“Studies on Seasonal Incidence of key pests of Linseed and Management Strategies for Linseed bud fly, *Dasyneura lini* Barnes (Diptera :Cecidomyiidae) at Raipur.”

M.Sc. (Ag.) THESIS

by

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DEPARTMENT OF ENTOMOLOGY
COLLEGE OF AGRICULTURE
INDIRA GANDHI KRISHI VISHWAVIDYALAYA
RAIPUR (C. G.)

2008

"Studies on Seasonal Incidence of key pests of Linseed and Management Strategies for Linseed bud fly, *Dasyneura lini* Barnes (Diptera :Cecidomyiidae) at Raipur."

Thesis

Submitted to the

Indira Gandhi Krishi Vishwavidyalaya, Raipur

by

Syed Mohammed Ali Humayun

In Partial Fulfillment Of The Requirements For The Degree Of

Master of Science
In
Agriculture
(ENTOMOLOGY)

Roll No. 8517 **ID No. UG/AG/RYP/2001/82**

September, 2008

CERTIFICATE - I

This is to certify that the thesis entitled **"Studies on Seasonal Incidence of key pests of Linseed and Management Strategies for Linseed bud fly, *Dasyneura lini* Barnes (Diptera :Cecidomyiidae) at Raipur."** submitted in partial fulfillment of the requirements for the degree of "**MASTER OF SCIENCE IN AGRICULTURE"** of the Indira Gandhi Krishi Vishwavidyalaya, Raipur, is a record of the bonafide research work carried out by **SYED MOHAMMED ALI HUMAYUN** under my guidance and supervision. The subject of the thesis has been approved by student's Advisory Committee and the Director of Instructions.

No part of the thesis has been submitted for any other degree or diploma (certificate awarded etc.) or has been published/published part has been fully acknowledged. All the assistance and help received during the course of the investigations have been duly acknowledged by him.

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CERTIFICATE - II

This is to certify that the thesis entitled **"Studies on Seasonal Incidence of key pests of Linseed and Management Strategies for Linseed bud fly, *Dasyneura lini* Barnes (Diptera :Cecidomyiidae) at Raipur."** submitted by **SYED MOHAMMED ALI HUMAYUN** to the Indira Gandhi Krishi Vishwavidyalaya, Raipur in partial fulfillment of the requirements for the degree of **M.Sc. (Ag.)** in the **DEPARTMENT OF ENTOMOLOGY** has been approved by the external examiner and student's Advisory Committee after oral examination.

Date: **EXTERNAL EXAMINER**

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ACKNOWLEDGEMENT

I take this golden opportunity to express my heartfelt and deepest sense of gratitude to those who helped me to complete my research program. I start in the name of God who has bestowed upon me all the physical and mental attributes that I possess and skills to cut through and heal a fellow human.

With great reverence, I express my warmest feelings with deep sense of gratitude to my Advisor Dr.Rajeev Gupta, Professor, Department of Entomology, College of Agriculture, Raipur. I have no words to express my thanks to him for his illuminating guidance, unfailing encouragement, scholarly suggestions, unique supervision, constructive criticism, sympathetic attitude and keen interest during the course of this investigation and preparation of this manuscript. Moreover, I am highly indebted to him for his painstaking efforts in trying to install in me some important and useful character on personal level.

I am highly grateful to Dr.B.C. Shukla Head, Department of entomology and member of my advisory committee for providing excellent suggestion and faithful criticism during the period of investigation.

I extend my thanks to respected teachers Shri Avinash Gupta, Scientist, Department of Entomology, Dr. M. L. Lakhera Associate Professor, Department of Mathematics, Statistics and Computer Science and Shri S.K.Jha, Scientist, Deparment of Agronomy College of Agriculture, Raipur, Members of my advisory committee for their critical suggestions and regular encouragement during the course of this investigation.

I wish to record my sincere thanks to Dr.C.R. Hazra, Hon'ble Vice-Chancellor, Dr.A.S.R.A.S.Shastri, Director Research Services, Dr. S.S. Kohle Director of Instructions and Dr. B.S. Thakur, Dean of College of Agriculture, IGKV, Raipur for providing necessary facilities in successful conduction of this research work.

I am extremely thankful to Dr. S.K.Shrivastava, Dr. A. K. Dubey,. V.K. Koshta, Dr. H.K.Chandrakar, Dr. V. K. Dubey, Dr. R. N. Ganguly, Dr D. K. Rana , Dr. (Smt) J. Ganguly, Shri Navneet Rana and Mrs Sonali Deole for their ever remembering co- operation and comments. Thanks are due to Shri R.S. Yadav lab technician, Shri Dev narayan Chandrakar, Shri Hemchand Nayak and Shri K.L.sahu, R.P. Sahu and shri Domen Yadav for their, kind co.operation

I wish to extend my heartiest thanks to my brother Sajid, Zoeb, Fahad, Shoeb and friends Vivek, Usat, Ajit, Daaku, Ravi, Nripraj Sweta, Smita, Dipti, Anuradha, Payal, Simmi, Rachna, Padmesh, Rakesh, Vinod, Yogendra, janmejai, jaindra, Lakhan for their moral support and eveready helping nature of my juniors Jittu, Rajnikant, Raju, Devendra, Harsh, Neha, Sandeep, Ashutosh, for their encouragement and cooperation during the research programme.

Diclien is not enough to express my gratitude to my Beloved parents Mr. SYED MAHMOOD ATHAR (BABA) and Mrs. SHAHINA SYED (AMMI), whose selfless love, filial affection, obstinate sacrifices, sincere prayers, expectations and blessings have always been the motivation in my life. There is no substitute for the love and affection bestowed on me by my niece ASBAH

Above all, my humble and heartiest thanks to ALLAH for showering his unprecedented favour upon me.

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CHAPTER I

INTRODUCTION

Oilseed crops have been the backbone of agricultural economy of India from time immemorial. Oil is an important constituent of human food/diet. The Indian Council Of Medical Research (ICMR) has recommended an intake of digestible fats at the rate 20 grams per adult per day (7.3 kg/year). At this rate total oil requirement by 2020 A.D will be 10.495 million tones which can be extracted from 34.636 million tones of oilseeds on the assumption of 33 per cent recovery across all oilseeds (Hegde, 1999). The cultivated oilseeds comprise nine different crops, namely, groundnut, soybean, niger, rapeseed, mustard, sunflower, safflower and sesamum as edible oilseeds and castor and linseed as industrial oil crops (Mukherji *et. al*., 1999).

Linseed, *Linum usitatissimum* Linn is one of the most important industrial oilseed crops of India. It is grown either for oil extracted from seed or for fiber from stem. The seed contains oil ranging from 37 to 43 per cent. Linseed oil is extensively used in the industry for manufacture of paints, varnishes, lithographic ink and soaps. A very small fraction of it is used for edible purpose .The oil cake is a nutritious feed for milch cattle and is also used as manure. Now a days, a new form of linseed called **'linola'** has been specially bred to produce oil suitable for human consumption with fatty acid composition similar to the premium polyunsaturated oils such as sunflower, safflower and corn. Linseed stems yield fiber of good quality having strength and

durability. Fibers are lustrous and blend with wool, silk and cotton. The wood matter and short fibers may be used as raw pulp for making paper of high quality.

In India, linseed is cultivated in about 5.25 lakh hectares with total linseed production of 2.12 lakh tones and 403 kg/ha productivity. Besides Chhattisgarh, the other major linseed growing states are Madhya Pradesh, Maharashtra, Uttar Pradesh, Orissa and Bihar (Damodaran and Hegde, 2005).

Chhattisgarh is one of the important linseed growing states of India, which accounts for nearly 19.05 per cent area and 16.21 per cent production of the country. In Chhattisgarh, linseed is cultivated over 86 thousand hectare area with a production of 24.2 thousand tones and productivity of 281 kg/ha. It is a major crop grown as **'utera'** during Rabi season. The important linseed growing districts of Chhattisgarh are Rajnandgaon, Durg, Bilaspur, Kabirdham, Raipur, Dhamtari, Surguja, Kanker and Raigarh (Damodaran and Hegde, 2005).

Nearly 76 per cent of the oilseed area is rainfed, which is often subjected to vagaries of nature. The major constraints in its high productivity include the use of local varieties prone to insect pests and diseases under input starvation conditions on marginal and sub marginal land. Linseed crop is attacked by a number of insect pests at various phases of its growth. Linseed bud fly, (*Dasyneura lini* Barnes) with 88 per cent grain yield losses, is a key pest of this crop followed by semilooper (*Plusia orichalsia* Fab), thrips (*Caliothrips indicus* Bagnall) and linseed caterpillar (*Spodoptera exigua* Hub) (Mukherji *et.al*.,1999 and Malik *et .al*., 2000).

Adult of Linseed bud fly is a small orange coloured fly. Its tiny pinkish maggots feed on the developing buds, destroy the flower buds and thus prevent the pod formation. The infested buds become hollow and can be easily distinguished from the healthy buds. (Fig. 1.1 to 1.7)

The nymphs and adults of thrips, *Caliothrips indicus* Bangall cause damage to the plants by sucking sap from the leaves. The surface of the leaf tissue is lacerated deeply and suck up the oozing out sap which result in the formation of white streaks on the leaves. (Fig. 1.8)

The nymphs and adults of jassids, *Amrasca* sp suck the sap from the leaves. These insects produce toxins in leaf tissues, due to which yellowing of leaves takes place. (Fig. 1.9)

The larvae of linseed caterpillar , *Spodoptera exigua* Hub bore into the capsule and feed on its entire material. Seed formation does not take place in the infested capsules. (Fig. 1.10)

The semilooper, *Plusia orichalsia* Fab larvae feed on the leaves and cause 6.60 to16.70 per cent damage to the crop by defoliation (Mukherji *et. al*., 1999). (Fig. 1.11)

The larvae of Gram pod borer *Heliothis armigera* cause damage to linseed crop by feeding on the leaves. The earlyinstars scrap the chlorophyll of leaves while the later instars feed on the whole leaves, in case of seviour infestation the whole plant is defoliated. (Fig. 1.12)

The nymphs and adults of green stink bug, *Nezara viridula* suck the sap from aerial parts resulting in yellowing of the crop. In case of severe infestation, the crop appeared wilted and ultimately dry up. (Fig. 1.13)

The concept of integrated pest management is very encouraging as it provides an appropriate alternative control measure to the pest problem which is caused due to widespread introduction of monogenic resistant cultivars, killing of natural enemies, resistance problem among insects to insecticides, residue hazards of pesticides, upsetting of pest balance in nature and also due to abandonement of cultural control.

The need to phase out the use of chemical pesticides is now being felt and the use of plant products, bio-control agents, cultural and mechanical methods of plant protection are catching momentum of late.

Need based application of any insecticide for management of an insect pest in an IPM programme requires prior knowledge of damaging threshold levels of pest population and vulnerable stage of the crop. Linseed bud fly (*Dasyneura lini* Barnes) is a key pest of linseed during flowering stage of the crop. Information on economic threshold level (ETL) for bud fly in linseed is lacking for timely application of insecticides for proper pest management. It was, therefore, felt need of the hour to estimate the ETL for bud fly in linseed for effective and economical control measures which fitted well in IPM programme (Malik, 2005).

Among different copmponents of IPM programme, development of resistant cultivars to bud fly and other insect pests should be given top most priority. The resistant or tolerant cultivars are safer to natural enemies and ultimately to the whole ecosystem. The first step in developing resistant cultivars is to identify the sources of insect pest resistance and even disease resistance by screening germplasm from various locations. Some varieties of Linseed crop have been reported possessing moderate to high level of resistance against linseed bud fly (Singh et al., 1990).

The overall idea of IPM programme is either to minimize the use of chemical pesticides for pest control or to develop zero chemical pesticide strategy. It is imperative that effective formulations of neem are developed for controlling insect pests and diseases of agricultural crops (Shrivastava, 2001).

Studies on pest succession of any crop are essential as these provide information on the status of various insect pests and their natural enemy fauna and also help in identifying the vulnerable stage of the crop. This information helps in

developing an efficient management model for the insect pests attacking at various growth stages of the crop.

In keeping the above points in mind, the studies were conducted with the following objectives :

1. Seasonal incidence of key insect pests of Linseed and their natural enemies.
2. Screening of different entries of Linseed against *Dasyneura lini*.
3. Role of flowering period in Linseed resistance to *Dasyneura lini*.
4. Efficacy of neem plant products against *Dasyneura lini* on Linseed
5. Effect of neem plant products on oil content and test weight of Linseed
6. Determination of Economic Threshold Level of *Dasyneura lini*.

Chapter-II

REVIEW OF LITERATURE

The literature available from Chhattisgarh, India and abroad pertaining to different aspects of the present investigation has been grouped under the following heads :

2.1 Seasonal incidence of key insect pests of Linseed and their natural enemies

Ferguson and Fitt (1991) reported *Thrips angusticeps, Aphtoma euphorbiae* and mirid bug as the potential pests of linseed crop in U.K. *Thrips angusticeps* caused 14 per cent yield losses.

Desmukh *et al.* (1992) observed *Agrotis ypsilon* as a potential pest during vegetative phase and *D. lini*, *H. armigera* and mites, *Peterobia latens* and *Byrabia* spp. as menacing pests during reproductive phase of the crop. *Phytomyza horticola* was observed on the crop from vegetative to reproductive phase.

The bud fly, *Dasyneura lini* Barnes caused major damage to the linseed crop. The extent of damage has been estimated to be 80 per cent (Gupta, 1995).

The intensity of infestation was initially one to two larvae per bud in last week of January. Maximum number of larvae (16-25 larvae/bud) were recorded during last week of February and middle of March (Singh *et. al.,* 1998).

Eleven insect pests and four natural enemies occurred in an overlapping manner in which *Caliothrips indicus* and *D. lini* were the major pests, attacking at the vegetative and reproductive phases of the crop at Raipur (Sahu,1999).

Out of eleven insect pests, *Dasyneura lini* Barnes appeared as key pest of linseed at Ranchi followed by capsule borer, *Spodoptera exigua* which fed on green capsules. (Prasad and Prasad , 2004).

Out of several insect pests recorded on linseed, *Empoasca kerri*, *Bemisia tabaci*, *Nezara viridula*, *Helicoverpa armigera*,*Spodoptera litura*, *Agrotis ypsilon*, and *Spilosoma obliqua*, *Dasyneura lini* and *Caliothrips indicus* were the major pests, whereas, *E. kerri* and *H. armigera* showed moderate pest status and other species were considered as minor pests in Assam. (Borah *et. al.*, 2005).

Caliothrips indicus, *Dasyneura lini* and *Spodoptera exigua* emerged as key pests attacking the linseed crop at different growth stages at Raipur. Lady bird beetle, *Menochilus sexmaculata* and *Coccinella septumpunctata* preyed upon thrips, white flies and aphid, whereas, *Systecis desineuri* was observed as a parasitoid on bud fly maggot. (Patel and Thakur, 2005).

Out of seven insect species causing damage at various stages of linseed crop, *Caliothrips indicus* and *Dasyneura lini* were categorized as the major pests. Preying upon these pests were two species of lady bird beetle, *Coccinella septumpunctata* and *Menochilus sexmaculata* and a predatory spider, *Lynx* sp. A significantly positive correlation existed between thrips and lady bird beetles. (Mamtarani, 2007).

2.2 Effect of Ambient Weather on Population Dynamics

Temperature and morning relative humidity were positively correlated with maggot population of linseed bud fly on variety Neelum at Jabalpur (Shrivastava *et.al*.,1994).

Bud fly infestation was positively correlated with temperature and negatively correlated with relative humidity during 1985 - 86 and 1986 - 87 (Singh *et.al.*, 1998).

Maximum bud fly multiplication occurred at temperature between 16-20 ^{0}C and 60-70 per cent relative humidity from January end to early march (Mukherji *et.al.* 1999).

Temperature had significantly positive effect on bud fly infestation, while relative humidity played a negative role. Temperature 17-20 ^{0}C (Maximum 23 -28 ^{0}C and minimum 9 -12 ^{0}C) and relative humidity 60-70 percent (morning 65 -75 and evening 57 - 65 per cent) were congenial for pest multiplication at Kanpur. (Malik *et.al*. ,2000).

Maximum temperature of 28.1^{0}C and minimum temperature of 12^{0}C were congenial for pest multiplication at Raipur. Minimum temperature and bud fly maggot population was significantly negatively correlated with "r" =(-) 0.655 at 5 per cent level (Patel and Thakur,2005).

The bud damage due to bud fly was significantly positively correlated with maximum and minimum temperatures having (r) values 0.7288 and 0.8050, respectively. Multiple correlation studies also revealed a significantly positive relationship between different weather parameters and bud fly damage with R value 0.9431. (Mamtarani, 2007).

2.3.Screening of different entries of Linseed against *Dasyneura lini*.

Sood (1978) screened different linseed varieties at Jabalpur and found minimum bud fly infestation in variety JLS (J)-1 which was significantly less infested than the varieties R-158, R-339, R-575, R-110 and R-552 but was at par with the other varieties like R-17, R-440 and R-229. Maximum bud infestation of 36.99 per cent was found in variety r-552.

Malik *et al.* (2000) screened thirty varieties of linseed against linseed bud fly in a field trial at Kanpur. Among the varieties tested, Jawahar-1 had significantly minimum 14.34 per cent bud infestation followed by Neela 16.60 per cent and were rated as moderately resistant varieties. Gaurav, Shubhra, Garima, Flake-1, Chambal, Jeevan, Surbhi, Shikha, Shweta, Lakhmi-27 and T-397 were categorized as moderately susceptible and variety Neelum was highly susceptible to bud fly

2.4 Role of flowering period in Linseed resistance to *Dasyneura lini*.

Sood and Pathak (1983) observed 107 linseed varieties for the extent of infestation by *D. lini*. and found that the varieties with longer flowering duration were more susceptible to bud fly attack as compared to those with shorter flowering duration.

Field trials were carried out in India in 1971-72, 1972-73 and 1973-74 to determine the susceptibility of 108 cultivars of linseed to the attack by *Dasyneura lini* Barnes. In 1971-72, only nine cultivars had less than 10% bud infestation; the lowest rate (2.90%) was observed in Bangal-15, followed by 4.40% in Bangal-6 and 5.50% in JLS. J-1, as compared with 75.80% in E.C. 41585 and E.C. 22586, the most susceptible cultivars. During the last two years of the study, the least susceptible cultivars, with less than 10% bud infestation, were JLS. J-1, Bangal-17, R-17 and K.P.4, while the exotic E.C. 22586 and E.C. 22568 were most susceptible, with more than 50% infestation. Delay of the flowering period and its duration were positively correlated with infestation by *D. lini*. (Jakhmola and Yadav, 1983).

Malik *et al.* (1991) screened 102 varieties of linseed against bud fly infestation at Kanpur, India. The blooming duration was found positively correlated with the bud fly infestation. The varieties having longer blooming period were severely infested by bud fly as compared to those with shorter blooming period.

2.5 Efficacy of neem based formulations against *Dasyneura lini* on Linseed

Malik *et.al.* (1996) evaluated ethyl alcohol extracts of various parts of seven plants with four insecticides against *D. lini* on linseed cv Neelum at Kanpur. Plant extracts of sweet flag (1.0%) received significantly low (11.70%) bud infestation at harvest with a higher yield of 12.30 q/ha followed by neem 1.0 per cent having 12.75 per cent bud infestation and 11.80 q/ha yield . Decamethrin (0.02%) having 6.65 percent bud infestation and 15.10 q/ha yield was most effective among the treatments.

Gupta *et. al*. (2000) evaluated neem plant products against the infestation of bud fly on linseed for three consecutive years at Tikamgarh, M.P. The maggot infestation and capsule damage were minimum in phosphamidon 0.04 per cent followed closely by neem oil 1.0 per cent and neem oil 0.5 per cent . Grain yield increased significantly in all the neem products and phosphamidon.

Ali *et.al.* (2002) evaluated the bioefficacy of neem products and phosphamidon (0.05%) against linseed bud fly (*D. lini*.Barnes) at Faizabad. Out of seven neem based insecticides, nimbecidine 2%, NSKE 2%, neemazol 2% ,rakshak 2%, achook 2%, neemgold 2% and neemol 2% , none was superior to phosphamidon and endosulphan but NSKE and nimbecidine were found better.

Neem based insecticides proved to be significantly effective in reducing the incidence of *D. lini* and *H. armigera* infesting linseed and enhancing the seed yield at Ranchi. Achook (1%) when applied twice was most effective with lowest bud damage (14.6 %) and minimum capsule damage (10.6 %). Maximum bud infestation (40 %) and capsule damage (16.86%) and lowest yield (405.60q/ha) were obtained in untreated crop. (Prasad, 2003).

Significantly minimum bud damage by bud fly (6.48 per cent) and capsule borer (1.96 per cent) were obtained on the crop sprayed 5 times at 10 days interval with NSKE 5 per cent and gave maximum seed yield (1288.06 kg/ha) at Ranchi. (Prasad and Prasad, 2003).

Studies on the efficiency of neem products against bud fly infestation on linseed during three consecutive rabi seasons indicated that the incidence of bud fly decreased and seed yield increased with increase in concentration of neem leaf extract, neem seed kernel extract and neem oil (Gupta and Rawat, 2004).

2.6 Effect of neem based formulations on oil content and test weight of Linseed.

Mamtarani (2007) conducted a trial with linseed variety Neelum to see the effect of different Neem plant products on oil content and test weight of linseed, but there was no significant effect of any treatment on test weight and oil content of linseed grains.

2.7 Determination of Economic Threshold Level of *Dasyneura lini*.

Pedigo (1991) suggested that economic threshold level of linseed bud fly can be calculated as 75 per cent below economic injury level**.**

Malik *et. al.* (1996a) assessed the economic threshold level of linseed bud fly on variety Neelum at Kanpur. Increase in bud infestation resulted in increased yield losses. The ETL of bud fly were determined as 2.0, 4.5 and 7.0 per cent and EIL of 2.67, 5.90 and 8.65 per cent, respectively, with two fortnightly applications of phosphamidon , decamethrin and chlorpyriphos.

Malik (1999) determined the economic threshold of 10.50 and 11.90 per cent for linseed bud fly during 1995-96 and 1996-97 with mean value of 11.20 per cent bud infestation.

Malik *et. al.* (2000) determined the economic injury level of 13.66 and 10.50 per cent during 1994-95 and 1995-96, respectively with mean value of 12.08 per cent bud infestation at Kanpur.

Malik (2005) determined the threshold level of linseed bud fly on variety Neelam during 1998 to 2002 at Kanpur. Linseed yield was reduced by 26.4 kg/ ha with every percent increase in bud fly infestation. The avoidable yield losses due to this pest were estimated up to 41.7 per cent. The EIL for the study period was determined as 12.6, 9.5, 10.5 and 11.0 per cent, while the ETL for these values were 9.7, 7.1, 8.1 and 8.3 percent bud infestation, respectively.

CHAPTER III

MATERIALS AND METHODS

The present investigation entitled **"Studies on Seasonal Incidence of key pests of Linseed and Management Strategies for Linseed bud fly, *Dasyneura lini* Barnes (Diptera :Cecidomyiidae) at Raipur."** was conducted during Rabi season of 2007-08 at Oilseed Research Area, IGKV, Raipur (C.G.).

The present investigation was under taken with the following objectives:

1. Seasonal incidence of key insect pests of Linseed and their natural enemies.
2. Screening of different entries of Linseed against *Dasyneura lini*.
3. Role of flowering period in Linseed resistance to *Dasyneura lini*.
4. Efficacy of neem plant products against *Dasyneura lini* on Linseed
5. Effect of neem plant products on oil content and test weight of Linseed
6. Determination of Economic Threshold Level of *Dasyneura lini*.

Geographical Location

Raipur is situated in central east part of Chhattisgarh at $21^0$16' North latitude, $81^0$3' East longitude and 289.56 meters above mean sea level.

Climate

Raipur comes under dry moist, sub humid region. It has a seasonal rainfall of 1325 mm. Nearly 85 per cent of the annual rainfall is received from 3rd week of June to 2nd week of September. The weather conditions during the crop growth period are given in table 3.1 and fig 3.1

3.1 Seasonal incidence of key insect pests of Linseed and their natural enemies.

Insect pest complex of Linseed was observed on variety Neelum which was sown on 27th November 2007, having spacing of 30x10 cm. Incidence of different insect pests and their natural enemies was recorded at weekly interval on randomly selected 25 plants. During the whole cropping season *i.e*. from December to March, the bud fly infestation was recorded weekly by counting the total number of buds and the number of buds infested by bud fly. The population of thrips and jassids was counted by shaking the plant on white card sheet. Similarly, the incidence of other minor insect pests – linseed caterpillar, semilooper, gram pod borer and green stink bug and major predators like coccinellid beetle and spider were also observed.

The pest succession of major insect pests of Linseed was co- related with weather parameters to observe the effect of individual parameter on pest incidence. Similarly, the correlation between the density of pests and that of natural enemies was worked out to assess the biotic potential of the latter against the major pests. Where 'r' was found significant, linear regression equation $y = a \pm bx$ was worked out.

Here, y = Dependent variable

a = Constant

b = Regression coefficient , and

x = Independent variable.

To observe the combined effect of weather on seasonal incidence, multiple correlation studies were carried out between different weather parameters and incidence of bud fly and thrips infestation, taking insect population as dependent factor and weather parameters, such as, temperature, relative humidity and sunshine hours as independent factors.

3.2 Screening of different entries of Linseed against *Dasyneura lini*.

A screening trial consisting of 70 entries/varieties (Table 3.2 and Fig. 3.2) of Linseed was sown on 27th November, 2007 for bud fly resistance. Each entry was sown in two rows 30 cm apart. Susceptible check Neelum and resistant check Neela were sown after every 10 entries. Single line of variety Neelum was sown as infester row in between the path and around the field. Observation of Linseed bud fly damage was recorded at dough stage on randomly selected ten plants from each entry by counting the number of capsules and number of damaged buds.

$$\text{Percentage of bud fly infestation} = \frac{\text{Number of infested buds}}{\text{Number of capsules + infested buds}} \times 100$$

The cultivars were grouped in to highly resistant, resistant, moderately resistant and susceptible on the basis of bud fly infestation index. (B.I.I) (Patel, 1996) as depicted in table 3.3.

Table 3.3 :Grouping of linseed entries based on Bud fly Infestation Index (B.I.I)

% Infestation	B.I.I
0-5	Highly resistant
5.1-10	Resistant
10.1-20	Moderately resistant
More than 20	Susceptible

3.3 Role of flowering period in Linseed resistance to *Dasyneura lini*.

Thirty breeding materials/varieties (Table3. 4) were sown on 27th November, 2007. Each entry was grown in two rows with all recommended cultural practices

except pesticidal application. Days to 50 per cent flowering were observed in each entry and bud fly infestation was recorded at dough stage on ten randomly selected plants in each entry/variety.

Table 3.4: Linseed varieties/entries screened against bud fly to observe the effect of days to 50% flowering on bud fly resistance.

S. No.	Germplasm/Variety	S. No	Germplasm/Variety
1	LC-2279	16	JLT-204
2	LMS-149-4	17	NEELA (RC)
3	NDL-2004-05	18	NL-119
4	OLC-10	19	RLC-95
5	RLC-96	20	SLS-66
6	PKDL-65	21	R-552
7	RLC-114	22	RLC-106
8	JLS-9	23	KIRAN
9	LC-54	24	RLC-92
10	NL-97	25	RLC-76
11	PADMINI	26	PARVATI
12	SHEKHAR	27	KIRAN
13	T-397	28	RLC-106
14	J-23	29	R-17
15	RLC-106	30	R-7

Correlation study was worked out between the two variables (Bud fly infestation as dependent factor and days to 50 % flowering as independent factor).

3.4. Efficacy of neem based formulations against *Dasyneura lini* on Linseed.

To evaluate the efficacy of neem based formulations against *D. lini*, Linseed cv Neelum was sown on 27th November, 2007 in randomized block design with ten treatments replicated three times (Table 3.5 and Fig. 3.3). Insecticidal treatments were applied twice at fortnightly interval starting from bud initiation stage. Bud fly infestation was recorded at dough stage of the crop on randomly selected ten plants/ plot. The data on per cent bud infestation recorded were transformed to arc sine. Net plot yield was recorded at harvest which was converted to kg per hectare. The data on

bud fly infestation and yield was subjected to statistical analysis for critical differences. Economics of different treatments were also worked out.

Table 3.5: Neem based formulations tested against *Dasyneura lini* on Linseed.

S. No	Name of Treatment	S. No	Name of Treatment
1	Neem leaf extract 2%	6	Neem seed extract 5 %
2	Neem leaf extract 5%	7	Neem seed coat extract 2%
3	NSKE 2%	8	Neem seed coat extract 5%
4	NSKE 5%	9	Nimbolin 0.5%
5	Neem seed extract 2%		

Preparation of formulations :

1. Neem leaf extract- Extracted the pure juice of fresh Neem leaves by crushing and squeezing them.
2. Neem Seed Kernal Extract- Neem seed kernals were soaked in water on weight by weight basis before 72 hours of applying.
3. Neem seed extract- Whole Neem seeds were soaked in water on weight by weight basis before 72 hours of applying.
4. Neem seed coat extract- Only Neem seed coat was soaked in water on weight by weight basis before 72 hours of applying.

Neem leaf extract, Neem seed kernal extract, Neem seed extract and Neem seed coat extract were filtered with the help of fine muslin cloth before spraying. The filterate was treated as the mother solution.

3.5. Effect of neem based formulations on oil content and test weight of Linseed.

The effect of nine neem formulations tested against bud fly in the previous experiment was observed on the oil content and test weight of Linseed.

Oil content –

To estimate the oil content, the seed yield of all the three replications of each treatment was mixed and six samples of 15 gm each were taken. Oil content was estimated with the help of Nuclear Molecular Resonance machine. (Fig. 3.4)

Test Weight :-

To observe the effect of different neem formulations on test weight of linseed variety Neelum, 1000 grains from all the treatments were counted and weighed with the help of electronic weighing machine. The process was repeated six times.

The data on oil content and test weight in different treatments were subjected to statistical analysis for their critical differences.

3.6 Determination of Economic Threshold Level of *Dasyneura lini*. (Fig. 3.5)

A field experiment was laid out in randomized bock design with seven treatments including untreated control replicated three times. Linseed cv Neelum was sown on 27th November, 2007 in plot size 4x2.5m. Seven exposure periods of bud fly infestation were maintained by spraying Dimethoate 30 EC @ 0.04% from one to six times at weekly interval starting from bud initiation stage. Bud fly infestation was recorded at dough stage of the crop on randomly selected ten plants/ plot. Net plot yield was recorded at harvest, which was converted to kg per hectare. Economic

injury level of bud fly infestation was determined as per the methodology suggested by Stone and Pedigo (1972).

$$\text{1. Percentage of bud fly infestation} = \frac{\text{Number of infested buds}}{\text{Number of healthy + infested buds capsules}} \times 100$$

2. Linear regression model – "$y = a \pm bx$" for yield / infestation relationship

Here,

y = Yield of linseed in kg/ha

a = Constant

b = Regression coefficient, and

x = Percentage of bud infestation

$$\text{Gain threshold} = \frac{\text{Cost of Plant Protection (Rs/ha)}}{\text{Price of Produce (Rs/Kg)}}$$

$$\text{Calculated EIL} = \frac{\text{Gain threshold}}{\text{Regression coefficient}}$$

$$\text{Actual EIL} = \text{Calculated EIL} + \text{Unavoidable lossess}$$

Economic Threshold Level of linseed bud fly was calculated as suggested by Pedigo (1991).

CHAPTER IV

RESULTS AND DISCUSSION

The present investigation entitled **"Studies on Seasonal Incidence of key pests of Linseed and Management Strategies for Linseed bud fly, *Dasyneura lini* Barnes (Diptera :Cecidomyiidae) at Raipur."** was conducted during Rabi season of 2007-08 at Oilseed Research Area, IGKV, Raipur (C.G.).

The present investigation was under taken with the following objectives :

1. Seasonal incidence of key insect pests of Linseed and their natural enemies.
2. Screening of different entries of Linseed against *Dasyneura lini*.
3. Role of flowering period in Linseed resistance to *Dasyneura lini*.
4. Efficacy of neem based formulations against *Dasyneura lini* on Linseed
5. Effect of neem based formulations on oil content and test weight of Linseed.
6. Determination of Economic Threshold Level of *Dasyneura lini*.

4.1 Seasonal incidence of key insect pests of Linseed and their natural enemies

The studies on the seasonal incidence of key pests of linseed crop on variety Neelum, revealed that the occurrence of insect pest complex commenced from 45 days of sowing. Observations on pest incidence *i. e.* population of each insect was recorded on randomly selected 25 plants at weekly interval. Besides the insect pests, associated natural enemies were also recorded on the crop.During the course of study, seven insect species, viz, linseed bud fly, thrips, jassids, linseed caterpillar, semilooper, gram pod borer and green stink bug were noticed causing damage at various growth stages of linseed crop. Among these, linseed bud fly and thrips were of major importance

(Table 4.1). Among the predators two species of coccinellid beetles and a predatory spider were mainly observed preying on them.

4.1.1 Pest Succession studies (Table 4.2)

Linseed Bud Fly, *Dasyneura lini* Barnes

The bud fly was recorded as the major insect pest of linseed. The incidence of *D. lini* was first recorded on the crop with the formation of buds in the first week of February with 1.90 per cent bud damage. It remained active throughout the cropping period on linseed. From first week of February, the activity of bud fly increased gradually with peak density of the bud fly in the fourth week of March recording 34.10 per cent bud damage with a seasonal mean of 22.86 per cent.

Thrips, *Caliothrips indicus*

Thrips was second most important insect pests of linseed. It made its first appearance on vegetative stage of the crop in the last week of December with a mean population of 2.28 thrips per plant .The pest density increased gradually and first peak of thrips population, 15.50 thrips per plant, was observed in the last week of January. In the first week of February there was a slight decline in the pest activity. A second peak of 39.03 thrips per plant was recorded in second week of February with a seasonal mean of 13.70 thrips per plant. Thereafter, there was a downward trend in the thrips density. There was a sharp decline in the thrips activity in the second week of March and the insect completely disappeared from the crop after the fourth week of March as the crop approached maturity. The average thrips population per plant varied from 1.9 to 39.03 during the cropping period.

Jassids, *Amrasca sp*

The infestation by jassids was first recorded on linseed crop during the last week of December with 0.34 jassid per plant. It remained active on variety Neelum throughout the cropping season. Although the pest pressure was low which ranged from 0.06 to 0.46 jassid per plant with a seasonal mean of 0.28 jassid per plant. The pest disappeared completely from the crop during the third week of March as the crop approached maturity.

Linseed Caterpillar, *Spodoptera exigua*

The incidence of linseed caterpillar started in the second week of January with 0.05 larva per plant. Its activity was confined to next six weeks *i.e.*upto last week of February. It was observed in traces and its population ranged from 0.03 to 0.16 larva per plant (seasonal mean : 0.08 larva/plant).

Semilooper, *Plusia orichalsia*

Semilooper was first observed on linseed crop in the first week of January with 0.06 larva per plant and remained static till the second week of January. There was a slight decline in the pest density in the third week of January with 0.03 larva per plant. The pest finally disappeared from the crop after the first week of February (seasonal mean : 0.04 larva/plant).

Gram Pod Borer, *Heliothis armigera*

Gram pod borer made its first appearance on the crop in the last week of February with 0.03 larva per plant. There was a gradual increase in the pest activity from the second week of February with peak density of 0.1 larva/plant in the third

week of February and a seasonal mean of 0.05 larva per plant. Thereafter, there was an abrupt decline in the pest population and the insect disappeared from the crop after the last week of February.

Green Stink Bug, *Nezara viridula*

The incidence of green stink bug started from the second week of February. Its activity was confined only till the last week of February. The pest infestation ranged from 0.04 nymph per plant in the first week to 0.10 nymph per plant in the third week of February with a seasonal mean of 0.04 nymph per plant.

Based on pest succession studies on linseed variety Neelum, bud fly and thrips were categorized as the major pests out of the seven insect species recorded . Sahu (1999) observed eleven insects on linseed in which thrips and bud fly were the major ones attacking at the vegetative and reproductive stages of the crop. Patel and Thakur (2005) also recorded thrips, bud fly and linseed caterpillar as key pests among nine insect pests recorded at various growth stages of the crop at Raipur.

Gupta (1995) and Prasad and Prasad (2004) recorded *D. lini* as the major pest causing upto 80 per cent damage at Ranchi. On the other hand, Ferguson and Fitt (1991) recorded thrips as the major pest of linseed in U.K.

Borah et.al. (2005) observed jassids and gram pod borer as moderate pests of linseed in Assam, whereas, Deshmukh *et. al.* (1992) recorded *A. ypsilon* as the potential pest during the vegetative stage and *D. lini* as menacing pest at the reproductive stage of the crop .

Peak activity of thrips with 39.03 thrips/plant was observed during second week of February on variety Neelum in the present studies, whereas, Patel and Thakur (2005) recorded peak population of only 7.76 thrips per plant during the same period

on variety Neelum at Raipur. They recorded maximum of 2.88 maggots per bud during second week of February, whereas, in the present studies peak activity of linseed bud fly was observed in the last week of March with bud damage of 34.10 per cent.

Singh *et. al*. (1998) recorded peak activity of bud fly from February end to mid March with maximum of 16 to 25 maggots/ bud. In the present studies, the major active period of bud fly activity was also observed between last week of February and fourth week of March when bud damage ranged from 25.74 to 34.10 per cent. Mamtarani (2007) recorded peak activity of linseed bud fly (45.92 % bud damage) in the third week of March.

4.1.2 Predatory Fauna of Linseed Pests (Table 4.2 & 4.3)

Linseed is mainly attacked by bud fly, thrips and jassids at different growth stages of the crop. To assess the potential of biological control of these insects on linseed, a study was under taken during Rabi, 2007-08. It revealed following predatory fauna on these insects:

Lady Bird Beetle (Fig. 4.1)

Two species of lady bird beetle, *Menochilus sexmaculata* and *Coccinella septumpunctata* were recorded as major bio-agents. They made their first appearance on the crop in the third week of January with 0.02 grub / adult per plant. They were observed feeding on the nymphs and adults of thrips and jassids. Their activity continued till the third week of March. Peak activity of the predatory beetles was observed in the first fortnight of February with 1.85 to1.87 grubs / adults per plant with a seasonal mean of 0.83 beetle per plant.

Spider (Fig. 4.2)

Besides the lady bird beetles, a predatory spider, *Lynx* sp. was found preying upon thrips and jassids. The spider made its first appearance on the crop in the first week of January with the appearance of its hosts on the crop. It was active throughout the growth period of the crop to a greater or lesser extent till third week of March. Its population ranged from 0.03 to 1.60 with a mean of 0.72 spider per plant. The spider disappeared from the crop in the last week of March with the disappearance of its hosts.

Other predators (Fig. 4.3& 4.4)

Besides the above predators, Rove beetle, *Paederus* sp**.** and lace wings, *Chrysoperla carnea* were observed feeding on early larval instars of semilooper, thrips and jassid. They were active during the months of January and February. However, their population was negligible.

In the present investigation, four predators were observed preying upon different insects on linseed. Lady bird beetle, *M. sexmaculata* and *C. septumpunctata* were observed as major bio- agents against thrips and jassids, whereas, a predatory spider, *Lynx* sp. was also noticed feeding on them. Similar observations were recorded by Patel and Thakur (2005) and Mamtarani (2007). The latter also observed Rove beetle, *Paederus sp*. and lace wings, *Chrysoperla carnea* preying upon larval instars of semilooper, thrips and jassids.

Correlation Studies (Table 4.4 & Fig. 4.5)

To observe the effect of predator population on the activity of the pests, the population of thrips and jassids was co-related with lady bird beetle and spider

population. It revealed a significantly positive relationship between thrips and lady bird beetle , thrips and spider and jassids and spider population with correlation coefficient values (r) of 0.76, 0.82 and 0.45, respectively. Mamtarani (2007) also reported similar findings.

Regression equation of thrips for Coccinellid beetles (Fig. 4.6)

$y = a \pm bx$

y = Dependent variable / thrips population

a = constant

b = regression coefficient

x = Independent variable / coccinellid beetle population

$y = 0.0505x - 0.0547$

Regression equation of thrips for Spiders (Fig. 4.7)

$y = 0.0423x + 0.0867$

Regression equation of Jassids for spiders (Fig. 4.8)

$Y = 0.0737x + 0.1878$

4.2 Effect of Ambient Weather on Population Dynamics (Table 4.5 & Fig. 4.9)

Seasonal incidence of major insect pests of linseed *viz* thrips and bud fly and effect of various weather parameters on their population fluctuation was observed on variety Neelum during Rabi , 2007-08.

During the period of observation, weekly fluctuation of maximum and minimum temperatures ranged from 24.4^{o}C to 35.5^{o}C and 10.3^{o}C to 22^{o}C, respectively. The morning and evening relative humidity ranged from 68 to 90 and 19 to 62 per cent, respectively. Similarly, the sunshine hours ranged from 2.3 to 9.5 hours per day. There was no rainfall during the whole cropping season.

Bud Fly (*D. lini* Barnes)

Bud fly was first observed on the crop in the first week of February with 1.90 per cent bud damage, which was associated with 25.8 ^{o}C and 11 ^{o}C maximum and minimum temperatures and 85 and 32 per cent morning and evening relative humidity and 9.2 hours of sunshine. The insect gradually increased its density and exhibited peak activity in the last week of March with 34.10 per cent bud damage. It was associated with 3.9 hours of sunshine, 33 ^{o}C and 22 ^{o}C maximum and minimum temperatures and 80 and 54 per cent morning and evening relative humidity. (Fig. 4.10 &4.11)

There was a highly significant positive correletion between the bud fly damage and maximum temperature and highly significant negative correlation with morning relative humidity with correlation coefficient (r) values of 0.7670 and (-) 0.8990, repectively.

Regression equation for maximum temperature was

$$y = a \pm bx$$

where, y = Dependent variable / Per cent bud fly infestation

a = Constant

b = Regression coefficient

x = Independent variable / Maximum temperature (^{0}C)

$$y = 2.9215x - 66.896$$

Regression equation for morning relative humidity was

$$y = (-)0.4682x + 88.051$$

where, y = Per cent bud damage

x = Morning Relative Humidity

To observe the combined effect of maximum and minimum temperatures, morning and evening relative humidity and sunshine hours on the incidence of bud fly,

multiple correlation studies were carried out between different weather parameters and bud fly incidence which revealed a significant relationship with R = 0.95322.

Based on the present investigation, maximum temperature between 28-33 ^{0}C and minimum temperature between 10-22 ^{0}C and morning relative humidity around 70-82 per cent and evening relative humidity between 19-54 per cent were found congenial for bud fly multiplication on linseed. Almost similar findings were reported by Patel and Thakur (2005) at Raipur. They observed a negative relationship between minimum temperature and bud fly maggot population with r = (-) 0.655, whereas, in the present studies, bud fly damage was positively correlated with maximum temperatures with r value 0.7670 but the morning relative humidity was negatively correlated with pest damage (r = (-) 0.8990). These findings are partially in agreement with those of Shrivastava *et.al.* (1994) who found positive correlation between maggot population and mean temperature and morning relative humidity at Jabalpur. Singh *et. al.* (1998) also observed a negative relationship between relative humidity and bud fly damage as reported in the present studies.

Mukherji *et. al.* (1999) observed maximum bud fly multiplication at 16-20 ^{0}C and 60-70 per cent relative humidity from end of January to early March. Malik *et. al.(*2000*)* also observed significant effect of temperature on bud fly infestation but relative humidity was negatively correlated at Kanpur. In the present studies, linseed bud fly made its first appearance on the crop in the first week of February with peak activity in the last week of March, whereas, Shrivastava *et.al.* (1994) reported the first appearance of the pest in second to third week of January with peak activity in second week of March.

Thrips*, Caliothrips indicus*

Thrips made its first appearance on linseed crop in the last week of December, which was associated with maximum and minimum temperatures of 29.9^{o}C and 13.4 ^{o}C and morning and evening relative humidity of 89 and 34 per cent with nine hours of sunshine. It continued to damage the crop to a greater or lesser extent throughout the cropping period till the last week of March. Two peaks of 15.50 and 39.03 thrips per plant were observed in the last week of January and second week of February, respectively, when the maximum temperature ranged from 24.4 to 24.5^{o}C, minimum temperature from 13.8 to 16.6 ^{o}C, morning relative humidity was 88 per cent, evening relative humidity ranged from 54 to 62 per cent and sunshine hours from 2.3 to 3.3 hours. The data so obtained was correlated with different weather parameters to observe their influence on the population fluctuation of the insect. Thrips population was non-significantly correlated with all the weather parameters individually. The values of correlation coefficient (r) are shown in table 4.5. But the combined effect of weather parameters on the incidence of thrips was found to be significant with R value 0.72886.

2 Screening of different entries of Linseed against *Dasyneura lini*.

During Rabi, 2007-08 an experiment was conducted to screen 70 linseed cultivars against linseed bud fly. It is evident from Table 4.6 that bud fly infestation ranged from 4.76 per cent in BAU-06-6 to 47.82 percent in BAU-06-11 as against 26.92 to 35.08 percent bud damage in susceptible check Neelum and 12.23 to 20.00 percent bud fly infestation in resistant check Neela. These entries were categorized into various groups based on B.I.I. (Table 4.7). Under highly resistant group (o to

5%) only one cultivar BAU-06-6 was observed having 4.76 per cent bud fly infestation. No cultivar was observed under resistant group (5.1 to 10%). However, under moderately resistant group (10.1 to 20%), twenty five cultivars were observed. In the category of susceptible group (more than 20%), there were forty four cultivars in which the bud fly infestation ranged between 20.15 and 47.82 per cent.

Malik et. al. (2000) observed minimum bud damage of 14.34 per cent in Jawahar-1 followed by Neela with 16.60 per cent. In the present investigation 12.23 to 20.00 per cent bud damage was found in Neela. They categorized T-397 and Surabhi as moderately susceptible and variety Neelum as highly susceptible to bud fly. In the present studies, these three entries were highly susceptible with 25.09, 42.10 and 30.63 per cent bud damage, respectively. Entry R-552 recorded 27.27 per cent bud damage. On the contrary, Sood (1978) recorded 36.99 per cent bud infestation in the same variety at Jabalpur.

3. Role of flowering period in Linseed resistance to *Dasyneura lini*. (Table 4.8)

During Rabi 2007-08 an experiment was conducted with 30 linseed cultivars to see the effect of days to 50 per cent flowering in linseed resistance to *D. lini*. The days to 50% flowering in different varieties ranged between 40 and 93 days and the bud fly infestation varied from 12.27 to 36.05 per cent. A positive correlation was observed between blooming period and bud fly infestation with r value 0.613. The variety Nl-119 with minimum flowering duration of 40 days was observed to be less attacked by the bud fly with 12.27 per cent bud damage, while the variety SLS-66 with flowering duration of 93 days was found most susceptible with 36.05 per cent bud damage. The varieties, which had a shorter flowering duration, escape the damage by bud fly. The days to 50% flowering thus can be considered as one of the factors responsible for Linseed resistance against bud fly. The regression equation of *D. lini*

for days to 50 per cent flowering also indicated that the bud fly infestation increased with increase in blooming period.(Fig. 4.12)

Sood and Pathak (1983) and Malik et. al. (1991) also observed that the varieties having longer blooming period were severely infested by bud fly. Jakhmola and Yadav (1983) recorded that delay in the flowering initiation and its duration were positively correlated with infestation by *D lini*. In the present studies, days to 50 per cent flowering were significantly positively correlated with bud damage by bud fly.

4. Efficacy of neem based formulations against *Dasyneura lini* on Linseed.

(Table 4.9)

Different formulations of Neem based insecticides were evaluated under field condition during 2007-08 against linseed bud fly so that their use may be enhanced in IPM models as these are eco-friendly and comparatively safer to the natural enemies.

4.1 Effect on Bud Fly Infestation

Bud fly infestation ranged from 14.15 to 25.99 per cent in different neem based formulations as against 30.69 per cent bud damage in untreated control. NSKE 5 per cent with bud infestation of 14.15 per cent was most effective against linseed bud fly. It was at par with NSKE 2 % and Nimbolin 5 per cent having bud damage of 16.25 and 16.36 per cent, respectively, but differed significantly from Neem seed extract 2 and 5 per cent, Neem leaf extract 5 per cent and Neem seed coat extract 2 and 5 per cent with 19.00, 16.71, 18.23, 24.83 and 21.57 per cent bud infestation, respectively. Neem leaf extract 2 per cent with significantly highest bud damage of 25.99 per cent was

least effective against bud fly among neem based formulations as against 30.69 per cent bud damage in untreated control.

4.2 Effect on Grain Yield

The data on grain yield indicated that NSKE when applied at a concentration of 5 per cent was most effective against bud fly with highest grain yield of 1309.325 kg/ha. It was significantly followed by NSKE 2 per cent with grain yield of 1165.326 kg/ha. The latter was at par with Nimbolin 0.5 per cent (1146.660 kg/ha), Neem seed extract 5 per cent (1139.04 kg/ha) but differed significantly from Neem leaf extract 5 per cent (1091.185 kg/ha) and Neem seed extract 2 per cent (1065.898 kg/ha), these two being at par. Neem leaf extract 2 per cent with 916.185 kg/ha grain yield was least effective against bud fly and was at par with Neem seed coat extract 2 per cent and untreated control with 926.470 and 842.661 kg/ha grain yield.

NSKE 5 per cent with cost benefit ratio of 1:19.8 was most economical against bud fly. It was followed by NSKE 2 per cent, Neem seed extract 5 per cent, Neem leaf extract 5 per cent, Neem seed extract 2 per cent and Nimbolin 0.05 per cent, with 1:15.8, 1:14.8, 1:12.2, 1:11.7, 1:10.6 and 1:6.62 cost benefit ratio. Neem leaf extract 2 per cent with cost benefit ratio of 1:2.8 was least economical against bud fly. (Table 4.10)

Prasad and Prasad (2003) recorded 6.48 per cent minimum bud damage by linseed bud fly and 1.96 per cent damage by capsule borer and maximum seed yield of 1288.06 kg/ha and net monetary return of Rs 9467/ha at Ranchi when the crop was

sprayed five times at ten days interval with NSKE 5 per cent. In the present studies, NSKE when applied twice at a concentration of 5 per cent was most effective against bud fly with lowest bud damage of 14.15 per cent and highest grain yield of 1309.325 kg/ha.

While testing the bioefficacy of different neem products against linseed bud fly at Faizabad, Ali (2002) found that NSKE performed better than other botanical insecticides. On the other hand, Prasad (2003) recorded lowest bud infestation of 14.6 per cent with Achook 1.0 per cent at Ranchi when sprayed twice at fifteen days interval starting with bud initiation stage. The next best treatment was NSKE 5 per cent. He further reported that neem based insecticides were significantly superior in reducing the incidence of *D. lini* and enhancing the seed yield.

Gupta and Rawat (2004) reported reduction in the incidence of *D. lini* and increase in grain yield with increase in concentration of neem leaf extract, NSKE and neem oil.Similar trend was observed in different neem based formulations in the present studies. They further reported that admixture of neem oil 0.5% or NSKE 3% either with dimethoate or methyl demeton 0.023% further reduced the incidence and increased the yield**.**

While testing the neem products against *D. lini* at Tikamgarh (M.P.), Gupta *et. al.* (2000) recorded highest grain yield and maximum net profit with neem oil 0.1%followed by neem oil 0.5%. In the present studies, neem oil 0.5% was least effective against bud fly with 32.62 per cent highest bud damage and 968.56 kg / ha lowest grain yield.

Malik *et. al.* (1996) while testing the efficacy of ethyl alcohol extracts of various parts of seven plants against linseed bud fly at Kanpur observed sweet flag 1% to be most effective with significantly low bud damage (11.70%) and higher grain

yield of 12.3 q/ha. It was followed by neem oil 1% with 12.75% bud damage and 11.2 q/ha grain yield

5.Effect of Neem based formulations on oil content and test weight of Linseed.

(Table 4.11 & 4.12)

To see the effect of different neem based insecticidal formulations on oil content and test weight of linseed, the seed yield of all the three replications of each treatment was mixed and six samples of 15 grams each were taken for estimation of oil content by NMR machine. For estimation of test weight, 1000 grains from all the treatments were counted and weighed with the help of electronic weighing machine.The process was repeated six times. The data on test weight clearly indicated that there was no significant effect of any treatment on test weight of linseed. The test weight ranged from 9.10 gm in Neem leaf extract 2 per cent to 9.62 gm in Neem seed extract 5 per cent, as against 9.22 gm in untreated control.

Similarly the data on oil content indicated that there was no apparent effect of different Neem based formulations on oil content of linseed. However, the oil content in different protection levels ranged from 40.47 gm to 41.31 gm among nine protection levels as against 40.60 gm in untreated control. Mamtarani (2007) also found no significant effect of Neem based formulations on oil content and test weight of Linseed.

6. Determination of Economic Threshold Level of *Dasyneura lini*.

(Table 4.13 and Fig. 4.13)

Present studies were carried out on variety Neelum for developing efficient management module by determination of economic injury level of linseed bud fly for sustainable increase in productivity of this crop. To determine the economic threshold level of bud fly, the crop was treated with Dimethoate 30 EC @ 0.04%. There were seven treatments in which the number of sprays ranged from 6 to zero. Accordingly, the crop was exposed to bud fly infestation for different periods ranging from zero to 42 days when the crop was not treated with any insecticide.

6.1 Effect on Bud Fly Infestation

The crop exposed to different exposure periods showed different degree of infestation. Significantly lowest bud fly damage (9.13%) was noticed when the crop was kept under complete protection against bud fly. This quantum of bud fly infestation under complete protection was treated as unavoidable losses to linseed crop for this Rabi season. The bud fly infestation increased with the enhancement in exposure period of the crop to the pest and significantly highest bud fly infestation of 32.52 per cent was recorded on the untreated crop having 42 days of exposure period.

6.2 Effect on Grain Yield

The seed yield was recorded in each plot separately at harvest and converted to yield in Kg/ha and the data thus obtained for seed yield was computed for critical differences.

Seed yield decreased with increase in bud damage by bud fly during 2007-08. Significantly maximum seed yield of 1635.42 kg/ha was obtained from the crop

having maximum protection as against lowest yield of 1041.89 kg/ha from untreated crop.

6.3 Estimation of Economic Injury Level (EIL)

Economic injury level of bud fly on linseed crop was worked out for effective and economic control of the test insect .The EIL of bud fly infestation was determined as per the methodology suggested by Stone and Pedigo (1972).

$$EIL = \frac{\text{Gain threshold}}{\text{Regression coefficient}}$$

$$\text{Gain threshold} = \frac{\text{Cost of plant protection (Rs/ha)}}{\text{Price of produce (Rs/kg)}}$$

$$= \frac{985}{25} = 39.40 \text{ kg/ha}$$

Regression equation

$y = a \pm b\,x$

y = Dependent Variable / Grain Yield

a = Constant

b = Regression coefficient

x = Independent variable / Bud fly infestation

$y = 1817.9 - 25.132x$

$$\text{Calculated EIL} = \frac{39.40}{25.132} = 1.56 \text{ \% bud infestation}$$

Actual EIL = Calculated EIL + Unavoidable losses

= 1.56 +9.13 = 10.69 % bud infestation

The EIL was calculated on the basis of significant linear regression equation y = a $\pm$ bx for yield /infestation relationship. The gain threshold was calculated as 39.40 kg/ha on the basis of cost of treatment (6 applications of Dimetheoate 30EC@ 0.04%) and price per kilogram of linseed for this year. On the basis of gain threshold and regression coefficient, the EIL was determined as 1.56 per cent bud infestation. but there were 9.13 per cent unavoidable losses. Hence, the actual EIL was worked out to be 10.69 per cent bud infestation for this year.

As suggested by Pedigo (1991), Economic threshold level (ETL) of linseed bud fly is 75 per cent below the economic injury level. Hence the ETL of linseed bud fly was determined as 8.02 per cent bud damage.

Economic injury level of linseed bud fly as determined by Malik (1999) and Malik *et. al.(*2000) ranged from 10.50 to 13.00 per cent with a mean value of 11.20 to 12.08 per cent bud infestation at Kanpur during 1994- 95 and 1995-96, whereas , in the present studies , it was 10.69 per cent bud damage . Similarly, the ETL for bud fly, in the present studies, was worked out to be 8.02 per cent, whereas, Malik (2005) reported 7.1 to 9.5 per cent ETL of linseed bud fly at Kanpur during 1998-02. Earlier, Malik *et. al.* (1996) determined ETL of 2.02, 4.5 and 7.0 per cent bud damage with phosphamidon, decamethrin and chlorpyriphos. In the present studies , 8.02 per cent ETL of bud fly was obtained with Dimethoate 30 EC when applied at the rate of 0.04 per cent.

Chapter -v

SUMMARY, CONCLUSION AND SUGGESTIONS FOR FUTURE RESEARCH WORK

The present investigation entitled **"Studies on Seasonal Incidence of key pests of Linseed and Management Strategies for Linseed bud fly, *Dasyneura lini* Barnes (Diptera :Cecidomyiidae) at Raipur."** was conducted during Rabi season of 2007-08 and the results are summarized below :

1. Seasonal incidence of key insect pests of Linseed and their natural enemies

During the course of study, seven insect species were noticed causing damage at various growth stages of linseed crop. They were linseed bud fly, thrips, jassids, linseed caterpillar, semilooper, gram pod borer and green stink bug. Among these, linseed bud fly and thrips were of major importance. The bud fly and thrips made their first presence on linseed crop during first week of February and last week of December, respectively. The activity of bud fly increased gradually with peak density of the fly in the fourth week of March recording 34.10 per cent bud damage with a seasonal mean of 22.86 per cent. The thrips density increased gradually and first peak of thrips population, 15.50 thrips/plant, was observed in the last week of January and second peak of 39.03 thrips/plant was recorded in second week of February with a seasonal mean of 13.70 thrips per plant. Apart from these two pests, jassids, linseed caterpillar, semilooper, gram pod borer and green stink bug were recorded as minor pests with a seasonal mean of 0.28, 0.08, 0.04, 0.05 and 0.04 insect/plant, respectively.

Preying upon these pests were two species of lady bird beetle, *Coccinella septumpunctata* and *Menochilus sexmaculata* and a predatory spider, *Lynx* sp. A significantly positive correlation existed between thrips and lady bird beetles, thrips and spiders and jassids and spiders with (r) values 0.76, 0.82 and 0.455, respectively.

Effect of Ambient Weather on Population Dynamics

Seasonal incidence of major insect pests of linseed, *viz* ; bud fly and thrips was observed on variety Neelum. Bud fly was first observed on linseed in the first week of February with 1.90 per cent bud damage. It was associated with 25.8 ^{0}C and 11.0 ^{0}C maximum and minimum temperatures and 85 and 32 per cent morning and evening relative humidity with 9.2 hours of sunshine. Peak activity of bud fly (34.10 % bud damage) observed in the fourth week of March was associated with 33.0 and 22.0 ^{0}C maximum and minimum temperatures and 80 and 54 per cent morning and evening relative humidity with 3.9 hours of sunshine. It was significantly positively correlated with maximum temperature having (r) values 0.77 and significantly negatively correlated with morning relative humidity (r = -0.89). Multiple correlation studies also revealed a significantly positive relationship with R value = 0.95322.

Thrips made its first appearance on the crop in the last week of December with a mean population of 2.28 thrips per plant. It was associated with maximum and minimum temperatures of 29.9 ^{0}C and 13.4 ^{0}C and morning and evening relative humidity of 89 and 34 per cent, respectively with 9 hours of sunshine. Two peaks of 15.50 and 39.03 thrips per plant were observed in the last week of January and second week of February, respectively, when the maximum temperature ranged from 24.4 to 24.5^{o}C, minimum

temperature from 13.8 to 16.6 ^{o}C, morning relative humidity was 88 per cent, evening relative humidity ranged from 54 to 62 per cent and sunshine hours from 2.3 to 3.3 hours. The individual effect of different weather parameters on the incidence of thrips was found to be non significant but the combined effect of all the weather parameters was found to be significant with R value 0.72886.

2 Screening of different entries of Linseed against *Dasyneura lini*.

In a screening trial with 70 linseed cultivars against linseed bud fly, the bud fly infestation ranged from 4.76 per cent in BAU-06-6 to 47.82 per cent in BAU-06-11 as against 26.92 to 35.08 percent bud damage in susceptible check Neelum and 12.23 to 20.00 percent bud fly infestation in resistant check Neela. These entries were categorized into various groups based on B.I.I. Under highly resistant group (o to 5%) only one cultivar BAU-06-6 was observed having 4.76 per cent bud fly infestation. The other cultivars had bud fly infestation above 10 per cent.

3. Role of flowering period in Linseed resistance to *Dasyneura lini*.

Experiment was conducted with 30 linseed cultivars to see the effect of days to 50 per cent flowering on linseed resistance to *D. lini*. A positive correlation was observed between blooming period and bud fly infestation with r value 0.613. The variety Nl-119 with minimum flowering duration of 40 days was observed to be less attacked by the bud fly with 12.27 per cent bud damage, while the variety SLS-66 with flowering duration of 93 days was found most susceptible with 36.05 per cent bud damage.

4. Efficacy of neem based formulations against *Dasyneura lini* on Linseed.

Among different Neem based formulations, NSKE 5%, when applied twice at 15 days interval starting from the bud initiation was most effective against bud fly with least bud damage (14.05%) and highest grain yield of 1309.325 kg/ha and cost benefit ratio of 1:19.8. It was followed by NSKE 2 per cent and Nimbolin 0.5 per cent with 16.25 and16.36 per cent bud damage, 1165.325 and 1146.660 kg/ha grain yield and 1:15.8 and 1:14.8 cost benefit ratio, respectively. Neem leaf extract 2 per cent with cost benefit ratio of 1:2.8 was least economical against bud fly.

5.Effect of Neem based formulations on oil content and test weight of Linseed.

The data indicated that there was no apparent effect of Neem based formulations on oil content and test weight of linseed. The oil content in different treatments ranged from 40.7 to 41.31 per cent, as against 40.60 per cent in untreated control. Similarly the test weight ranged from 9.10 gm to 9.62 gm among nine treatments as against 9.22 gm in untreated control.

6. Determination of Economic Threshold Level of *Dasyneura lini*.

The EIL was calculated on the basis of significant linear regression equation $y = a \pm bx$ for yield /infestation relationship. The gain threshold was calculated as 39.40 kg/ha on the basis of cost of treatment (6 applications of Dimetheoate 30EC@ 0.04%) and price per kilogram of linseed (Rs 25/kg) for this year. On the basis of gain threshold and regression coefficient, the EIL was determined as 1.56 per cent bud infestation. but there were 9.13 per cent unavoidable losses. Hence, the actual EIL was worked out to be 10.69 per cent bud infestation for this year.

As suggested by Pedigo (1991), Economic threshold level (ETL) of linseed bud fly is 75 per cent below the economic injury level. Hence the ETL of linseed bud fly was determined as 8.02 per cent bud damage.

Suggestions for Further Work

Linseed being a poor man's crop, the economic constraints generally limit the judicious use of costly insecticides. Hence, more emphasis is to be given to explore the possibility of pest suppression through cultural practices for the management of linseed pests. The future work may be concentrated on the following aspects:

1. No conclusion can be drawn from one year study on seasonal incidence. Hence, such studies should be carried out for 3-5 years to identify the most vulnerable stage of the pest and the crop.
2. Natural enemies of different insect pests, particularly the parasitic fauna of major insect pests should be identified.
3. Insecticides comparatively safer to natural enemies should be identified.
4. Studies to work out economic threshold level of major pests should be undertaken to identify optimum time of chemical protection.
5. More research should be carried out on cultural practices that reduce pest incidence.

"Studies on Seasonal Incidence of key pests of Linseed and Management Strategies for Linseed bud fly, *Dasyneura lini* Barnes (Diptera :Cecidomyiidae) at Raipur."

By

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ABSTRACT

Linseed bud fly and thrips were observed as the major pests of linseed on variety Neelum with seasonal mean of 13.70 thrips/plant and 22.86 per cent bud damage, respectively. Two species of lady bird beetles, C. *septumpunctata* and M. *sexmaculata* and a predatory spider, *lynx sp*. were noticed preying on thrips and jassids. A significantly positive correlation existed between thrips and lady bird beetle, thrips and spider and jassid and spider population with r values 0.76, 0.82 and 0.45, respectively.

Among different weather parameters, the maximum temperature was significantly positively correlated and morning relative humidity significantly negatively correlated with bud fly infestation with r values 0.77 and 0.89, respectively. All the weather parameters combined together had a significant effect on bud fly and thrips population fluctuation with R values 0.95322 and 0.72886, respectively.

Among 70 linseed cultivars only one cultivar BAU-06-6 came under highly resistant group, 25 were found moderately resistant and rest were found susceptible to bud fly.

Bud fly incidence increased with increase in days to 50% flowering. It was significantly positive correlated with per cent bud fly infestation.

NSKE 5 per cent when applied twice at 15 days interval starting with bud initiation stage was most effective against linseed bud fly with lowest bud damage of 14.15 per cent and highest grain yield of 1309.325 kg/ha and cost benefit ratio of 1:19.8 as against 30.69 per cent bud damage and 842.661 kg/ha grain yield in untreated control.
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The economic injury level and economic threshold level of bud fly were determined as 10.69 and 8.02 per cent bud damage on linseed variety Neelum.

Raipur **Chairman**

Dated Advisory Commitee

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Table 4.2 : Seasonal incidence of insect pests of linseed on variety Neelum during Rabi, 2007-08

Population density of insect pests and predators/week									
Date of observation	**Thrips /plant**	**Bud fly infestation (%)**	**Jassids /plant**	**Linseed caterpillar /plant**	**Semilooper /plant**	**Gram pod borer /plant**	**Green stink bug/plant**	**Coccinellid beetles /plant**	**Spider /plant**
31.12.07	2.28	-	0.34	-	-	-		-	-
07.01.08	5.28	-	0.42	-	0.06	-	-	-	0.03
14.01.08	9.20	-	0.33	0.05	0.06	-	-	-	0.43
21.01.08	14.30	-	0.36	0.03	0.03	-	-	0.02	0.70
28.01.08	15.50	-	0.23	0.16	0.03	0.03	-	1.10	0.90
04.02.08	11.00	1.90	0.36	0.16	-	-	-	1.85	1.40
11.02.08	39.03	5.37	0.46	0.08	-	0.06	0.04	1.87	1.30
18.02.08	27.77	21.86	0.16	0.03	-	0.10	0.06	1.40	1.60
25.02.08	22.80	25.74	0.20	0.03	-	0.03	0.10	1.05	1.10
03.03.08	19.20	27.19	0.16	-	-		-	0.70	0.80
10.03.08	6.80	32.96	0.06	-	-			0.20	0.30
17.03.08	3.10	33.83	-	-	-			0.10	0.10
23.03.08	1.90	34.10	-	-	-			-	-
Seasonal mean	13.7	22.86	0.28	0.08	0.04	0.05	0.04	0.83	0.72

Table 4.7 : Showing status of different linseed cultivars in reaction to their resistance and susceptibility to *D. lini*

No.	Status	Range of bud fly infestation (%)	No. of cultivars	Name of Entries
1	Highly resistant	0.0 to 5.0	1	BAU-06-6
2	Resistant	5.1 to 10.0	-	- -
3	Moderately resistant	10.1 to 20.0	25	BAU-06-17, SLS-9, LMS-P-5, PARVATI, SLS-66, KIRAN, LCK-6028, NDL-2005-24, JLT-204, JLT-215, LCK-5021, BAU-06-12, NDL-2005-17, PKDL-75, SHEELA, OLC-10, LMS-149-4, PADMINI, PKDL-65, MEERA, PLC-35-06, JLS-9, NL-97, LMS-63-6, RLC-117
4	Susceptible	More than 20	44	Remaining all the cultivars

Table 4.6 : Relative resistance of different linseed varieties against *D. lini* during Rabi, 2007-08

Entries No.	Name of Entry	Bud fly Infestation (%)	Entries No.	Name of Entry	Bud fly Infestation (%)
1	BAU-06-3	27.45	37	PCL-12-3-06	35.48
2	BAU-06-4	30.76	38	PCL-35-06	19.35
3	BAU-06-6	4.76	39	PKDL-52	24.00
4	BAU-06-7	38.09	40	PKDL-62	29.26
5	BAU-06-11	47.82		NEELUM (SC)	30.00
6	BAU-06-12	16.40		NEELA (RC)	14.52
7	BAU-06-14	25.00	41	PKDL-65	19.11
8	BAU-06-15	20.15	42	PKDL-71	21.20
9	BAU-06-16	26.90	43	PKDL-72	25.53
10	BAU-06-17	11.69	44	PKDL-73	25.00
	NEELUM (SC)	32.52	45	PKDL-74	21.27
	NEELA (RC)	14.00	46	PKDL-75	16.66
11	JLT-27	32.55	47	RLC-114	22.22
12	JLT-204	15.00	48	RLC -116	24.87
13	JLT-215	15.38	49	RLC -117	20.00
14	KL-232	21.00	50	RLC -121	28.57
15	LC-2279-4	34.45		NEELUM (SC)	32.76
16	LCK-5021	15.44		NEELA (RC)	12.23
17	LCK-6028	14.28	51	SLS-66	13.23
18	LCK-7002	44.44	52	SLS-71	12.50
19	LCK-7034	21.05	53	BANER	35.71
20	LCK-7035	34.48	54	J-23-10	23.07
	NEELUM(SC)	31.00	55	JLS-9	19.44
	NEELA (RC)	14.64	56	NEELUM	29.10
21	LCP-146	45.97	57	KIRAN	13.97
22	LMS-149-4	18.82	58	LC-54	40.00
23	LMS-23-6	28.57	59	MEERA	19.23
24	LMS-63-6	19.84	60	NAGARKOT	43.87
25	LMS-95-4	22.84		NEELUM (SC)	35.08
26	LMS-P-3	28.96		NEELA (RC)	15.21
27	LMS-P-5	13.04	61	NL-97	19.74
28	NDL-2004-05	25.00	62	PADMINI	19.09
29	NDL-2005-17	16.66	63	PARVATI	13.18
30	NDL-2005-24	14.63	64	R-552	27.27
	NEELUM (SC)	26.92	65	SHEELA	16.67
	NEELA (RC)	20.00	66	SHEKHAR	26.30
31	NDL-2005-26	38.00	67	NEELUM	25.00
32	NDL-2005-29	21.73	68	SURABHI	42.10
33	NL-2005-34	26.11	69	SUYOG	26.31
34	NL-260	23.52	70	T-397	25.09
35	OLC-10	17.07		NEELUM (SC)	27.58
36	PCL-1-06	21.87		NEELA (RC)	12.68

Table 4.8 : Showing Bud fly infestation per cent concerned with Days to 50% flowering in different varieties during Rabi, 2007-08

Sr. No.	Germplasm/Variety	Days to 50 % flowering	Bud fly infestation (%)
1	NL-119	40	12.27
2	LMS-149-4	41	14.82
3	RLC-114	42	17.22
4	RLC-95	44	18.60
5	NL-97	45	17.74
6	R-7	52	22.48
7	RLC-106	52	23.61
8	RLC-92	53	24.44
9	PADMINI	54	19.04
10	RLC-76	54	25.90
11	RLC-106	54	18.40
12	T-397	55	22.09
13	J-23	55	23.07
14	JLT-204	56	22.34
15	R-17	56	24.63
16	PKDL-65	58	17.11
17	JLS-9	58	19.44
18	SHEKHAR	58	26.30
19	KIRAN	60	28.08
20	PARVATI	61	26.18
21	R-552	61	27.27
22	RLC-96	61	28.11
23	LC-54	65	31.00
24	NDL-2004-05	66	28.00
25	LC-2279	67	30.45
26	NDL-2005-16	72	28.84
27	OLC-10	73	34.07
28	RLC-106	74	33.61
29	NEELA (RC)	87	14.21
30	SLS-66	93	36.05
Corr-coefficient (r)		0.613**	

** Significant at 1%

Table 4.3 : Predatory Fauna observed on Insect Pests of Linseed during Rabi , 2007-08

Common name	Systematic Position	Period of activity	Insect species preyed	Range of incidence / plant	Status of peak activity
Lady Bird Beetle	*Menochilus sexmaculata* *Coccinella septumpunctata* Coccinellidae: Coleoptera	Jan- Mar	Nymphs /adults of thrips and jassids	0.02-1.87	Second week of February
Spider	*Lynx* sp. Class : Arachnida	Jan- Mar	All stages of thrips and jassids	0.03- 1.60	Thirdweek of February
Rove Beetle	*Paederus* sp. Staphylinidae : Coleoptera	February	Early instars of semilooper	Traces	-
Lace Wings	*Chrysoperla carnea* Chrysopidae : Neuroptera	Feb-Mar	Nymphs / adults of thrips and jassids	Traces	-

Table 4.4 :Seasonal Incidence of Thrips, Jassids and associated predators on linseed variety Neelum during Rabi, 2007-08

Date of observation	Mean population Per Plant			
	Thrips	Jassids	Coccinellid beetles	Spiders
31.12.07	2.28	0.34	-	-
07.01.08	5.28	0.42	-	0.03
14.01.08	9.20	0.33	-	0.43
21.01.08	14.30	0.36	0.02	0.70
28.01.08	15.50	0.23	1.10	0.90
04.02.08	11.00	0.36	1.85	1.40
11.02.08	39.03	0.46	1.87	1.30
18.02.08	27.77	0.16	1.40	1.60
25.02.08	22.8	0.20	1.05	1.10
03.03.08	19.20	0.16	0.70	0.80
10.03.08	6.80	0.06	0.20	0.30
17.03.08	3.10	_	0.10	0.10
23.03.08	1.90	_	0.00	0.00
Seasonal mean	13.70	0.28	0.83	0.72
Corr-coefficient (r)	Thrips		0.76*	0.82*
	Jassids		0.411	0.455*

* Significant at 5%

Table 4.5 : Effect of Weather Parameters on the Seasonal Incidence of Bud fly and Thrips on Linseed variety Neelum during Rabi, 2007-08

Date of observation	Thrips /Plants	Bud fly infestation (%)	Temperature (^{0}C)		Relative Humidity (%)		Sunshine hours
			Max	Min	Morning	Evening	
31.12.07	2.28	-	29.9	13.4	89	34	9.00
07.01.08	5.28	-	29.1	11.9	87	30	8.20
14.01.08	9.20	-	29.6	18.5	90	30	7.50
21.01.08	14.30	-	29.7	12.3	86	32	9.20
28.01.08	15.50	-	24.4	13.8	88	54	3.30
04.02.08	11.00	1.90	25.8	11.0	85	32	9.20
11.02.08	39.03	5.37	24.5	16.6	88	62	2.30
18.02.08	27.77	21.86	28.6	10.3	82	28	9.50
25.02.08	22.80	25.74	31.2	13.3	74	25	9.50
03.03.08	19.20	27.19	31.9	13.5	72	19	9.10
10.03.08	6.80	32.96	35.3	15.9	70	20	8.60
17.03.08	3.10	33.83	35.5	19.7	68	26	6.10
23.03.08	1.90	34.10	33.0	22.0	80	54	3.90
Correlation coefficient (r)	Thrips		-0.53	-0.32	0.12	0.27	-0.17
	Bud fly		0.77**	0.43	-0.89**	0.29	0.02

** Significant at 1%

Table 4.11 : Effect of different Neem based formulations on the oil content of linseed variety Neelum.

Name of Treatment	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Sample 6	Mean
Neem leaf extract 2%	41.23	40.83	39.31	41.19	40.66	40.60	40.63
Neem leaf extract 5%	42.43	40.90	40.58	42.45	40.74	40.41	41.25
NSKE 2%	40.58	40.90	40.74	40.53	40.90	40.74	40.73
NSKE 5%	41.77	41.64	40.72	41.67	41.71	40.35	41.31
Neem seed extract 2%	41.08	41.40	41.01	41.15	41.39	41.01	41.17
Neem seed extract 5 %	40.28	41.04	40.88	40.31	41.20	40.88	40.76
Neem seed coat extract 2%	40.96	40.72	40.88	40.85	40.63	40.58	40.77
Neem seed coat extract 5%	40.32	40.99	40.35	40.19	40.30	40.69	40.47
Nimbolin 0.5%	41.20	42.12	40.26	41.13	42.12	40.26	41.18
Untreated (Control)	40.78	40.39	40.60	40.76	40.47	40.60	40.60
SEm							N S
C D at 5%							

Table 4.12 : Effect of different Neem based formulations on the test weight of linseed variety Neelum.

Name of Treatment	Sample 1	Sample 2	Sample 3	sample 4	Sample 5	Sample 6	Mean
Neem leaf extract 2%	9.11	8.90	9.32	9.11	8.90	9.30	9.10
Neem leaf extract 5%	9.26	9.64	9.44	9.26	9.64	9.44	9.44
NSKE 2%	9.84	9.70	9.19	9.84	9.70	9.19	9.57
NSKE 5%	9.17	9.71	9.32	9.17	9.21	9.32	9.31
Neem seed extract 2%	9.67	9.59	9.42	9.67	9.80	9.42	9.59
Neem seed extract 5 %	9.60	9.55	9.71	9.60	9.55	9.71	9.62
Neem seed coat extract 2%	9.61	9.66	9.11	9.61	9.66	9.54	9.53
Neem seed coat extract 5%	9.45	9.33	8.99	9.45	9.74	8.29	9.20
Nimbolin 0.5%	9.55	9.53	9.68	9.55	9.20	9.68	9.53
Untreated (Control)	9.25	9.18	9.16	9.40	9.18	9.16	9.22
SEm							N S
C D at 5%							

Table 4.9 : Effect of different Neem based formulations on bud fly infestation and Grain yield of linseed during, Rabi 2007-08

Treatment	Name of Treatment	Bud fly infestation (%)	Yield (kg/ha)
T1	Neem leaf extract 2%	25.99 (30.63)	916.185
T2	Neem leaf extract 5%	18.23 (25.25)	1091.041
T3	NSKE 2%	16.25 (23.7)	1165.326
T4	NSKE 5%	14.15 (22.04)	1309.325
T5	Neem seed extract 2%	19.00 (25.8)	1065.898
T6	Neem seed extract 5 %	16.71 (24.09)	1139.041
T7	Neem seed coat extract 2%	24.83 (29.86)	926.470
T8	Neem seed coat extract 5%	21.57 (27.66)	1011.422
T9	Nimbolin 0.05%	16.36(23.8)	1146.660
T10	Untreated (Control)	30.69(33.62)	842.661
SE(m)±		0.63	25.20
CD(at 5%)		1.9	74.90

Figures in parenthesis are angular transformed values

Table 3.1 : Meteorological data during Rabi season, 2007-08.

Standard Meteorological Week	Temperature ^{0}C		Relative Humidity %		Sunshine Hours
	Maximum	Minimum	Morning	Evening	
48	28.4	11.1	1	27	8.3
49	26.8	11.2	90	34	7.3
50	28.2	13	93	39	8.2
51	28	11	88	27	8.8
52	29.9	13.4	89	34	9
1	29.1	11.9	87	30	8.2
2	29.6	18.5	90	30	7.5
3	29.7	12.3	86	32	9.2
4	24.4	13.8	88	54	3.3
5	25.8	11	85	32	9.2
6	24.5	16.6	88	62	2.3
7	28.6	10.3	82	28	9.5
8	31.2	13.3	74	25	9.5
9	31.9	13.5	72	19	9.1
10	35.3	15.9	70	20	8.6
11	35.5	19.7	68	26	6.1
12	33	22	80	54	3.9
13	36.1	21.8	69	30	9
14	33.6	19.9	72	36	8.4

Table 3.2 : Entries/varieties of Linseed , screened against *Dasyneura lini*.

S. No	Name of Entry	S.No	Name of Entry
1	BAU-06-3	37	PCL-12-3-06
2	BAU-06-4	38	PCL-35-06
3	BAU-06-6	39	PKDL-52
4	BAU-06-7	40	PKDL-62
5	BAU-06-11		NEELUM (SC)
6	BAU-06-12		NEELA (RC)
7	BAU-06-14	41	PKDL-65
8	BAU-06-15	42	PKDL-71
9	BAU-06-16	43	PKDL-72
10	BAU-06-17	44	PKDL-73
	NEELUM (SC)	45	PKDL-74
	NEELA (RC)	46	PKDL-75
11	JLT-27	47	RLC-114
12	JLT-204	48	RLC -116
13	JLT-215	49	RLC -117
14	KL-232	50	RLC -121
15	LC-2279-4		NEELUM (SC)
16	LCK-5021		NEELA (RC)
17	LCK-6028	51	SLS-66
18	LCK-7002	52	SLS-71
19	LCK-7034	53	BANER
20	LCK-7035	54	J-23-10
	NEELUM(SC)	55	JLS-9
	NEELA (RC)	56	NEELUM
21	LCP-146	57	KIRAN
22	LMS-149-4	58	LC-54
23	LMS-23-6	59	MEERA
24	LMS-63-6	60	NAGARKOT
25	LMS-95-4		NEELUM (SC)
26	LMS-P-3		NEELA (RC)
27	LMS-P-5	61	NL-97
28	NDL-2004-05	62	PADMINI
29	NDL-2005-17	63	PARVATI
30	NDL-2005-24	64	R-552
	NEELUM (SC)	65	SHEELA
	NEELA (RC)	66	SHEKHAR
31	NDL-2005-26	67	NEELUM
32	NDL-2005-29	68	SURABHI
33	NL-2005-34	69	SUYOG
34	NL-260	70	T-397
35	OLC-10		NEELUM (SC)
36	PCL-1-06		NEELA (RC)

Table 4.1 : Insect pests Fauna observed on Linseed variety Neelum during Rabi, 2007-08

Common Name	Systematic Position	Damaging stage	Period of activity	Range of incidence/plant	Status of peak activity
Linseed Bud Fly	*Dasyneura lini* Barnes Cecidomyiidae: Diptera	Maggot	Feb - Mar	1.90-34.10 %	Fourth week of March
Thrips	*Caliothrips indicus* Bagnall Thripidae: Thysanoptera	Nymph & Adult	Dec - Mar	1.9- 39.03	Second week of February
Jassids	*Amrasca* sp Cicadellidae: Hemiptera	Nymph & Adult	Dec - Mar	0.06-0.46	Second week of February
Linseed caterpillar	*Spodoptera exigua* Hub Noctuidae: Lepidoptera	Larva	Jan - Feb	0.03-0.16	Last week of Jan and First week of February
Semilooper	*Plusia orichalsia* Fab Noctuidae: Lepidoptera	Larva	Jan	0.03-0.06	First and second week of January
Gram pod borer	*Heliothis armigera* Noctuidae: Lepidoptera	Larva	Jan - Feb	0.03-0.10	Third week of February
Green stink bug	*Nezara viridula* Pentatomidae: Hemiptera	Nymph &Adult	Feb	0.04-0.10	Last week of February

Table 4.10: Cost Benefit Ratio of Linseed crop using different Neem based formulations during Rabi, 2007-08

Name of treatments	Average Yield (Kg/ha)	Increased yield over control (Kg/ha)	Profit over control (Rs/ha)	Amount of insecticide (Lit/ha)	Cost of insecticide (Rs/ha)	Cost of labour/spray (Rs/ha)	Total cost of spray (Rs/ha)	Net return (Rs/ha)	C:B Ratio
Neem leaf extract 2%	916.185	73.524	1838.1	10	40	200	480	1358.1	1:02.8
Neem leaf extract 5%	1091.1	284.38	7109.5	25	80	200	560	6549.5	1:11.7
NSKE 2%	1165.3	322.6	8066.6	10	40	200	480	7586.25	1:15.8
NSKE 5%	1309.3	466.6	11666.5	25	80	200	560	11106.6	1:19.8
Neem seed extract 2%	1065.9	223.2	5580.9	10	40	200	480	5100.9	1:10.6
Neem seed extract 5 %	1139.04	296.38	7409.5	25	80	200	560	6849.5	1:12.2
Neem seed coat extract 2%	926.5	83.8	2095.23	10	40	200	480	1615.2	1:03.4
Neem seed coat extract 5%	1011.4	168.7	4219.1	25	80	200	560	3659.1	1:06.5
Nimbolin 0.05%	1146.6	303.9	7599.9	2.5	350	1075	480	7119.9	1:6.62

Fig 4.9: Seasonal Fluctuation of Linseed Bud fly and Thrips as influenced by weather during Rabi, 2007-08

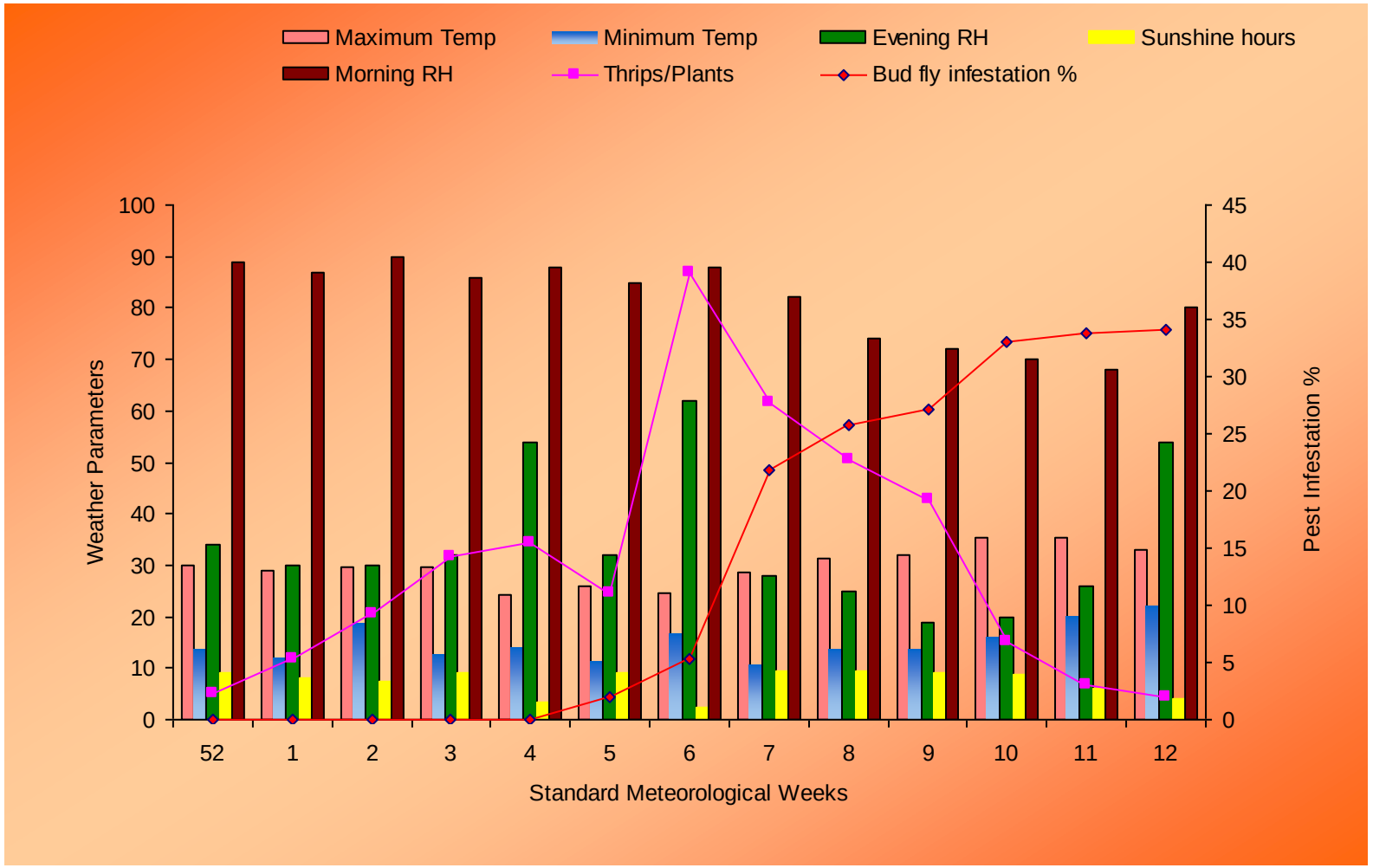

Fig 3.1 : Weekly Meteorological Parameters during Rabi, 2007-08

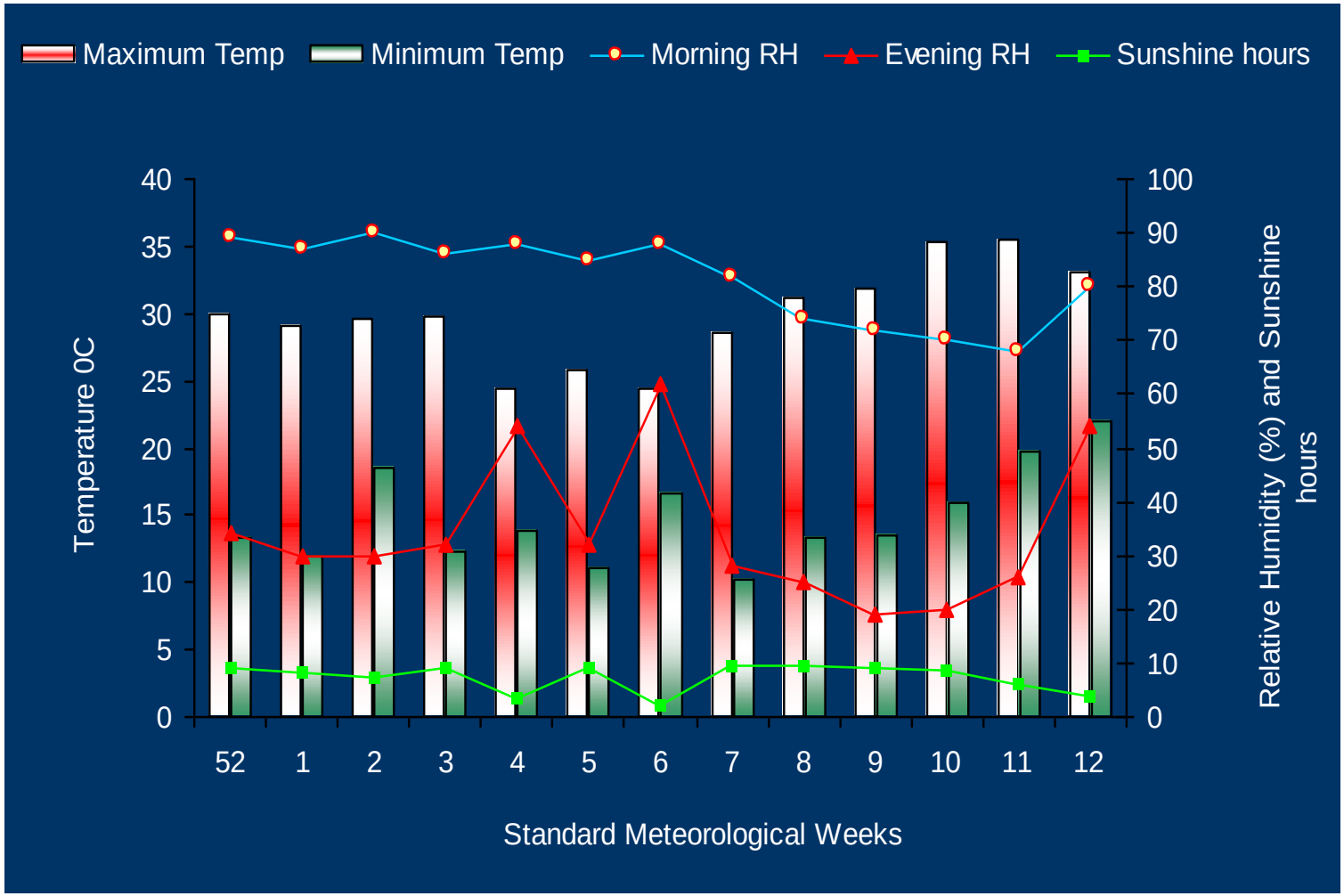

Fig 4.5 : Seasonal Incidence of Thrips and Jassids on Linseed and their natural enemies during Rabi, 2007-08

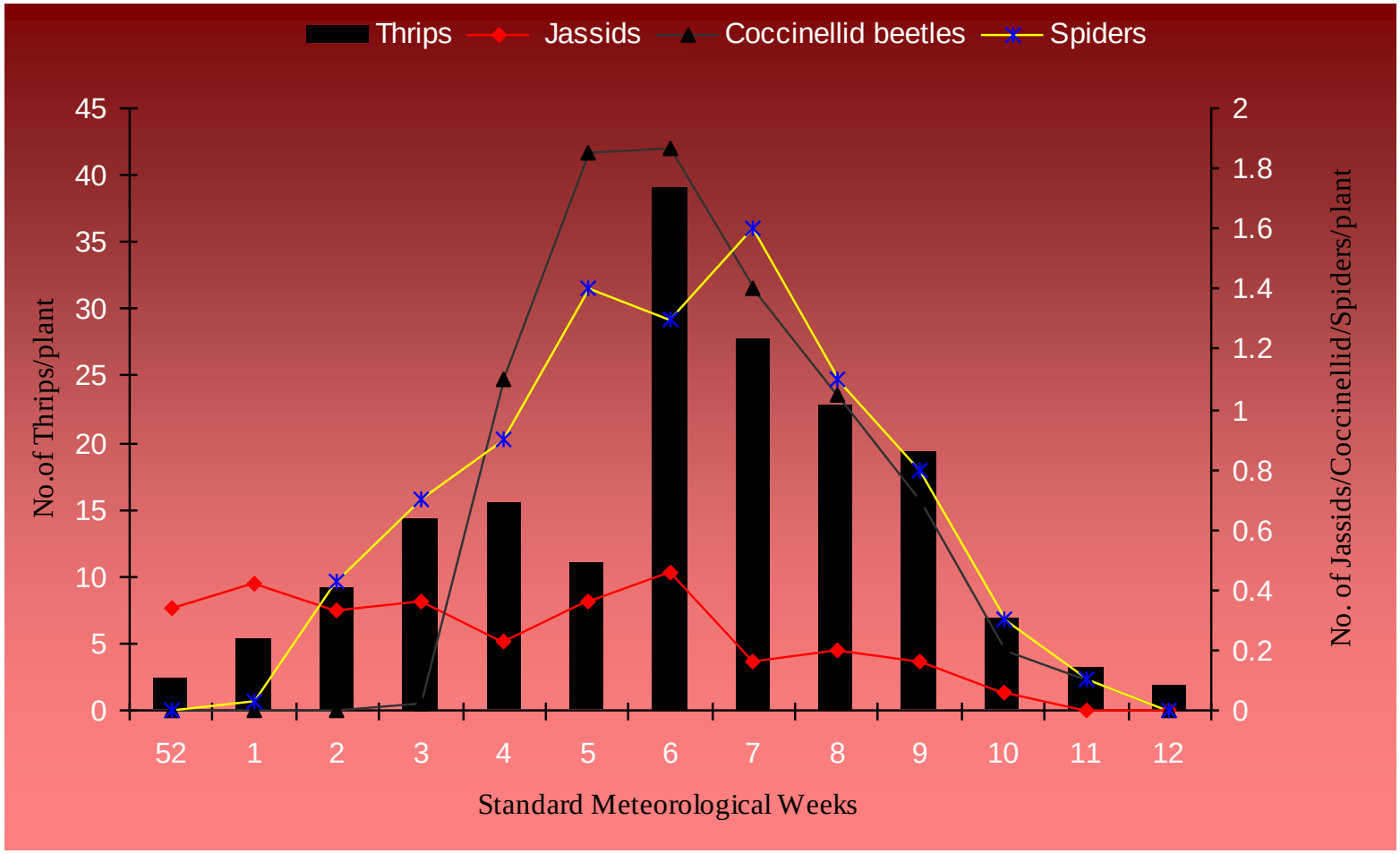
Thrips
Jassids
Coccinellid beetles
Spiders
No.of Thrips/plant
No. of Jassids/Coccinellid/Spiders/plant
0
5
10
15
20
25
30
35
40
45
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
52
1
2
3
4
5
6
7
8
9
10
11
12
Standard Meteorological Weeks

Fig 4.10 : Regression Equation of Dasyneura lini for Maximum Temperature

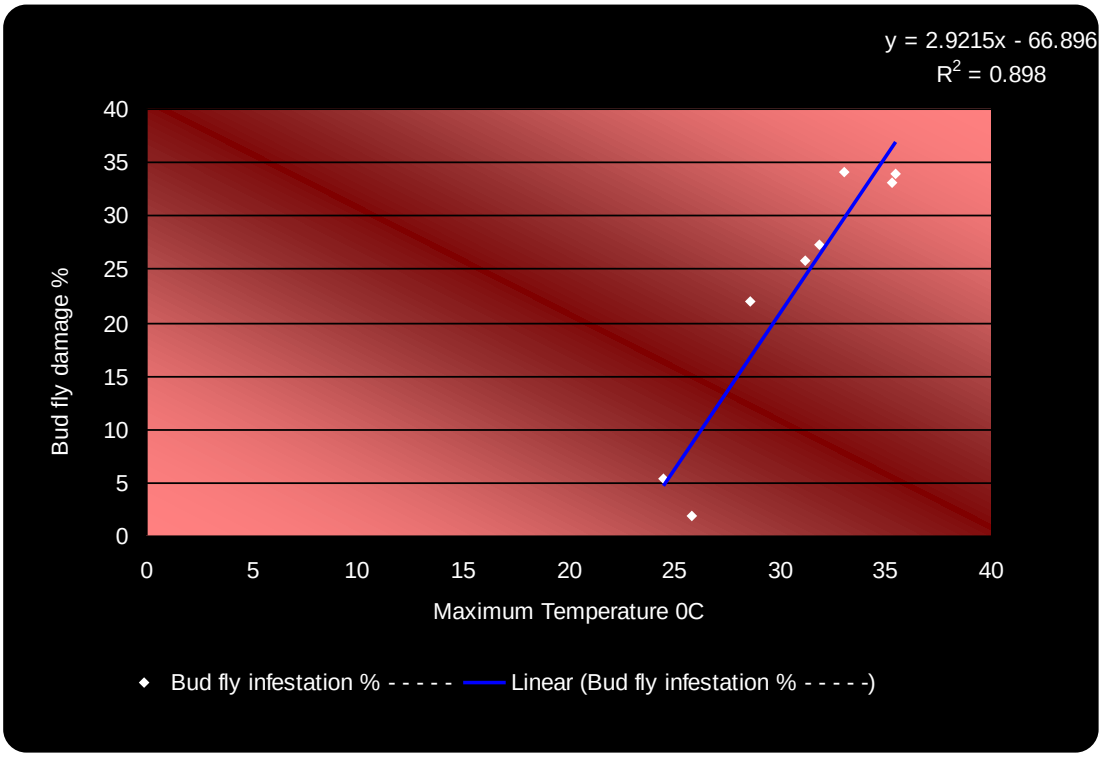

Fig 4.11 : Regression Equation of Dasyneura lini for Morning relative humidity

Fig 4.6: Regression Equation of Thrips for Coccinellid beetles

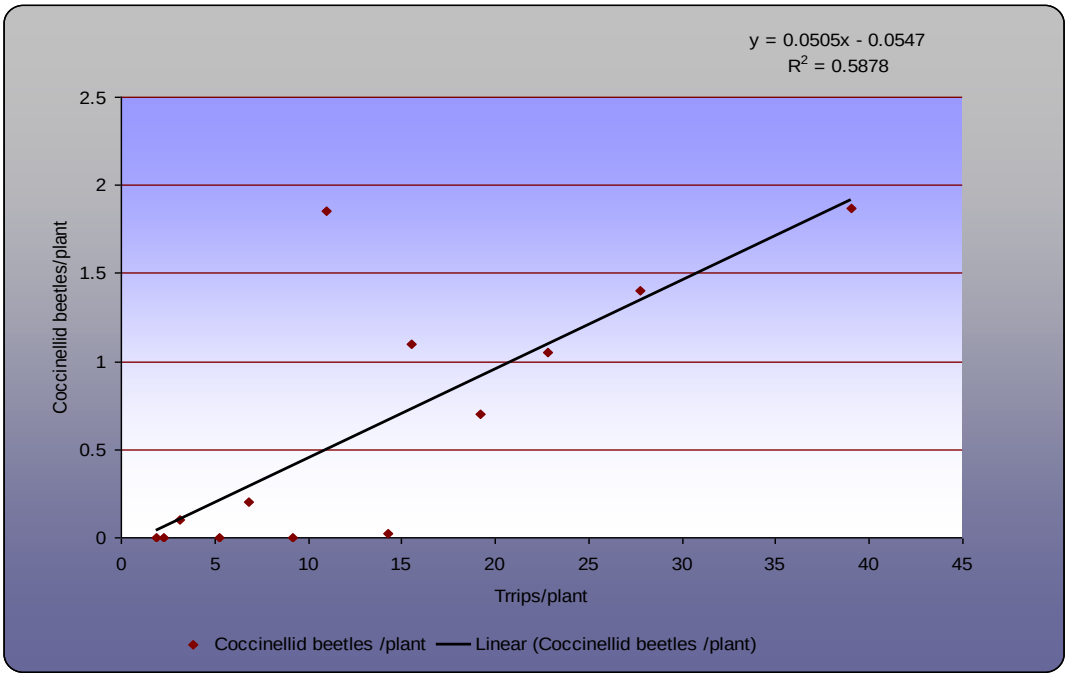

Fig 4.7: Regression Equation of Thrips for Spiders

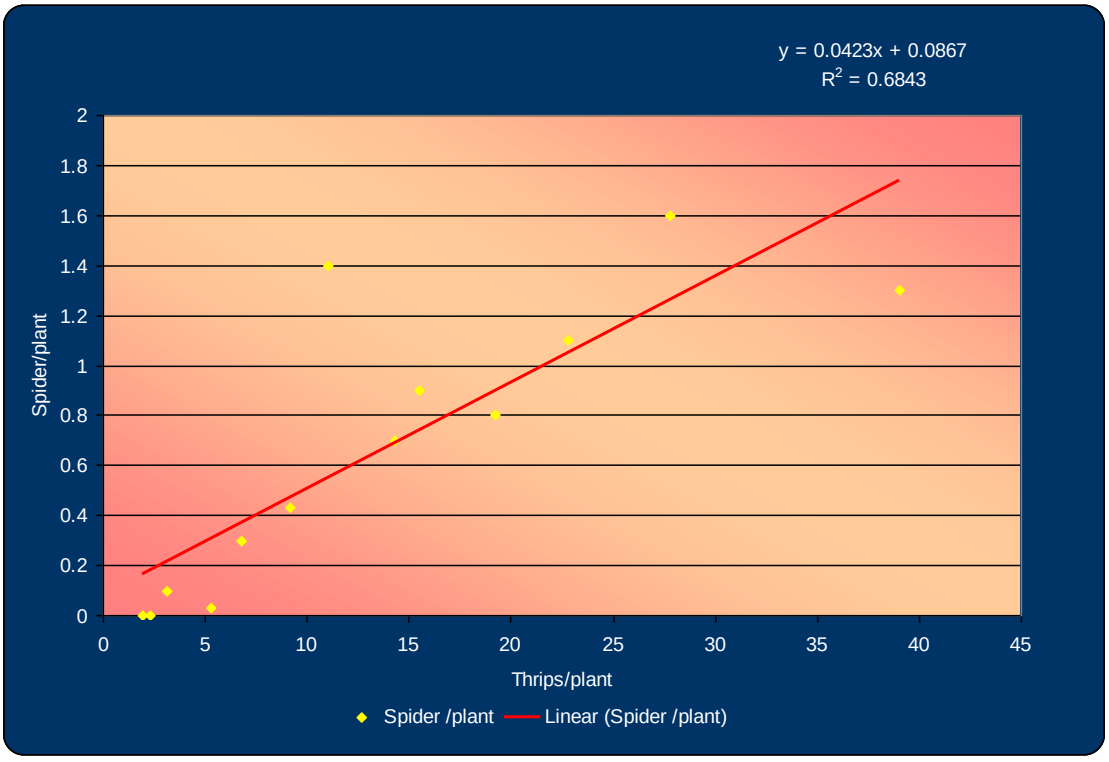

Fig 4.8: Regression Equation of Jassids for Spiders

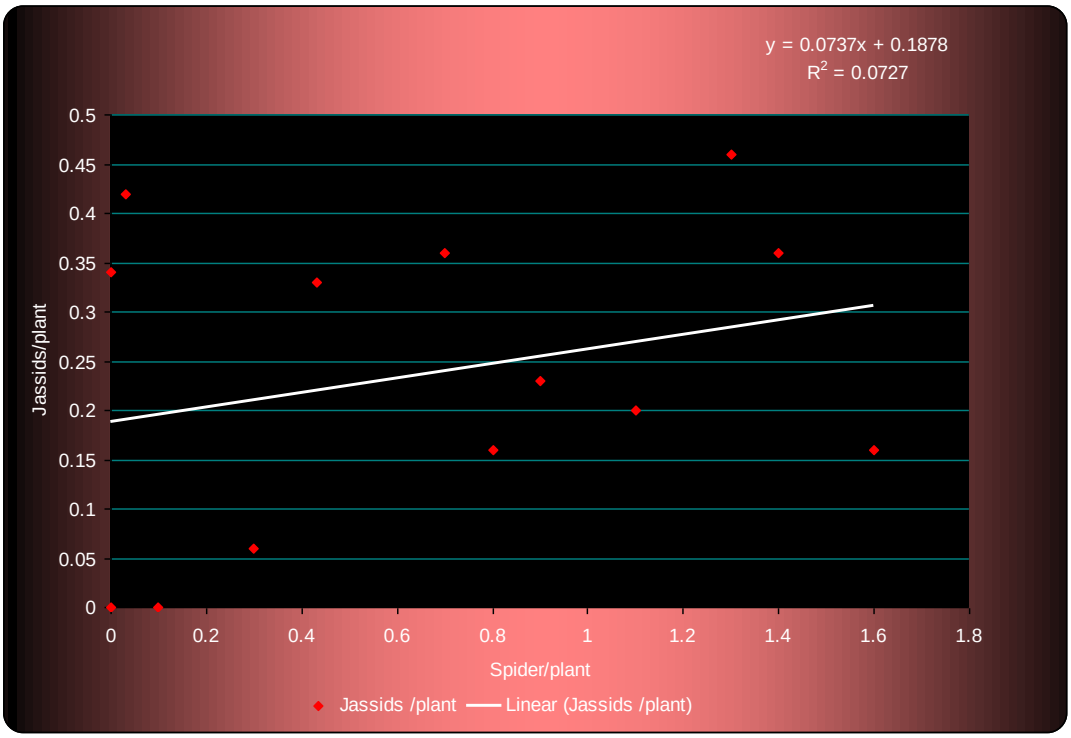

Fig 4.12: Regression equation of *D lini* for flowering duration

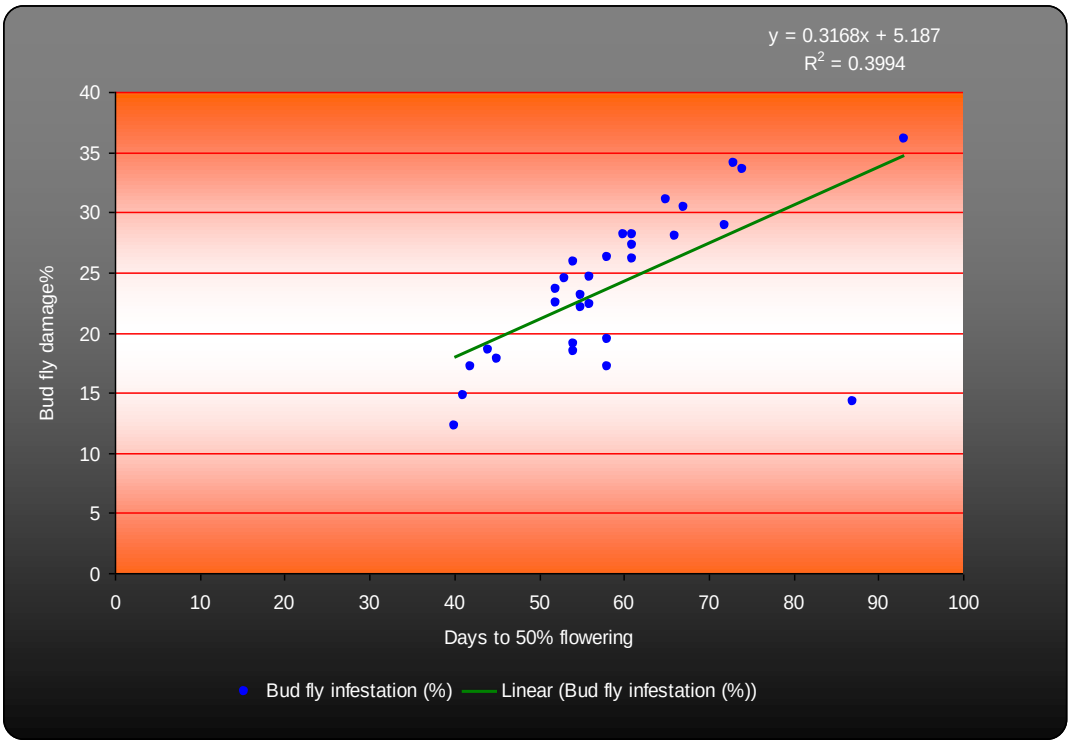

Table 4.13 : Effect of exposure periods on bud fly incidence and seed yield of linseed variety Neelum during Rabi, 2007-08

Treatment	No. of sprays	Exposure Period (days)	Bud fly infestation (%)	Yield (kg/ha)
T1	6	0	9.130 (17.54)	1635.42
T2	5	7	12.373 (20.54)	1512.75
T3	4	14	16.417 (23.89)	1370.27
T4	3	21	18.907 (25.77)	1309.32
T5	2	28	21.683 (27.73)	1263.99
T6	1	35	26.460 (30.94)	1136.04
T7	0	42	32.520 (34.76)	1041.89
SE(m) ±			0.59	61.75
CD (at 5%)			1.82	190.29

Figures in parenthesis are angular transformed values

Fig 4.13: Regression equation for Yield/Infestation relationship

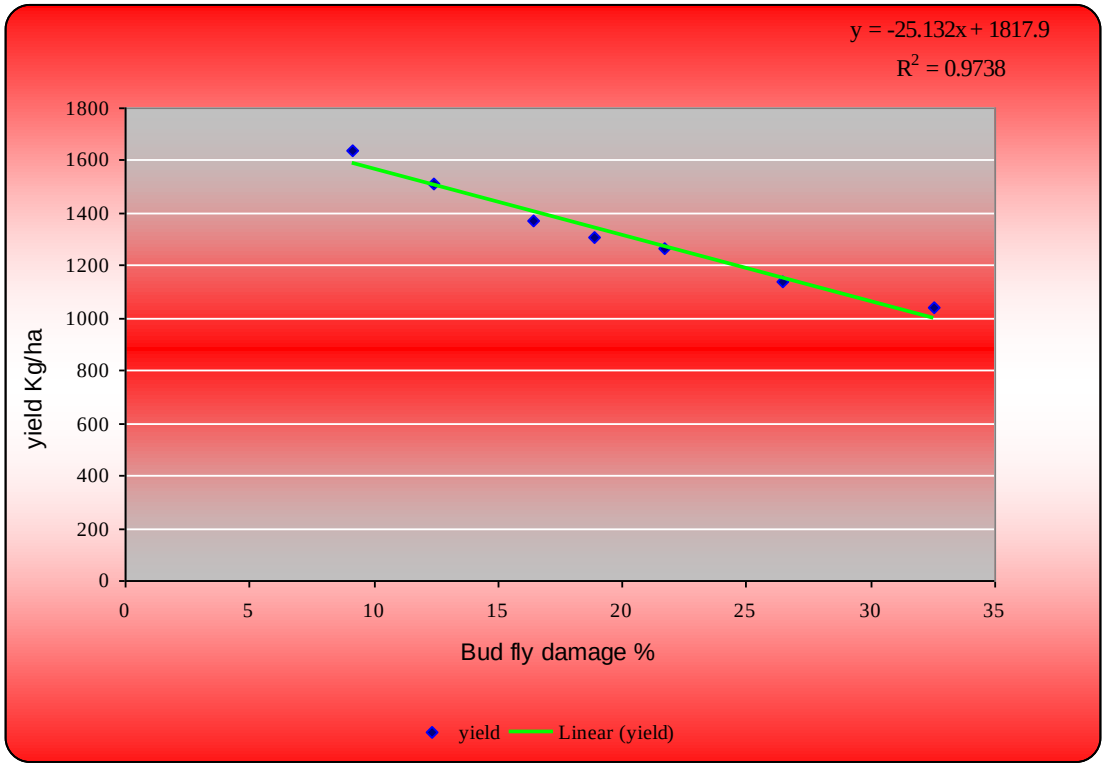

Fig 1.1 : Maggots of Linseed Bud Fly

Fig 1.2 : Pupa of Linseed Bud Fly

Fig 1.3 : Adult of Linseed Bud Fly

Fig 1.4 : Infested Buds by Bud Fly

Fig 1.5 : Infested Buds by Bud fly

with maggots inside

Fig 1.6 : Healthy Buds of Linseed

Fig 1.7 : Healthy Capsules of Linseed

Eig 1.8 : Thrips, *Caliothrips indicus*

Fig 1.9 : Jassid, *Amrasca sp*

Fig 1.10 : Linseed caterpillar, *Spodoptera exigua*

Fig 1.11 : Semilooper, *Plusia orichalsia*

Fig 1.12 : Gram pod borer, *Heliothis armigera*

Fig 1.13 : Green Stink Bug, *Nezara viridula*

Fig 4.1(a) : Grub of Lady Bird Beetle, *C. septumpunctata*

Fig 4.2 : Predatory Spider, *Lynx sp.* feeding on jassids

Fig 4.1(b) : Adult of *C. septumpunctata*

Fig 4.3 : Rove Beetle, *Paederus sp.*

Fig 4.1(c) : Adult of *M. sexmaculata*

Fig 4.4 : Lace Wings, *Chrysoperla carena*

Fig 3.2 : Showing a view of trial on Screening

Fig 3.3: Showing a view of trial on Neem based formulations

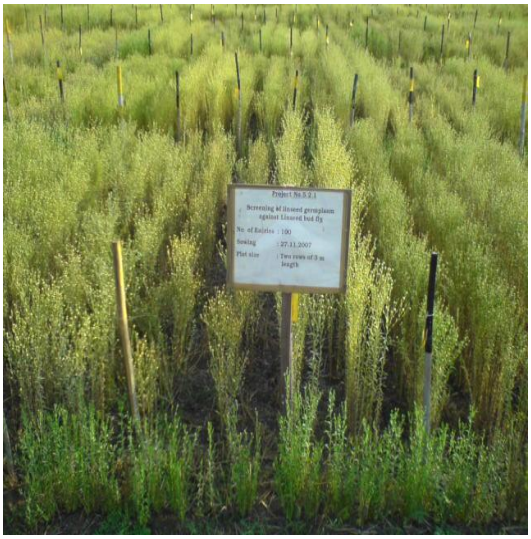

Fig. 3.4 Showing N M R Machine

Fig. 3.5 Showing trial on Economic Injury Level