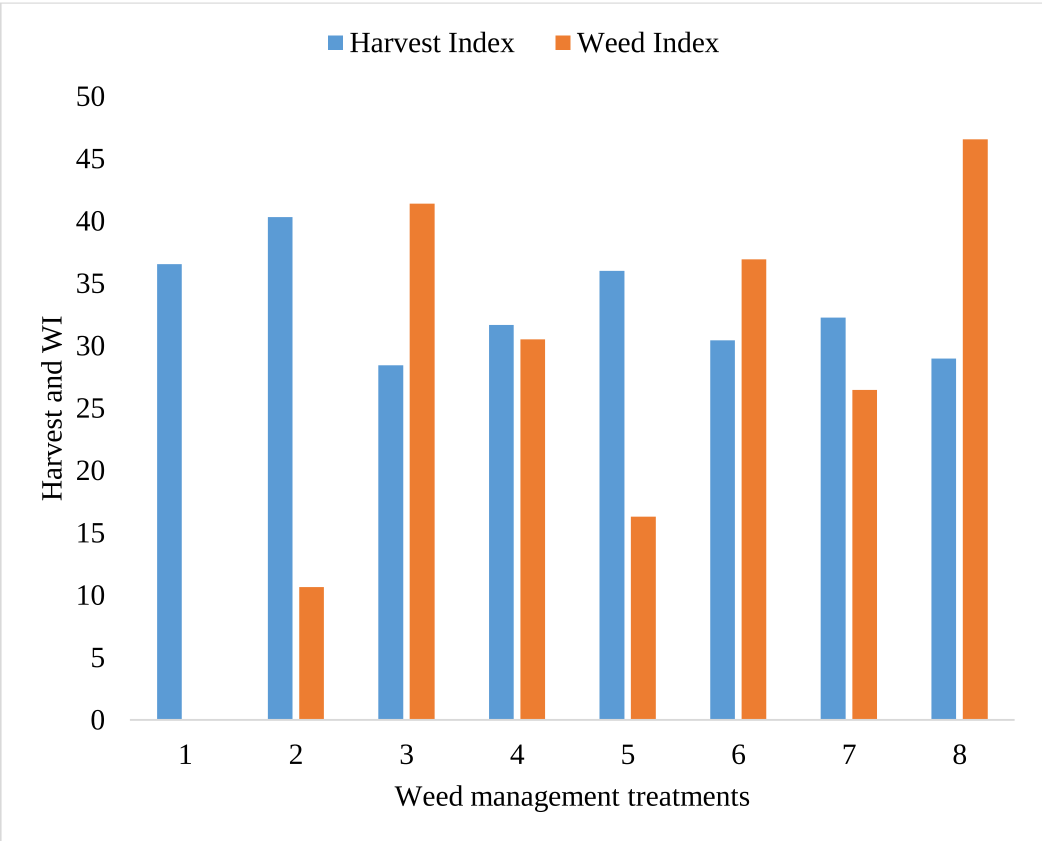


Fig 4.70 (b) yield characters of cowpea. (Pooled data 2021 and 2022)

Chart 4.75 Influnce of herbicides on Finances of cowpea. (2021 and 2022)

Treatments	Gross returnS (₹ ha^{-1}) 2021	Gross returns (₹ ha^{-1}) 2022	Pooled data	Cost of cultivation (₹ ha^{-1}) 2021	Cost of cultivation (₹ ha^{-1}) 2022	Pooled data	Net returns (₹ ha^{-1}) 2021	Net returns (₹ ha^{-1}) 2022	Pooled data	B:C ratio 2021	B:C ratio 2022	Pooled data
T_1	68029	71719	70216	23166	23742	23454	44863	47977	46420	1.94	2.02	1.98
T_2	70756	69676	69874	24221	24681	24451	46535	44995	45765	1.92	1.82	1.87
T_3	58991	60161	59576	22617	23102	22859	36374	37059	36716	1.61	1.60	1.61
T_4	62586	63486	63036	22628	23344	22986	39958	40142	40050	1.77	1.72	1.74
T_5	66283	67543	66913	24326	24842	24584	41957	42701	42329	1.72	1.72	1.72
T_6	60902	62522	61712	22609	23531	23070	38293	38991	38642	1.69	1.66	1.68
T_7	64529	66329	65429	25698	26207	25952	38831	40122	39476	1.51	1.53	1.52
T_8	33494	35654	34574	21477	21940	21708	12017	13714	12865	0.56	0.63	0.59

4.5.12 Economics of cowpea

The data concerning the economics of cowpea is effect ofdifferent weed control actions shown in charts 4.74 and 4.69.

Cost of cultivation

The data concerning the statistics on gross as well as net returns are modified through various weed control methods, as shown in Graph 4.78.

The cumulative statistics for the years 2021 and 2022 by respect to the cost of cultivation provided in chart 4.74 indicated that the highest cost of cultivation was recorded in HW. While the unweeded had the lowest charge of cultivation. The maximum budget for cultivation is acquired through HW, which requires more labour to weed the plot while keeping it weed-free.

Gross as well as net returns

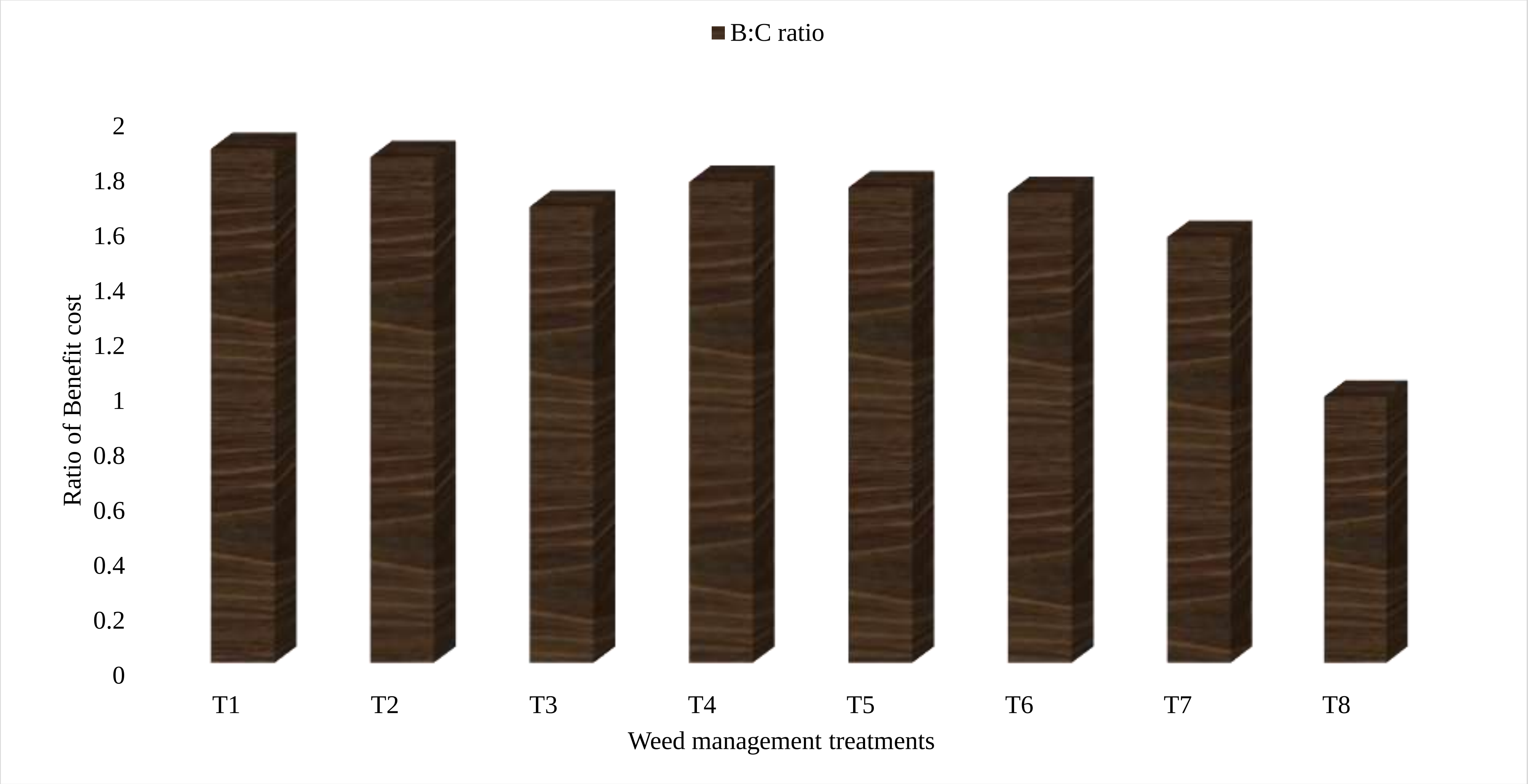
The data concerning the net profit shown in graph 4.74 shows that both gross and net returns are effect ofvarious weed control applications.

The highest gross and net returns (₹70216 ha^{-1}) and (₹46420 ha^{-1}) were noted for treatment (T_1) by pendimethalin. Higher gross income and lower cultivation costs are true. Instead of using a single method, the integration of weed management techniques has resulted in effective weed control, according to Rajesh Kumar (2017), Taramani Yadav (2015), and Pravindra Kumar (2017). Lower gross return, net return, and ratio of benefit-cost were noted in HW (20 and 40 days later seeding) and Quizalofop-ethyl (20 days later seeding) as associated by the check.

Benefit-cost ratio (B: CR)

The info on ratio of benefit-cost is significantly influenced through dissimilar weed controller actions in chart 4.74 and figure 4.69.

The best and most cost-effective way of weed management in cowpea is the application of herbicides combined with HW, followed by HW at the most crucial stage and maintenance of weed free condition. Better weed management has been achieved at the crucial time of crop weed competition as a consequence of the integration of several weed control techniques that control weeds both in the early stages and the new weed flushes in the later stages. In the crucial phase of crop weed competition, pendimethalin PE and HW could effectively keep the field weed-free, and this was reflected in the yield and yield characteristics. As a result, these tried-and-true integrated weed control techniques can be suggested for cowpea to increase yield and profit. In cumulative data on the years of 2021 and 2022 the highest ratio of benefit-cost 1: 98) was noted treatment (T_1) by by Pendimethalin such as minimum benefit-cost ratio is in Imazethapyr 20 Days later seeding then Quizalofop-ethyl 20 Days later seeding over the weedy check. Such outcomes were in concurrence with the outcomes of Silva *et al.,* (2003) and Hanumanthappa *et al.,* (2012).



Graph 4.71 Influnce of herbicides on Economics of cowpea. (Pooled data 2021 and 2022)

Chart 4.76 Influnce of herbicides on Economics of maize- cowpea cropping system. (2021 and 2022)

Treatments	Gross returns (₹ ha^{-1}) 2021 and 2022 Maize	Gross returns (₹ ha^{-1}) 2021 and 2022 cowpea	Pooled data Maize-cowpea cropping system 2021 and 2022	Cost of cultivation (₹ ha^{-1}) of maize 2021 and 2022	Cost of cultivation (₹ ha^{-1}) of cowpea 2021 and 2022	Pooled data Maize-cowpea cropping system 2021 and 2022	Net returns (₹ ha^{-1}) of Maize 2021 and 2022	Net returns (₹ ha^{-1}) of cowpea 2021 and 2022	Pooled data Maize-cowpea cropping system 2021 and 2022	B:C ratio Of maize 2021 and 2022	B:C ratio Of cowpea2021 and 2022	Pooled data Maize-cowpea cropping system2021 and 2022
T_1	82422	69874	76148	30048	23454	26751	52374	46420	49397	1.74	1.98	1.86
T_2	83914	70216	77065	31124	24451	27788	52790	45765	49278	1.70	1.87	1.79
T_3	83249	59576	71412	30195	22859.5	26527	53054	36716	44885	1.76	1.61	1.69
T_4	79708	63036	71372	30291	22986	26639	49417	40050	44734	1.63	1.74	1.69
T_5	87637	66913	77275	30926	24584	27755	56711	42329	49520	1.83	1.72	1.78
T_6	81266	61712	71489	31335	23070	27203	49931	38642	44287	1.59	1.68	1.64
T_7	87029	65429	76229	32015	25952	28984	55014	39476	47245	1.72	1.52	1.62
T_8	51639	34574	43106	27731	21708	24720	23908	12865	18387	0.86	0.59	0.73

4.6.1 Economics studies in Maize-cowpea cropping system

4.6.2 Cost of cultivation

As shown in figure 4.76, the statistics on gross as well as net returns are modified through various weed controller treatments.

The cumulative data on the years of 2021 and 2022 data on the cost of production existed in chart 4.76 exposed that the maximum budget of cultivation was noted in HW, whereas the lowermost charge of cultivation was noted in the Un-weeded. The highest budget of cultivation is found as of HW due to more labors weedings the plot to keeping it weed-free.

4.6.3 Gross and net returns

The data on gross and net returns are subjected by different weed controller treatments, as existed in chart 4.76.

The cumulative data the years of 2021 and 2022 the gross and net returns is significantly influenced by dissimilar weed controller actions in chart 4.78 and graph 4.78 on Maize- Cowpea cropping sytem. In cumulative data on the years of 2021 and 2022 the Maize- Cowpea cropping cropping system the highest gross and net returns (₹77275) and (₹49520) was noted treatment (T_5) by 2, 4-D Sodium Salt 800 g PoE combined with HW at 60 Days later seeding in maize and (T_5): Metolachlor 1.0 kg PE combined using HW 20 Days later seeding in cowpea.

4.6.4 Benefit-cost ratio (B: CR)

The data on the benefit-cost relation is significantly influenced by dissimilar weed controller actions in chart 4.76.

The cumulative data on the years of 2021 and 2022 the benefit-cost relation is expressively influenced by different weed controller usages in chart 4.76 on Maize-Cowpea cropping sytem. In cumulative data the years of 2021 and 2022 the Maize- Cowpea cropping system the highest benefit-cost relation (1:86) was noted treatment (T_1) by Atrazin 750 g (PE) 850 g in Maize and Pendimethalin @ 1.0 kg (PE) in cowpea

V. SUMMARY AND CONCLUSION

The research trial entitled **"Evaluation of pre- and PoE herbicides on weed control growth and yield of a maize-cowpea cropping system" Under the Trans-Gangetic Plains of Punjab,** the perspective work was carried out in the division of agriculture research, Department of Agronomy, Lovely Professional University, Jalandhar, and Punjab. The experiment has an RBD design by 8 treatments and 3 replications. The total number of plots is 24, by a size of 8 m5 m (40 m^2). The treatments consist of (for maize) Atrazine 700 g PE, Atrazine 500 g PE + HW (30 days later seeding), Metribuzin 800 g PE, Tembotrione 120 g PoE, 2, 4-D Na 800 g PoE combined by HW at 60 days later seeding, Topramezone 200 g PoE HW twice (30 and 60 days later seeding), and Weedy Check. Then the treatments for cowpea were Pendimethalin PE, Pendimethalin PE combination by HW at 20 days later seeding, Imazethapyr at 20 days later seeding, Quizalofop-ethyl at 20 days later seeding, Metolachlor combined by HW at 20 days later seeding, Quizalofop-ethyl at 20 days later seeding, HW (20 and 40 days later seeding) and Weedy check. During the years 2021-2022, the pioneer hybrid 9108 maize variety and the CL-367 cowpea variety were used in this study.

The results of experiment are given below:

Observation are noted on the weeds *viz*. species wise count of weeds, dry wt., weed control effectiveness, and then WI

Observation are noted on the growth (plant population, plant height, plant fresh and dry weight, CGR, RGR), yield constraints (cobs/plant, kernel rows/cob, kernel rows/cob, 100 seed weight, seed yield, and Stover yield as well as index of harvest)

I. Maize

1. Post-emergent use of 2, 4-D Na combined through HW at 60 Days later seeding was noted minimum count of *Commelina benghalensis* L. at harvest.
2. Minimum weed population of *Cynodon dactylon* L. noted in 2, 4-D Na 800 g mutual by HW at 60 Days later seeding as compare to namual weeding over Un-weeded check.
3. Minimum count of *Cyperus rotundus* L. was noted in 2, 4-D Na by HW at 60 Days later seeding subsequently Metribuzin 800 gPE as compare to HW over Un-weeded.

4. 2, 4-D Na 800 PoE combined by HW at 60 Days later seeding noted minimum count *Chenopodium album* L. and noted best weed control treatment among other herbicidal treatments up to harvest.
5. At harvest HW twice (30 & 60 Days later seeding) noted minimum count of *Parthenium hysterophorus* L. and remain best among the herbicidal treatments during both years over Un-weeded check.
6. Minimum count of *Cannabis sativus* L. noted in 2, 4-D Na by mutual weeding at 60 Days later seeding and HW twice (30 & 60 Days later seeding) up to harvest.
7. Minimum count of *Sinapis arvensis* L. was noted in HW twice (30 & 60 Days later seeding) and2, 4-D Na mutual by HW at 60 Days later seeding at harvest.
8. Minimum total weed population were noted in 2, 4-D Na mutual by HW at 60 Days later seeding tracked by indicator weeding two times (30 & 60 Days later seeding).
9. Minimum lowest dry weightof *Commelina benghalensis* L. were noted in 2, 4-D Na mutual by HW at 60 Days later seeding trailed by HW twice (30 & 60 Days later seeding).
10. Minimum dry weight of *Cynodon dactylon* L. subsequently Atrazine PE + single HW (30 Days later seeding) over Un-weeded check.
11. At harvest the lowest dry weightof. *Cyperus rotundus* L. Recorded in 2, 4-D Na combined by HW at 60 Days later seeding over Un-weeded check.
12. Minimum dry weight of *Chenopodium album* noted in 2, 4-D Na mutual by HW at 60 Days later seeding over Un-weeded check.
13. 2, 4-D Na 800 gPoE mutual by HW at 60 Days later seeding noted minimum dry weight of *Parthenium hysterophorus* L.
14. At harvest, minimum dry weightof *Cannabis sativus* L. was noted in HW twice (30 & 60 Days later seeding) and 2, 4-D Na mutual by HW at 60 Days later seeding.
15. The suggestively minimum dry weight of *Sinapis arvensis* L. next to 2 HW (30 & 60 Days later seeding) and Atrazine PE + Single handeded weeding (30 Days later seeding) over the Un-weeded check.
16. Lowest dry weightof total weed population subsequently handeded weeding two times (30 & 60 Days later seeding) and Atrazine PE + One HW (30 Days later seeding) over Un-weeded check up to harvest.

17. Higher WCE of *Commelina benghalensis* L. was noted in 2, 4-D Na PoE mutual by HW at 60 Days later seeding and2 HW (30 & 60 Days later seeding) as asociated to other herbicidal treatments.
18. Higher WCE of *Cynodon dactylon* L. was noted in 2, 4-D Na PoE combined by HW at 60 Days later seeding and HW twice (30 & 60 Days later seeding) over the Un-weeded.
19. At harvest, higher WCE of *Cyperus rotundus* L. was noted in HW twice (30 & 60 Days later seeding) subsequently Atrazine PE + one HW (30 Days later seeding) as asociated to other herbicidal treatments.
20. At harvest higher WCE of *Chenopodium album* L.was noted in 2, 4-D Na PoE combined by HW at 60 Days later seeding and HW twice (30 & 60 Days later seeding) over the Un-weeded.
21. At harvest higher WCE of *Parthenium hysterophorus* L. was noted in 2, 4-D Na PoE combined by HW at 60 Days later seeding and HW twice (30 & 60 Days later seeding) over the Un-weeded.
22. At harvest heighest WCE of *Cannabis sativus* L. was noted in 2, 4-D Na combined by HW at 60 Days later seeding and HW twice (30 & 60 Days later seeding) over the Un-weeded.
23. At harvest superior WCE of *Sinapis arvensis* L. Was noted in 2, 4-D Na combined by HW at 60 Days later seeding and 2 HW (30 & 60 Days later seeding) over the Un-weeded check.
24. At harvest supreme weed control efficiency total weed population was noted in 2, 4-D Na combined by HW at 60 Days later seeding and HW twice (30 & 60 Days later seeding) over the Un-weeded.
25. The greater plant height was noted in 2, 4-D Na mutual by HW at 60 Days later seeding and 2 HW (30 & 60 Days later seeding) over the Un-weeded check.
26. The high leaf area index of maize was noted in 2, 4-D Na mutual by HW at 60 Days later seeding and HW double (30 & 60 Days later seeding).
27. The higher fresh weight was noted in 2, 4-D Na joint by HW at 60 Days later seeding and HW twice (30 & 60 Days later seeding) over the Un-weeded check.

28. The superior dry weight was noted in 2, 4-D Na 800 gPoE combined by HW at 60 Days later seeding and HW twice (30 & 60 Days later seeding) over the weed check.
29. The higher 50% tasselling and slicking were noted in 2, 4-D Na mutual by HW at 60 Days later seeding subsequently HW twice (30 & 60 Days later seeding) as asociated to the Un-weeded.
30. The higher cobs/plant, number of kernel row/cob, and weight of kernel/cob were noted in 2, 4-D Na combined by HW at 60 Days later seeding subsequently HW twice (30 & 60 Days later seeding) and Atrazine 500 gPE + One HW (30 Days later seeding).
31. Seed, straw yield and harvest index were noted in 2, 4-D Na 800 gPoE combined by HW at 60 Days later seeding subsequently HW twice (30 & 60 Days later seeding) plus minimum WI were noted in 2, 4-D Na combined by HW at 60 Days later seeding subsequently HW twice (30 & 60 Days later seeding).
32. The minimum gross returns, net returns, and benefit-cost relation were noted in 2, 4-D Na combined by HW at 60 Days later seeding.
33. The superior rate of growth of crop was noted in HW twice (30 & 60 Days later seeding) subsequently Atrazine + One HW (30 Days later seeding) and 2, 4-D Na combined by HW at 60 Days later seeding.
34. The higher rate of relative growth was noted in 2, 4-D Sodium combined by HW at 60 Days later seeding and Atrazine PE + One HW (30 Days later seeding) over the Un-weeded check.
35. The minimum germination percentage observed in 2, 4-D Na 800 gPoE mutual by HW at 60 Days later seeding next Atrazine.
36. At harvest, the average root length observed in all chemical treatments because due to less herbicidal concentration present in the soil.
37. The minimum shoot length observed in 2, 4-D Na combined by HW at 60 DAS subsequently Atrazine as asociated to other treatments.

Cowpea

1. Minimum count of *Commelina benghalensis* L. has noted in the PE use of Pendimethalin in combination by HW at 20 Days later seeding and HW at 20 & 40 Days later seeding.

2. Minimum count of *Cynodon dactylon* L in PE use of Pendimethalin combination by HW at 20 Days later seeding and HW at 20 & 40 Days later seeding.
3. At harvest minimum count of *Cyperus rotundus* L. Were noted in Pendimethalin combination by HW at 20 Days later seeding and HW at 20 & 40 Days later seeding.
4. Minimum count of *Boerhavia erecta* L. PE use of Pendimethalin 1 kg PE and Pendimethalin ombination by HW at 20 Days later seeding.
5. Suggestively the minimum count of *Parthenium hysterophorus* L. Recorded in PE use of Pendimethalin combination by HW at 20 Days later seeding and HW at 20 & 40 Days later seeding.
6. Minimum count total weed population of were noted in PE use of Pendimethalin combination by HW at 20 Days later seeding and HW at 20 & 40 Days later seeding.
7. At harvest, the minimum dry weightof *Commelina benghalensis* L. was noted in the treatment of Quizalofop-ethyl 20 Days later seeding subsequently Pendimethalin 1.0 kg PE as asociated to other herbicidal treatments.
8. At harvest the minimum dry weightof *Cynodon dactylon* L. was noted in the treatment of Quizalofop-ethyl Days later seeding subsequently HW (20 and 40 Days later seeding).
9. At harvest, the minimum dry weightof *Cyperus rotundus* L. was noted in the treatment of Pendimethalin in combination by HW at 20 Days later seeding by HW (20 and 40 Days later seeding).
10. At harvest, the minimum dry weightof *Boerhavia erecta* L. was noted in HW at 20 Days later seeding.
11. At harvest, the minimum dry weightof *Parthenium hysterophorus* L. was noted in the treatment of Quizalofop-ethyl 20 Days later seeding.
12. At harvest, the minimum dry weightof the total weed population was noted in the treatment of Quizalofop-ethyl 20 Days later seeding.
13. Higher WCE of *Commelina benghalensis* L. has been noted in Pendimethalin combination by HW at 20 Days later seeding and HW twice (20 & 40 DAS).

14. Higher WCE of Cynodon dactylon L. was noted in Quizalofop-ethyl 20 Days later seeding subsequently HW twice (20 & 40 Days later seeding) over the Un-weeded check.
15. Higher WCE of *Cyperus rotundus* L. was noted in Pendimethalin combination by HW at 20 Days later seeding and Pendimethalin.
16. Heighest WCE of *Boerhavia erecta* L. has been noted in Quizalofop-ethyl 20 Days later seeding subsequently HW twice (20 & 40 Days later seeding) over the Un-weeded.
17. Heighest WCE of *Parthenium hysterophorus* L. has been noted in Pendimethalin combination by HW at 20 Days later seeding and HW twice (20 & 40 Days later seeding).
18. Heighest WCE of total weed population was noted in Quizalofop-ethyl Days later seeding subsequently Metolachlor combined by HW 20 Days later seeding over weedy check.
19. At harvest, the average germination percentage observed in allchemical treatments due to less herbicidal concentration present in the soil.
20. At harvest average root and shoot lengths were observed in all chemical treatments due to less herbicidal concentration present in the soil.
21. Heighest crop stand was noted in PE treatment because of the arrest of the weeds at the initial growth stage as asociated to PoE herbicide over the Un-weeded.
22. At harvest all herbicidal treatments noted average plant Pendimethalin combination by HW at 20 DAS.
23. At harvest all herbicidal treatments noted no. branches per plant Pendimethalin combination by HW at 20 Days later seeding and Pendimethalin.
24. The superior no. of root nodules per plant was noted in Pendimethalin combination by HW at 20 Days later seeding and Pendimethalin over the Un-weeded.
25. The greater leaf area index was noted in Pendimethalin combination by HW at 20 Days later seeding and Pendimethalin.
26. At harvest all herbicidal treatments noted an average fresh weight of plant Pendimethalin combination by HW at 20 Days later seeding and Pendimethalin.

27. The heighest dry weight of the plant was noted in Pendimethalin combination by HW at 20 Days later seeding and HW (20 and 40 Days later seeding).
28. The superior rate of growth of crop was noted in Metolachlor combined by HW 20 Days later seeding and HW (20 and 40 Days later seeding) over the Un-weeded check.
29. The minimum rate of relative growth was noted in Pendimethalin then Imazethapyr 50 g 20 Days later seeding. The heighest rate of relative growth was noted in Metolachlor PE combined by HW 20 Days later seeding and HW (20 and 40 Days later seeding).
30. Significant superior no. of pods/plant, no. of grain/plant, length of the pod, and test weight in PE use of Pendimethalin PE combination by HW at 20 Days later seeding and Pendimethalin.
31. Significant superior seed, straw yield, and harvest index in the PE use of Pendimethalin combination by HW at 20 Days later seeding and Pendimethalin PE.
32. Significant highest Gross return, net return and Benefit Cost ratio were noted in Pendimethalin PE.

❖ Conclusion

This study revealed that PoE use of 2, 4-D Na + one-HW at 60 DAS *FB* Atrazine + one HW at 30 DAS. They were the most effective control of *Commelina bengalensis, Cynodon dactylon, Cyperus rotundus, Chenopodium album, Parthenium hysterophorus, Cannabis sativus,* and *Sinapis arvensis* in maize, increasing the seed yield (4.60 t), net returns (₹ 56,711), and highest benefit cost ratio (1.83) of *spring* corn.

In *Kharif* cowpea, pendimethalin PE effectively controls *Commelina bengalensis, Cynodon dactylon, Cyperus rotundus, Boerhavia erecta, and Parthenium hysterophorus.* It gives the heaviest plant growth, a higher seed yield (7.64 q), the highest net returns (₹ 46,420), and a greater benefit-cost ratio (1.98) in cowpea. These treatments can be used for effective weed control in cowpea during labour shortages byout any residual effect. In cumulative data for the years 2021 and 2022, in the maize-cowpea cropping system, the highest benefit-cost ratio (1.86) was noted in treatment (T_1) by atrazin 750 g (PE) in maize and pendimethalin (PE) in cowpea.

VI. References

Anmyous 2018 Department of Agriculture, Government of India.

Anmyous 2018 Department of Agriculture, Government of Punjab.

Arun. K and Thakur, K.S. (2004). Efflect of integrated nutrient management on promoting composite Maize varieties under rain fed mid hillconditions of Himachal Pradesh. *Indian Journal of Agricultural Sciences*. 74 **(1):** 40-42.

Andargie, M, Remy, P., Gowda, B., Muluvi, G., Timko, M. 2011. Construction of a SSR-based genetic map and identification of QTL for domestication traits using recombinant inbred lines from a cross between wild and cultivated cowpea [*Vigna unguiculata* (L.) Walp.]. *Mol. Breed.,* 28: 413-420.

A. Rajeshkumar, NS Venkataraman, S. Ramadass, R. Ajaykumar and S.Thirumeninathan A (2017) .Study on Inter-cropping system and weed management practices on weed interference and productivity of maize *International Journal of Chemical Studies*; 5**(5)**: 847-851.

A. Sundari, S. Kalaisudarson, A. P. Srinivasaperumal, S. Subashchandedran and R. Gowtham; (2019). Response of Irrigated Maize to New Herbicides *Plant Archives* Vol. 19 No. **2,** pp. 2465-2468.

Bahirgul S and Ramesh Babu (2019). Influence of Early Post Emergent Herbicide Mixtures on Weed Control and Gain Yield of Maize (*Zea mays* L.) *Volume 3 Issue* 5 May.

Barad, B., Madhukia, R. K., Gohil, B. S and Chhodavadia, S. K. (2016). Integrated Weed Management in *Rabi* popcorn maize (*Zea mays* var. everta). *Journal of Crop and Weed,* 12(**1)**:150-153.

C.M. Parihar, S. L. Jat, A.K. Singh, R. Sai Kumar, K.S. Hooda, Chikkappa G.K. and D.K. Singh. Maize Production Technologies in India. DMR Technical Bulletin2011/---. Directorate of Maize Research, Pusa Campus, New Delhi-110 012. Pp 30.

Chatta, MU, Ali, A. And Bilal M. (2007). Influence of planting techniques on growth and yield of spring planted sugarcane. *Pakistan Journal of Agriculture Science* 44: 452–456.

Daniel E, Dadari S. A, Ndahi W. B, Kuchinda N. C and Babaji B. A. (2019). Seed rate and nitrogen fertilizer effects on weed biomass, growth and yield of two sesame (*Sesamum indicum* L.) varieties. *Nigerian Journal of Weed Science* **32**: 31–53.

D. K. Tiwari, V. K. Parad kar, C. L. Gour and Rajiv D (2017). Evaluation of the Bio-efficacy of Topramezone against Weed Control of Maize (*Zea mays* L.) Vol.**6** No. 2, 41-44.

D. P. Nagdeve and Arun kumar (2014). Effect of growth analysis by 2, 4-d herbicide residue on the Safety production of maize *Agriways* 2 (**1**): 1-7.

Ehsas. J, Desai L, Ahir, N. B and Joshi, J.R. (2016). Effect of integrated weed management on growth, yield, and yield attributes and weed parameters on summer maize (*Zea mays* L.) under South Gujarat condition. *International Journal of Science, Environment and Technology*. 5 (4), 2050-2056.

Gupta, K. C., Gupta, A. K., and Saxena, R. (2016). Weed management in cowpea [*Vigna unguiculata* (L.) Wasp.] Under rainfed conditions. *Int. J. Agri. Sci.,* 12(2): 238-240.

Getachew M., Sharma J., Lisanework N., and Tamado T., (2016). Growth and Yield Response of Cowpea (*Vigna unguiculata* L. Walp.) to Integrated Use of Planting Pattern and Herbicide Mixtures in Wollo, Northern Ethiopia *Adv Crop Sci Tech*, 4:6.

Satyendra K., Gupta, G., C. Mishra and Purushottam (2018.) Efficacy of pre and PoE Herbicide on weed control in *kharif* maize (*Zea mays* L.) *International Journal of Chemical Studies*; 6 (**1**):1126-1129.

Hatti, V., Sanjay, M. T., Prasad, T. V. R., Murthy, K. N. K., Kumbar, B. and Shruthi, M. K. (2014). Effect of new herbicide molecules on yield, soil microbial biomass and heir phytotoxicity on maize (*Zea mays* L.) under irrigated conditions. *The Bioscan*. 9 (**3**): 1127 1130.

Hargilas (2020). Effective weed management strategy for maize (Zea mays) under rainfed condition of Southern Rajasthan *Indian Journal of Agricultural Sciences* 90 (**4**): 693.

Hanumanthappa, D. C. Mudalagiriyappa Rudraswamy Kumar, G. N. V. and Padmanabha, K. (2012). Effect of weed management practices on growth and yield of cowpea (*Vigna unguiculata* L.) under rainfed conditions. *Crop Res*., (Hisar) 44(**1/2**): 55-58.

Jat RK, Gopar R and Gupta R. (2012). Conservation agricultural in maize wheat cropping systems of eastern India: Weed dynamics and system productivity. In: Extended summaries

J.K. Sinchana and Sheseja K Raj* integrated weed management impact on soil biological indicators in cowpea Indian Journal of Weed Science 52(**3**): 296–299, 2020Vol. 3, 3rd *International Agronomy Congress*, November 26-30, 2012, New Delhi, India.

Kakade, S.U., Deshmukh, J.P., Bhale, V.M., Solanke, M.S. and Shingrup, P.V. (2016). Efficacy of pre and post emergence herbicides in Maize. Extended Summaries Vol. **1**: 4th *International Agronomy Congress,* Nov. 22–26, 2016, New Delhi, India. pp -442-443.

K. M. Shambulinga and A. K. Guggari. (2017). Effect of post emergence herbicides on weed Growth and yield of irrigated maize *J. Farm Sci.*, 30(**3**): (421-423).

K. Swetha, M. Madhavi, G. Pratibha1 and T. Ramprakash (2015). Weed management by new Generation herbicides in maize *Indian Journal of Weed Science* 47(**4**): 432–433.

Kumar, B., Kumar, R., Kalyani, S., and Haque, M. (2018). Integrated weedmanagement studies on weed flora and yield in *kharif* maize. Trends in Biosciences. 6 (2): 161- 164.

Kumar A, Kumar J, Puniya R, Mahajan A, Sharma N and S. tanzen L. (2015). Weed management in maize based cropping system. *Indian Journal of Weed Science* **47**(3): 254–266.

Kumawat P, Kaushik M., K, Meena V., K, Chouhan B., S, Meena R., K and Kumar R. (2017). Effect of weed management and fertility levels on productivity of cluster bean [*Cyamopsistetragonoloba* (L.) Taub]. *Legume Research* 40(5): 884–889.

Mohanty, S., Satyasai, K. J. (2015). Feeling the Pulse Indian Pulses Sector. *NABARD Rural Pulse.*

Mitra B, Bhattacharya P., M, Ghosh A, Patra K, Chowdhury A., K, and Gathala M., K. (2018). Herbicide options for effective weed management in zero-till maize. *Indian Journal of Weed Science* 50(2): 137–141.

Mukherjee P., K and Rai A. (2015). Weed management in no-tilled dibbling maize after rice residue. pp. 148. *In: 25th Asian-Pacific Weed Science Society Conference on "Weed Science for Sustainable Agriculture, Environment and Biodiversity*", Hyderabad, India during 13-16 October.

Madukwe, D. K., Ogbuehi, H. C. and Onuh, M. O. (2012). Effect of weed control method on the growth and yield of cowpea (Vigna unguiculata (L) Walp) under Rain- fed condition Owerri. *American-Eurasian J. Agriculture and Environment* Sci., 12 (**11**): 1426-30.

Mahesh K., and Jasbir S. C. (2019). Comparative study on weed control efficacy of different Pre-and PoE herbicides in Kharif maize *Indian Journal of Weed Science* 51(**1**): 32–35.

Madhavi, M., Ramprakash, T., Srinivas, A., Yakadri, M. (2013). Integrated Weed management in maize (*Zea mays* L.) for supporting food security in Andhra Pradesh, India. *The role of weed science in supporting food security by 2020.Proceedings of the 24th Asian-Pacific Weed Science Society Conference, Bandung, Indonesia, October 22-25, 2013.*

Mishra J., S and Singh V. P. (2005). Effect of tillage and weed control methods on weeds and yield of rice-wheat and soybean wheat cropping systems. *Indian Journal of Weed Science* 37 (3&4): 251–253.

Muthuram T, Krishnan R and Baradhan G. (2018). Productivity enhancement of irrigated green gram (*Vigna radiata*) through integrated weed management. *Plant Archives* **1**(18): 101–105.

Patel V., J, Upadhyay P., N, Patel J., B and Meisuriya M. I. (2006). Effect of herbicide mixture on weeds in *Kharif* maize (*Zea mays* L.) under middle Gujarat conditions. *Indian Journal of Weed science* **38** (1&2): 54–57.

Parvati D, S.L. Mundra, J.Trivedi, R.H. Meena and R. Verma Nutrient uptake in maize under Different weed and nutrient management options *Indian Journal of Weed Scienc*e 50(**3**): 278–281, 2018.

Pravindra Kumar and Raghuveer Singh Integrated Weed Management in Cowpea (*Vigna unguiculat*a (L.) Wasp.) Under Rainfed Conditions I*nt.J.Curr.Microbiol.App.Sci* (2017) 6(**3**): 97-101.

Priyanka Prajapati, Namrata Jain* and Anamika Jain Badkul Pre- and PoE herbicides for weed control in blackgram- cowpea inter cropping *Indian Journal of Weed Science* 50(**2**): 177–179, 2018.

R.S. Chhokar, R.K. Sharma, S.C. Gill and R.K. Singh Mesotrione and atrazine combination to Control diverse weed flora in maize *Indian Journal of Weed Science* 51(**2**): 145–150, 2019.

Samanth, T. K., Dhir, B.C., Mohanty, B. (2015). Weed growth, yieldcomponents, productivity, economicsand nutrient uptake of maize (*Zea mays* L.) as influenced by various herbicideuses under rainfed condition.Indian *Journal of Weed Science*., 2 (1):79-83.

Sharma, C.K and Gautam, R.C. 2010. Weed growth, yield and nutrient uptake in maize (*Zea mays)* as influenced by tillage, seed rate and weed control methods. *Indian Journal of Agronomy*. 55 (**4**): 299–303.

Singh, A. and Dangwal, L. R. (2013). A survey of weed flora in maize fields of district Rajouri (J&K), India. *International Journal of Scientific Research*. 2(1): 6-9.

Shaik Nazreen and D. Subramanyam Sequential use of pre-and PoE herbicides to control mixed weed flora in maize *Indian Journal of Weed Science* 49(**3**): 293–294, 2017.

Sraw, P.K., Kaur, A. and Singh, K. (2016).Integrated weed management in kharif maize at farmers field in Central Punjab. *International Journal of Agricultural Science and Research*. 6(2): 97-100.

Sunday, O. Udensi, U. E. 2013. Evaluation of PE herbicides for weed control in cowpea (*Vigna unguiculata* (L.) *American J. Experimental Agri*., 3(**4**): 767-779.

Subba Ramireddy, A. S. Rao, G. Subba Rao, T .C. M Naidu, A. Lalitha Kumari and N. Trimurthulu (2020). Diversity of Weed Flora, Weed Density and Crop Weed Competition in Maize. *International Journal of Current Microbiology and Applied Sciences* ISSN: 2319-7706 *Volume 9 Number* 1.

Taramani Yadav, Nisha. K. Chopra and N.K. Chopra Efficacy of pre- and PoE herbicides by and byout weeding in forage cowpea (*Vigna unguiculata*) *Indian Journal of Agronomy* 60 (**4**): 622_625 (December 2015).

Tarundeep Kaur*, M S Bhullar and Simerjeet Kaur Tembotrione- a PoE herbicide for Control of diverse weed flora in maize (*Zea mays* L.) in *North-West India Maydica electronic publication* - 2018

Tripathi, S.S. and Singh. 2001. Critical period of weed competition in summer cowpea (*Vigna unguiculata L.*). *Indian J. Weed Sci.,* 33: 67–**8**.

T Ramesh Babu and T Senthivel Yield and economics of hybrid maize as influenced by Plant spacing and weed management practices *Journal of Pharmacognosy and Photochemistry* 2019; SP2: 876-879.

U. Triveni*, Y. Sandhya Rani, T.S.S.K. Patro and M. Bharathalakshmi1 Dobariya1, Effect of Different pre- and PoE herbicides on weed control, productivity and economics of maize *Indian Journal of Weed Science* 49(**3**): 231–235, 2017.

Vinod Sharma and Thakur D R 1998 Integrated weed management in maize (*Zea mays*) under the mid-hill condition of North-Western Himalayas. *Indian Journal of Weed Science* 30 (3 & 4): 158-162.

Yadav, T., Chopra, Nisha, K., Chopra, N.K., Kumar, Rakesh, Singh, M., Datt, C., Soni, P.G., Rathore, D.K. and Kumar, S. 2016. Influence of Weed Control Methods on Yield and Quality of Cowpea Fodder. *Indian J. Animal Nutri*. 33(**1**):70-74.9.

Pijush Kanti Mukherjee*, Shobha Sondhia1, Putan Singh and R.L Atrazine use to control weeds and its residue determination in fodder crops of maize and sorghum. Sagar *Indian Journal of Weed Science* 51(**2**): 163–168, 2019.

Prithwiraj D, T. Pratap, S. Mishra, Pramit Pandit Weed seed bank in soil as affected by Different Weed spring management practices in spring sweet corn *Indian Journal of Weed Science* 50(**3**): 269–272, 2018

Puscal S, B. Duary and Raghavendra S Tank mix use of tembotrione and atrazine to reduce weed Growth and increase productivity of maize I*ndian Journal of Weed Science* 50(**3**): 305–308, 2018.

R.S. Chhokar, R.K. Sharma, S.C. Gill and R.K. Singh Mesotrione and atrazine combination to Control diverse weed flora in maize *Indian Journal of Weed Science* 51(**2**): 145–150, 2019.

R. Nagasai Vardhan Naik and A. Velayutham Economics of integrated weed management Practices in Rabi hybrid maize (*Zea mays*) *Journal of Pharmacognosy and Phytochemistry* 2020; 9(4): 246-248.

Sapna Bhagat*, Anil Kumar and R. Puniya Effect of herbicides and their combinations on weeds, Productivity and profitability of maize in rainfed sub-tropics of Jammu *Indian Journal of Weed Science* 51(**4**): 358– 361, 201.

Sasode DS, Joshi E, Jinger D, Sasode RS, Gupta V, and Singh YK. 2020. Conservation tillage and weed management practices effect on weeds, yield and profitability of cowpea (*Vigna unguiculata*). *Indian Journal of Agricultural Sciences* 90(1): 86–90.

Shyam R, Singh R and Singh VK. 2014. Effect of tillage and weed management practices on weed dynamics, weed seed bank and grain yield of wheat in rice-wheat system. *Indian Journal of Weed Science* 46(4): 322–325.

Shankar, K.A., Yogeesh, L.N, Prashanth, S.M., Channabasavanna, A.S. and Channagoudar, R.F. (2015). Effect ofweed management practices on weed growth and yield of maize. International Journal of Science, Environment and Technology. 4 (6):1540-1545.

Satyendra Kumar Gupta and GC Mishra Effect of herbicides in combination and sequential use on crop growth and production potential in hybrid maize *International Journal of Chemical Studies* 2017; 5(**6**): 2112-2115.

Sonali B, Srabani D, Abhijit S and Benukar B Weed Management in Maize System in New Alluvial Zone of West Bengal, I*ndia International Journal of Current Microbiology and Applied Sciences* ISSN: 2319-7706 Volume 7 Number 04 (2018)

Sheela amanth, T. K., Dhir, B.C., Mohanty, B. (2015). Weed growth, yield components, productivity, Economics and nutrient uptake of maize Barla*, R.R. Upasani, A.N. Puran and R. Thakur Weed management in maize *Indian Journal of Weed Science* 48(**1**): 67–69, 2016.

Sraw, P.K., Kaur, A. and Singh, K. (2016).Integrated weed management in kharif maize at farmers field in Central Punjab. *International Journal of Agricultural Science and Research*. 6 (**2**): 97-100.

V. Varshitha*, Ramesh Babu, P. Jones Nirmalnath, Ashpakbeg M. Jamadar and M. Roopashree Effect of Early Post of three emergent plants. *Environ. Sci. Pollut. Res. 2015, 22, 9646–9657.* [*Cross Ref*] Emergent Herbicides/ Herbicide Mixtures on Weed Control and Soil Biological Activity in Maize L *International Journal of Current Microbiology and Applied Sciences* ISSN: 2319-7706 Volume **8** Number 03 (2019).

Wang, Q.; Que, X.; Zheng, R.; Pang, Z.; Li, C.; Xiao, B. Phytotoxicity assessment of atrazine on growth and physiology of Maize.

Self Citation

P.J. Khose[1]*, L.S. Vyvahare[1] , S. Menon[1] , K. Yadav[2] , B.R. Divyavani[3] and S. Patil[2] Effect of herbicides on WCE and Yield Response of Kharif Cowpea (*Vigna unguiculata* L.) in sandy loam soils of Punjab *Eco. Env. & Cons.* 29 (1): 2023; pp. (508-511) Copyright @ EM International ISSN 0971–765X DOI No.: http://doi.org/10.53550/EEC.2023.v29i01.074

http://www.envirobiotechjournals.com/EEC/volume29issue1/EEC-74.pdf

CHAPTER- VII

Appendices

Appendix-A: Calculation of fixed cost of cultivation (Rs ha^{-1}) of Maize (pooled data 2021-2022)

S. No.	Particulars	Fixed cost of cultivation (Rs ha^{-1})		
		Input	**Price (Rs)**	**Total cost (Rs ha^{-1})**
1.		**Land preparation**		
a.	Ploughing	1 tractor (4hr) ha^{-1}	700 Rs hr^{-1}	2800
b.	Harrowing and planking	1 tractors (1hrs) ha^{-1}	700 Rs hr^{-1}	700
2.		Seeds and sowing		
a.	Cost of seed	12 kg ha^{-1}	400 Rs kg^{-1}	4800
b.	Sowing and fertilizer application	1 tractor (2 hrs) ha^{-1}	800 Rs hrs^{-1}	1600
3.	Irrigation	8 labourers	200 Rs $laboure^{-1}$	1600
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 Dichlorovos (76 % EC)	1.5 liter ha^{-1}	750 Rs $liter^{-1}$ + 600	1350
b.	Spraying (2) Cost of Emamectin benzoate (5 % SG)	1 kg ha^{-1}	1000+600	1600
5.	Harvesting, Threshing and Winnowing	10 laboures	250 Rs $laboure^{-1}$	2500
A.	**Common cost**			23999.5
B.	Miscellaneous 10 % of common cost			2390.5
Grand total				**26390.00**

Rs = Rupees, ha^{-1} = Hectare, hrs^{-1} = per hours, g = Gram, kg^{-1} = per kilogram, % = Percent

Appendix-B: Variable cost (Rs ha^{-1}) of Maize (pooled data 2021-2022)

Weed management practices	Dose (g a. i. ha^{-1})	Variable cost (Rs ha^{-1})		
		Price (Rs ha^{-1})	Cost of application (Rs ha^{-1})	Total variable cost (Rs ha^{-1})
T_1: Atrazine 50 %WP	700	1129	1000	2129
T_2: Atrazine 50 %WP +1 HW @ 30 DAS	500	806+1000	1000	2806
T_3: Metribuzin 70 % WP	800	960	1000	1960
T_4: Tembotrione 42% CS	120	198	1000	1980
T_5: 2,4-D Sodium Salt 80 % WP +1HW @ 60 DAS	800	560+1000	1000	2560
T_6 : Topramezone 33.6 % CS	200	1900	1000	2900
T_7 : Hand weeding		4000		4000
T_8 Unweeded check (Control)	-	-	-	-

Hand weeding twice = 20 labour ha^{-1} Rs 300 day^{-1} labour^{-1},
Atrazine 50 %WP = 1600 Rs Kg^{-1},
Metribuzin 70 % WP = 1200 Rs Kg^{-1},

2, 4-D Sodium Salt 80 % WP +1HW @ 60 DAS = 700 Rs kg^{-1}

Topramezone 33.6 % CS = 445 Rs litre^{-1} = 1900 Rs liter^{-1}

Appendix-C: Total cost incurred by different weed management practices of Maize (pooled data 2021-2022)

Sr. No.	Treatments	Weed Management cost (ha^{-1})	Cost of cultivation on (ha^{-1})	Interest on the column 3+4 @ (12%per annum for 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	2129	26390	856	713	30088
2	T_2	2806	26390	876	730	30802
3	T_3	1960	26390	851	709	29909
4	T_4	1980	26390	851	709	29930
5	T_5	2560	26390	869	724	30542
6	T_6	2900	26390	879	732	30901
7	T_7	4000	26390	912	760	32061
8	T_8	-	26390	792	660	27841

(D): SALES PRICE OUTPUT

Seed : 17 Rs kg^{-1} **Stover : 2 Rs kg^{-1}**

Economics of Maize as influenced by weed management practices. Pooled data (2021 and 2022)

Treatments	Gross return (₹ ha^{-1})	Cost of cultivation (₹ ha^{-1})	Net return (₹ ha^{-1})	B:C ratio
T_1	82422	30088	52374	1.74
T_2	83914	30802	52790	1.70
T_3	83249	29909	53054	1.76
T_4	79708	29930	49417	1.63
T_5	87637	30542	56711	1.83
T_6	81266	30901	49931	1.59
T_7	87029	32061	55014	1.72
T_8	51639	27841	23908	0.86

Appendix-D: Calculation of fixed cost of cultivation (Rs ha^{-1}) of Cowpea. Pooled data (2021-2022)

S. No.	Particulars	Fixed cost of cultivation (Rs ha^{-1})		
		Input	**Price (Rs)**	**Total cost (Rs ha^{-1})**
1.		**Land preparation**		
a.	Ploughing	1 tractor (4hr) ha^{-1}	700 Rs ha^{-1}	2800
b.	Harrowing and planking	1 tractors (1 hrs) ha^{-1}	700 Rs ha^{-1}	700
2.		**Seeds and sowing**		
a.	Cost of seed	25 kg ha^{-1}	250 Rs kg^{-1}	6250
b.	Seed treatment	1 laboure	300 RS $laboure^{-1}$	300
c.	Sowing and fertilizer application	1 tractor (2 hrs) ha^{-1}	800 Rs hrs^{-1}	1600
3.	Irrigation	3 labourers	300 Rs $laboure^{-1}$	900
4.		**Fertilizer**		
a.	Urea	54.3 kg ha^{-1}	7 Rs kg^{-1}	380
b.	SSP	312.5 kg ha^{-1}	10 Rs kg^{-1}	3120
5.	Plant protection			
a.	Spraying (1) Cost of Chloropyriphos (20 % EC)	160 ml ha^{-1}	457+600	1057
5.	Harvesting, Threshing and Winnowing	Manual	3000 Rs ha^{-1}	3000
A.	Common cost			18709.00
B.	Miscellaneous 10 % of common cost			1871.00
	Grand total			**20580.00**

Rs = Rupees, ha^{-1} = Hectare, hrs^{-1} = per hours, g = Gram, kg^{-1} = per kilogram, % = Percent

Appendix-E: Variable cost (Rs ha^{-1}) of Cowpea. Pooled data (2021-2022)

Weed management practices	Dose (g ha^{-1})	Variable cost (Rs ha^{-1})		
		Price (Rs ha^{-1})	Cost of application (Rs ha^{-1})	Total variable cost (Rs ha^{-1})
T_1: Pendimethalin 30 % EC	1000	600	1000	1600
T_2: Pendimethalin 30 % EC + One HW	1000	600 +1000	1000	2600
T_3: Imazethapyr 10 % SL	50	80	1000	1080
T_4: Quizalofop-ethyl 5 % EC	50	90	1000	1090
T_5: Metolachlor 7.6 % EC + One HW	1000	700+1000	1000	2700
T_6: Quizalofop-ethyl 5 % EC	40	72	1000	1072
T_7: Hand weeding at 20 & 40 DAS	-	4000	-	4000
T_8 Unweeded check (Control)	-	-	-	-

Hand weeding twice = 10 labour ha^{-1} Rs. 300 day^{-1} labour^{-1},
Pendimethalin 30 % EC = 2250 Rs 60 gm^{-1},
Imazethapyr 10 % SL) = 1000 Rs kg^{-1},
Quizalofop-ethyl 5 % EC = 350 Rs kg^{-1}.
Metolachlor 7.6 % EC 700 Rs kg^{-1}.

Appendix-F: Total cost incurred by different weed management practices of cowpea. Pooled data (2021-2022)

Sr. No.	Treatments	Weed Management cost (ha^{-1})	Cost of cultivation on (ha^{-1})	Interest on the column 3+4 @ (12%per annum for 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	1600	20580	665	555	23400
2	T_2	2600	20580	695	580	24455
3	T_3	1080	20580	650	542	22851
4	T_4	1090	20580	650	542	22862
5	T_5	2700	20580	698	582	24560
6	T_6	1072	20580	650	541	22843
7	T_7	4000	20580	737	615	25932
8	T_8	-	20580	617	515	21712

(D): SALES PRICE OUTPUT

Seed : 90 Rs kg^{-1}

Stover : 1.5 Rs kg^{-1}

Table Economics of cowpea as influenced by weed management practices Pooled data (2021 and 2022)

Treatments	Gross return (₹ ha^{-1})	Cost of cultivation (₹ ha^{-1})	Net return (₹ ha^{-1})	B:C ratio
T_1	70216	23454	46420	1.98
T_2	69874	24451	45765	1.87
T_3	59576	22859	36716	1.61
T_4	63036	22986	40050	1.74
T_5	66913	24584	42329	1.72
T_6	61712	23070	38642	1.68
T_7	65429	25952	39476	1.52
T_8	34574	21708	12865	0.59

VITA

Name of student : Mr. Khose Pratap Jambuvant
Date of birth : 10 September, 1993
Name of the college : School of Agriculture, Lovely Professional University, Punjab
Permanent Address: At- Malakapur, Po- Anala, Tal- Paranda, Dist-Dharashiv 413505 (MH)
Mobile No.: 9604708713
Email id: pratap.khose90@gmail.com

Degree	**Year**	**University/ Board**
High School	2010	MSBSHSE, Latur, Maharashtra
Higher Secondary	2012	MSBSHSE, Latur, Maharashtra
B.Sc. (Agriculture)	2016	Dr.B.S.K.KV, Dapoli, Maharashtra
M.Sc. (Ag) Agronomy	2018	Hemavati Nandan Bahuguna Garhwal University, (A Central University), Srinagar (Garhwal), Uttarakhand-246174.

Professional Experience: Assistant Professor Department of Agronomy Govindraoji Nikam College of Agriculture Mandki-Palvan, Tal: Chiplun, Dist: Ratnagiri (MH)
Publicaions : 10
Awards : -

Signature

(Mr. Khose Pratap Jambuvant).