EFFECTS OF DIFFERENT SOURCES OF NUTRIENT ON PRODUCTION AND PEST INFESTATION IN MUSTARD (*Brassica juncea* L.)

THESIS

Submitted to the

LOVELY PROFESSIONAL UNIVERSITY, PHAGWARA, PUNJAB, INDIA

In partial fulfilment of the requirements for the award of degree of

MASTER OF SCIENCE
IN
(AGRONOMY)

BY
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June, 2015

CERTIFICATE

This is to certify that the thesis entitled **"Effects of different sources of nutrient on production and pest infestation in mustard (*Brassica juncea* L.)** submitted by **Mr. Navninder Singh (11301646)** son/daughter of **Shri Sukhwant Singh** to the Lovely Professional University, Phagwara in partial fulfilment of the requirements for the degree of **Master of Agriculture/Horticulture** in the discipline of Agronomy has been approved by the Advisory Committee after an oral examination of the student in collaboration with an External Examiner.

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Certification

This is to certify that the thesis entitled "**Effects of different sources of nutrient on production and pest infestation in mustard (*Brassica juncea* L.)**submitted in partial fulfillment of the requirements for the degree of Master of Science in Agronomy of the Department of Agronomy, School of Agriculture, Lovely Professional University, Phagwara, is a record of bonafide research carried out by **Navninder Singh**, Registration No. 11301646 under my supervision and no part of the thesis has been submitted for any other degree or diploma.

The assistance and help received during the course of this investigation have been duly acknowledged.

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I hereby declare that the project work entitled "**Effect of different sources of nutrient on production and pest infestation in mustard (*Brassica juncea* L.)**" is an authentic record of my work carried out at Lovely Professional University as requirements of Project work for the award of degree of Master of Science in Agronomy, under the guidance of Dr. Lokender Kashyap, Associate Professor, School of Agriculture, Lovely Professional University, Jalandhar, Punjab, India.

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Acknowledgements

I can take this opportunity to present my votes of thanks to all those who really acted as lightening pillars to enlighten our way throughout this project that has led to successful and satisfactory completion of this study. I am grateful to our **Lovely Professional University** for providing me with an opportunity to undertake this project in the university and providing us with all the facilities. I am really thankful from my heart to **Dr. Lokender Kashyap,** who allowed me to do this project under his guidance. I am highly thankful to my family and friends for their active support, valuable time and advice, whole-hearted guidance, sincere cooperation and pains-taking involvement during this study.

Lastly, I thankful to all those, particularly the various friends, who have been instrumental in creating proper, healthy and conductive environment and including new and fresh innovative ideas during the project, without their help, it would have been extremely difficult for me to prepare the project in a time bound framework.

Yours faithfully

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ABBREVIATIONS

N	Nitrogen
P	Phosphorus
K	Potassium
S	Sulphur
%	Percent
DAP	Di-ammonium phosphate
MOP	Muriate of potash
cm	Centimeter
m	Meter
ha	hectare
@	At the rate of
Q	Quantal
MMT	Million metric tons
kg	Kilogram
g	gram
RBD	Randomized block design
DAS	Day after sowing
AE	Agronomic efficiency
LAI	Leaf area index
DAE	Day after emergence
ET_c	Evapotranspiration
HI	Harvest index
PP	Plant population
V	Variety
S	Spacing
F	Fertilizer
R	Replication
ºC	Degree Celsius
hr	Hours

Effect of different sources of nutrient on production and pest infestation in mustard (*Brassica juncea* L.)

ABSTRACT

The aim of the present study was to investigate the effect of different sources of nutrient on production and pest infestation in mustard (*Brassica juncea* L.). The experiment was laid out in randomized complete block design (RCBD) with three replications, comparing eight treatments involving different nutrient combination of Urea, SSP, MOP, Sulphur and DAP fertilizer dose and absolute control on experimental plot at Department of Agriculture, Faculty of Agriculture, Lovely Professional University, Punjab. The successive growth of plant depends on different nutrients. The application of different combination of fertilizers has been demonstrated to enhance plant height, leaf area index, pod length or number of pods per plant, seed yield, straw yield and oil content. The present study revealed that treatment T4 (Urea+SSP+MOP) lead to significant increase in plant height, leaf area index, pod length or number of pods per plant, seed and straw yield when compared with other treatments. Different insecticides were also evaluated to study their bioefficacy against aphid, where only three insecticides T1 (Imidaclorpid 30.5%SC), T2 (Thiamethoxam 25%WG) and T6 (Acetamiprid 20%SP) proved to be effective.

INTRODUCTION:

Mustard belongs to the Cruciferae family, which is commonly known as the indian mustard. Mature plants grow to a height of one to two meters. The lower leaves are deeply lobed, while the upper leaves are narrow and entire. It is distinct from its close relatives (B. *napus* and *B. rapa*) in that the upper leaves of *Brassica juncea* L. are not clasping**.** Mustard seed is a rich source of oil and protein content. The seed has oil as high as 46-48%, and whole seed meal has 43.6% protein. The oilseed form essential part of human diet. The present production of edible oil seeds in the country meets only about 50 per cent of the requirement of edible oil is further increasing at the rate of 4-6 per cent. Oilseeds have an important role in Indian agriculture which ranks fourth after China, EU and Canada in the world in the production of mustard. Its contain 40-45% oil and 20-25% protein (Hasanuzzaman *et al.*, 2008). In India, mustard is grown on an area of 6.9 million hectare with production of 8.18 million tonnes and productivity of 1185 kg per hectare and the share of oilseeds is 14 percent out of the total area in India (Anonymous 2013b). Major mustard producing states in the country are Rajasthan, accounting more than 50% of its production followed by Uttar Pradesh, Haryana, Madhya Pradesh and Gujarat. It is also grown under some nontraditional areas of South India including Karnataka, Tamil Nadu, and Andhra Pradesh.

Oilseed crops are quick responsive to fertilizers and irrigations. Nitrogen is necessary for chlorophyll synthesis, involved in photosynthesis process (Mason and Brennan 1998). Adequate levels of nitrogen, sulfur, phosphorus, and potassium are essential for rapid stand establishment and optimum yields. The proper management gave higher yield of crops and reduced fertilizer cost (Hossain and Islam, 1986). But the amount of fertilizer is in appropriate in most cases due to lack of proper knowledge and over 97% of the farmers do not follow the recommended dose of fertilizer (Hossain *et al.*,1981). It is essential to find out the optimum rate of fertilizer application for efficient use by the plants for better yield.

Beside this the crop is also being attacked by number of insect-pests such as diamond back moth (*Plutella xylostella),* mustard saw fly (*Athalia lugens proxima*), aphid (*Lipaphis erysimi)* and leaf minor (*Chromatomyia horticola)* at various stages of crop growth. Among them *Lipaphis erysimi* Kaltenbach, (Aphididae, Homoptera) is the most notorious pest (Morzia and Husain 1994, Morzia *et al.,* 1996, Rouf and Kabir 1997). Yield loss caused by aphid infestation in mustard ranged from 87.16 to 98.16% (Anon, 1995). For controlling this insect, farmers used several types of insecticides. Therefore, the present investigation was put forth to overcome the irregular fertilizers application and to know the pest build up nature by adding these nutrients in mustard.

Objectives

Hence, the purpose of this research was to investigate the "Effect of different sources of nutrient on production and pest infestation in mustard (*Brassica juncea* L.)" based on the following objectives;

1. To determine the effect of nutrients in mustard yield.
2. To evaluate the field efficacy of insecticides against the target pests of mustard.

Chapter II

REVIEW OF LITERATURE

2.1 N, P, K Combination

Dalal *et al.,* (2011) evaluated the six different levels of N, P, and K @ on different growth parameters such as plant height, number of branches and on the seed yield. They reported that the maximum seed yield was with the application of 50:40:25 kg NPK per hectare, while the NPK application at the rate of 60:50:30 and 70:50:35 kg per hectare, decrease the yield. Similarly there was no enhancement in plant height, number of branches per plant and number of pod per plant in higher doses.

Patel and Thakur (1998) studied the effect of N and P levels on growth, yield and quality of toria under irrigated conditions at Raigarh (M.P.) and reported that application of N up to 80 kg per hectare significantly increased the plant height only, whereas, branches/plant, siliquae/plant, 1000-seed weight and seed yield were recorded significantly higher at 60 kg N per hectare They also observed that 40 kg phosphorus per hectare significantly increased the siliquae/plant, 1000-seed weight and seed yield over 20 kg phosphorus per hectare.

Bali *et al.,* (2000) conducted a field experiment at Srinagar (J&K) with three levels each of N (30, 60 and 90 kg per hectare) and P (30, 45 and 60 kg per hectare) on brown sarson and observed that N up to 60 kg per hacter significantly increased primary and secondary branches/plant, siliquae/plant, seeds/siliquae, 1000-seed weight and seed yield, while application of P at various levels did not produce significant variation in yield and yield attributes of brown sarson. However, application of 60 kg Phosphorus per hectare resulted in maximum values.

Sharma *et al.,* (1999) in another experiment on nutrient management in soybean (*Glycine max*) and mustard (*Brassica juncea* L.) crop sequence inferred that during rabi season, maximum uptake of NPK nutrients was recorded where mustard crop received recommended dose (80:40:20) of fertilizers, preceded by the treatment receiving 50% through inorganic sources applied to kharif season crop (soybean).

Singh *et al.,* (2002) studied the response of brown sarson to residual effect of organic manure, nitrogen and transplanting dates of rice at Kashmir observed that the number of siliquae per plant and seed yield increased with increasing N rates. The value for 1000-grain weight was highest at 100 and 150 kg per hectare. Siliquae per plant was highest with FYM application. They further observed that P uptake increased with increasing residual N rates from 100 to 150 kg N per hectare, whereas N and K uptake increased only up to 100 kg N per hectare.

Patel and Shelke (1998) worked on indian mustard (*Brassica juncea* L.) at Parbhani (Maharashtra) found that phosphorus application significantly increased the plant height, branches/plant, siliquae/plant, total dry matter/plant, seeds/siliquae, 1000-seed weight up to 120 kg Phosphorus per hectare

Adeniyan *et al., (*2011) evaluated the effect of different organic manures with NPK fertilizer for improvement of chemical properties of acid soil. Results showed that application of 5tonnes per hectare of each of the evaluated organic manures and 100 kg per hectare NPK 15-15-15 fertilizer improved chemical properties of both acid and nutrient depleted soils compared with unfertilized soil. Application of different types of organic manures reduced the acidic levels of both the soils application of NPK fertilizer gave the highest dry matter yield of 4.77 g/plant while in nutrient depleted soil; application of NPK fertilizer gave the highest dry matter yield of 5.58 g/plant.

Cheema *et al.*, (2010) conducted a field experiment to determine the optimum N level and its stage of application for canola crop under irrigated conditions in Faisalabad, Pakistan. Five N levels (0, 30, 60, 90 and 120 kg per hectare) were applied at different times i.e. full N at sowing, ½ N at sowing + ½ N at branching, ½ N at sowing + ½ N at flowering and ½ N at branching + ½ N at flowering. The seed yield, oil yield and protein content were significantly affected by different nitrogen rates. The highest N level (120 kg per hectare) produced maximum values for all these traits as compared to minimum in control during both years of study.

Salaria and Dhillon (2003) observed that seed yield of 22.71 quintel per hectare of *gobhi sarson* with 125 kg N per hectare which was at par with 150 kg N per hectare but significantly higher than 100 kg N per hectare. Oil content decreased, whereas protein content increased with each successive increment of nitrogen levels. The maximum oil yield was obtained with application of 125 kg N per hectare. Erucic acid content did not exceed 2 per cent with

successive increment in nitrogen levels. The seed and oil yield remained unaffected with phosphorus application.

Narits (2010) reported that nitrogen fertilization had positive effect on seed yield and seed protein content in mustard. On the other hand, nitrogen fertilization, especially in higher rates, had negative effect on oil content. It was concluded that the quantity of the fertilizer had not as strong impact to seed yield and quality as fertilizer application time. The highest yields of seed and raw oil were obtained from the three split-N application (40+40+40) 120 kg per hectare i.e. the first at the beginning of spring vegetation, the second when stem length was 10 cm and the third at the beginning of flowering.

Ozturk *et al.,* (2010) observed the effect N sources and dosages on the yield and quality traits of winter rapeseed. Three N sources such as ammonium sulfate, ammonium nitrate and urea were applied as hand broadcast on the soil surface at five dosages (0, 50, 100, 150, and 200 kg N hectare. There were significantly effects on seed yield, oil and protein content, and other yield components due to N sources and rates. In general, ammonium sulfate and urea gave higher seed yield than ammonium nitrate they reported the importance of adequate N fertilization and true N source in seed yield in winter rapeseed and suggest that ammonium sulfate at 150 kg N per hectare will be about adequate to meet crop N requirements.

Singh *et al.,* (1997) observed that the nitrogen application up to 80 kg per hectare improved the siliquae/plant, seeds/siliqua, seed yield/plant and 1000 seed weight. Seed yield of Indian mustard in 2 years increased significantly up to 80 kg N per hectare. Increase in seed yield was due to the improvement in yield attributes of Indian mustard caused by the favorable effect of nitrogen on growth and development.

Gill and Narang (1991) studied the response of 'GSL-1' variety of gobhi sarson to irrigation and nitrogen. Three levels of irrigation (1, 2 and 3) and 4 levels of N (0, 50, 100 and 150 kg per hectare) were used. The crop responded to both N and irrigation positively. Nitrogen 150 kg per hectare gave the highest seed yield (2111 kg per hectare) with 3 post-sowing irrigations.

Aulakh *et al.,* (1995) showed that the maximum yield was obtained when N and S were applied together and protein content also increased greatly from 12.7 per cent in the control to 24.2 per cent under N and S treatment. Application of 100 g N per hectare + 20 kg S per hectare increased the oil yield to 999 kg per hectare compared with 452 kg per hectare in the control.

Buttar and Aulakh (1999) also found similar effects on Indian mustard with application of N from 75 to 125 kg per hectare at Bathinda, Punjab. Thakur (2005) also reported a significant increase in yield attributes of *Gobhi Sarson* (*Brassica Napus* L.) up to 60 kg N per hectare in Kangra (H.P)

Thakur *et al.,* (2005) evaluated the high-yielding variety of gobhi sarson and its nitrogen requirement under mid-hill conditions of north-western Himalayas. The treatments consisted of 4 gobhi sarson varieties ('Hyola 401','Neelam','Sheetal' and 'GSL 1') tested against 'Kranti' of Indian mustard (*Brassica juncea* L.) at 3 nitrogen levels (60, 90 and 120 kg N per hectare). Among different yield attributes, siliquae/plant and seeds/siliqua were highest in gobhi sarson hybrid 'Hyola 401', while 1000 seed weight was highest in Indian mustard 'Kranti'. The seed yield also increased with increasing nitrogen levels, being significantly highest with the application of 120 kg N per hectare. The nutrient highest uptake values recorded from 'Hyola 401' and with the application of 120 kg N per hectare.

Patel and Thakur (1998) at Raigarh (M.P.) found that the application of 60 kg N and 40 kg Phosphorus per hectare to toria showed a significant increase in N and P uptake. Tomer *et al.,* (1992) reported that application of 40 kg per hectare of phosphorus significantly increased leaf areas index and dry matter accumulation over control and 20 kg per hectare of phosphorus application on sandy loam soil testing medium in available phosphorus (16.2 kg per hectare) at Haridwar, Uttar Pradesh.

Kapur *et* al., (1984) reported that application of 40 kg per hectare of phosphorus produced significantly higher seed yield than without its application to sandy loam soil. Available information indicates significant differences in yield attributes viz. number of siliquae per plant, seeds per siliqua, siliqua length and 1000 - seed weight and seed yield with up to 70 kg per hectare of phosphorus. Khan *et al.,* (1986) observed that the beneficial effect of phosphorus application up to 50 kg per hectare of phosphorus on the plant height and branches per plant of Indian mustard.

Kumar *et al.,* (2007) while working on direct and cumulative residual effect of phosphorus and sulphur on Indian mustard– sunflower– urdbean cropping system observed the positive response of residual P applied to sunflower on the yield and yield attributes of urdbean. The increase in seed yields of urdbean and other crops owing to residual effect of applied P and S to preceding crops were also reported by Jain and Dahama (2006).

Shenoy and Kalagudi (2005) reported that application of Phosphorus (P) is a critical nutrient for plant growth due to its involvement in cellular energy transfer, respiration and photosynthesis. Inadequate supply of phosphorus in rapeseed-mustard plant restricts both foliage and root growth (Bidwell 1979). It is important not only for growth and development of crops but is also essential for the enhancement of different quality traits. Deficiency of P reduced crop growth, delayed flowering and maturity, and reduced the yields of mustard crops.

Malavia *et al.,* (1988) reported that application of phosphorus up to50 kg per hectare had significantly increased seed weight and seed yield of Indian mustard. Sharma and Kamath (1990) observed that increasing rate of phosphorus from 0 to 90 kg per hectare increased the content and uptake of phosphorus in mustard (*Brassica juncea* L.). Deo and Khandelwal (2009) found that application of 60 kg per hectare of Phosphorus increased the seed yield of Indian mustard by 26.5 and Stover yield by 12.6 per cent over control on loamy sand soil testing high in available phosphorus (26.2 kg P per hectare) at Rajasthan.

Sumeria (2003) reported that application of 60 kg per hectare of Phosphorus significantly increased yield attributing characters like number of siliquae per plant, number of seeds per siliqua and seed yield of mustard compared to 20 and 40 kg per hectare of phosphorus on loamy sand soil testing low in available phosphorus at Udaipur, Rajasthan. Sah *et al.,(*2006) observed that application of 60 kg per hectare of Phosphorus significantly increased phosphorus uptake by seed and Stover over 40 and 20 kg per hectare of Phosphorus on sandy loam soil testing medium in available phosphorus (18.3 kg P per hectare) at Varanasi; Uttar Pradesh.

2.2 OIL CONTENT AND YIELD ATTRIBUTES

Sardana (1990) observed that organic manure increased protein content and oil yield of toria and gobhi sarson over unmanured. Prasad *et al.,* (1991) reported maximum P, S and Fe uptake by (*Brassica juncea* L.) from poultry manure (10 tons per hectare) treated plot. Bailey and Grant (1990) from Manitoba, Canada observed that phosphorus application up to 25 kgper hectare of phosphorus increased seed protein and oil content. Tyagi and Rana (1992) reported highest oil yield with application of 40 kg per hectare of phosphorus on sandy loam soil testing medium in available phosphorus (18.5 kg P/ha) at Meerut, Uttar Pradesh.

Brar *et al.,* (1998) reported that seed yield, straw yield and oil yield increased significantly with each increment of nitrogen. Maximum seed yield (14.3 q per hectare in 1992 and 13.78 q per hectare in 1993) and oil yield (5.69 q per hectare in 1992 and 5.71 q per hectare during 1993) were recorded when 200 kg N per hectare was applied.

Premi and Kumar (2004) reported higher oil content with application 80 kg per hectare of Phosphorus over control and 40 kg per hectare of Phosphorus on clay loam soil testing medium in available phosphorus (18.2kg P per hectare) at Bharatpur, Rajasthan. Similarly, Patel and Shelke (1998) recorded the significant increase in oil content by application of 80 kg per hectare of Phosphorus over lower doses.

Mir *et al*., (2010) found that application of 60 kg per hectare of phosphorus significantly increased the number of siliquae per plant, seeds per siliqua, seed yield and oil yield of Indian mustard over 30 kg per hectare of Phosphorus on sandy loam soil testing high in available phosphorus (50.5 kg P per hectare) at Aligarh, Uttar Pradesh.

2.3 Effect of fertilizers of insect population

Aslam *et al.,* (2004) observed that four levels of Nitrogen, i.e. 0, 250, 500 and 1000 mg/pot were applied before planting. Sampling for aphid (*Lipaphis erysimi* Kalt) was done weekly from early February to late March. Seasonal mean 7 populations were non-significantly different among plants receiving different levels of Nitrogen, whereas population was significantly different on different varieties highest population (18.22 aphid/top 10cm inflorescence) was recorded on variety Oscar. Minimum population (8.51 aphid/top 10 cm inflorescence) was found on the population recorded, variety Oscar can be classified as susceptible and Con-I as resistant to mustard aphid.

Aslam *et al.,* (2004) evaluated the susceptibility of five canola varieties abaseen, Con-I, Con-III, Oscar and Shiralee in pots for nitrogen at Multan, Pakistan. Four levels of nitrogen i.e. 0, 250, 500 and 1000 mg/pot were applied before planting. Sampling for aphid (*Lipaphis erysimi Kalt.*) was done weekly from early February to late March. Seasonal mean aphid population was non-significantly different among plants receiving different levels of Nitrogen, whereas population was significantly different on different varieties. Highest population (18.22 aphid/top 10 cm inflorescence) was recorded on variety Oscar. Varieties Shiralee and Abaseen had non-significant difference in population between them, having 18.8 and 13.56 aphid/ top 10 cm

inflorescence. Minimum population (8.51 aphid/top 10 cm inflorescence) was found on Con.I. Based on the population recorded, variety Oscar can be classified as susceptible and Con-I as resistant to mustard aphid.

Gavloski *et al.,* (2010) observed that the principal orders of insects found in fields of oilseed crops include Orthoptera, Thysanoptera, Hemiptera, Coleoptera, Lepidoptera, Diptera, and Hymenoptera. Several species of spiders and mites also comprise a substantial component of the arthropod biodiversity of oilseed crops.

2.4 Effect of insecticides against insect-pest in mustard

Shah *et al.,* (2008) observed that three insecticides Metasystox-R 25 EC, Dimethion 40 EC, and Fentro 50 EC has positive effect on the yield and yield attributing characters as well as oil content of mustard. The crop was sprayed with the insecticides twice after sowing at the rate of 0.05% and 0.025% and growth parameters; yield and oil content were observed. It was found that these three insecticides influenced on the various growth parameters and yield attributing character leading to much higher seed yield as compared to control. The yield of all the treatments was significantly better than the control. The response of Metasystox-R @ 0.05% was comparatively better for various growth parameters and yield of mustard. Oil content in seeds was found to be marginally decreased due to insecticide application, though the values were statistically significant.

Sultana *et al.,* (2009) studied the effect of different insecticide/biopesticides against aphid (*Lipaphis erysimi)* such as Neem Kernel extract, Jet powder + Neem Kernel extract with two chemical insecticide Aktara® 25WG and Diazinon® 60EC on mustard. The highest aphid population was 84 per plant was observed in the 2rd week of January in 2009. Among the treatments Aktara reduced the highest aphid population (92%) with the highest BCR (4.20) Followed by Diazinon® (89%) and Neem Kernel extract + Jet powder (65%). Diazinon® 60EC gave the second highest BCR (3.83) Followed by Jet powder (3.62) and Neem kernel extract + Jet powder (3.07). The highest yield (1568 kg per hectare) was also found in Aktara treated plot which was statistically similar to Diazinon® treated plot (1485 kg per hectare) and the lowest yield (840 kg per hectare) was found in control plot.

Sahoo *et al.,* (2009) reported that the mustard aphid is the most serious insect-pest of mustard crops. The natural appearances of the aphid on the yellow sarson variety, Binoy (B-9) was observed from 52nd standard week, with the peak population on 6th standard week and the aphid disappeared after 10th standard week. Among the different chemical insecticides evaluated for their bio-efficacy against it, Dimethoate 30EC and Oxydemeton-methyl 25EC were proved to be more effective. The plots treated with Dimethoate and Oxydemeton-methyl produced more yield ranging from 1151.6 to 1310.3 kg seed per hectare. The most favorable return was obtained under Dimethoate 30EC (1:20.8 & 1:13. 3) Followed by Oxydemeton-methyl 25EC (1:16. 8 & 1:9.1).

Razaq *et al.,* (2011**)** studied that two aphid species were examined on late sown crops of *Brassica napus*, *Brasica juncea* and *Brassica carinata*. Pod weight, pods per plant and yield per hectare was significantly increased by application of insecticides (Dimethoate 30EC, Oxydemeton-methyl 25EC, Aktara) for all the three species.

Narjary *et al.,* (2013) evaluated the effect population started increasing gradually from 2nd week of December, reached peak population around last week of January. In both of the varieties in 15th October sowing. In 30th October sowing aphid population started building up from 1st week of January and reached peak population around 1st week of February. It was observed that humid thermal ratio as well as the aphid population increased, but as aphid population reached its peak the humid thermal ratio values reduced. In both early (15th October) and late sown (30th october) crop the aphid population had a significant negative correlation with growing degree days but positively correlated with humid thermal ratio. As the growth and development of insects mainly depends upon the accumulated amount of heat, growing degree days and humid thermal ratio computation could be used for prediction of aphid population build up.

Chapter III

MATERIALS AND RESEARCH METHODOLOGY

The field experiment entitled "**Effect of different sources of nutrient on production and pest infestation in mustard (*Brassica juncea* L.)**" was carried out at Lovely Professional University during *rabi* season 2014-2015. The details of materials, procedures adopted, and techniques used during the course of this study are described in this chapter

3.1 Description of experimental site

The present study was carried out at the field Experimental of the Departent of Agronomy, School of Agriculture of Agriculture, Lovely Professional University, Jalandhar, Punjab (India) during 2014- 2015.

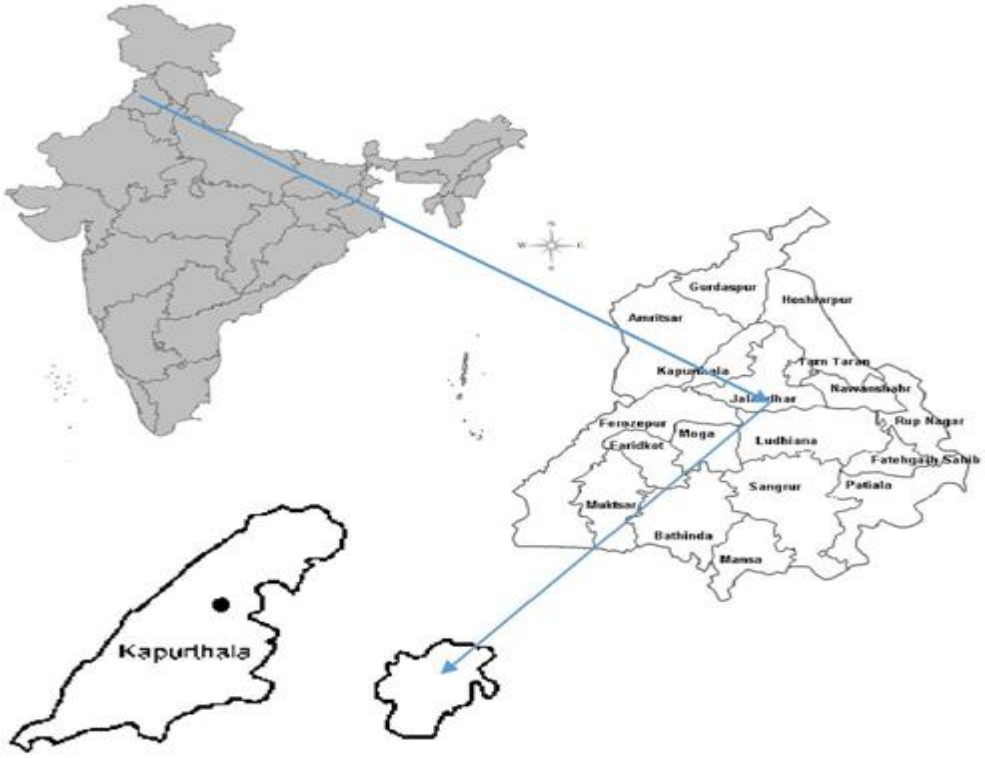

Figure 3.1 Picture showing the location of study area

The experimental site is localized in "*Central Plain Zone (PB-3)"* of Punjab. The rainfall in the region varies from 500-800 mm and about 80 per cent of which is received in a short period 3 months *(mid June to mid September)*. Major constraints of the region are declining water table and soil salinity. The soil predominantly belongs to Central Alluvial Plain or sandy loam. The major crops grown in the region are mainly wheat, rice, maize, groundnut, cotton, gram, barley, pear and guava. The experimental site is located at 31º 15' N latitude and 75^0 41' E longitudes at an elevation of 245 m above mean sea level. The climate of the experimental area is characterized as hot and dry summer and wet and humid monsoons, distinctly experiences all the four seasons. The soil of experimental field was Sandy loam. The table below contains details on experimental soil status before sowing

3.2 Climatic and weather

The climate of the experimental site is located in Punjab State which experiences by the extreme hot and extreme cold conditions. The annual temperature in Punjab State range from 1 to 45^oC and can reach 49.5^oC during summer and 0^oC in winter. Its annually average rainfall ranges from 960 mm in the sub mountain region and 460 mm in the plains. It is also characterized by heavy rain in the northeast area near the foothills of Himalayas, whereas it receives less rainfall and high temperatures in the area lying in south and west. It experiences also three seasons as follows: Summer season (April and June) and it is characterized by the increase in temperatures up to 40^oC, Monsoon season (July to September) and it is during this period when the majority of rain occurs and in last, Winter season (December to February) with typical fall of temperatures up to 0^oC.

3.3 Meteorological data during growing season

Weather and climate are important factors that determining the success or failure of agriculture. Weather influences agricultural operations from sowing to the harvest, the reason why it is important to present the variations of climate during growing season. The mean of weekly meteorological observations were recorded during entire growing season and are represented in Table 4.3. Crops were sown on 26/11/2014. Pea was harvest on 25/3/2015. Maximum and minimum temperatures during growing season were 33.49ºC and 6.90ºC respectively, relative humidity varied between 63 and 85 per cent. There was a total rain of 190 mm during growing period.

Month		Temperature		RH%	Rainfall (mm)
	Maximum	Minimum	Average		
November	26.9	10.9	18.9	63	0
December	17.6	6.9	12.25	80	42
January	15.6	7	11.3	85	24.5
February	22.2	10.5	16.35	79	38.6
March	25.5	13.3	19.4	76	84.6
April	33.49	19.17	26.33	62	0
Total					190

(Source: Department of Meteorology, PAU)

Table 3.3 Monthly air temperature, relative humidity and total precipitation from November 2014 to April 2015

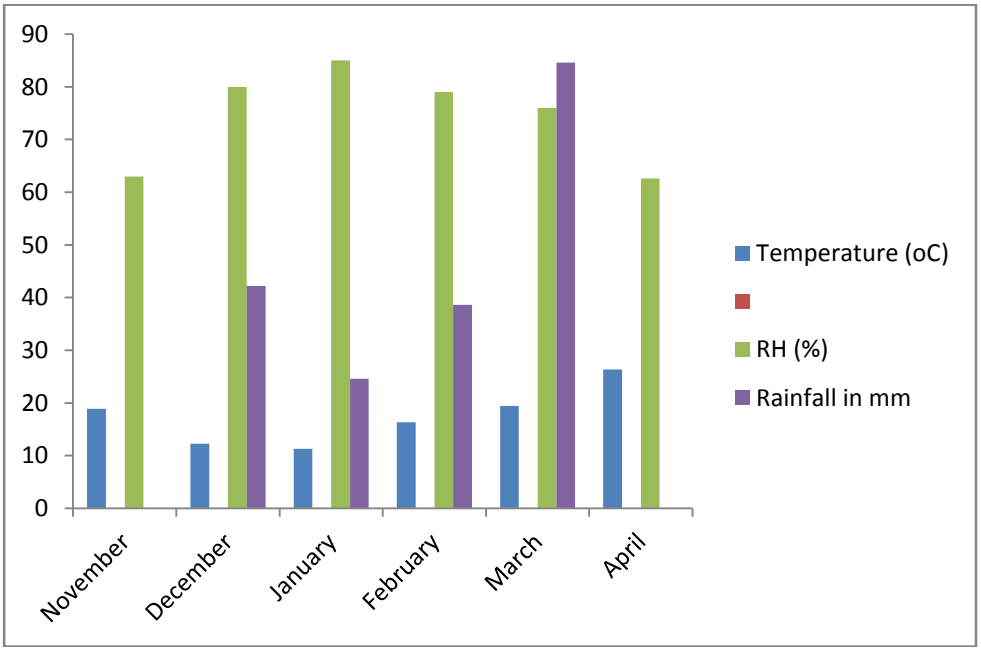

Figure 3.3 Monthly meteorological reports

3.4 Soil Analysis

To find out physical and chemical characteristics of the experimental soil, top soil samples from 0-15 cm depth were collected from each replicates before sowing then after harvesting all crops soil samples were collected from each plot and they were air dried and sieved then a composite sample was obtained by mixing them together for further analysis of both physical and chemical properties. The results of soil analysis before sowing presented in table 4.4 showed that the soil was silt loam, slightly alkaline in reaction, non-saline, low in organic carbon, low in available nitrogen and potassium and medium in available phosphorus status.

Table: 3.4 Soil physical and chemical properties of the experimental field soil.

Sr. No	**Particulars**	**Values (0- 30 cm depth)**	**Method employed**
Physical properties			
1	Coarse sand (%)	61%	International pipette method (Piper, 1955)
2	Silt (%)	7%	
3	Clay (%)	32%	
Chemical properties			
1	pH	7.7	Buckmoric Hmeter (Piper,1955)
2	Electrical conductivity (dS/m)	0.33	Jackson (1973)
3	Organic carbon (%)	0.56	Wet oxidation method (Jackson, 1957)
4	**Available nutrient status**		
A	Available N (kg/ha)	163	Alkaline per magnate method (Subbaiah and Asija,1955)
B	Available P (Kg/ha)	24.4	Olsen’s method (Jackson,1957)
C	Available K (kg/ha)	325	Flame photometer method (Tandon, 1993)

3.5 Procedures of soil analysis

3.5.1 Triangle Method for soil textural class

Soil textural class was determined by using U.S. soil texture triangle method (Soil Survey Staff, 1998).

3.5.2 Particles distribution (%): International pipette method (Piper, 1950)

For determination of soil texture, 50 g of dried soil were sieved with the help of 2 mm sieve and placed into 500 ml bottle. After that 100 ml of dispersion solution was added into 50 g soil in 500 ml plastic bottle. Sample bottles were shacked at regular interval for half an hour on shaking machine for preparing homogeneous solution. The obtained solution was transferred in 1000 ml glass measuring cylinder then after water was added to make solution of 1000 ml. As per International approved system, the sample solution was shaken for 30 seconds. Depending on the solution temperature and sedimentation chart, first pipetting was done with 50 ml pipette at 10 cm depth. In first pipetting, 50 ml solution were sucked and transferred into 60 ml petri dish. The formed sample solution contained mixture of clay and silt particles. Depending on the solution temperature and sedimentation chart, second pipetting was done with 50 ml pipette at 10 cm depth. In second pipetting 50 ml solution were sucked and transferred in 60 ml china dish. This solution contained clay particles in soil sample. Remaining soil solution was transferred in 1 litre. Measuring cylinders and 0.02 mm sieves were washed using jet of water. Sand particles on sieve were collected in china dish. Pipetted solution was transferred in 3 dishes and kept overnight in an oven at temperature of 105^{o}C. Solutions were cooled in desiccators and weight was taken quickly. The weight of fine was determined by deducting the weight of clay, silt and coarse sand particle from 100.

3.5.3 Electrical Conductivity: Water suspension (Jackson, 1967)

To find out the electrical conductivity of soil, 25 g of dried soil were taken then transferred into 100 ml beaker then after 50 ml of distilled water was added. The suspension was mixed intermittently for half an hour and left it for 30 minutes without any disturbances. Conductivity cell was inserted in solution and EC value was recorded.

3.5.4 Organic carbon: Rapid titration method (Walkley and Black 1934)

To determine organic carbon of soil, 2 g of dried soil samples were weighed and taken into 250 ml conical flask, to which 10 ml of 1 N $K_2Cr_2O_7$ solution and 20 ml of concentrated H_2SO_4 were added. The content was shaken for a minute and was left for a half an hour to make reaction complete. Then after 200 ml of distilled water, 10 ml of orthophosphoric acid and 4 drops of drops of diphenylamine indicator were added and the violate color was appeared in the suspension. The obtained solution was titrated with ammonium ferrous sulphate and the point of the titration was marked with the change of colour from violate to bright green. The blank titration was performed in the similar way.

3.5.5 Available Nitrogen: Alkaline Permanganate Method (Subbiah and Asija, 1956)

To determine available nitrogen in the soil, 5 g of dried soil were taken and transferred into the distillation flask of micro-Kjeldhal distillation assembly. About 52 ml of 0.32% $KMnO_4$ solution was added to the distillation unit. From 150 ml conical flask, 10 ml of N/50 H_2SO_4 were pipetted out and mixed with two drops of methyl-red indicator. The conical flask and the delivery tube of the distillation unit were placed in such a way that the delivery tube was well placed into the content of the conical flask. The quantity of 25 ml of 2.5% NaOH solution was added into the distillation flask containing soil and $KMnO_4$ through the set provided in the distillation tube and the inlet was immediately closed with stop-cock. Then after, distillation was started and 30 ml of the distillate was collected. The content of the conical flask was titrated with N/50 NaOH and the end point was indicated with change of color from pink to yellow.

3.5.6 Available Phosphorus: 0.5 M $NaHCO_3$, pH=8.5 (Olsen *et al.* 1954)

A soil of 1 g of was weighed and transferred into 150 ml conical flask. A pinch of Darco-G 60 and 20 ml of 0.5 $NaHCO_3$ were added into the conical flask, then after the flask was shaken for half an hour on an electrical shaker and the suspension was filtered through Whatman No.1 filter paper. Similarly a blank solution was prepared. About 5 ml of the extract was transferred into a 25 ml volumetric flask and then after 0.5 ml 5N H_2SO_4 were added and the solution was shaken for a while till CO_2 evolution disappeared. A quantity of 4 ml of ascorbic

acid (solution B) was added to it and the volume was made by addition of distilled water then after the flask content was mixed. The intensity of the blue colour developed within a calorimeter was measured at 760 µm wavelength using red filter.

3.5.7 Available Potassium: 1 N Neutral ammonium acetate (Black, 1965)

A quantity of 5 g of dried soil was weighed and was taken into in 150 ml conical flask, then after 52 ml of neutral ammonium acetate solution were added to the flask. The content was shaken for five minutes on mechanical shaker and filtered through Whatman No.1 filter paper. The extract was collected into beaker then after 5 ml of the extract was diluted with distilled water. The diluted extract was atomized flame photometer to note K reading.

3.6 Experimental details

3.6.1. Treatment

Table: 3.6.1 Details of treatments used in the experiment

Treatment 1	UREA 84.37gm + SULPHUR 8.43 gm
Treatment 2	UREA 84.37gm + SSP 70 gm
Treatment 3	UREA 84.37gm + MOP 2.5gm
Treatment 4	UREA 84.37gm + SSP 70gm+MOP 2.54gm
Treatment 5	DAP 24.45gm +MOP 2.5 gm
Treatment 6	DAP 24.45gm +SULPHUR 8.43 gm
Treatment 7	N:P:K MIXTURE 0.93gm
Treatment 8	CONTROL

3.6.2 Design and layout

The experiment laid out in RBD (randomized block design) and consisted of eight treatments with three replications and each replication received nine treatments randomly. Thereby it was 24 total experimental plots and plot size was 2.5 m x 1.5 m. The field preparation was done by applying the primary and secondary tillage, using mould board plough, harrow and rotavator respectively which were mounted on a tractor. It was followed by planking of the field using. Once the field was leveled uniformly, the layout was carried out manually.

(i) Total number treatments : 3 x 8 = 24
(ii) Replications : 3
(iii) Design : RBD
(iv) Total number of plots : 24
(vi) Net plot size : 2.5 m x 1.5 m = 3.75 m^2
(vii) Spacing : 30 cm x 10 cm

Table: 3.6.2 Field Layout with treatments randomly in each replication

1	UREA+SULPHUR	CONTROL	N:P:K mixture
2	UREA+SSP	DAP+MOP	UREA+MOP+SSP
3	UREA+MOP	UREA+SULPHUR	DAP+SULPHUR
4	UREA+MOP+SSP	N:P:K mixture	CONTROL
5	DAP+MOP	DAP+SULPHUR	UREA+SSP
6	DAP+SULPHUR	UREA+MOP	UREA+SULPHUR
7	N:P:K mixture	UREA+MOP+SSP	DAP+MOP
8	CONTROL	UREA+SSP	UREA+MOP

3.6.3 Different insecticides used for control aphid :

Table: 3.6.3 Different treatment of insecticides

Treatment 1	IMIDACLORPID 30.5%SC
Treatment 2	THIAMETHOXAM 25%WH
Treatment 3	MONOCROTOPHOS 36%SL
Treatment 4	DIMETHOATE 30%EC
Treatment 5	MALATHION 50%EC
Treatment 6	ACETAMIPRID 20%SP
Treatment 7	MULTINEEM
Treatment 8	CONTROL

3.7 Variety and fertilizer description

3.7.1 Source of Seed

Seed used in this research was obtained from Punjab Agriculture University,

3.7.2 Variety detail

Seed and sowing

The variety RLC -1 of mustard was used as the test crop. The seeds were sown by pora method @ 1.40 gram per plot and the sowing was done on 25th November, 2014- 2015.

3.8 Field preparation and subsequent operations

November 15th 2014 the first ploughing was done and this was followed by harrowing and leveling the soil to provide a good seedbed before sowing. All crop residues and weeds were removed as necessary to control weeds during the growing period. The Urea, DAP and Potash were basally applied in plots according to the treatment assigned in each plot before sowing in mustard. In each plot 30 cm was maintained as planting distance between two successive rows.

The other normal agricultural practices required including irrigation water canal cleaning were done.

Table: 3.8 Schedule of various agronomic operations done in the experiment

Sr.N.	Operations	2014-2015
1	**FIELD PREPARATION**	
A	Disc harrowing (cross)	15-11-14
B	Planking	15-11-14
C	Layout demarcation	18-11-14
2	**TREATMENT APPLICATION**	
A	Pre- sowing irrigation	20-11-14
B	Cross –ploughing and planking	25-11-14
D	Basal dose of N ,P and k treatment	25-11-14
C	Sowing	26-11-14
D	Thinning –Ist	12-12-14
E	Thinning-IInd	19-12-14
f	Hoeing, weeding Ist	21-12-14
G	Hoeing IInd	12-1-15
H	Hoeing and weeding IIIrd	28-1-15
I	Harvesting	10-4-2015
J	Threshing and winnowing	15-4-2015
K	Oil content	2-5-2015

3.9 Data Collection

Before collecting data directly from the field, in each plot four mustard plants were randomly selected, tagged and used to record vegetative parameters including plant height, number of leaves and number of pods etc.

3.10 Measurements

In this thesis various plant parameters such as plant height, leaf area index, number of pods plant per pant, pod length, seed yield and straw yield.

3.10.1 Plant height

Plant height of 4 tagged plants in each plot was recorded two times using a meter scale from ground level to the upper youngest leaf of the plant. Height of these four plants was measured at harvest stage from base of the plant to top of the main shoot by metre scale and average height was expressed in cm.

3.10.2 Determination of leaf area index

Leaf area index is the ratio between leaf areas to ground area.

LAI = leaf area /ground area

3.10.3 Number of pods per plant

The number of pods on single plant was counted when pods were filled with grains. The pods were counted from our tagged plants in each plot.

3.10.4 Pod and root length

The pod and root lengths were measure with the help of scale.

3.10.5 Pod characteristics

At maturity (when the leaf canopy started to change to yellow), 10 random plants were cut and used to determine pod length, the number of pods per plant and seeds per pod.

3.10.6 Seed yield

After threshing and winnowing, the clean seeds from each plot were weighed and the weight was recorded as seed yield in kg per plot and then converted in quintal per hectare.

3.10.7 Straw yield

Stover yield was obtained by subtracting the seed yield from biological yield of the respective net plot and it was expressed as quintal per hectare.

3.10.8 Oil Content

Oil content in seed was determined by Nuclear Magnetic Resonance (NMR) technique given by Tiwari and Bur k (1980) at NRC on Rapeseed and mustard, Sewar, Bharatpur (Rajasthan)

3.10.9 Number of insect

Number of insect 4 tagged plants in each plot was recorded three times with the help of lens. Insect of these four plants was measured 2 days after spraying, 5 days after spraying, 10 days after spraying.

3.11 Statistical analysis

All the field and laboratory data were analyzed statistically by the methods described by FRBD software. The oil content analysis work was done as per the methodology given by Tiwari and Bur k (1980) at NRC on Rapeseed and mustard, Sewar, Bharatpur (Rajasthan)

Chapter IV

RESULTS AND DISCUSSION

The experimental results pertaining to the current study entitled *"*The effect of different sources of nutrient on production and pest infestation in mustard (*Brassica juncea* L.*)"* have been presented in this chapter under following headings:

Effect of different treatments on various growth parameters

Effect of different treatments on yield attributing characters and yield

Effect of different treatments on oil content parameters

Effect of different insecticides

Effect of different treatments on growth parameters

Plant height

The data presented in Fig 4.1 revealed that at 60 DAS, highest magnitude of increase in plant height was registered under treatment T4 (UREA+SSP+MOP) followed by T3 (UREA+MOP). However, a significant average height T4 treatment was recorded between 60 and 68 cm. The lowest plant height was observed between 40 to 45cm.The treatment T8 plant height very less 47.33cm as comparison with other treatment

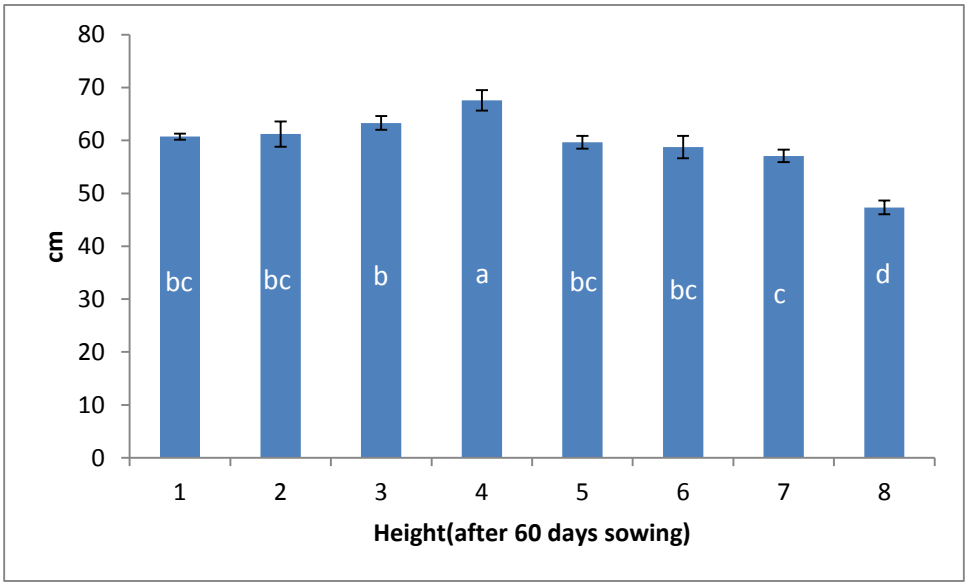

Fig 4.1 Effect of different nutrient sources on plant height.

Treatment	Height (60days)	Height(120days)
1	60.74bc±0.57	151.5c±0.57
2	61.22bc±2.4	156c±2.42
3	63.32b±1.3	159.42b±1.30
4	67.58a±1.95	167.5a±1.23
5	59.66bc±1.23	157.25bc±2.12
6	58.77bc±2.12	154.92bc±1.17
7	57.08c±1.17	153.83bc±2.37
8	47.33d±1.3	131.33d±1.95

The data presented in Fig 4.2 revealed that at 120 DAS, highest plant height was recorded under treatment T4 (UREA+SSP+MOP) followed by T3 (UREA+MOP) and T5 (DAP+MOP) with the value of 167.5cm, 159.42cm and 157.25cm. Above treatments gave statistically similar plant height. However, treatment T4 (UREA+SSP+MOP) gave significantly higher plant height in comparison with other treatment. The lowest plant height was observed 131.33cm under bsolute treatment T8.

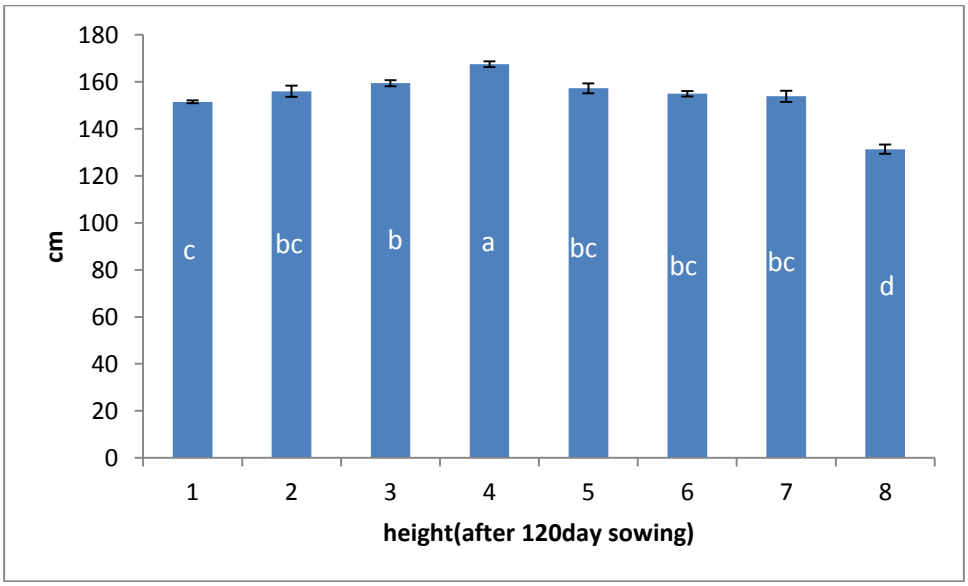

Fig 4.2 Effect of different nutrient sources on plant height.

The present findings are supportive to the Dalal *et al.*, (2011) who studied the effect of N, P, and K effect on different growth parameters such as plant height, number of branches and on the

seed yield They reported that the maximum seed yield was with the application of 50:40:25 kg NPK per hectare, while the NPK application at the rate of 60:50:30 and 70:50:35 kg per hectare, decrease the yield. Similarly there was no enhancement in plant height, number of branches per plant and number of pod per plant in higher doses. Patel and Shelke (1998) worked on Indian mustard (*Brassica juncea* L.) at Parbhani (Maharashtra) found that phosphorus application significantly increased the plant height, branches/plant, siliquae/plant, total dry matter/plant, seeds/siliquae, 1000-seed weight up to 120 kg Phosphorus per hectare. Patel and Shelke (1998) worked on indian mustard (*Brassica juncea* L.) at Parbhani (Maharashtra) found that phosphorus application significantly increased the plant height, branches/plant, siliquae/plant, total dry matter/plant, seeds/siliquae, 1000-seed weight up to 120 kg Phosphorus per hectare. Khan *et al.*, (1986) observed that the beneficial effect of phosphorus application up to 50 kg per hectare of phosphorus on the plant height and branches per plant of Indian mustard.

Leaf area, pod length and pod number

Leaf area 60days	Leaf area 100 days	Pod length	Pod number
0.28a±0.08	0.35a±0.07	5.12c±0.07	522.25c±5
0.19abc±0.02	0.29bc±0.03	5.2c±0.1	544.42b±8.75
0.14bc±0.02	0.32b±0.02	5.62b±0.19	532.33bc±7.93
0.3a±0.04	0.36a±0.08	6.16a±0.08	610.67a±0.79
0.23abc±0.02	0.29bc±0.07	5.08c±0.04	527bc±3.1
0.24ab±0.03	0.31b±0.08	4.99c±0.07	514.25c±2.26
0.22abc±0.03	0.3bc±0.1	5.24c±0.07	523.25c±2.67
0.1c±0.07	0.24c±0.19	4.2d±0.1	439.58d±11.04

Leaf areas index

The effect of different treatment on leaf area of mustard crop at 60 DAS and 100 DAS The data presented in Fig 4.3 revealed that at 60 DAS, highest magnitude of increase in plant leave area was registered under treatment T4 (UREA+SSP+MOP). Respectively however, a significant average leave area index is recorded between ($0.18cm^2$ and $0.3cm^2$). The average LAI was observed under control is 0.1 cm, then 100 DAS highest magnitude of increase in plant leave area was registered under treatment T4 (UREA+SSP+MOP). Respectively however, a significant average leave area was recorded between ($0.31cm^2$ and $0.36cm^2$). The average LAI was observed

under control is 0.24cm. The treatment T4 (UREA+SSP+MOP) gave significantly higher leave areas comparison with other treatment. The lowest plant height was observed under absolute T8 treatment. The present findings are supportive to the Tomer *et al.*, (1992), who studied the effect of 40 kg per hectare of phosphorus significantly increased leaf areas index and dry matter accumulation over control and 20 kg per hectare of phosphorus application on sandy loam soil testing medium in available phosphorus 16.2 kg per hectare.

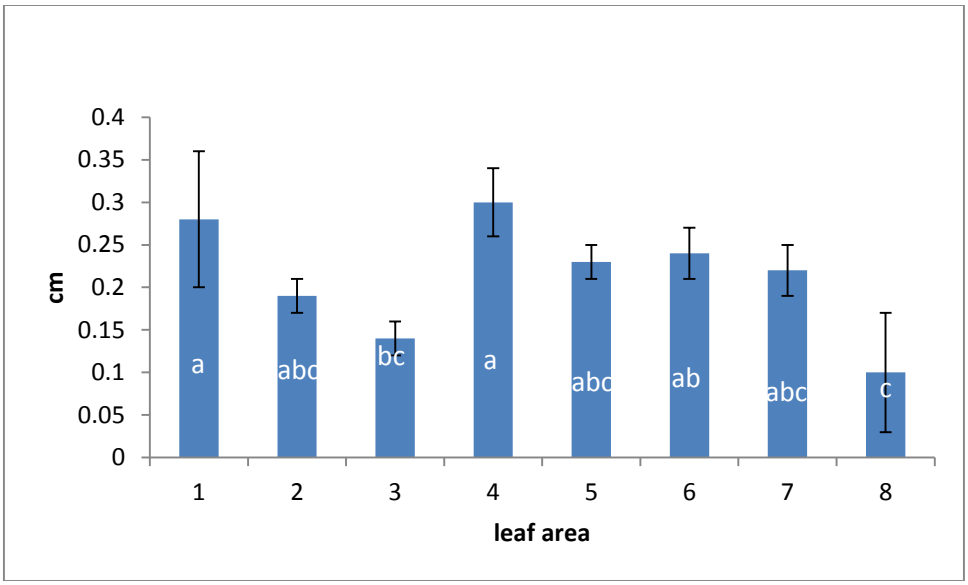

Fig 4.3 Effect of different nutrient sources on leaf areas.

Pod length (cm)

The data presented in Fig 4.4 revealed that the highest pod length was recorded under treatment T4 (UREA+SSP+MOP) followed by T3 (UREA+MOP) and T2 (UREA+SSP) (fig 2.2) with the value of 6.16cm, 5.62cm and 5.20cm. Respectively Above treatments gave statistically similar pod length. The lowest pod length 4.2 was observed under absolute T8 treatment.

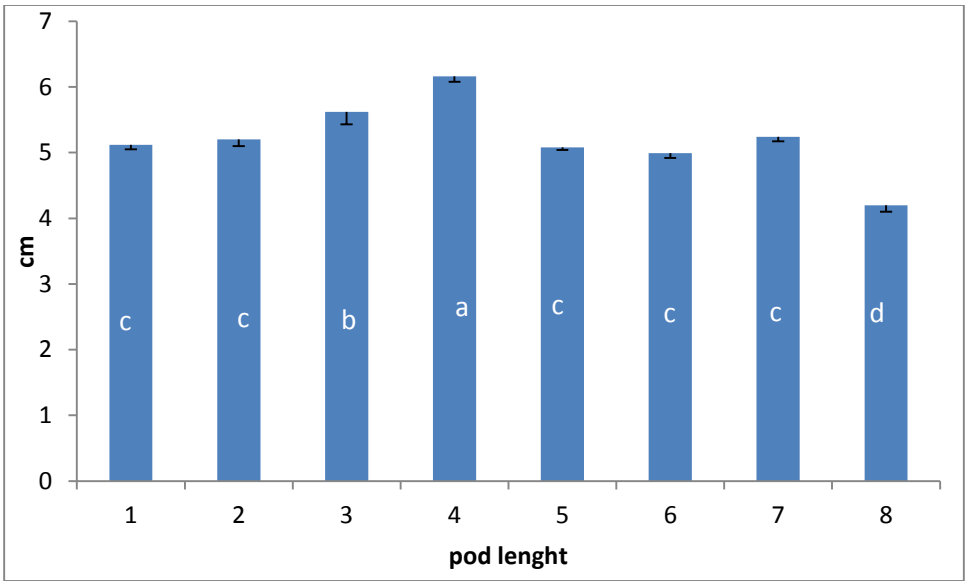

Fig 4.4 Effect of different nutrient sources on pod length.

The present findings are supportive to the Kapur *et* al., (1984) who had reported that application of 40 kg per hectare of phosphorus produced significantly higher seed yield than without its application. Available information indicates significant differences in yield attributes viz. number of siliquae per plant, seeds per siliqua, siliqua length and 1000 - seed weight and seed yield with up to 70 kg per hectare of phosphorus.

Number of pods

The data presented in Fig 4.5 revealed that the randomly selected plants were used for counting number of pods per plant. The highest pod number was recorded under treatment T4 (UREA+SSP+MOP) followed by T2 (UREA+SSP) and T3 (UREA+MOP) with the number of pods 610.67, 544.42 and 532.33. Respectively However, treatment T4 (UREA+SSP+MOP) gave significantly higher pod number in comparison with other treatment. The lowest number of pods 439.58 was observed under treatment T8.

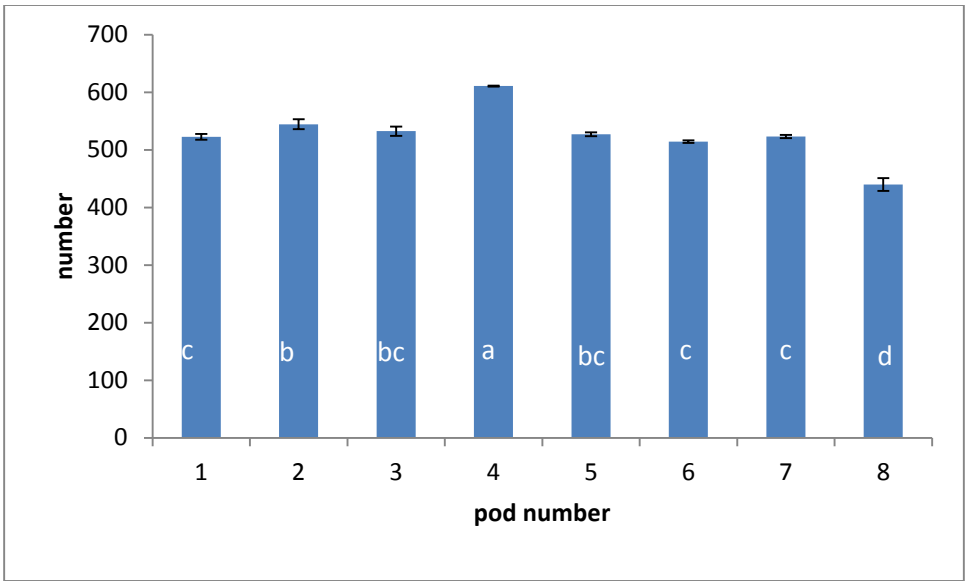

Fig 4.5 Effect of different nutrient sources on pod number.

The present findings are in line to the Saini and Thakur *et al*., (1996) studied the effect of different doses of nitrogen at Leo (H.P.) and concluded that an application of 30 kg N per hectare and 39.6 kg P per hectare significantly increased plant height, pods/plant, grains/pod and green-pod yield of pea plants compared with other doses. Similar results has been reported by Sharma(1995) on Chinese sarson with P levels at 30, 60 or 90 kg per hectare and K at 30, 60 or 90 kg per hectare .The found that seed yield per plant and per hectare was highest with 30 kg P2O5 + 60 kg K2O per hectare (57.42 g and 21.34 g per hectare , respectively). Phosphorus significantly improved plant height, pods/plant, seeds/pod, pod length compared with no P (Rathi *et al*., 1995)

Yield parameter and oil parameter

Seed Yield g/Plot	Seed Yield kg/Hectare	Straw Yield kg/Plot	Straw Yield kg/Hectare	Oil content%
441.62bc±21.19	1177.65±39.44	1.17b±0.6	3120.00±17.43	37.73b±0.36
480.96b±11.24	1282.56±22.23	1.31b±0.1	3493.33±29.21	37.30b±0.43
466.25b±6.15	1243.33±7.18	1.3b±0.02	3466.67±9.23	37.84b±0.27
541.25a±3.34	1443.33±11.36	1.67a±0.05	4453.33±5.23	39.35a±0.31
414.79c±16.09	1106.11±27.21	1.13b±0.06	3013.33±19.36	37.40b±0.53
466.17b±5.22	1243.12±1.26	1.18b±0.07	3146.67±12.23	37.04b±0.42
459.21b±9.72	1224.56±35.21	1.18b±0.07	3146.67±25.27	36.82b±0.39
343.45d±22.01	915.87±42.08	0.89c±0.02	2373.33±13.75	33.51c±0.37

Seed Yield

The data presented in Fig 4.6 revealed that at The highest magnitude of increase in mustard crop grain yield was registered under treatment T4 (UREA+SSP+MOP) followed by T2 (UREA+SSP) and T3 (UREA+MOP) with the grain yield 1443.33kg 1282.56kg and 1243.33kg per hectare. In the present investigation treatment T4 (UREA+SSP+MOP) gave significantly higher grain yield in comparison with other treatment. The lowest grain yield (915.87) was registered under absolute control T8.

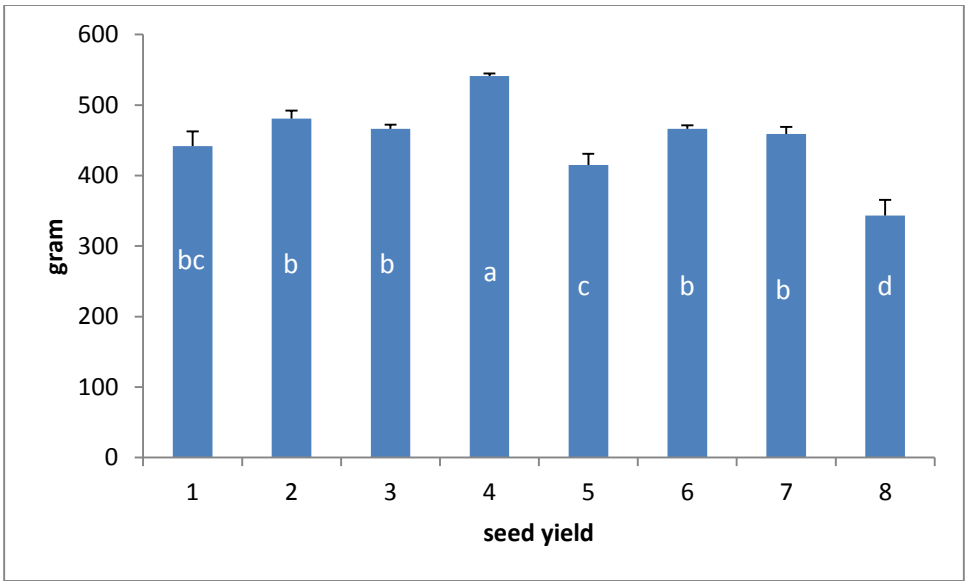

Fig 4.6 Effect of different nutrient sources on seed yield.

Patel and Thakur (1998) who studied the effect of N and P levels on growth, yield and quality of mustard and reported that application of N up to 80 kg per hectare significantly increased the plant height only, whereas, branches/plant, siliquae/plant, 1000-seed weight and seed yield were recorded significantly higher at 60 kg N per hectare and are in conformity with the present finding They also observed that 40 kg P2O5 per hectare significantly increased the siliquae/plant, 1000-seed weight and seed yield over 20 kg P2O5 per hectare .The present investigation is also in agreement with Bali *et al.,* (2000) who found that the three levels of N (30, 60 and 90 kg per hectare) and P (30, 45 and 60 kg per hectare) significantly increased the primary and secondary branches/plant, siliquae/plant, seeds/siliquae, 1000-seed weight and seed

yield, while application of P at various levels did not produce significant variation in yield and yield attributes of brown sarson. However, application of 60 kg Phosphorus per hectare resulted in maximum values.

Straw Yield

The data presented in Fig 4.7 revealed that at dry seed pods are harvested from each treatment and the left over straw was weighed out and expressed as straw mean yield per treatment. The highest magnitude of increase in mustard crop straw yield was registered under treatment T4 (UREA+SSP+MOP) followed by T2 (UREA+SSP) and T3 (UREA+MOP) with the straw yield 4453.33kg, 3493.33kg and 3466.67kg per hectare. In the present investigation all the treatment were found statistically at par with each other parameter, lowest straw yield (2373.33) per hectare was registered under absolute T8 control.

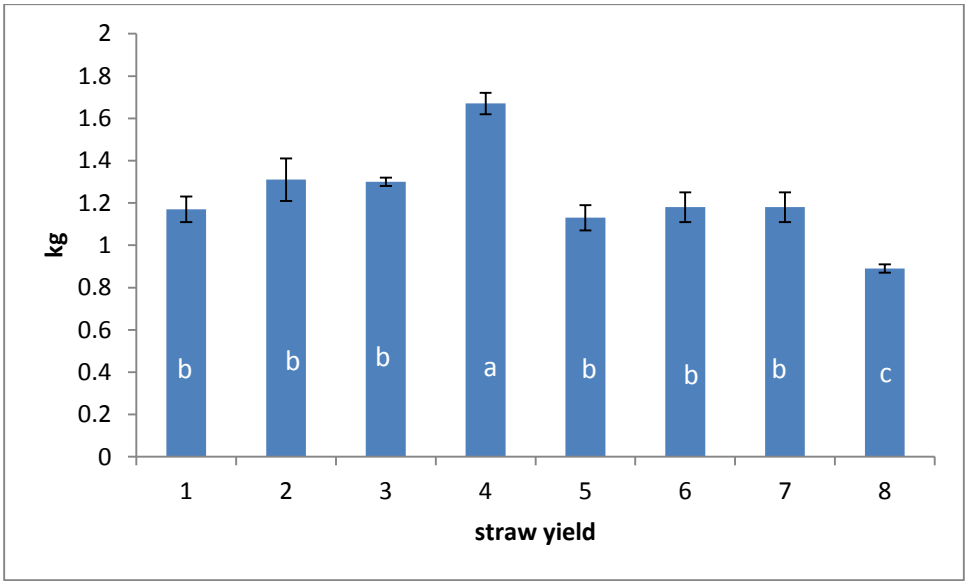

Fig 4.7 Effect of different nutrient sources on straw yield.

The present findings are in agreements with Ozturk *et al.*, (2010) who observed the significant effect N sources and dosages on the yield and quality traits of winter rapeseed. Three N sources such as ammonium sulfate, ammonium nitrate and urea were applied as hand broadcast on the soil surface at five dosages (0, 50, 100, 150, and 200 kg N hectare. There were significantly effects on seed yield, oil and protein content, and other yield components due to N sources and rates. In general, ammonium sulfate and urea gave higher seed yield than ammonium

nitrate they reported the importance of adequate N fertilization and true N source in seed yield in winter rapeseed and suggest that ammonium sulphate at 150 kg N per hectare will be about adequate to meet crop N requirements.

Oil content in seed

The data presented in Fig 4.8 revealed that at highest oil content was recorded under treatment T4 (UREA+SSP+MOP) followed by T3 (UREA+MOP) with the value of (39.35% and 37.84%) All treatments gave statistically not similar oil content present .However, treatment T4 (UREA+SSP+MOP) gave significantly higher oil content in comparison with other treatment. The lowest plant height was observed under absoluteT8 control.

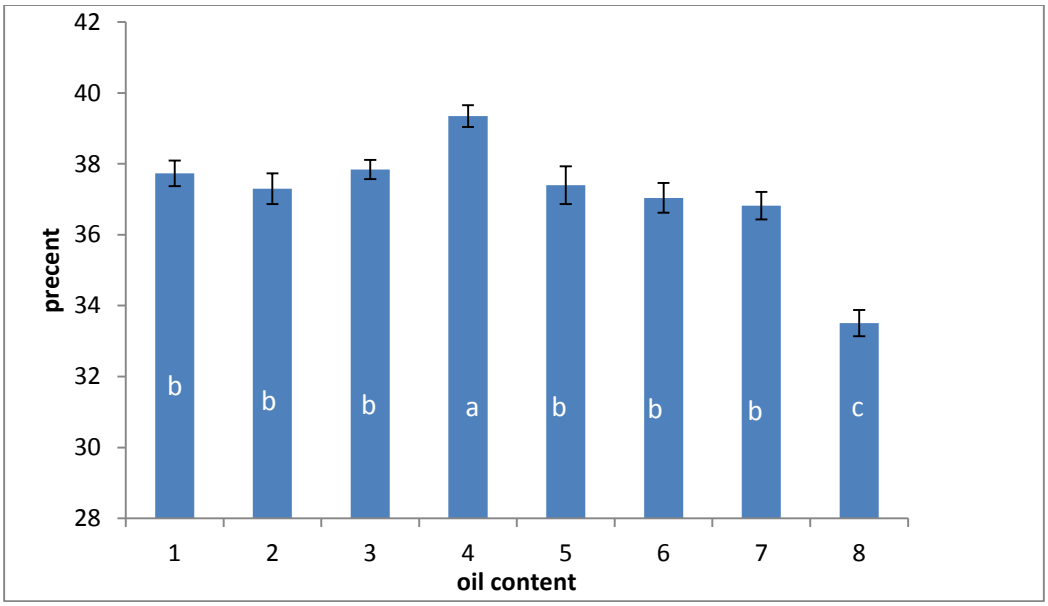

Fig 4.8 Effect of different nutrient sources on oil content.

The present observation on oil content in seed are in close conformity to the findings of Premi and Kumar (2004), who reported higher oil content with application 80 kg per hectare of P_2O_5 over control and 40 kg per hectare of P_2O_5 on clay loam soil testing medium in available phosphorus (18.2 kg P per hectare) at Bharatpur, Rajasthan. Similarly, Patel and Shelke (1998) recorded the significant increase in oil content by application of 80 kg per hectare of P_2O_5 over lower doses. Narits (2010) reported that nitrogen fertilization had positive effect on seed yield and seed protein content in mustard. On the other hand, nitrogen fertilization,

especially in higher rates, had negative effect on oil content. It was concluded that the quantity of the fertilizer had not as strong impact to seed yield and quality as fertilizer application time. The highest yields of seed and raw oil were obtained from the three split-N application (40+40+40) 120 kg per hectare

Mean reduction insect population after spray

Treatment	Before spray	Insect (after 2 day)	Insect(5days)	Insect(10days)
1	14.58±0.32	3.66±0.28	5.08±0.36	7.5±0.28
2	14.15±0.40	3.41±0.38	4.91±0.43	7.25±0.38
3	13.58±0.32	4.83±0.5	6.08±0.27	9.5±0.28
4	14.16±0.42	5.08±0.14	6.33±0.31	10.5±0.38
5	13.58±0.52	4.75±0.3	6.16±0.53	9.58±0.50
6	14.33±0.18	3.66±0.3	4.58±0.42	7.25±0.14
7	14.41±0.3	6.5±0.28	7.5±0.39	10.33±0.30
8	14.41±0.3	16±0.38	17.16±0.37	13.66±0.30

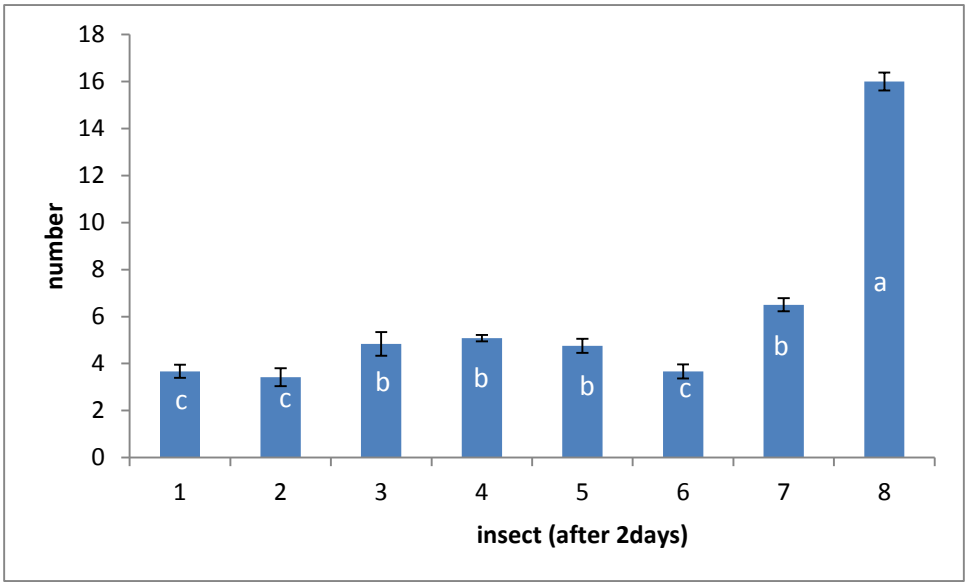

Fig 4.9 Mean reduction in aphid population 2 DAS

The data presented in Fig 4.9 revealed that at 2 day after spray , highest magnitude of increase insect number was registered under treatment T8 (control) However, a significant average insect number is recorded between 15 and 16. Hence there is more difference in other treatment and The treatment T1 (Imidaclorpid 30.5%SC), T2 (Thiamethoxam 25%WG) and T6 (Acetamiprid 20%SP) shows less insect as compare to other treatment. But the lowest insect number was observed under T2 (Thiamethoxam 25%WG).

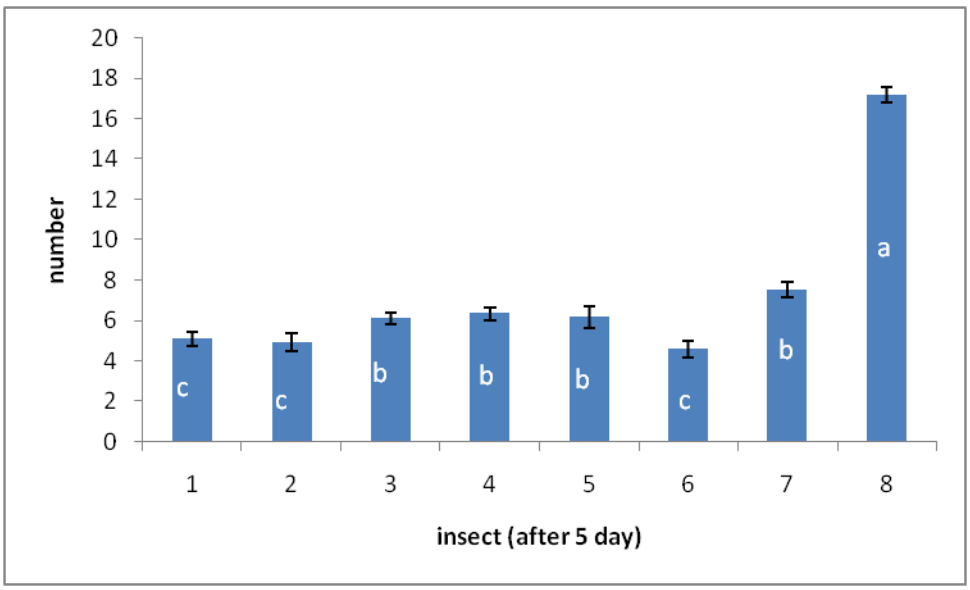

Fig 4.10 Mean reduction in aphid population 5 DAS

The data presented in Fig 4.10 revealed that at 5 day after spray different insecticides were evaluated for their bioefficacy against the aphid (nymph+adult) on mustard. Among the different insecticides Thiamethoxam resulted is the maximum reduction in population, highest magnitude of increase insect number was registered under treatment T8 (control) However, a significant average insect number was recorded between 17 and 18.The next best treatment again the aphid was observed in T1,T2 and T6. Similar result has been reported by Sahoo *et al.,* (2009) against the aphid and observed that Dimethoate 30EC and Oxydemeton-methyl 25EC were proved to be more effective.The plots treated with Dimethoate and Oxydemeton-methyl produced more yield ranging from 1151.6 to 1310.3 kg seed per hectare. The most favorable return was obtained under Dimethoate 30EC (1:20.8 & 1:13. 3) Followed by Oxydemeton-methyl 25EC (1:16. 8 & 1:9.1).

On the 10th day after spray (Fig 4.11) the maximum reduction was observed under T2 and found to be statistically at par with T1 and T6. The highest magnitude of increase insect number was registered under treatment T8 (control) However, a significant average insect number is recorded between 12 and 13. Hence there is more difference in other treatment and T1 (Imidaclorpid 30.5%SC), T2 (Thiamethoxam 25%WG) and T6 (Acetamiprid 20%SP) shows less insect as compare to other treatment. But the lowest insect number was observed under T2 (Thiamethoxam 25%WG).

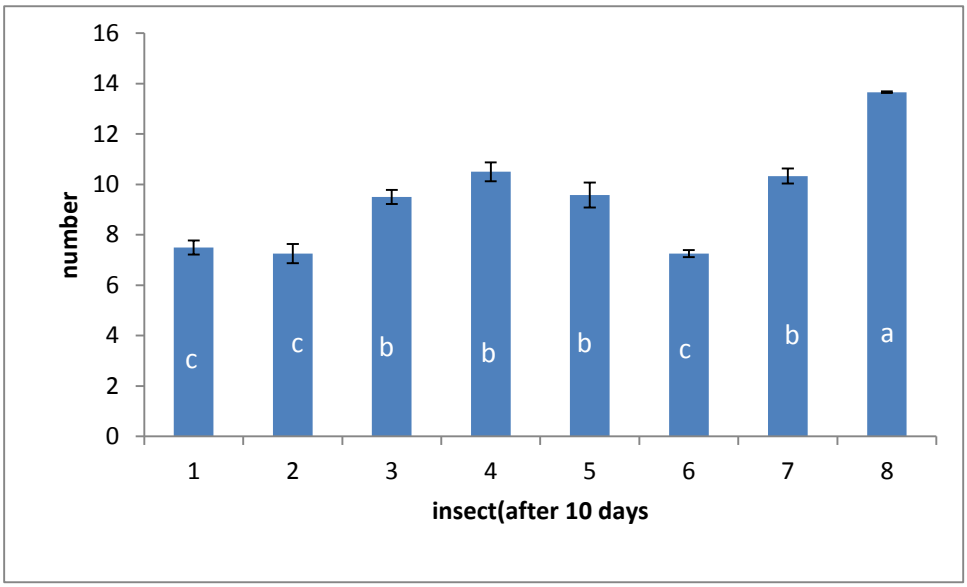

Fig 4.11 Mean reduction in aphid population 10 DAS

Effect of insecticides were evaluated and among them (Metasystox, Dimethion, and Fentro) and Razaq *et al.*, (2011) showed the effectiveness of Dimethion, Aktara (Thiamethoxam) against the aphid population that is in line to the present investigation.Shah *et al.*, (2008) observed that three insecticides Metasystox-R 25 EC, Dimethion 40 EC, and Fentro 50 EC has positive effect on the yield and yield attributing characters as well as oil content of mustard. The crop was sprayed with the insecticides twice after sowing at the rate of 0.05% and 0.025% and growth parameters; yield and oil content were observed. It was found that these three insecticides influenced on the various growth parameters and yield attributing character leading to much higher seed yield as compared to control. The yield of all the treatments was significantly better than the control. The response of Metasystox-R @ 0.05% was comparatively better for various growth parameters and yield of mustard. Oil content in seeds was found to be marginally decreased due to insecticide application, though the values were statistically significant.

Chapter V

SUMMARY AND CONCLUSION

The present study was conducted to investigate the "The effect of different sources of nutrient on production and pest infestation in mustard (*Brassica juncea* L.)". Perusal of the data from this study yielded in the following salient findings

1. The application of Urea 84.37gm + Sulphur 8.43 gm per plot showed significant influence on plant height and also it showed significant influence on leaf area in mustard.
2. In Urea 84.37gm + SSP70 gm per plot showed significant influence on plant height and also it showed significant influence on pod number and seed yield and quality parameter in mustard crop.
3. The application of Urea 84.37gm + MOP 2.5gm per plot caused a significant increase in the leaf area, plant height, pod length, number of pod per plant and yield in mustard crop.
4. Application of Urea 84.37gm + SSP 70gm+MOP 2.54gm per plot caused a significant increase in the plant height, pod length, number of pod per plant, seed yield, straw yield and oil content in mustard crop.
5. DAP 24.45gm +MOP 2.5 gm per plot showed a significant effect on plant height, pod length and number of pod per plant in mustard crops.
6. The application of DAP 24.45gm +Sulphur 8.43 gm per plot gave significant increase in pod length and pod number in mustard crops.
7. N:P:K mixture 0.93gm found to be significant effect on plant height and growth parameter in mustard crops.
8. The application of T1 (Imidaclorpid 30.5%SC), T2 (Thiamethoxam 25%WG) and T6 (Acetamiprid 20%SP) showed reduction in aphid population when compared to the other treatments.

Hence it is concluded that different nutrient sources effects on plant growth and yield**.** Therefore, the treatment T4 UREA 84.37gm + SSP 70gm+MOP 2.54gm per plot was found to be beneficial to mustard crop which result in the significant impact on growth, quality and yield of the mustard crop. The nitrogen gave the positive effect on growth parameter as compared to phosphorus and potash. Whereas phosphorus and potash have shown the significant effect on quality of mustard i.e. oil content of mustard crop and seed quality parameter and can be used to enhance its quality as well as quantity. For the management of aphid, the most proving insecticides were Imidaclorpid 30.5%SC, Thiamethoxam 25%WG and Acetamiprid 20%SP and can be used for the control of aphid population in mustard.

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Appendix