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"Effect of pesticide application on plant growth characteristics of maize (*Zea mays L)*"

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Abstract

Maize is one of the most important versatile cereal crops grown in tropical and temperate regions of the world Field study were conducted at lovely Professional University Phagwara, Punjab during kharif season of year the 2016-17 from June to Oct experiment on "Effect of pesticide application on plant growth characteristics of maize". In this experimental study will document the possible adverse or synergistic effect of pesticides application on the plant growth and development and yield of maize plants in the absence of the pest and disease causing agent in which seven treatment with three replication, by using two weedicide (Atrazine, Alachlor), two fungicide (Thiram, Indofil) and two insecticide (Chlorpyrifos, Monocrotophos) were used in experimental farm. All these were arranged in a randomized complete block design. The maize hybrid of Pioneer (P3396) which gives high yield, it was selected to grow as an experimental trail. Its maturing period is 90-100 Days of sowing. It is a mid-duration maize Hybrid variety. Weedicide (Atrazine-pre emergence) was used before sowing using only in R1T1, R2T1, R3T1 and Fungicide (Thiram –seed treatment) was using only R1T3, R2T3, R3T3 weedicide (Alachlor applied 2-3 week after sowingR1T2, R2T2R3T2. SPSS software was used to compute interrelation between various variables and correlation coefficients. Significant differences between means were estimated by the least significant difference at 5%. Result revealed that weeedicide Atrazine-pre emergence and Alachlor were given significant results and they suppressed the weeds growth in initial stage as well as different interval of times so competition level in between crop and weed decreased in different interval of time and it directly effect on growth parameters (height of plant, number of green leaves ,girth of stem etc)and yield of contributing factors (tested grain, average grain yield etc)maize crop.

Keywords: Weedicide; Atrazine; Alachlor; Thiram; Indofil; Chlorpyrifos; Monocrotophos; Growth parameters, Pre emergence

Introduction

Maize *(Zea mays L.)* is most important cereal crop. It is grown in tropical and temperate regions of the world. India ranks fifth in area (8.7 million ha) and third in the production (22.5 million ton) among cereal crops. Punjab is one of the leading states of maize in production. Total area (Punjab) under maize cultivation - 30 thousand hectares and production is 507 thousand tons 2015-2016 the average yield of maize in Punjab was 39.0 quintal per hectare. Average productivity of maize in India is 2.43 t/ha. In North India, *Kharif* (monsoon) season is the main growing season for maize crop, but it can be successfully grown in spring (summer) and rabi (winter) season in many parts of the country. Maize is cultivated on 178 million hectares in about 160 countries and contributes 1,170 million ton to the global grain production. The largest producer with highest productivity of maize (more than 9.6 t/ha) is U.S.A which is double than global average. Total 35% contribution by USA in world production. India average productivity is 2.43 t/ha. In India it is the third important food crop after rice and wheat. In all the state of India it's easily grown. Maize grain contains about 10% of Protein, 4% of oil, 70% of carbohydrate, 2.3%of crude fiber, 1.4% of ash About 14%of the total production in India in 2014-15 was exported. From that export value, 35% is exported to Indonesia and 17% to Malaysia. Thus the demand for Indian Maize is very high in the international markets. The water requirement for the crop is high. In South Africa approximately 8.0 million tons of maize grains are produced annually on approximately 3.1 million ha of land. Half of the production consists of white maize, for human food consumption. The maize stem varies in height from less than 0.6m in some genotypes and more than 5.0 m others .The stem is solid, cylindrical and divided into nodes and internodes. Maize stem may have 8 to 21 internodes. Land preparation methods for maize production include: slashing and burning slashing, hand hoeing, herbicides application and tractor ploughing and harrowing. These methods open-up the soil surface for seed sowing and vegetative growth. Although no tillage practices accumulate soil surface organic matter and improve soil biochemical properties, the ploughing and harrowing rather facilitate root penetration, seed sowing and organic matter incorporation into the soil and improve soil structure. when soil is not tilled, yield decreased because it is decreased aeration, soil water storage, crop water use efficiency and reduced penetrability of roots. Since the use of herbicides destabilizes soil biochemical properties and the adoption of a land preparation method that provides suitable conditions for maize production should be encouraged [1]. Weed control is an important aspect of crop production. Weed control can be carried out by mechanical and chemical methods in maize crop. Weeds between plant rows are removed by mechanical cultivation and weeds on the rows are controlled by hand hoeing and also by herbicides. Good weed control usually involves a mixture of the available methods and good cultural practices. Within 4-8 weeks after planting best time to minimize the effect of weeds on the maize yield.

The most widely practiced cultural weed control technique is still hand weeding because of the high cost of herbicides, the harmful effect of herbicides, and lack of proper information, about their use. The frequency of weeding greatly influence growth and yield of maize since weeds reduce yield of maize. Potential of maize crop can be fully exploited by adopting suitable agronomic practices such as fertilizers, optimum spacing, soil conditions, water availability and growing season. Maize crop is mainly sown in the districts of Hoshiarpur, Amritsar, Gurdaspur, Jalandhar, Kapurthala, Patiala, and Ludhiana in Punjab state. Traditionally maize was grown as *kharif* crop and now sowing during *rabi* season has also been started in some districts with invention of new varieties. Maize production practices to increase yield need to be better understood, including the relation of grain yield and various yield components. The production practices of maize crop are dependent on pesticide and herbicide application apart from fertilizers inputs. The use of pesticide has been reported to effect the plant growth and development characteristics apart from the direct effect on the pest and disease causing organisms.

Material and Research Methodology

This chapter includes all the experiment aspects of field experiment entitled "Effect of pesticide application on plant growth characteristics of maize" which was conducted at agricultural research farm of Lovely Professional University, Phagwara, Punjab during kharif season of year the 2016-17. A brief description of all material and methods like location of the experiments, properties of soil, climatic conditions, treatments and all agronomical operations is given in this chapter. Statistical analysis of data collected from experimental field is described in a tabular as well as graphical form.

Description of Experimental Site

Location of the experiments

This experiment was conducted at agricultural research farm department of agronomy. Lovely Professional University, Phagwara, Punjab during kharif season of the year 2016-17. The research field is graphically located at latitude31º22'31.81''North and longitude 75º23'03.02East, and at the altitude of 252m above sea level.

Climate and weather condition

The experiment site enjoyed sub tropical type of weather situation with cool winters, hot summers and a distinct rainy period with yearly rainfall of 1919.5 mm. The lowest temperature never goes down to subzero point even during the coldest months (December-January) and the series of lowest temperature was 6-10ºC.The greatest winter temperature up to 27ºC . In most recent month of year (April, May and June) the highest temperature goes as high as 42ºC. In common the site establish rainfall during rainy season which started from June and continued up to September .the month June –July received the highest rainfall .different journal data is different weather parameter
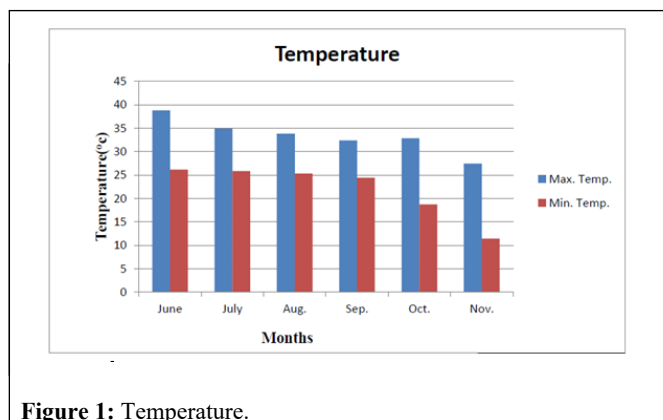
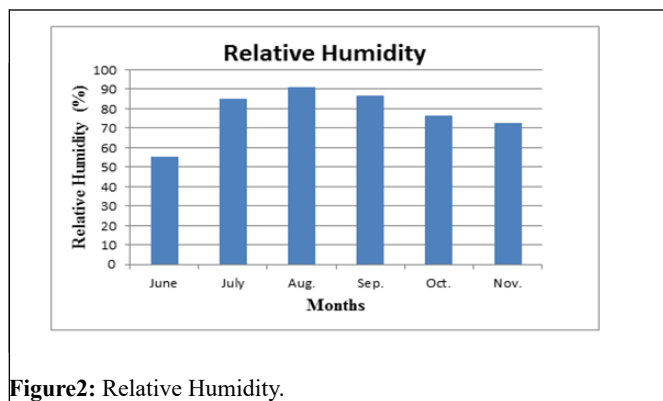## Climate and weather condition

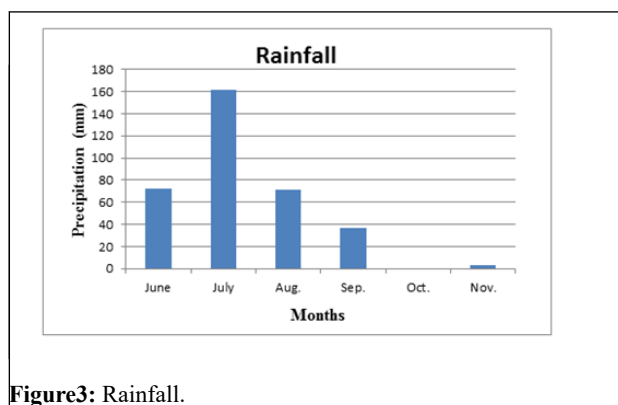**Figure 1:** Temperature.

Figure2: Relative Humidity.

Figure3: Rainfall.

Properties of soil

The experiment was conducted at the student research farm school of agriculture, lovely professional university Jalandhar, Punjab, previously soil sample was collected randomly from the experimental site and analyzed .The soil of the experimental site was found to be sandy clay loam and ph of the soil was 7.8-7.9

pH

We measured the ph of soil by pH meter, we firstly dried the soil for 3-4 days in sunlight or oven and then we weight 12.5 g of soil and put in a 150ml flask/breaker after that take 25ml of distilled water and we stir at least 3-4 time in half an hour intervals, then again stir the solution and measure pH with the help of pH meter. pH meter is being used to estimate the pH of soil [2].

Soil texture

Soil texture is the percentage of sand, silt and clay particles in the soil. Soil can be estimated simply by feel and appearance. Experts can judge the texture of soil easily and accurately with the feel method. There is also a triangle which helps us to determine the type of the soil. The three sides of the triangle contain percentage of sand, silt and clay. Inside the triangle there are different types of soil. On the basis of these percentages of sand, silt and clay proportions soil can be easily determined.

Characteristics	Percentage (%)
Sand content	75
Silt content	10.3
Clay content	14.7
Soil texture	Sandy Loam

Table1: Physical properties of tested soil.

Plot no.	Texture of soil	pH
1	Sandy Loam	7.7
2	Sandy Loam	7.6
3	Sandy Loam	7.9
4	Sandy Loam	7.8
5	Sandy Loam	7.7
6	Sandy Loam	8
7	Sandy Loam	7.8

Table2: Chemical properties of experimental soil.

Cropping history

Experiment site maize wheat rotation was fallowed from many years .The farm site was under continuous cropping. Maize-wheat cropping pattern was followed on the farm site from last 4 years. Wheat was the last crop of the experimental site and it was harvested in April 2016 and then experimental Maize crop was grown in the field during kharif season of 2016-17.

Layout and experimental design

The experiment was laid with the randomized complete block design (RCBD). There were three pesticides application used (two weedicide, two fungicide and two insecticide) for the sowing of the maize crop thus we have chosen randomized complete block design for the easy to operate the field preparation to harvest. Total area required for the experiment was approx 277m2 .The experiments was conducted with 7 treatments and 3 Replications, thus the total number of plots reach to 21. All the treatments were arranged with randomization (un-biased) in the plots. Each plot is of 4 ×3 m2. There were separated irrigation channels of 0.5m to provide irrigation to each plot separately [3].

Treatment combination	7

Replication	3
Design	RCBD
Row to row distance	60cm
Plant to plant distance	22.5cm
Plot size	12m2
Total number of plot	21
Total area of plot	277.2
Varity of maize	P3396
Seed rate	8kg

Table3: Experiment detail.

Table4: Treatments detail.

Field Preparations and Planting Material

Field preparation

Maize crop requires arable soil, weed free, friable. Crop can be grown even seedbed is not fine. Soil should be loosen up to 20-25 cm depth, two inter-crossing ploughing were sufficient to prepare the seedbed for the experimental site. The field was free from the weeds and crop residues of previous crop were properly mixed into the soil. Planking was done after the ploughing to bread the clods and to minor leveling the field.

Planting material

The maize hybrid of Dupont Pioneer (P3396) which gives high yield India was selected to grow as an experimental trail. Its maturing period is 90-100 Days of sowing. It is a mid-duration maize Hybrid variety. It has a unique plant structure and responds as well in kharif season in North climatic conditions of India. It has large plants with well-developed root system. Leaves are broad and dark green in color. Cobs are medium to long with orange color flint caryopsis. Most of the leaves stay green even at harvesting time of cobs.

Seed rate and sowing

The recommended seed rate for the sowing of the crop is 20 Kg/ha. Mid June – July is the best time for the sowing of maize crop. Sowing should be done 10-15 Days before the onset of the monsoon, if not water stagnation in the field affects the crop and always avoid water stagnation in the maize crop. It has been found that if water stagnation in the maize field even for 6 hours then there will be decrease in the yield of the crop. Sowing was done on 18 th June 2016. Row × Row spacing was 60 cm and Plant × Plant was 22.5 cm. Seeds were placed 3 cm deep in the soil [4].

Seed treatment

To protect the seeds from the Fungus, seeds should be treatment with fungicides .Seeds can be treating with Captan/Thiram. It can

improve seedling establishment in the field Thiram@ 3g//Kg of seed only plot T3 in three replication (R1, R2, R3)

Irrigation

The crop requires 4-6 irrigations from sowing to harvesting. Irrigation can be given as per the availability of the soil moisture. First irrigation was given just after the sowing of the seeds. Then irrigations were planned as per the requirement. Total 4 irrigations were given to the crop in addition to the rainfall

Weed management

It is very important to control the weeds at initial stages of crop growth. Otherwise weeds will suppress the growth of the maize crop and yield will be affected. Thus, it is best to choose pre-emergence weedicide to control the weeds. Atrazine is the recommended weedicide to reduce the growth of the weeds without affecting the growth of the maize crop. Weeds can be suppressed up to 40 days after the application of the weedicide. It can be sprayed @ 1-1.5 Kg a.i. in 1000 litres of water to spray in area of one hectare. It is done in different plot R1T1, R2T1, R3T1 not all treatments and Alachlor after sowing 2-3 weeks@2-3 kg/ha and it also suppress the weeds

Insect management

It is very important to protect the crop from the insects. Thus, firstly Monocrotophos was sprayed in R1T6 ,R2T6,R3T6 on 25th June ,2016 to protect from sucking, chewing and boring insect and spider, mite in maize crop and it is very harmful for birds then next day Chlorophyrihpos20% EC was sprayedR1T5,R2T5,R3T5 in the field on 26th June ,2016 to protect the crop from the termites. There was no severe attack of insects in the field.

Harvesting and threshing

When the crop completely dried and turns into brown in color then crop is ready to harvest. The leaves and stalks of the crop appear green in color at the time of harvesting. The crop was harvested on 25th September 2016. Each cob was harvested manually and put into the polythene bags. Each polythene was marked so that they cannot mix and on the basis of the marking each treatment dried and weigh separately.

Treatment evaluation

Both Growth and Yield Parameters were recorded at different days interval.

Growth Parameters

Plant Height

Plant Height was recorded at 15, 30, 45, 60 and 75 Days after sowing and crop was harvested at 90 days of sowing. For this purpose three plants were randomly selected in each plot and tagged. Plant Height was measured with the help of measuring tape. Then mean height was calculated and expressed in cm.

Number of green leaves per plant

Green leaves were counted at15, 30 days, 45, 60 days and 75 days after sowing of the crop, three plants in each plot were randomly selected and there average was calculated. Number of green leaves reduces towards maturity.

Stem girth

Randomly selected plants were used to take the reading for the stem girth. Readings were taken at 15, 30, 45, 60 and 75 Days after sowing. Middle portion of the stem was measured with the help of the measuring tape and was expressed in cm.

Total plants per plot

With the proper Row × Row and Plant × Plant spacing plot attains 70-72 plants per plot. Extra seed was placed at the time of sowing to attain the good plant population. Thinning was done to maintain the proper spacing between rows and plants.

Yield Parameters

Cob length

Cob length was measured when the cob attains it proper size. Cob length of the three plants in each plot was measured with the help of measuring tape and recorded on notebook. Then the mean of each plot was taken.

Number of cob/s per plant

Cob/s from each of the tagged plant was counted. Then the average of the three values from the each plot was taken for further analysis.

Number of grains per cob

Tagged cobs were harvest separately and marked. Then the numbers of grains of these cobs were counted and mean was take to compare the numbers of grains under different treatments.

Test weight

Test weight is the weight of the 1000 grains. From the sun dried grains, 1000 grains from each treatment were counted separately and weighed them. It was measured in grams.

Grain Yield (Kg/ ha)

Harvested cobs were kept for sun drying. After drying of the cobs grains were separated with maize sheller. Grains were separately collected and weighed.

Statistical analysis

Statistical analysis was done to check the significance of different treatments. Data were assessed by Duncan's multiple range tests with a probability $P<0.05$.difference between mean value were evaluated by a one way analysis of variance (ANOVA) using of the software SPSS16.Unless otherwise stated and level of significance referred to in the results in $P<0.05$.

Result and Discussion

The results of the experiment entitled "Effect of pesticide application on plant growth characteristics of maize" was conducted during the kharif season of 2016-17 at farms of Lovely Professional University, Punjab are presented in this chapter. The data appertain to the influence of different treatments on the yield of the crop. The results show variation due to treatments on growth parameters (Plant height, Stem girth, Number of leaves), Yield parameters (cob length, Number of grains per cob, number of cob/s per plant, test weight, Grain yield). The data obtained from the trail was statistically analyzed for test of significance with the use of SPSS Software [5]. The result has been expressed in graphs and tables.

Effect of Different pesticides effect on growth parameters and yield of maize crop

Different pesticides application applied on different plots at different time intervals .Weedicide pesticide, fungicide in different plots .These different treatments show different results and effect on different growth parameters in maize crops and as well as yield of maize crop

Plant Height

Plant Height of all the treatments was recorded at15, 30, 45, 60 and 75 Days after sowing. For this purpose, plants were randomly selected in each plot. Averages of the plant height were taken to get the plant height of each plot. It is expressed in graph and data in table

At 15 Days

The first plant height reading was recorded at 15 Days after sowing. The height was measured with measuring tape. Three plants were randomly tagged in each plot to take the data. The data showed that T1(weedicide)i.e.Atrazine shows maximum plant height 41.63 cm which was 40%more over control; T2 (weedicide)i.e. Alachlor on shows plant height of 39.30cm more 14.5% over control(T7), T3 (fungicide)i.e. Thiram shows plant height of 36.36cm which was 7.5% more over control(T7). Treatment T4 (fungicide)i.e. Indofil shows plant height of 35.7 cm which was 5.8%more over control (T7) and T5 (insecticide)i.e. Chlorpyrifos shows plant height 34.43 cm which was more 2.4%over control (T7) and T6(insecticide)i.e. Monocrotophos These results are expressed in graph The value in the graph bar shows the superiority of treatments on each other. For eg: in T1bar shows value a, which means that treatment is superior over all the treatments and vice versa. Show in table 5

At 30 Days

The first plant height reading was recorded at 30 Days after sowing. The height was measured with measuring tape. Three plants were randomly tagged in each plot to take the data. The data showed that T1 (weedicide)i.e.Atrazine shows maximum plant height 143.90 cm which was 10.7%more over control; T2 (weedicide)i.e. Alachlor on shows plant height of 148.03cm more 15.3% over control(T7), T3 (fungicide)i.e. Thiram shows plant height of 141cm which was 8.9% more over control(T7). Treatment T4(fungicide)i.e. Indofil shows plant height of 143.23 cm which was 10.3%more over control (T7) and T5 (insecticide)i.e. Chlorpyrifos shows plant height 150.96 cm which was more 14.97%over control (T7) and T6(insecticide)i.e. Monocrotophos These results are expressed in graph 4.2.The value in

the graph4 bar shows the superiority of treatments on each other. For eg: in T5, T6, T2 significantly similar bar shows value a, which means that treatment is superior over all the treatments and vice versa.

At 45Days

The first plant height reading was recorded at 45 Days after sowing. Three plants were randomly tagged in each plot to take the data. The data showed that T1,T2,(weedicide)i.e.atrazine,alachlor significantly similar plant height 182.5 cm which was 9.9%more over control and T3 (fungicide) i.e. thiram also show similar to T1,T2 ;Treatment T4(fungicide)i.e. indofil also shows approximately significant, T5 (insecticide)i.e. chlorpyrifos shows plant height 177.4cm which was more 7.3%over control (T7) and T6(insecticide)i.e. monocrotophos shows plant height 175.8 which was more 6.7% over control These results are expressed in graph 4.3 and data in table 4.1.2 The value in the graph bar shows the superiority of treatments on each other. For eg: in T1, T2,T3 significantly similar bar shows value a, which means that treatment is superior over all the treatments and vice versa. In table 5 and Graph 6 representation of data .

At 60 Days

The first plant height reading was recorded at 60 Days after sowing. The data showed that T1(weedicide)i.e.Atrazine shows plant height 192.4cm which was 23.41%more over control; T2 (weedicide)i.e. Alachlor on shows plant height of 193.1cm more 19.26% over control(T7), T3 (fungicide)i.e. Thiram shows plant height of 197.2cm which was 20.94% more over control (T7). Treatment T4 (fungicide) i.e. Indofil shows plant height of 180.7 cm which was 13.72%more over control (T7) and T5 (insecticide) i.e. chlorpyrifos shows plant height 185.06 cm which was more 15.75%over control (T7) and T6 (insecticide) i.e. monocrotophos shows plant height 178.66 which was 12.29 more over control (T7) These results are expressed in graph 4.4 The value in the graph bar shows the superiority of treatments on each other. For eg: in T1, T2, T3, T4 bar shows value a, which means that treatment is superior over all the treatments and vice versa.

At 75 Days

The first plant height reading was recorded at 75 Days after sowing. The data showed that T1,T3,T6 (weedicide , fungicide and insecticide)i.e.Atrazine , thiram and monocrotophos shows significantly similar plant height 203.8cm which was 16.40%more over control; T2 (weedicide)i.e. thiram shows plant height of 195.13cm which was 12.69% more over control (T7). Treatment T4(fungicide)i.e. indofil shows plant height of 199.90cm which was 14.77%more over control (T7) and T5 (insecticide)i.e. chlorpyrifos shows plant height 192.13 cm which was more 11.33%over control (T7) As the plant moves towards the maturity and completes its vegetative phase. The rate of primary growth declines and reproductive phase is higher at this stage. Thus we observed very slow growth rate in the plant height between 60 and 75 Days after sowing. These results are expressed in graph .The value in the graph bar shows the superiority of treatments on each other. Data show in table 5.

Treatment	Height of plant 15days	Height of plant 30days	Height of plant 45days	Height of plant 60days	Height of plant 75days
T1	41.63a ± 0.91	143.90ab ± 1.75	182.5a ± 1.9	192.4a ± 8.3	203.8a ± 9.35

T2	39.30ab ± 2.07	148.03a ± 2.26	182.5a ± 5.68	193.1a ± 9.17	195.13a ± 0.75
T3	36.36ab ± 2.45	141ab ± 4.96	182.5a ± 11.58	197.2a ± 11.24	203.60a ± 3.45
T4	35.7ab ± 1.37	143.23ab ± 7.04	181.5a ± 6.07	180.7a ± 4.9	199.90a ± 6
T5	34.43b ± 1.71	150.96a ± 7.32	177.4a ± 3.1	185.06a ± 9.14	192.13a ± 2.02
T6	34.36b ± 1.23	145.96a ± 6.46	175.8a ± 2.95	178.06b ± 0.73	202.60a ± 8
T7	33.60b ± 3.38	128.36a ± 0.6	164.3a ± 5.04	155.90b ± 5.53	170.36a ± 9.48

Table5: Effect of pesticides on the Height of plant (cm) of maize crop at different interval of days.
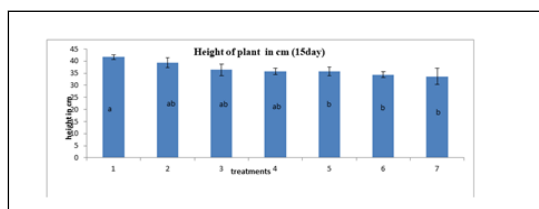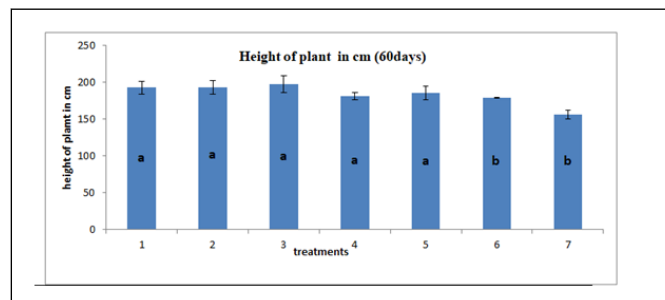

Figure4: Effect of pesticides application on the height of plant (cm) of maize – 15 DAS.
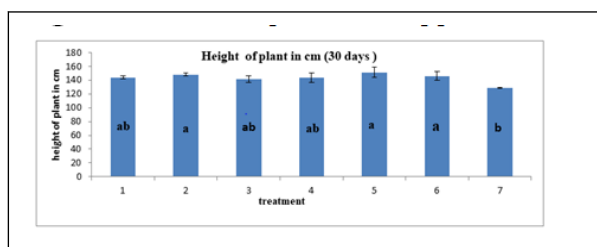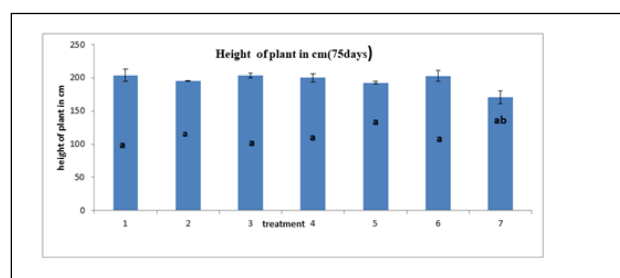

Figure5: Effect of pesticides application on the height of plant (cm) of maize – 30 DAS.
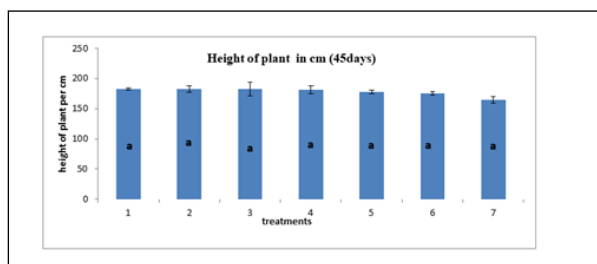
Figure6: Effect of pesticides application on the height of plant (cm) of maize – 45 DAS.

Figure7: Effect of pesticides application on the height of plant (cm) of maize – 60 DAS.

Figure8: Effect of pesticides application on the Height of plant (cm) of maize –75DAS.

Number of green leaves

Numbers of green leaves were also counted at 15, 30, 45, 60 and 75 days of sowing. Data was taken from the tagged plants. Averages were taken per plot. On the basis of the green leaves we can judge the plant superiority. There was significant difference in number of green leaves at different treatments. Data of green leaves is expressed in table 6

At 15 Days

Fast growth rate was observed initially. Most of the leaves were green at initial stages. At 15 Days of sowing treatments T1, T2, T3, T4, T5,T6,T7 are approximately significantly similar to each other with respect to number of green leaves i.e. 4.2,4.10,3.66,4.76, There was significant difference in number of green leaves at different treatments. Data of green leaves is expressed in table 6 .These results are expressed in graph 9.The value in the graph bar shows the superiority of treatments on each other

At 30 Days

Most of the leaves were green at initial stages at 30 Days there were not growth of leaves as much ,different plot treated with different treatment which effect differently and show some significant results T1(weedicide)i.e. atrazine show number of green leaves 10.53 which is 30.29% more than control(T7) , T2(weedicide) i.e. Alachlor of green leaves 10.20 which is 25.19% more than control (T7), T3(fungicide)i.e. thiram show number of green leaves 8.06 which is 5.33%more than control, T4(fungicide)i.e. indofil show number of green leaves 10.10 which is 24.4%more than control, T5,T6(insecticide)i.e. chlorpyrifos, monocrotophos show significantly similar result number of green leaves 8.40 which is 9.1% more than control are approximately There was significant difference in number of green leaves at different treatments. The value in the graph bar shows the superiority of treatments on each other. For eg: in T1, T2,

bar shows value a, which means that treatment is superior over all the treatments and vice versa. Data of green leaves is expressed in table 6 and graph expressed in 10

At 45 days

Most of the leaves were green at initial stages at 30 Days there were not growth of leaves as much ,different plot treated with different treatment which effect differently and show some significant results T1,T2 (weedicide)i.e. Atrazine, Alachlor show significant number of green leaves 10.53 which is 30.29% more than control(T7) , T2; T3(fungicide)i.e thiram also show same result as T1, T4(fungicide)i.e. indofil show number of green leaves 10.76 which is 15.7%more than control(T7), T5 (insecticide)i.e. chlorpyrifos show number of green leaves 10.96 which is 17.33%more than control(T7), T6(insecticide)i.e. monocrotophos show number of green leaves 10 which is 9.4%more than control(T7), There was significant difference in number of green leaves at different treatments. The value in the graph bar shows the superiority of treatments on each other. For eg: in T1, T2, T3 bar shows value a, which means that treatment is superior over all the treatments and vice versa. Data of green leaves is expressed in table 6 and graph show in 11

At 60 days

The result at 60 days showed that there was increased in the numbers of green leaves. The size of the leaves was increased at 60 days and the maximum average numbers of leaves were reaches to13.16. As in previous15 and 30 days data we observed that the maximum average numbers of leaves were 11.63and the size of the leaves were very small as compared to the leaves at 60 Days. T1 (weedicide)i.e. atrazine show number of green leaves 13.16 which is 33.66% more than control(T7) , T2(weedicide) Alachlor ; T3(fungicide)i.e thiram show approximately significant result. T4(fungicide)i.e. indofil show number of green leaves 11.2 which is 22%more than control(T7), T5 (insecticide)i.e. chlorpyrifos show number of green leaves 10.86 which is 19.6%more than control(T7), T6(insecticide)i.e. monocrotophos show number of green leaves 9.8 which is 10.9%more than control(T7), There was significant difference in number of green leaves at different treatments. The value in the graph bar shows the superiority of treatments on each other. For eg: in T1, bar shows value a, which means that treatment is superior over all the treatments and vice versa. Graph show in 12 and Data of green leaves is expressed in table 6

At 75 days

It was observed that as the crop moves towards maturity the number of green leaves declines. But all the leaves were not completely dry even at harvesting of the cobs. There was very slight increment in the green leaves of the crop after 60 days. T1 (weedicide)i.e. atrazine show number of green leaves 12.66 which is 29.6% more than control(T7) , T2(weedicide) Alachlor show number of green leaves 13.36 which is 33.3% more than control ; T3(fungicide)i.e. thiram,T4,(fungicide)i.e indofil T5,T6(insecticide) show approximately significant result There was significant difference in number of green leaves at different treatments. The value in the graph bar shows the superiority of treatments on each other. For eg: in T2, bar shows value a, which means that treatment is superior over all the treatments and vice versa.

| Treatment	Number of leaves per plant 15day	Number of leaves per plant 30day	Number of leaves per plant 45day	Number of leaves per plant 60day	Number of leaves per plant 75day
T1	4.2a ± 0.49	10.53a ± 0.78	11.63a ± 0.68	13.16a ± 0.69	12.66ab ± 0.33
T2	4.1a ± 0.58	10.20a ± 0.28	11.2a ± 0.75	12.96ab ± 0.75	13.36a ± 0.68
T3	3.66a ± 0.33	8.06d ± 0.06	11.63a ± 0.63	12.43cba ± 0.31	11.7cba ± 0.78
T4	4.7a ± 0.82	10.1cba ± 0.5	10.76ab ± 0.78	11.2dcba ± 0.57	10.8dcb ± 0.36
T5	4.7a ± 0.33	8.40dc ± 0.41	10.96ab ± 0.61	10.86dcba ± 0.46	10.06dc ± 0.66
T6	3.6a ± 0.66	8.5dcb ± 0.76	10ab ± 0.55	9.8ed ± 0.79	10.6dcb ± 1.17
T7	2.8a ± 0.6	7.63d ± 0.66	9.06ab ± 0.06	8.7e ± 0.37	8.9d ± 0.47

Table6: Effect of pesticide application on the number green leaves per plant of maize crop at different interval of days.
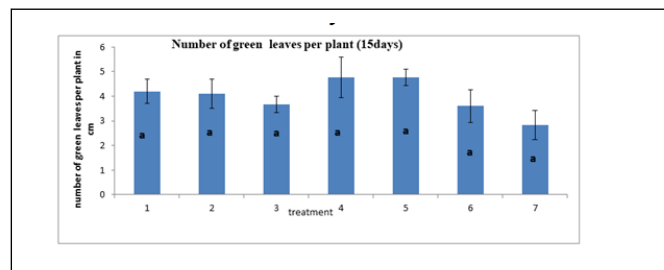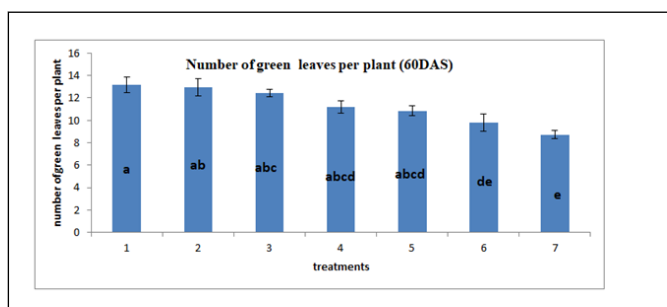

Figure9: Effect of pesticide application on the number of green leaves per plant at 15 DAS.
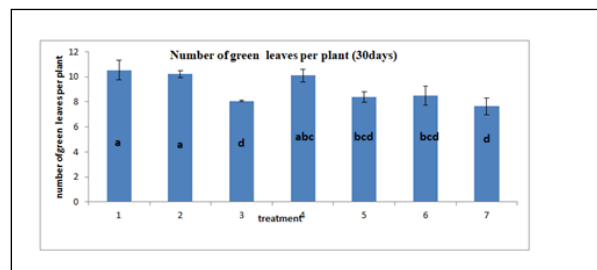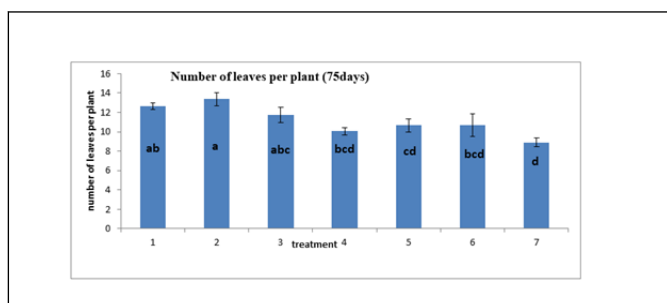

Figure10: Effect of pesticide application on the number of green Leaves per plant at 30 DAS.
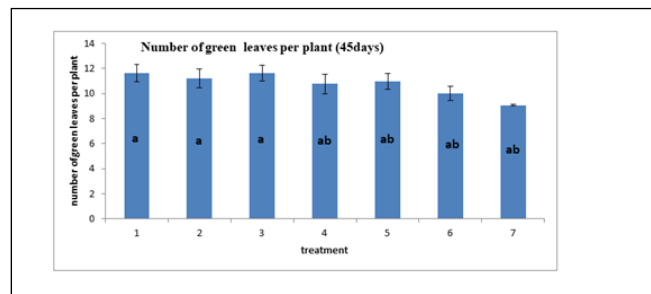
Figure11: Effect of pesticide application on the number green of leaves at 45 DAS.

Figure12: Effect of pesticide application on the number of green leaves at 60 DAS.

Figure13: Effect of pesticide application on the number of green leaves at 75 DAS.

Stem Girth (cm)

Stem Girth was also recorded at15, 30, 45, 60 and 75 Days after sowing from the tagged plants. Average of the plants from each plot was taken to get data of each plot. Stem girth was measured with the help of measuring tape and was taken few cm above the soil surface. Table 7 shows the significant difference among treatments.

At 15 days

The results shows that stem girth of plants were different in different treatments the maximum stem girth reaches to 3.20 cm at 15 Days, we know that the entire nutrient from soil to leaves moves through the stem of the plants. Thus healthy the stem girth of the plant, easily the nutrients will move. And also affected by the pesticide application we were applied in different plots T1(weedicide)atrazine show stem girth3.2cm ,T2(weedicide)Alachlor show stem girth 2.5cm ,T3(fungicide)thiram show stem girth 2.06cm,T4(fungicide)indofil show stem girth 2.3cmT5,T6(insecticide)chlorpyrifos, monocrotophos show similar stem girth2.16 cm . The value in the graph bar shows the superiority of treatments on each other [6]. For eg in T1, bar shows value a, which means that treatment is superior over all the treatments and vice versa. The graphical representation is expressed in graph 14 and data in table 7

At 30 days

T1(weedicide)atrazine show stem girth7.7cm ,T2(weedicide)alachlor show stem girth 8.2cm, T3(fungicide)thiram show stem girth 5.8cm,T4(fungicide)indofil show

stem girth 7.4cmT5,(insecticide) chlorpyrifos show stem girth 7.3cmT6(insecticide),monocrotophos show similar stem girth6.1cm . The value in the graph bar shows the superiority of treatments on each other. The graphical representation of data is expressed in graph15

At 45days

T1(weedicide)atrazine show stem girth12cm ,T2(weedicide)alachlor show stem girth 11.4cm, T3(fungicide)thiram show stem girth 11.2cm,T4(fungicide)indofil show stem girth 9.4cmT5,(insecticide) chloropyrifos show stem girth10 cmT6(insecticide),monocrotophas show similar stem girth9.3cm . The value in the graph bar shows the superiority of treatments on each other. The graphical representation of data is expressed in graph16

At 60 days

T1(weedicide)atrazine show stem girth 13cm ,T2(weedicide)Alachlor show stem girth 12cm, T3(fungicide)thiram show stem girth 10.6cm,T4(fungicide)indofil show stem girth 10.2cmT5,(insecticide) chloropyrifos show stem girth 10.6cm,

T6(insecticide),monocrotophos show similar stem girth10.1cm . The value in the graph bar shows the superiority of treatments on each other. The graphical representation of data is expressed in graph17

At 75 days

T1(weedicide)atrazine show stem girth13.8cm ,T2(weedicide)alachlor show stem girth 13cm, T3(fungicide)thiram show stem girth 11.1cm,T4(fungicide)indofil show stem girth 12.6cmT5,(insecticide) chlorpyrifos show stem girth11.7cmT6(insecticide),monocrotophos show similar stem girth10.8cm . The value in the graph bar shows the superiority of treatments on each other. The graphical representation of data is expressed in graph18

Treatment	Stem girth 15day	Stem girth 30days	Stem girth 45day	Stem girth 60day	Stem girth 75day
T1	3.2a ± 0.05	7.7a ± 0.39	12a ± 0.5	13a ± 0.06	13.86a ± 0.14
T2	2.5ab ± 0.32	8.2a ± 0.2	11.4ab ± 0.7	12a ± 0	13ab ± 1
T3	2.06b ± 0.03	5.8a ± 1.44	11.2ab ± 0.15	10.6b ± 0.3	11.1a ± 0.72
T4	2.3b ± 0.3	7.4a ± 0.8	9.4dc ± 0.3	10.2cd ± 0.69	12.6ab ± 0.33
T5	2.16b ± 0.26	7.3a ± 0.5	10cd ± 0.11	10.6b ± 0.24	11.7ab ± 0.43
T6	2.16b ± 0.16	6.1a ± 0.4	9.3cd ± 0.85	10.13cd ± 0.57	10.8ab ± 0.16

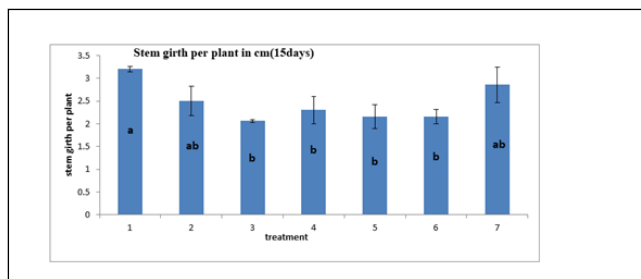|					
T7	2.806ab ± 0.39	5.7a ± 0.3	8.3d ± 0.35	9.16c ± 0.16	12.9ab ± 1.45

Figure14: Effect of pesticide application on the Stem Girth (cm) at 15 DAS.
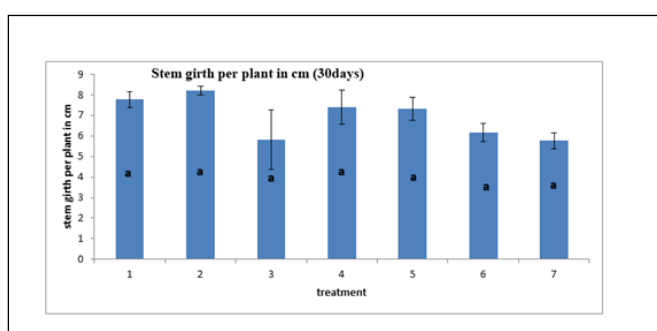

Figure15: Effect of pesticide application on the stem girth (cm) at 30 DAS.
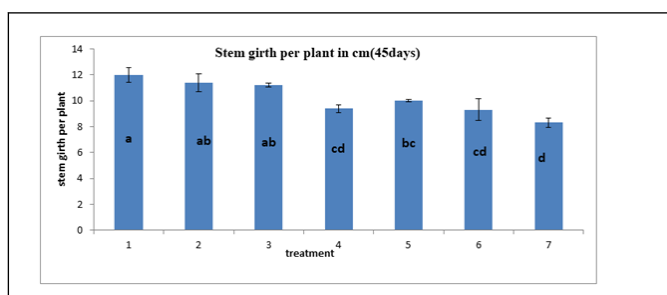

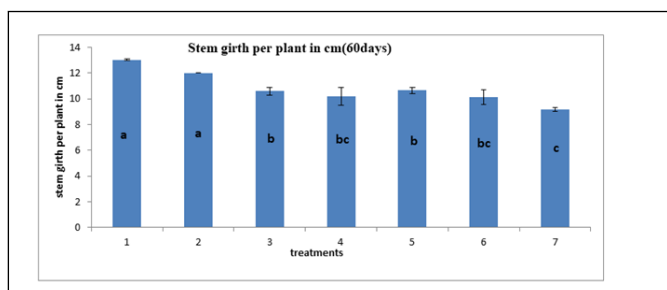**Figure16:** Effect of pesticide application on stem girth (cm) at 45 DAS.

Figure17: Effect of pesticide application on stem girth (cm) at 60 DAS.
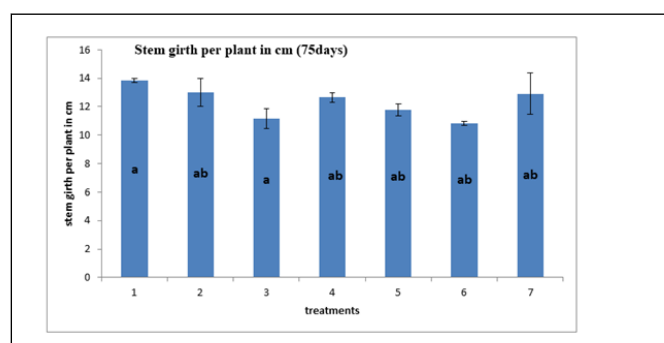

Figure18: Effect of pesticide application on the stem girth in (cm) 75DAS.

Cob Length

Cobs Length from tagged plants was measured. Then average was taken to check the difference of the different treatments on the length of cobs .Maximum cobs were collected from the three tagged plants T1(weedicide) atrazine show cob length was 23cm which was 13.7%more than control(T7).T2(weedicide)alachlorT3(fungicide)thiram show cob length was 18.7, T4(fungicide)indofil show cob length17.5cm,T5(insecticide)chloropyrifos show cob length was18.3,T6(insecticide)monocrotophos show cob length15.36 T7(control) .The value in the graph bar shows the superiority of treatments on each other. For eg: in T1, bar shows value a, which means that treatment is superior over all the treatments and vice versa. Data show in table 8 and graph 19.

Treatment	Cob length
T1	23a ± 0.55
T2	18.7cb ± 1.39
T3	17.5cb ± 0.56
T4	18.7cb ± 0.56
T5	18.3cb ± 0.58
T6	15.3cb ± 0.49
T7	19.8ab ± 2.8

Table8: Effect of pesticide application on the Cob length (cm) of maize crop.

Numbers of cob per Plant

The maximum numbers of cob per plant can be reaches up to 2-3 cobs per plant but most of the plant having a single cob. Data was taken from the tagged plant and then average was considered. Numbers of cob per plant is expressed in Table 4.1.5.Many researches show that if crop is grown under suitable conditions then it is able to achieve good growth and yield. Thus by providing suitable pesticide application with different interval of time and under suitable conditions we can reach to the crop yield potential. In some cases both cobs are similar but it may be possible that one crop is larger than 2nd of the same plant. T1(weedicide) Atrazine show average 1.63 number of cob/s,T2(weedicide) Alachlor show maximum average 2.4 number

of cob/.T3(fungicide)Thiram show average cob/s2.16 T4(fungicide)Indofil,T5(insecticide) Chloropyrifos show significantly similar result of cob/s per plant. Thus this helps to achieve more grain yield per plot. Thus we can say that pesticides application, different treatments used has influence on the numbers of grains per cob. The value in the graph bar shows the superiority of treatments on each other. For eg: in T2and T3, bar shows value a, which means that treatment is superior over all the treatments and vice versa. Data show in graph 20.

Treatment	Number of cob/s per plant
T1	1.6ab ± 0.33
T2	2.4a ± 0.1
T3	2.16a±0.43
T4	1.2ab ± 0.1
T5	1.2ab ± 0.1
T6	1.53ab ± 0.39
T7	1.1b ± 0.1

Table9: Effect of pesticide application on the number of Cob/s per plant.

Number of grains per cob

The maximum of cob in T2(weedicide) Alachlor ,it show significant role number of grain per cob in T1 is 273.23, Thus we can say that pesticides application, different treatments used has influence on the numbers of grains per cob. The value in the graph bar shows the superiority of treatments on each other. For eg: in T2and T3, bar shows value a, which means that treatment is superior over all the treatments and vice versa. Graph in 21

Treatment	Number of grain per cob
T1	268.83ab ± 4.2
T2	273.23a ± 0.9
T3	260.63b ± 4.8
T4	261.87ab ± 3.8
T5	266.93ab ± 1.7
T6	262.13b ± 1.8
T7	250.48c ± 2.8

Table10: Effect of pesticide application on number of grain per cobs of maize crop.

Test weight (gm)

Test Weight is the weight of 1000 grains. All the treatments shows significant result over the control. The Effect of pesticide application on Test Weight are expressed in Table 4.8.In T2 (8.3) % superior followed by T1 (6.8%), T5,T6(5.2%),T4 (4.16 %) ,T3(3.9%),superior over the control treatment . The value in the graph bar shows the superiority of treatments on each other. For eg: in T2, bar shows value

a, which means that treatment is superior over all the treatments and vice versa. Graph 22.

| Treatment	Test weight
T1	268.8 ab ± 4.2
T2	273.2a ± 0.9
T3	260.63b ± 4.8
T4	261.2 b ± 3.4
T5	263.9 ab± 3.2
T6	263.9ab ± 1.7
T7	250.4c ± 2.7

Table11: Effect of pesticide application on test weight of maize crop.

Average grain Yield per plant (kg)

Grains Yield was taken after removal of the grains from the cob. It can be done manually or by maize Sheller. After harvesting of the cobs there was need for sun drying. It may take 4-5 days or as per the availability of the moisture in the grains. Grain weight of each plot was measured separately to measure the average yield per acre or hectare. It was measured in Kg/ Plot. The effect of different treatments (pesticides) on Grain Yield of the maize crop expressed in Table 4.5.The results shows the treatments have significant effect on the grain yield of the maize. Different treatments show different readings of the grain yield control in which no chemical apply show 3.66 .Result shows that T2 attain more grain yield as compare to other treatments. Graph 23.

Treatment	Average yield
T1	5.8ab±1.2
T2	7.16a±1.8
T3	5.2ab±0.9
T4	2.7c±0.4
T5	4.5cb±0.4
T6	2.8c±0.3
T7	3.6cb±0.5

Table12: Effect of pesticide application on the average grain yield per plot (kg) in maize crop.
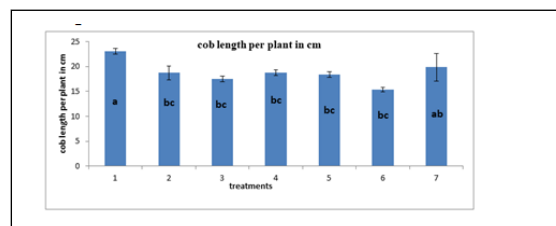
Figure19: Effect of pesticide application on the Cob length (cm) maize crop.
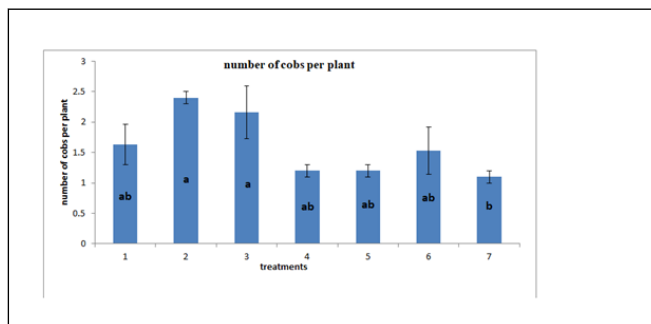
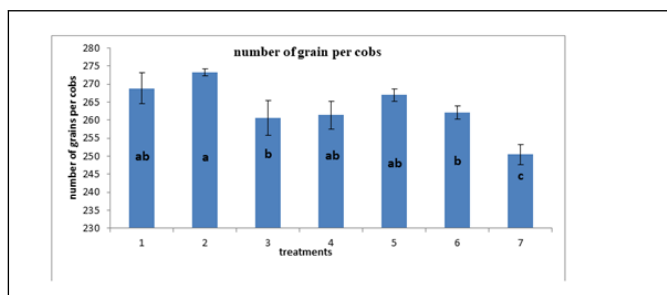**Figure20:** Effect of pesticide application on the number Cob/s per plant.

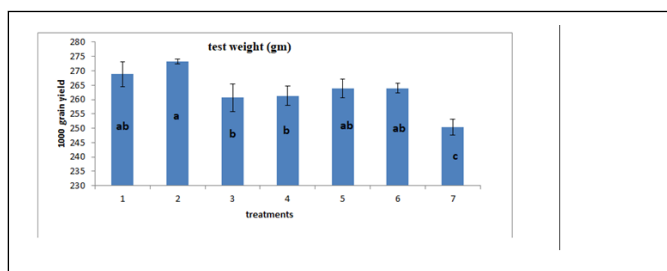**Figure21:** Effect of pesticide on the number of grain per cobs in maize crop.

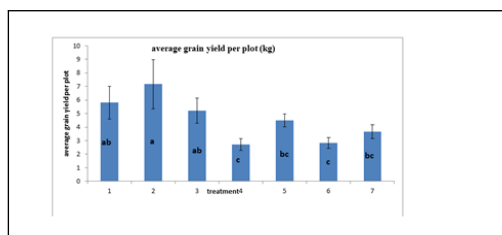**Figure22:** Effect of pesticide application on the test weight (gm) of maize crop.

Figure23: Effect of pesticide on the average grain yield (kg) per plot in maize crop.

Discussion

Effect of pesticide application on plant growth characteristics of maize

A field experiment was conducted as research farm of school of agriculture, Lovely Professional University, Phagwara to study the "effect of pesticide application on plant growth characteristics of maize" during kharif season of 2016. The experiment was laid with the randomized complete block design (RCBD). There were three pesticides application used (two weedicide, two fungicides and two insecticides) for the sowing of the maize crop thus we have chosen randomized complete block design for the easy to operate the field preparation to harvest. The experiment was conducted with 7 treatments and 3 Replications, thus the total number of plots reach to 21. All the treatments were arranged with randomization (un-biased) in the plots. Each plot is of 4 ×3 m2. There were separated irrigation channels of 0.5m to provide irrigation to each plot separately.

The Treatments were used; T1: Weedicide (Atrazine), T2: Weedicide (Alachlor), T3:Fungicide(Thiram),T4:Fundicide(Indofil),T5:Insecticide(chloropyrifos),T6:Insecticide(monorotophos,T7:control(no chemical).The observation were taken of crop growth parameters(plant height, number of leaves, stem girth)yield parameters number of cob/s, length of cob/s, tested grains, average yield, economic analyses(gross return, net return, benefit cost ratio).These all show different result in different plots by applied different pesticides application and different interval of time.

Statistical analysis

Statistical analysis was done to check the significance of different treatments. Data were assessed by Duncan's multiple range tests with a probability P<0.05.difference between mean value were evaluated by a one way analysis of variance (ANOVA) using of the software SPSS16.unless otherwise stated and level of significance referred to in the results in P<0.05.

Effect of Different pesticides effect on growth parameters and yield of maize crop

Different pesticides application applied on different plots at different time intervals .Weedicide, pesticide, fungicide in different plots .These different treatments show different results and effect on different growth parameters in maize crops and as well as yield of maize crop

Plant height

Plant Height of all the treatments was recorded at15, 30, 45, 60 and 75 Days after sowing. For this purpose, plants were randomly selected in each plot. Averages of the plant height were taken to get the plant height of each plot.

Height of plant in 15days (cm)

T1 shows best result in initial stage by applying of pre emergence atrazine application in R1T1(15days)height 41.6cm and which shows 40%more than T7(control)where no chemical is used ,in T1R1 atrazine suppress the weeds growth ,like *Cynadon dactylon, , Chenopodium album,* broad leaved weeds found in maize. *Cyperus rotundus* and *Cynodon dactylon* which are among the worst weeds of the world .Atrazine stops the production of oxygen and thus interferes with photosynthesis and effects the weed growth .It effective up to 40-45 days in soil and initial stage no competition in between weeds and maize crop so plant height increased in maize crop Musser et al., (2003), demonstrated the effect pesticide application on maize. This result show the plant height increased significantly with the pesticide application

Height of plant in 30 days in cm

T2 and T5 shows good result in 30days by applying Alachlor application in R1T2,R1T5 height 148.03cm and 150.96 cm and which shows 15 %approximately more than T7 (control)Alachlor mainly effective on weeds like *Cyperus rotundus and Cynodon dactylon it mainly absorbs near the first nodes of germinated shoots and secondary by root and translocated throughout the plant and metabolized within 10 days and chloropyrifos 20%EC was sprayed in the field to protect the crop from termites due to this it result show height increased.*

Height of plant in 45 days in (cm)

T1 shows significant result by applying pre emergence atrazine application in R1T1 (15days) height 182.5cm and which shows 9.9%more than T7 (control) where no chemical is used ,in T1R1 atrazine suppress the weeds growth ,like *Cynadon dactylon, , Chenopodium album,* broad leaved weeds found in maize. *Cyperus rotundus* and *Cynodon dactylon* which are among the worst weeds of the world .Atrazine stops the production of oxygen and thus interferes with photosynthesis and effects the weed growth .It effective up to 40-45 days in soil and initial stage no competition in between weeds and maize crop so plant height increased in maize crop

Height of plant in 60days (cm)

T3 fungicide (thraim) seed treatment can improve seedling establishment in the field, by thraim treated on seeds shows that some fungicide effect on seed of maize crop was protected so plant height increased in maize crop R1T3Ameta et al., (2000) demonstrated the effect of pre-sowing fungicides seed treatment on seed germination, emergence and seedling vigor in maize and concluded that the seed treated with fungicides had improved the germination of seeds

Height of plant in 75 days (cm)

T1(weedicide) and T3(fungicide) both shows significant result by applying pre emergence atrazine application and thraim application in R1T1,R1T3height 203.8and which shows 16.4%more than T7(control)where no chemical is used , atrazine suppress the weeds growth ,like *Cynadon dactylon, , Chenopodium album,* broad leaved weeds found in maize. By thraim seed treatment can improve seedling establishment in the field ,by thraim treated on seeds shows that some fungicide effect on seed of maize crop was protected so plant height increased in maize crop . Pinjari et al., (2007), demonstrated the effect pesticide application on sweet corn. This result show the plant height increased significantly with the effect of pesticide application

Number of green leaves per plant 15days

T4 (fungicide) show good result by applying Indofil number of leaves per plant shows 4.76 and which shows 32.6%more than T7(control)no chemical used in it. Indofil application protect from fungicide effect of maize crop so this result show number of leaves increased in R1T4 initial stage

Number of green leaves per plant 30, 45,60days

T1 (weeding) pre emergence atrazine show significant result in 30, 45, 60 days atrazine suppress the weeds growth, like *Cynadon dactylon,Chenopodium album,* broad leaved weeds found in maize. *Cyperus rotundus* and *Cynodon dactylon* which are among the worst

weeds of the world. Atrazine stops the production of oxygen and thus interferes with photosynthesis and effects the weed growth .It effective up to 40-45 days in soil and initial stage no competition in between weeds and maize crop so plant height increased with increased in number of leaves in maize crop so Khan et al. (2002) concluded that maximum number of leaves maize was noted in those treatments where weeds were controlled

Number of green leaves per plant 75days

T1 and T2 (weedicide), pre emergence Atrazine and Alachlor show significant result in increased the number of leaves in maize crop, atrazine suppress the weeds growth like *Cynadon dactylon, Chenopodium album,* broad leaved weeds found in maize. *Cyperus rotundus* and *Cynodon dactylon* which are among the worst weeds of the world .Atrazine stops the production of oxygen and thus interferes with photosynthesis and effects the weed growth. Alachlor mainly effective on weeds like *Cyperus rotundus* and *Cynodon dactylon it mainly absorbs near the first nodes of germinated shoots and secondary by root and translocated throughout the plant and metabolized within 10 days due to this increased in height as well as number of green leaves increased*

Stem girth 15, 30, 45, 60,75days

T1(weedicide) show significant result in all 15,30,45,60,75 days by applying pre emergence Atrazine suppress the weeds growth ,like Cynadon dactylon, , Chenopodium album, broad leaved weeds found in maize. Cyperus rotundus and Cynodon dactylon which are among the worst weeds of the world .Atrazine stops the production of oxygen and thus interferes with photosynthesis and effects the weed growth .It effective up to 40-45 days in soil and initial stage no competition in between weeds and maize crop so plant height increased, number of green.

Length of cob/s in cm

T1(weedicide)pre emergence Atrazine show significant result average length of cob/s 23 cm which was 13.7%more from T7(control) because Atrazine stops the production of oxygen and thus interferes with photosynthesis and effects the weed growth .It effective up to 40-45 days in soil and initial stage no competition in between weeds and maize crop so plant height increased with increased in number of leaves as well as length cob in maize

Number of cob/s

T1(weedicide) Atrazine show average 1.63 number of cob/s,T2(weedicide)Alachlor show maximum average 2.4 number of cob/.T3(fungicide)Thiram show average cob/s2.16 T4(fungicide)Indofil T5(insecticide)Chloropyrifos show significantly similar result of cob/s per plant. Thus this helps to achieve more grain yield per plot. Thus we can say that pesticides application, different treatments used has influence on the numbers of grains per cob reported that maximum leaf area was recorded in manually weed-controlled plots at tasseling. These results are in agreement with Shakoor et al., (1986), who reported that dry biomass of weed from the weedy control plots was significantly greater than chemical and manual weeded plots ,so weeds controlled and effect on growth parameters ,number cobs increase per plant.

Tested grain yield

Test Weight is the weight of 1000 grains. All the treatments show significant result over the control. In T2 (8.3) % superior followed by T1 (6.8%), T5,T6(5.2%),T4 (4.16 %) ,T3(3.9%),superior over the control treatment because in initial as well as different interval of time weed control and competition of crop and weeds deceased so number of cob increased as well as quality.

Conclusion

The experimental trail was concluded in the field to investigate the "effect of pesticide application on plant growth characteristics of maize"Overall in this experiment we proved that T2 weedicide Alachlor have significantly better result as compare to other treatments, above we discussed and justified that T2weedicide giving best impact and their effect on growth parameters and yield attributes of maize crop, other treatments also effect on growth parameters like insecticide and fungicide these also impact on the growth parameters of maize crop. This is short term study if this experiment is conducted in long term then consistency will given recommendation to farmers. Scope of this study is limited only on growth parameters and yield factors but its impact on molecular study, impact on soil, impact on nutrients etc, so it is also required to understand other parameters .In the experimental field weedicide given best or significant results also with other impacts on crop of maize.

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