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REPORT

"Effect on growth, development and productivity in Wheat *(Triticum aestivum*)-Chickpea (*Cicer arietinum L.*) inter-cropping under high and limited water conditions."

This is to certify that the declaration statement made by this student, **Diptanu Banik, Reg No. 11717462 (M.Sc.) Agronomy** is correct to the best of my knowledge and belief. The Project Proposal based on the **"Effect on growth, development and productivity in Wheat (*Triticum aestivum*)-Chickpea (*Cicer arietinum L.*) inter-cropping under high and limited water conditions."** is fit for the submission and partial fulfilment of the conditions for the award of M.Sc. in Agronomy from Lovely Professional University, Phagwara.

(Signature of the student)	**(Signature of the Major advisor)**
Diptanu Banik	**Dr. Hina Upadhyay (Associate professor)**
Reg No. 11717462	**UID:-**

DECLARATION

I hereby declare that the project work entitled **"Effect on growth, development and productivity in Wheat (*Triticum aestivum*)-Chickpea (*Cicer arietinum*) inter-cropping under high and limited water conditions."** is an authentic record of my work carried out by Lovely Professional University as requirement of project work for the award of degree of Master of Science in Agronomy, under the guidance of Dr. Hina Upadhyay (Associate professor), School of Agriculture, Lovely Professional University, Phagwara, Punjab.

(Diptanu Banik)

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INTRODUCTION

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Wheat is the one of most important cereal crops being grown across a wide range of environments around the world. Many species of wheat which together make up the genus *Triticum* the most widely grown is common wheat (*T. aestivum*). Wheat is known as the "King of cereals" for centuries and it retain the pride of place even today. Wheat is on the number one food grain consumed directly by human beings and is estimated that more than 35 per cent of the world population depends on wheat, as it supplies more nutrients particularly, essential amino acids than any other single crop. It has been a staple food with the level of consumption largely unaffected by changes in its prices and the price of other crops like rice, maize and millets (Titouan et al., 2015). Wheat is the second most important crop in India next to rice.

The total area under wheat crop has been estimated 1061602 acre (429602hectares) as compared to 1029268 acres (416522 hectares) of the year 2013 which is 3.14% higher than previous year. Average yield of wheat has been estimated 3.03 metric tons per hectare which is 0.66% of the higher than the last year (BBS, 2014). In India, wheat is the second important crop after rice occupying 29.40 million hectare, with a production of 88.31 million tonnes with an average productivity of 3000 kg per hectare (The Hindu, March 9, 2012). From the point of area and production of wheat Uttar Pradesh, Madhya Pradesh, Punjab and Haryana are on the top in India.

Wheat is a rabi season crop which is grown in tropics and sub tropics region and also need high temperature during its growth cycle. Heat stress is the main factor for growth stage like grain filling and if heat stress is more then it also reduce the yield. The fertilization of nitrogen increase the protein content significantly (Ames *et al.,* 2003). Wheat sown in late season is affected by heat stress in the anthesis period which results in the decreased productivity due to spikelet sterility.

In last some years the foliar fertilization of nutrients is the most effective method to increase the yield and improve the quality crop product. In foliar fertilization the nutrients are utilized properly and reduce the environmental pollution due to the less amount of fertilizers added in soil. In 2016, world production of wheat was 749 million tonnes, making it the second most-produced cereal after maize. The demand of wheat is increasing globally due to presence of unique viscoelastic and gluten protein. Wheat is also good source of carbohydrate. It is leading source of vegetal protein in human food with 13% protein content.

Taxonomical description of Chickpea (*Cicer arietinum* L.)

Chickpea is considered less labor-intensive crop and its production requires less external inputs as compared to cereals. Chickpea is widely grown around the world and serves as a multi-use crop. It plays a significant role in improving soil fertility by fixing the atmospheric nitrogen. It can fix up to 140 kg N ha-1 from air and meet most of its nitrogen requirement. After harvest, it leaves substantial amount of residual nitrogen for subsequent crops and adds some amount of organic matter to maintain and improve soil health and fertility. This saves the fertilizer input cost not only for chickpea but also for the subsequent crops.

Chickpea has the ability to grow on residual moisture which gives farmers the opportunity to engage in double cropping, where chickpea is sown at the end of the rainy season following the harvest of the main crop. This allows more intensive and productive use of land, particularly in areas where land is scarce. It is also an excellent source of protein, fiber, complex carbohydrates, vitamins, and minerals thus can help alleviating malnutrition and improving human health. The growing demand in both the domestic and export markets provides a source of cash for smallholder producers. Because of its deep tap root system, chickpea can withstand drought conditions by extracting water from deeper soil layers. It also increases livestock productivity as the residue is rich in digestible crude protein content compared to cereals.

Chickpea was first produced in the Middle East about 7,000 years ago. At present, it is produced in over 40 countries represented in all continents. However, the most important chickpea producing countries are India, Turkey, Pakistan, Iran, Mexico, Australia, Ethiopia, Myanmar, and Canada. Chickpea is currently grown on about 11 million hectares worldwide with 65% and 8% share belonging to India and Pakistan,

respectively. Average annual production of chickpea is about 9 million tonnes with 95% of chickpea cultivation and consumption occurring in the developing countries. The diverse agro-climatic conditions in Ethiopia make it very suitable for growing chickpeas. Chickpea is widely grown across the highlands and semi-arid regions of Ethiopia and serves as a multi-purpose crop. The country is also considered as the secondary centre of diversity for chickpea (Anbessa and Bejiga, 2002). It has a major role in the daily diet of the rural community and parts of urban population.

Chickpea is used for human consumption as well as for feeding to animals. It is eaten both whole fried or boiled and salted, or more generally in the form of the split pulse which is cooked and eaten. Both husks and bits of the 'dal' are valuable cattle feed. Straw of chickpea is an excellent fodder for cattle. Chickpea flour (besan) is used in the preparation of various types of sweets. Chickpea is considered to have medicinal effects and it is used for blood purification. Chickpea contains 21.1 per cent protein, 61.5 per cent carbohydrate, 4.5 per cent fat. It is also rich in calcium, iron and niacin.

INTERCROPPING

Intercropping of cereals and grain legumes is a neglected theme in agricultural science and practice in both conventional and organic farming systems (Dahlmann, Fragstein, 2006). The purpose of intercropping is to generate beneficial biological interactions between the crops. Intercropping can increase grain yields and stability, more effciently use available resources, reduce weed pressure and sustain plant health (Hauggaard-Nielsen et al., 2003; Jensen et al., 2006). Mixing species in cropping systems may lead to a range of benefits that are expressed on various space and time scales, from a short-term increase in crop yield and quality, to longer-term agro ecosystem sustainability, up to societal and ecological benefits (Malezieux et al., 2009).

Intercropping is a system of management of crop which involves growing of two or more dissimilar crop species or varieties simultaneously in distinct row combination on the same piece of land (Katyayan 2005). Efficiency of resource utilization can be increased with intercropping (Tilman *et al.* 2002; Gao *et al*., 2014; Nasri *et al*., 2014). According to Sullivan (2003) intercrops staggered the maturity dates or development periods and take advantage of variations in peak resource demands for nutrients, water, and sunlight. In comparison with

corresponding sole crop, higher agricultural resource utilization of intercropping was observed in most studies. Tsubo *et al.* (2001) carried out a study to compare the production efficiency in intercropping (wheat/chick pea) with sole cropping (maize and been) in terms of radiation use efficiency (RUE). The authors concluded that the intercrop fraction of intercepted radiation and RUE was higher compared to sole cropping. Similar results were also observed by Awal *et al*. (2006) who reported greater RUE in intercropping of Maize/chickpea bean in comparison with sole cropping of maize and Chickpea.

OBJECTIVE-

Keeping in view all these aspects, the present study in Wheat-Chickpea is undertaken with the following objectives:.

1. To check the yield variations in different water condition in field.
2. To study the crop weed competition and its management.
3. To study the different phenotypical attributes in the standing crop of wheat and chickpea.
4. To study diseases and its management.

SCOPE OF STUDY

Studying and evaluating the effect on growth, development and productivity in Wheat (*Triticum aestivum*)-Chickpea (*Cicer arietinum* L.) inter-cropping under high and limited water conditions, we can determine the best suited intercropping method between these two crops in different areas. The different irrigation condition can help the best suited way for getting higher yield in wheat-chickpea intercropping. Because only the best suited irrigation condition can provide the best yield in the intercropping of these two crops. Thus we have to find out the best suited irrigation condition for the betterment of yield of our crop.

REVIEW OF LITERATURE

The world's population is increasing rapidly, and in order to feed it, one of the most attractive strategies is to increase productivity per unit area of available land or to increase the land area under production, which seems shrinking day by day. Therefore, to maximize land use and production, the ultimate goal of agriculture, namely yield, intercropping is an advanced agronomic technique that allows two or more crops to yield from the same area of land. Better utilization of resources and reduced weed competition minimize the risk of food shortages by enhancing yield stability. Several factors can affect intercropping: plant density, sowing time, the maturity of a crop, the selection of crop that is compatible with another as well as farmers' and the region's socioeconomic conditions. In intercropping, the land equivalent ratio (LER) is used to measure the productivity of land. Since wheat is the most important cereal around the world and is most suitable for intercropping, this review focuses on wheat-based intercropping.

WHEAT- CHICKPEA INTERCROPPING:

Mandal *et al.* (1991) concluded that wheat and chickpea intercropping gave higher yield of wheat as well as water use efficiency than wheat and rapeseed intercropping.

According to Sherma *et al.* (1993) mixture of legume and cereal result in higher yield than their respective sole crop. .

Intercropping resulted in lower weed infestation level (Liebman and Dyck 1993; Midmore 1993).

Malik *et al.* (1998) reported that yield and yield components of wheat were significantly affected by association of chickpea.

Li *et al.* (2001) observed that in wheat/Soybean intercropping, there was recovery of growth of soybean after harvesting wheat. Significant effect due to the association of chick pea, lentil and rapeseed on different yield and yield components of wheat has been shown in previous study.

Adesogan *et al*. (2002) described that for development of sustainable food production system, intercropping of cereal and legume is very important particularly where there are limited.

Intercropping of cereal and grain legume is neglected in agriculture science and practice in organic as well as conventional farming system (Dahlmann and Fragstein, 2006).

Previous work showed that intercropping of alfalfa in wheat increased yield as well as protein content of wheat (Magid *et al.*, 2008).... Three levels of urea fertilizer were used i.e. 0, 4 and 8 g nitrogen m-2. It was revealed that intercropping of pea and wheat resulted into maximum productivity without addition of nitrogen fertilizer Khan *et al.* (2005) carried out field experiments to study effect of rapeseed, lentil and chickpea in different proportion on yield and yield components of wheat. They concluded that plant height, spike length, number of

grains per spike and grain yield of wheat was higher when intercropped with chickpea with proportion of 1:1.

Yield of intercropping system is often higher than in sole cropping system (Lithourgidis *et al.*, 2007; Dahmardeh *et al.*, 2009).

In developing countries, intercropping is superior to monocropping in terms of farm income, which is key motivation for farmers who reaped a double crop and a double income when wheat (*Triticum aestivum* L.; cv. 'Inqalab91') was intercropped with chickpea (*Cicer arietinum* L) (Akhtar *et al.* 2010)

Intercropping offers potential benefits relative to monoculture by increasing yield through the effective use of resources, including water, nutrients, solar energy (Morris and Garrity, 1993; Nasri *etal*., 2014).

MATERIALS AND METHODS

Technical programme

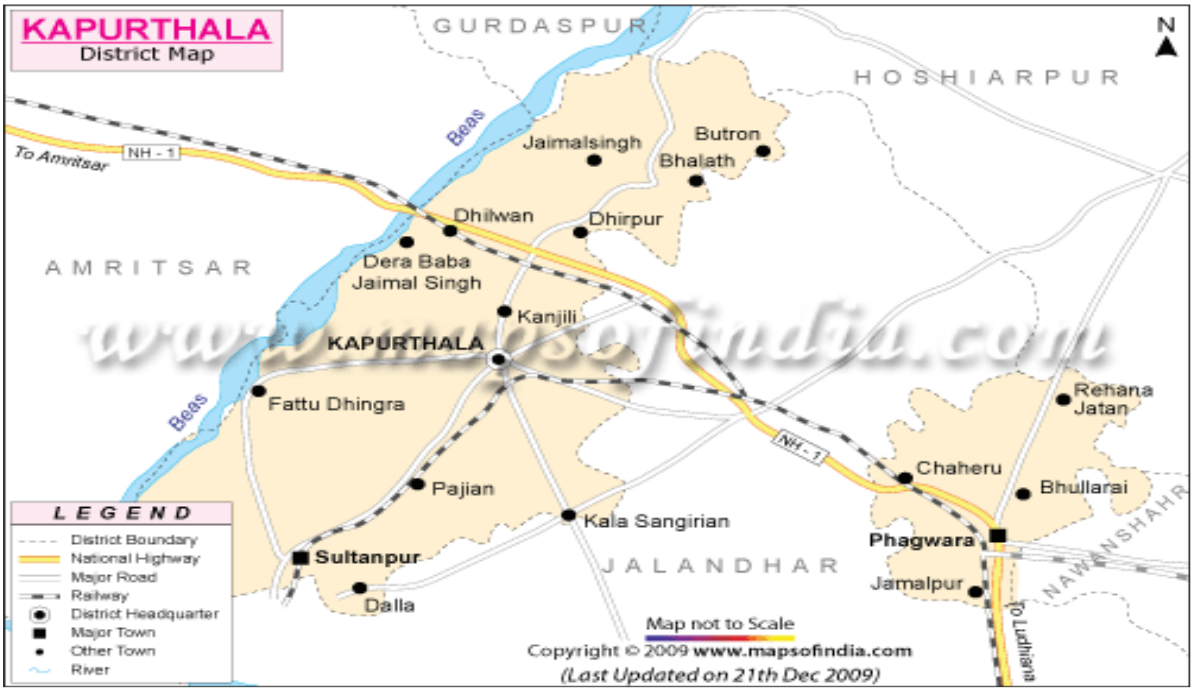
Name of experiment: Effect on growth, development and productivity in Wheat (*Triticum aestivum)*- Chickpea (*Cicer arietinum*.L) inter-cropping under high and limited water conditions.

Climate:

The climate of the fields comes under Agro ecological sub region (northern plain, hot sub humid eco-region Punjab). Agro climatic zone (trans-gangetic plain region). The area comes under the semi arid zone with annual rainfall 527.1mm/annually.

LOCATION:

The experiment has been conducted at Lovely Professional University Field Campus, Punjab. Six agro-climatic zones have been classified to characterized climatic zone distribution in Punjab and the study area is in Chaheru village of Kapurthala district, which lies in the northern plain zone between 31.2690° N, 75.7021° E . The district lies in the heart of Punjab and situated between the river Sutlej and Beas. Out of six agro-climatic zones of Punjab, the area lies in Central plain region. The soil of the village is covered by alluvial soil. It have sub- tropical monsoon type climate with normal rainfall 600 mm.



Layout details

1. Year of experimentation: 2017-2018
   2. No. of treatments: 3
   3. No. of replication: 3
   4. Total no. of plots: 9
   5. Plot size: 12m X 4m
   6. Irrigation channel: 0.5m
   7. Date of sowing: Last week of November
   8. Experimental design: RCBD (Randomize Complete Block Design)
   9. Crop and variety : Wheat (HD 3086), Chickpea (PBG-5)
   10 Estimated areas needed: 450 meter square

Collection of soil samples:

Soil samples will be taken before crop sowing to check the soil pH, organic carbon, electric conductivity, N, P, K and Fe ratio present in soil.

Soil Analysis:

Initial soil: Initial soil samples will be analyzed for pH, EC, Organic C, available N,P and K and Fe amount present in soil.

S. N.	Test parameter	Method	References
1	pH (1:2.5)	Glass electrode	Sparks (1996)
2	EC (1:2.5)	Conductivity meter	Sparks (1996)
3	Organic Carbon	Wet digestion	Walkley and Black (1934)
4	Available N	Alkaline potassium permanganate method	Subbiah & Asija (1956)
5	Available P	Olsen's Method	Olsen *et al*. (1954)
6	Available K	Flame photometer	Jackson (1973)

Statistical analysis

Data generated in the experiment will be analysed as per standard statistical procedure by Rangaswamy (2002)

Experimental detail

Variety – Wheat (HD3086) Chickpea (PBG-5)

Sowing time - November-December 2017

Sowing depth - 3-5 cm

Plot treatments

T_1 : RDF + W1 (RECOMENDED IRRIGATION)

T_2 : RDF + W2 (LESS IRRIGATION)

T_3 : RDF + W3 (HIGH IRRIGATION)

Data taken during the field trial:

Sowing date: 9th of December.

Rainfall: 11th December, 12th December, 23rd January, 12th February

Seed germination started: 21st December (Chickpea), 25th December (Wheat)

FIELD LAYOUT

T1 R1 12M **4M**	**0.5M**	**T3R3 12M** **4M**	**T2 R2 12M** **4M**	**0.5M**
T2R2 **4M**	**0.5M**	**T1R1** **4M**	**T3R3** **4M**	**0.5M**
T3R3 **4M** **12M**	**0.5M**	**T2R2** **4M** **12M**	**T1R1** **4M** **12M**	**0.5M**

OBSERVATION TO BE RECORDED

A. Morphological observation

- Plant height
- Number of branches
- Number of pods
- Stem girth
- Leaf size
- Ear head size
- Total no. of tillers.
- Weed infestation.

B. Biochemical observation

- Total soluble sugar (TSS)
- Total soluble protein (TSP)
- Total carbohydrate
- Total chlorophyll content of leaves

C. Yield attributes

- Grain yield (kg/m^2)
- Straw yield
- Seed index (100 seed weight)
- Harvest index

Expected outcomes:

The experiment was conducted at the Lovely Professional University, School of Agriculture, near experimental farm of Phagwara, Punjab. The experiment was conducted by using three treatment and three replication i.e. different irrigation and different recommended doses of fertilizer, it is expected that they will enhanced the yield and yield attributes of Wheat-Chickpea intercropping.

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