CROP LOSSES BY BLISTER BEETLE (*Mylabris pustulata* Thunberg) (Coleoptera: Meloidae) ON PIGEONPEA AND MUNGBEAN AND ITS MANAGEMENT

Thesis

Submitted to the Punjab Agricultural University
in partial fulfillment of the requirements
for the degree of

MASTER OF SCIENCE
in
ENTOMOLOGY
(Minor Subject: Plant Pathology)

By

Gurjeet Singh
(L-2009-A-30-M)

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LUDHIANA-141 004

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CERTIFICATE-I

This is to certify that the thesis entitled, **“CROP LOSSES BY BLISTER BEETLE (*Mylabris pustulata* Thunberg) (Coleoptera: Meloidae) ON PIGEONPEA AND MUNGBEAN AND ITS MANAGEMENT”** submitted for the degree of **Master of Science,** in the subject of **Entomology** (Minor subject: **Plant Pathology**) to the Punjab Agricultural University, Ludhiana, is a bonafide research work carried out by **Mr. Gurjeet Singh (L-2009-A-30-M)** under my supervision and that no part of this thesis has been submitted for any other degree.

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

Major Advisor
(Dr. Ravinder Singh)
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CERTIFICATE-II

This is to certify that the thesis entitled, **"CROP LOSSES BY BLISTER BEETLE (*Mylabris pustulata* Thunberg) (Coleoptera: Meloidae) ON PIGEONPEA AND MUNGBEAN AND ITS MANAGEMENT"** submitted by **Mr. Gurjeet Singh (L-2009-A-30-M)** to the Punjab Agricultural University, Ludhiana, in partial fulfillment of the requirements for the degree of **Master of Science** in the subject of **Entomology** (Minor subject: **Plant Pathology**) has been approved by the Student's Advisory Committee along with Head of the Department after an oral examination on the same.

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(Dr. Balwinder Singh)

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Dean Post-Graduate Studies
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ABSTRACT

Studies on seasonal incidence, crop losses, host preference and management of blister beetle (*Mylabris pustulata* Thunberg) (Coleoptera: Meloidae) on pigeonpea and mungbean were carried out at Punjab Agricultural University, Ludhiana during *Kharif* 2010 -11. The crop losses studies were carried out under net house conditions as well as under field conditions while the management studies were made under field conditions. The experiments on seasonal abundance revealed that blister beetle started appearing in the 4th week of August with peak activity period during the 4th week of September in pigeonpea and mungbean under Punjab conditions. The blister beetles were more active during morning and evening hours on both the crops. The activity during noon hours was relatively low. Studies on crop losses under field conditions showed that blister beetle caused up to 36.20 per cent damage to flowers and 53.22 per cent losses in yield at 1.96 beetles per plant in pigeonpea and 15.80 per cent damage to flowers and 35.90 per cent losses in yield at 1.3 beetles per plant in mungbean crop. The investigations on crop losses under net house conditions revealed that *M. pustulata* caused maximum reduction up to 54.18 per cent in pod setting, 20.15 per cent in seed setting and 65.00 per cent in grain yield @ 2 beetles per plant in pigeonpea. However, in mungbean crop, *M. pustulata* caused maximum reduction up to 67.14 per cent in pod setting, 26.65 per cent seed setting and 75.29 per cent in grain yield @ 4 beetles per plant. Host preference studies carried out under laboratory conditions revealed that *M. pustulata* showed highest preference towards pigeonpea (87.22 per cent flowers eaten), followed by urdbean (43.52 per cent flowers eaten) and mungbean (30.38 per cent flowers eaten). Amongst varieties, pigeonpea variety AL 201, mungbean variety ML 818 and urdbean variety Mash 338 were more preferred than other varieties of these pulse crops. The studies on management of *M. pustulata* showed that deltamethrin 2.8 EC @ 500 ml ha^{-1} > cypermethrin 25 EC @ 250 ml ha^{-1} > chlorpyriphos 20 EC @ 3750 ml ha^{-1} were the most effective insecticides among all the treatments in both pigeonpea and mungbean.

Keywords: Crop losses, host preference, management, mungbean, *Mylabris pustulata*, pigeonpea, seasonal incidence.

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ਪ੍ਰਮੁੱਖ ਸਲਾਹਕਾਰ ਦੇ ਹਸਤਾਖਰ

ਵਿਦਿਆਰਥੀ ਦੇ ਹਸਤਾਖਰ

CONTENTS

CHAPTER I

INTRODUCTION

Pigeonpea or redgram [*Cajanus cajan* (L.) Millsp.] and mungbean [*Vigna radiata* (L.) Wilczek.] are the major pulse crops of India. Globally, pigeonpea is cultivated on 4.92 m ha and 3.58 m ha (72.7 per cent) of it is confined to India alone (Saxena *et al* 2010). Pigeonpea is grown worldwide mainly in Southeast Asia, Africa, Kenya, Uganda and Malawi in eastern Africa and in the Dominican Republic and Puerto Rico in Central America. In Asia, which accounts for approximately 90 per cent of world population, pigeonpea is the third most important pulse crop with India, Myanmar and Nepal being the largest producers. Among these, the major center of world production is undoubtedly India, where it is the second most important pulse crop (Nene and Sheila 1990).

Mungbean is another major legume crop grown widely in south and Southeast Asia. This low input, short duration crop is prized for its seeds, which are high in protein, easily digested and consumed as food. It is an important source of dietary protein, especially in Indian subcontinent where consumption of animal protein is very low. Because of its short duration, mungbean is easily adopted to multiple cropping systems in the dry and warmer climates of lowland tropics and subtropics. In India, pigeonpea covers 442 thousand ha area with a production of 289 thousand t having an average yield of 655 kg ha^{-1} where as mungbean covers 287 thousand ha area with a production of 150 thousand t having an average yield of 529 kg ha^{-1} (Anonymous 2012b, Anonymous 2012c). Pigeonpea is grown almost in all the states of India such as Uttar Pradesh, Gujarat (eastern), Maharashtra (eastern) Karnataka (north-east) and Madhya Pradesh (western). Among different states, Maharashtra occupies maximum area (13.2 lakh ha) under pigeonpea with a production of 9.48 lakh t, where as in mungbean, Rajasthan has maximum area under mungbean (10.5 lakh ha) with a production of 6.52 lakh t (Anonymous 2012c). As far as Punjab is considered, pigeonpea and mungbean are most important *kharif* pulses. Pigeonpea occupies an area of 4.2 thousand ha with the production of 3.9 thousand t having an average yield of 934 kg ha^{-1} where as mungbean occupies 7.8 thousand ha area with a production of 6.3 thousand t with an average yield of 808 kg ha^{-1} during 2011 (Anonymous 2012a). Among the various factors responsible for the low yield levels of both these crops, the damage caused by insect pests is attributed as a major constraint in their successful cultivation. More than 350 insect pests species harbor pigeonpea crop. Out of these, 65.6 per cent have been reported from India only (Chhabra 2008). Pigeonpea is attacked by a number of insect pests from sowing to maturity out of which pod borer [*Helicoverpa armigera* (Hübner)], tur pod fly (*Melanagromyza obtusa* Malloch) and spotted borer [*Maruca vitrata* (Geyer)] cause serious damage. Subasinghe and Fellowes (1978) reported that severe infestation by a complex of flower and pod boring insects has virtually stopped the cultivation of pigeonpea in Sri Lanka. The complex includes the legume pod borer *M. vitrata*, lima bean pod borer *Etiella zinckenella*, *H. armigera*, pod fly (*M. obtusa*), long-tailed blue butterfly *Lampides boeticus* and the plume moths *Sphenarches anisodactylus* and *Exelastis atomosa*.

In mungbean, whitefly [*Bemisia tabaci* (Gennadius)], pod borer *H. armigera* and spotted borer *M. vitrata* are the major threats for its cultivation. Besides these pests, blister beetle (*M. pustulata* Thunberg) has emerged as a major flower-feeding pest on pigeonpea and mungbean. Mohamedsaid (1979) reported that *M. pustulata* found in Sri Lanka caused sporadic damage to numerous cultivated plants. COPR (1981) reported that many species of blister beetles such as *M. bifasciata, M. farguaharsoni, M. designata, M. escherichi* and *M. dilloni* caused damage in Africa, Southeast Asia, Bangladesh, and Sri Lanka. Garg (1985) and Dutta and Singh (1989) also reported many species of blister beetles on pulse crops. In northern India, *M. phalerata* Pall was severe on pigeonpea. Besides, *M. pustulata* and *M. macilenta* Marshall were also reported on pulses (Kashyap *et al* 1990). Similarly in the southern parts of India, *M. pustulata*, *M. thunbergii* Billberg and *Mylabris* sp. caused severe damage to pigeonpea and black gram, green gram and cowpea (Giraddi *et al* 1992, Durairaj 1999). Recently, due to the introduction of short duration varieties, blister beetle, once considered to be the minor pest, has become a serious problem of pigeonpea and mungbean. It has assumed the status of major pest and causes severe damage by eating buds and flowers wholly or partially resulting in economic yield loss (Durairaj and Ganapathy, 1996).

The adults of blister beetle cause damage to floral parts of several malvaceous, cucurbitaceous and pulse crops in India. A total of 52 hosts were indentified for *M. pustulata*, 27 hosts for *Mylabris* sp. and 16 for *M. thunbergii*. All these beetle species showed selective polyphagy among various hosts. The range of recorded host plants indicated that leguminous hosts were more predominant than others for all the three species. The beetle causes heavy yield losses by attacking crops at flowering stage and expresses direct impact on the quantity and quality of the production. The adult beetles severely damage buds, flowers, pods and even tender leaves by feeding either solitarily or gregariously resulting in reduced yields (Durairaj and Ganapathy 2003). Mann and Dhooria (1993) reported that 29 per cent of the buds and 14 per cent of the flowers were eaten wholly or partially by blister beetles in redgram. Blister beetles are the major cause of low grain yields of pigeonpea in the lower Kumaon hills and it may create a serious problem to other crops grown in the lower Kumaon hills if due attention is not paid to control this insect (Prasad 1995). According to Faleiro *et al* (1986), *M. pustulata* is a regular insect pest of cowpea during the *kharif* season.

In Punjab, the population of blister beetle has increased manifold on pigeonpea and mungbean during the *kharif* season over the past few years. Keeping into consideration the importance of these crops, there is strong need to have an understanding about the seasonal activity, extent of damage and its management on these crops. One of the main hindrances in the management of blister beetle is the occurrence of a wide range of alternate hosts and its ability to quickly adapt to newer hosts under diversified crop ecosystem. Currently, there is no information on crop losses by blister beetle in pigeonpea and mungbean and as well as its management on these crops in Punjab. Thus, it is of utmost importance to monitor the pest appearance on these crops in the area and to formulate suitable pest management practices for the beetle. Due to scanty information available on seasonal abundance and crop losses by blister beetle in pigeonpea and mungbean and its management, the present studies have been planned keeping in view the following objectives:

(i) To study the population dynamics of blister beetle on pigeonpea and mungbean.

(ii) To study the crop losses by blister beetle in pigeonpea and mungbean.

(iii) To study the preference of blister beetle towards different pulse crops.

(iv) Management of blister beetle in pigeonpea and mungbean.

Hypotheses

- There exists diurnal and monthly variation in population dynamics of blister beetle on pigeonpea and mungbean.
- Blister beetle causes substantial crop losses in pigeonpea and mungbean.
- There are comparative differences in preference of blister beetle towards different pulse crops.
- Chemical control using different insecticides is quite effective for the management of blister beetle in pigeonpea and mungbean.

CHAPTER II

REVIEW OF LITERATURE

Blister beetle, *Mylabris pustulata* (Coleoptera: Meloidae) is one of the destructive pests of pulse crops and other agricultural crops especially pigeonpea, mungbean and urdbean. Few workers have studied the crop losses due to this pest but the information on its seasonal incidence, extent of damage and management on pulse crops especially in Punjab region is lacking. The relevant literature has been reviewed as under:

2.1 Host Range and Feeding Preference

The adult beetles appear in swarms when *Hibiscus* blossoms in the rainy season. In North India, the beetle is on wing at the beginning of July and may be found till October. In South India, the beetles are noticeable almost throughout the year. The adult beetles are general feeders, feeding on the young leaves, tender shoots and inflorescence of many plants, shrubs, etc., particularly of the *Cucurbitaceae*, *Malvacaceae* and *Leguminoseae*. The beetles are also recorded on the flowers of redgram, groundnut, cowpea, lab-lab, wild *Ipomea*, prickly pear, roses, *Calotropis* (Fletcher 1914, Beeson 1941), *Hibiscus* spp. and *Artocarpus* spp. (Stebbing 1977).

It is reported that *M. pustulata* and *M. phalerata* have a wide host range consisting of green gram, cluster bean, cowpea, sesame, black gram and urd bean and the mung was more vulnerable to *M. pustulata. M. phalerata* and *M. pustulata* also caused extensive damage to maize crop by feeding upon maize silk and milky grains (Sharma *et al* 1964). Blister beetles were found destroying flowers of ornamental plants including roses (Anand 1978). This is an example of its wide host range.

The adult blister beetles are known to be pests on various agricultural crops, feeding gregariously at times. These beetles have been reported feeding on petals, anthers and pollen, thus affecting the yield considerably. A few species are also known to feed on leaves. Sometimes, these beetles cause serious damage to the crop. Seventeen species of the meloid beetles are reported as pests on various crops, more particularly cereal and millets, malvaceous and cucurbitaceous crops. A few species are known to infest fruit trees. Among these, *M. pustulata* has been reported to damage maize, sorghum, bajra, various cucurbits, lady's finger, redgram, cotton, rose, tenai and groundnut (Anand 1978).

Dhuri and Singh (1983) reported that flower beetle, *M. pustulata* appeared on black gram only in the *kharif* season. According to Reddy *et al* (1998b), among the 37 species of insects recorded on pigeonpea variety P-33, *M. pustulata* has attained status of major pest and appeared in the field from flowering to pod maturity stage of the crop.

Siddiqi (1983) observed that adults of *M. pustulata* were found to feed upon the flowers of the ornamental plants *Russelia equisetiformis, Jatropha panduraefolia, Hamelia patens, Caesalpinia pulcherrima* and *Tecoma grandiflora* in Aligarh (Uttar Pradesh) from July to October.

Kashyap *et al* (1990) observed that *M. phalerata*, *M. pustulata* and *M. macilenta* caused considerable damage to pigeonpea crop in Palampur, Himachal Pradesh.

Different species of blister beetles have now assumed the status of serious pests of various crops due to their peculiar habit of devouring flowers besides other parts of the plant. The damage caused to the flowers is so extensive that there is no fruit and seed formation. This is particularly true in cucurbits and malvaceous plants. However, these beetles are also known to attack potato, lucerne, sunnhemp, mustard, groundnut, guar, beans and pulses including cowpea, green gram, urd or black gram, arhar or *tur* and soybean (Dhingra and Sarup 1992).

M. pustulata has been reported as a flower feeder of groundnut, bhindi, cucurbits, cowpea, redgram and black gram (Panwar 1995). Balikai (2000) reported that severe infestation of *M. pustulata* was observed on pigeonpea, *Digitaria sanguinalis* and *Stylosanthes hamata* during August to December 1999 in Karnataka, India.

Sangha and Mavi (1995) reported that the meloid *M. phalerata* was active from July to November in the plains of the Indian Punjab. Ridge gourd, cowpeas, canna, China rose, redgram and rice were recorded as the major food plants. *M. phalerata* was also observed feeding on cotton, green gram, okra, soybean and tobacco.

Durairaj and Ganapathy (1996) reported that due to the continuous availability of hosts viz. green gram, black gram, cowpea and pigeonpea, blister beetle occurs throughout the year with a peak incidence (12.3-19.4 beetles per plant) between August and October, which coincides with the flowering period of pigeonpea. It was also observed that pigeonpea was the most preferred host crop followed by cowpea, black gram, and green gram.

Murugesan and Balu (2000) found that blister beetle, *M. pustulata* caused damage to the flowers of ornamental tree *Millingtonia hortensis* (known as the Indian cork tree, *neem-chameli* or *mara-malli*) during September- November in Tamil Nadu, India for the first time.

Chitra-Shanker *et al* (2001) described the host range, abundance and extent of damage done by the blister beetle to various agroforestry systems in northern India. Murugesan *et al* (1997) studied the damage potential of the blister beetle *M. pustulata*, which was newly reported on *Argyreia nervosa* (a medicinal and ornamental plant), *Clitoria ternatea* (a perennial climber), *Pongamia pinnata* and *Acacia leucophloea* (multipurpose trees) in Rajasthan. It was also a serious pest of various types of agricultural crops and ornamental plants.

Durairaj and Ganapathy (2003) reported that three species of blister beetle *M. pustulata*, *M. thunbergii* and *Mylabris* sp. have been found to feed on pulse crops in Tamil Nadu. When host plants are available, these beetles were present throughout the year and found to feed on more than 52 plant species which include cultivated and non-cultivated plants. In field survays conducted in selected locations on blister beetles during 1996-1999, *M. pustulata*, *M. thunbergii* and *Myalbris* sp. were found to be more cosmopolitan. Among the host plants, leguminous hosts dominated in number followed by *Malvaceae*. A total of 52 hosts were identified for *M. pusulata*, 27 hosts for *Mylabris* sp. and 16 hosts for *M. thunbergii*. All these beetle species showed selective polyphagy among the hosts. *M. pustulata* beetles preferred solitary, large sized (>4 cm dia) yellow or white colored flowers, while *M. thunbergii* and *Mylabris* sp. preferred small to medium sized (2-4 cm dia) solitary flowers. Generally yellow and white flowers were most preferred by both species. As regards to intensity of damage, *M. pustulata* preferred pigeonpea, cowpea, black gram, green gram, stylo, country mallow, powder puff, shoe flower and China rose more while *datura* and sunnhemp were the least preferred. More than five beetles per flowers were observed on these hosts while single beetles alone were observed on the least preferred hosts with low feeding either on petals or reproductive parts. Balasubramanian (1995) listed 14 plant species as feeding hosts for *M. pustulata* in Tamil Nadu besides *Opuntia dilenii* and *Canavalia ensiformis*.

Kumar *et al* (2010) recorded the population of *M. pustulata* as flower feeders from 4th week of August and till first week of October in all varieties of sesame during 2006 and 2007.

Sharma (2011) reported that *M. phalerata,* commonly known as banded blister beetle, is known to attack the flowers of pigeonpea crop, *Hibiscus rosa-sinensis* and other plants from July to September and devours them completely.

2.2 Seasonal Abundance

Two species of *Mylabris* beetles viz. *M. pustulata* and *M. phalerata* have been known to cause extensive damage to maize crop by feeding upon tender maize silk and milky grains resulting in no grain formation in the tassels where the silk had been eaten by these beetles as the pollination takes place through the silk. The over-wintering forms of the beetles appeared on wing in the end of March or early April, depending upon temperature, when their number was not large. However, the beetles from the new brood started appearing in July and assumed warning proportions by August in Himachal Pradesh and reported as many as 80,000 beetles per acre of maize crop at silking stage (Sharma *et al* 1964).

Stebbing (1977) observed that beetles start appearing on the hosts, soon after the advent of monsoon, in the beginning of July and their activity lasted until October with peak coinciding with the maximum flowering in different crops.

According to Singh and Singh (1978a), the effect of intercropping on insect pest buildup in pigeonpea showed that there is no or very low incidence of flower eating beetles (*M. pustulata*) when green gram was intercropped. In the first week of October, the pest appeared with a very low incidence (hardly one beetle per plot). The population continued to buildup and attained its peak by the end of October when 14 beetles per plot were observed in the intercrop against 38 beetles per plot in the monoculture. When intercropping with sorghum was done, the appearance of flower eating beetle was considerably delayed (by 3 weeks) on redgram at low incidence of 7 beetle per plot. The population rapidly increased reaching the maximum of 22 under this intercrop against 38 in monocrop by the first week of November. Intercropping with pearl millet also gave result similar to that of sorghum.

Singh and Singh (1978b) recorded the incidence of flower eating beetle on ‘BS 1’ and ‘Prabhat’ varieties of redgram and reported that the beetle was conspicuous with high incidence during 1975. The population of the pest which appeared with the onset of flowering in the later-half of September on ‘Prabhat’ attained its peak of 80 beetles per plot during the second week of October. Thereafter, the population of the pest declined sharply. Similar trend in the population build up of the pest was also noticed in ‘BS 1’ on which the incidence of the pest commenced a fortnight later (first week of October) than ‘Prabhat’, carrying comparatively lower population of the beetle (36 per plot) at the peak.

Suman and Wahi (1981) observed the distribution pattern of *M. pustulata* on redgram in the field. The results indicated that the dispersion of beetles was of an aggregated type. This was owing to their behavior and also heterogeneity in the crop.

Mahal *et al* (1989) observed that the adults of blister beetle, *M. pustulata* Thunberg, started appearing on pigeonpea in late August under Punjab conditions. The beetles were observed feeding on the floral parts and damaged the terminal portion of the unopened flower buds and different parts of flowers, including keel of corolla and petals until the end of October. All the injured buds/flowers dried up and were ultimately shed prematurely. It was observed that 3.72 per cent of the buds/flowers on a shoot were damaged by the beetles. They also observed that the beetles were more active in the morning and evening hours with average population being 1.30 and 1.27 beetles/ meter row length, respectively but the population at noon was relatively low (0.80 beetles/ meter row length) and beetles preferred to feed on the lower branches, preferably opposite the direction of the sun.

Patnaik *et al* (1993) studied the seasonal incidence of *M. pustulata* in northern and southern Orissa. In northern Orissa, beetle incidence reached a peak during the first half of October and in southern Orissa, peak incidence was observed during the 2nd and 3rd week of October. Field trials carried out in the eastern ghat highlands (southern Orissa) and the north central plateau (northern Orissa) indicated that the beetles usually emerge in large numbers once during April and twice during September every year. The population in April was of considerable importance as the subsequent generation that arose from this population explodes in September coinciding with the flowering stage of the pigeonpea, thereby seriously damaging the crop.

Sahoo *et al* (1993) reported that the populations of *M. pustulata* appeared during mid October and were present up to December on medium resistant varieties of pigeonpea in India and the higher populations were found on variety ICPL 77303 during mid October.

Dhamdhere *et al* (1995) observed the activity of flower beetle, *M. pustulata* on brinjal and reported that its activity was from flowering to the harvest on both summer and *kharif* crops. The pest population in two seasons was almost uniform and ranged from 1.00-4.40 beetles per 10 plants. Dhamdhere and Bhonsle (1992) recorded its activity from March to October on brinjal.

Prasad (1995) recorded 16 species of insects associated with various stages of pigeonpea. Of these, blister beetles (*M. phalerata* and *M. orientalis*) were present in large numbers (22 beetles per plant) and were thus, the most serious pest of pigeonpea in Kumaon hills of Uttar Pradesh. Swarms of beetles were observed on flowers, flower buds, and newly formed pods. Blister beetles appeared with the onset of flowering in early July, when mean maximum and minimum temperatures were 32.0 ˚C and 23.5˚C, respectively. Peak damage was recorded in late August-early September. Beetle population declined considerably (2 beetles per plant) with decline in temperature (11.2˚C in late October). The damaged flowers did not develop into pods, causing a drastic reduction in grain yield. The grain yield losses in untreated plots were up to 66 per cent. Garg (1985) and Prasad *et al* (1991) also found these beetles to be a serious pest on maize, sorghum, bajra, red gram, cotton, rose, groundnut, rice.

Studies on distribution pattern of *M. pustulata* infesting pigeonpea flowers were undertaken at New Delhi during *kharif* 1996 and 1997 by Reddy *et al* (1998a) and the authors reported that in all the weeks of observation during both the seasons the blister beetle followed contagious nature of distribution. Aggregative nature of distribution of this pest was confirmed by various tests.

Studies made by Singh (2001) revealed that during *kharif* 1999, a considerable high population of *M. pustulata* and *M. phalerata* was observed in pigeonpea in Gwalior. A severe attack of the pest was observed on the varieties having large number of flowers and compact inflorescence than those having less number of flowers and spread of inflorescence. The studies on seasonal incidence and distribution revealed that adult beetles were first seen in the first week of October (14 beetles/ 25 m^2 area). There was an increasing trend in the population and the peak was observed (94 beetles/ 25 m^2 area) in the third week of October.

Investigations carried out by Reddy *et al* (2001) on the impact of various abiotic factors on population build up of pigeonpea pests including *M. pustulata* showed that blister beetle appeared in the field during flowering period. In both the years of study, *M. pustulata* population build up showed significant positive relationship with daily minimum temperature. Daily maximum temperature, morning relative humidity, wind speed and sunshine hours exerted positive influence while evening relative humidity and rainfall showed non-significant negative relationship with population of *M. pustulata.* Sekhar (1991) also reported that the daily temperature and sunshine hours had significant positive bearing, while relative humidity and wind speed showed a non-significant negative and positive correlation with blister beetle population on pigeonpea, respectively.

Kumar and Nath (2003) studied the population dynamics of pest complex on an early variety of pigeonpea UPAS-120 at Varanasi showed that blister beetle caused damage to the flowers by feeding on them. It appeared in the field on 25th October coinciding with the initiation of flowers and disappeared after 24th November due to the absence of flowers during both years 1994 and 1995. The average maximum population was 1.22 beetles per five plants. The temporal distribution did not differ much, which was also confirmed by the dispersion parameters. The blister beetle visited the pigeonpea field during day hours and were found feeding upon the flowers and remained active till there were flowers present in the field. These beetles were never found sitting idle on the pigeonpea plants. The pest activity was recorded for a very short period which seems to be mainly because of the presence of flowers for a shorter duration on which these beetles fed.

Kumar (2004) conducted a field survey in Varanasi, Uttar Pradesh during 1994-95 and 1995-96 *kharif* seasons to determine the flower and pod pests of pigeonpea (cv. UPAS-120 and Bahar) and reported that UPAS-120 (early variety) was severely infested by *M. pustulata* along with other insect pests.

Dhakla *et al* (2010) observed the peak period of beetle infestation on pigeonpea to be the 2nd week of September (13.6 beetles/ plot). The maximum population of beetle was observed on genotypes H 2004-26 (5.4 beetles/ plot) and H 03-41 (5.3 beetles /plot), while lowest was observed on AL-1489 (2.7 beetles/ plot). The standard check *Manak* harbored high level of beetle population (5.0 beetles/ plot) throughout the crop season. It was observed that beetle population on different genotypes increased with increase in the flowering and reached the peak at maximum flowering stage (2nd week of September) and thereafter, the population started declining due to termination of flowering.

2.3 Nature and Extent of Damage

According to Rama Murthy *et al* (1970), 15.36 per cent of the ear heads in *Cumbu* were infested by *M. pustulata* resulting in 6.48 per cent loss in grain yield.

Kashyap and Adlakha (1971) reported that the beetle *M. pustulata* appeared in an epidemic form on soybean crop sown in maize plots at Kangra. The adults fed on the foliage voraciously and in some cases the whole plant was destroyed. The extent of damage was more than 60 per cent during July, being relatively low at other areas.

Maheshwari (1986) stated that the average per cent damage of flowers due to *M. pustulata* in mung, guar, cowpea, til, urd and soybean was 80.0, 60.0, 60.0, 50.0, 50.0, and 40.0, respectively. The average per cent of damage in leaves due to *M. pustulata* was determined in cowpea, mung, soybean, urd, til, groundnut and guar to be 13.27, 11.35, 11.06, 10.01, 5.17, 4.15 and 3.97, respectively.

Yadava *et al* (1988) reported that *M. pustulata* and *M. phalerata* caused damage in short-duration varieties of pigeonpea by devouring the flower and flower buds. To conclude, among the major pulse crops, pigeonpea is the highly preferred host followed by cowpea, urdbean and mungbean by the blister beetle.

Durairaj (2000) studied the host preference by *M. pustulata* and *Mylabris* sp. in the laboratory. The result showed that a maximum of 47.9 per cent flowers was damaged by *M. pustulata* in pigeonpea followed by 37.0 per cent on cowpea. The flower damage in urdbean and mungbean was 26.6 and 17.5 per cent, respectively and were significantly different from each other. This observation clearly showed that *M. pustulata* had the maximum feeding preference on pigeonpea followed by cowpea. The flowers of mung and urdbean were comparatively less preferred. *Mylabris* sp. had more than 50 per cent flower preference on pigeonpea in the presence of other pulse crops. The mean flower damage on cowpea was 37.6 per cent as against 29.1 per cent in urdbean and 19.1 per cent in mungbean. The investigation also revealed that the host preference is almost similar for both the beetle species studied. Earlier severe damage by *M. pustulata* on the flowers of pigeonpea was reported Kashyap *et al* (1990) and Mann and Dhooria (1993).

In experiments conducted by Durairaj and Ganapathy (2000) at Vamban, yield losses caused by *Mylabris* sp. in two short duration pigeonpea cultivars (Vamban 1 and ICPL 86012) at three beetle densities (50,100, and 150 per 50 plants) were assessed under caged conditions in the field. In both the cultivars, the number of pods set, number of seeds, and seed yield varied inversely with the beetle densities. In Vamban 1, at the lowest beetle density of 50 beetles (one beetle per plant), the number of pods set and the number of seeds per plant were higher (23.9 and 70.0, respectively) with the resultant yield loss of 15.1 per cent. At the highest beetle density of 150 beetles (three beetles per plant), the above parameters showed the minimum levels (2.7 and 7.3, respectively) with the maximum yield loss of 89.5 per cent. In the control, the pod numbers, seed numbers and seed yield per plant were 33.2, 86.0, and 6.0 g, respectively. Similarly in ICPL 86012, at the lowest beetle density (one beetle per plant), pod numbers and seed numbers were higher (23.5 and 52.9, respectively) with comparatively higher seed yield of 5.7 g per plant compared to the control. The variation in seed losses in these two cultivars was not greater, as these two cultivars have a uniform duration of 110 days with almost identical plant architecture with respect to terminal flower clusters. In pigeonpea, grain yield reduction due to blister beetle feeding was reported by Garg (1985), while Singh *et al* (1992) recorded 80 per cent yield loss due to *Mylabris* sp. in pigeonpea.

Velay *et al* (2001) studied the main insect pests of pigeonpea during a survey conducted in 41 households of Northern Uganda. Virtually all small farmers (95 per cent) considered blister beetle (*Mylabris* sp.) to be the most conspicuous insect damaging pigeonpea at the flowering stage.

Balikai and Yelshetty (2008) found that among the 30 insect pests feeding on pigeonpea crop, *M. pustulata* was reported to be moderately damaging pest along with 10 other insect pests resulting in 31-50 per cent damage to the crop.

On the basis of beetle population, genotype AL-1489 was considered as least susceptible while H 2004-24 as most susceptible to beetle attack. The data obtained on flower damage by blister beetle in different pigeonpea genotypes under laboratory conditions revealed that minimum flower damage was observed in AL-1495 and Pusa-7602 (20 per cent) while maximum was observed in H 2004-24 (27.5 per cent) as compared to *Manak* in which flower damage was observed as 25 per cent. The flower damage in different genotypes varied significantly and ranged from 16.6 to 27.5 per cent (Dhakla *et al* 2010). Similar observations were made by Durairaj (2000) who reported that a maximum of 47.93 per cent flowers of pigeonpea were damaged by this pest. The variations might be due to the differences in genotypes as well as the agroclimatic conditions. Mann and Dhooria (1993) reported that 29 per cent of the buds and 14 per cent of the flowers were eaten wholly or partially by the beetles which is in conformity with these studies.

2.4 Management

In view of its status as a polyphagous pest, various insecticides have been evaluated to determine their relative toxicity against *M. pustulata*.

The screening of 14 insecticides in laboratory against *M. pustulata* showed that out of these, only seven pesticides viz. phosphamidon, orthodibrom, dichlorovos, parathion, carbaryl, formothion and malathion were found to be more toxic than p, p-DDT being 100.9, 94.3, 81.3, 3.1, 1.8, 1.8 and 1.5 times, respectively as toxic as p, p-DDT. Thiodemeton, thiometon and lindane proved to be less toxic than p, p- DDT i.e., 0.37, 0.34 and 0.13 times as toxic as p, p-DDT. The toxicity of endosulfan, thanite and chlorobenzilate was quite low (Singh *et al* 1968).

Sinha *et al* (1979) reported that the early maturing varieties of pigeonpea were attacked mainly by *M. pustulata* and *M. testulalis*. Results of chemical control tests revealed that sprays containing 0.04 per cent monocrotophos or 0.05 per cent quinalphos (Ekalux) and dusts containing 5 per cent carbaryl or 5 per cent malathion were the most effective.

Sivaramakrishnan (1984) reported blister beetle as a pest of sandal during the survey of insect pests of sandal plant and its associates, at Bangalore. For chemical control, dusting of the plants with 4 per cent carbaryl or spraying of 0.05 per cent malathion or endosulfan, or 0.2 per cent carbaryl (wettable powder) was found effective. For mechanical control of beetles, collecting and destroying of adults during early hours (when they are relatively inactive) was found to be the best.

Bhalani (1988) evaluated the toxicity tests of 10 insecticides (0.07 per cent endosulfan, 0.04 per cent monocrotophos, 0.02 per cent fenvalerate, 0.05 per cent quinalphos, 0.2 per cent carbaryl, 0.004 per cent cypermethrin, 0.05 per cent acephate, 0.04 per cent deltamethrin and 0.05per cent methyl parathion) in the field against the adults of *M. phalerata* on pigeonpea. The results showed that these insecticides caused 28.8 to 52.8 per cent mortality in 30 h, 43.1 to 83.8 per cent in 6 h and 48.8 to 90 per cent in 12 h. Carbaryl was the most effective treatment.

Ram *et al* (1988) observed that the maximum control of flower nibblers (*M. pustulata*) was obtained by monocrotophos (0.04 per cent) and maximum seed yield was obtained from plots treated with this insecticide at 50 day old crop.

Kakar *et al* (1990) reported that insecticides sprayed for the control of blister beetle on French bean crop completely eliminated them within six days. A few beetles reappeared seven days after the treatment. However 10 days after treatment, minimum infestation was recorded in plots sprayed with deltamethrin and fenitrothion, followed by those sprayed with fenvalerate, permethrin and cypermethrin. Malathion treated plots had significantly more beetles than others but relatively less than the untreated control.

Sood and Kakar (1991) reported *M. pustulata*, *M. phalerata* and *M. macilenta* on crysanthemum and studied the toxicity of six insecticides against *M. pustulata*. The adults were confined in the laboratory on flowers from plants that had been sprayed in field. Persistent toxicity value of 1709, 1682, 1649, 1172, 1169 and 1104 were calculated for fenvalerate, cypermethrin and deltamethrin and endosulfan, fenthion and malathion, respectively.

In another experiment conducted by Dhingra and Sarup (1992), the order of toxicity of different pesticides on the basis of LC_{50} values (by taking the LC_{50} value of lindane as unity), was lambda cyhalothrin > alphamethrin > decamethrin > cypermethrin > fenpropathrin > fenvalerate > pyrethrin > monocrotophos > methyl parathion > malathion > carbaryl > phosphamidon > dimethoate > lindane with their relative toxicity values being 356.65, 115.14, 101.57, 39.88, 14.48, 13.21, 12.81, 12.02, 9.41, 6.94, 6.77, 6.54, 3.40 and 1.00, respectively. Evidently, synthetic pyrethroids were relatively more toxic than natural pyrethrin. The value of students‘t test' indicated that lambda cyhalothrin was significantly more toxic than the remaining pyrethroids. Also, alphamethrin and decamethrin were superior to the rest of synthetic pyrethroids tested. The toxicity values of fenproprathrin, fenevalerate and pyrethrin were at par. LC_{50} values for commonly used and recommended insecticides determined during the last two and a half decades (1968-1991) revealed a pronounced shift in the level of susceptibility of blister beetle to phosphamidon, malathion and lindane showing about 18.07, 2.57 and 1.54 increase in the LC_{50} values, respectively. However, the shift in the level of susceptibility of *M. pustulata* to synthetic pyrethroids was much pronounced within a short span of nine years (1983-1991). There were 82.7, 63.2 and 19.1 times increase in the LC_{50} values of decamethrin, cypermethrin and fenevalerate. On the other hand, toxicity of pyrethrum to *M. pustulata* remained more or less the same, the LC_{50} values being 0.040 in 1983 and 0.059 worked out during 1991. Obviously, response of *M. pusulata* to pyrethrum did not change significantly. The usually recommended endosulfan for various pests infesting different crops, however, was practically ineffective against the blister beetle. The situation remained almost the same as existed nearly quarter of a century ago. On the other hand, carbaryl, also commonly used for the control of various pests of blister beetle, showed that it developed 3.19 fold resistances after a lapse of about 25 years. Evidence of development of resistance in *M. pustulata* to synthetic pyrethroids, carbamate, organophosphates and chlorinated hydrocarbons was thus, experimently obtained.

Singh *et al* (1992) conducted an experiment on the management of blister beetles on pigeonpea cultivar (ICPL 85010) and observed that recommended insecticide endosulfan 35 EC @ 2 ml l^{-1} of water proved ineffective in controlling this pest. In field tests, endosulfan could kill only a few young beetles and the yield losses went up to 80 per cent, which were similar to the untreated control. On the basis of two years observations, it was concluded that

2-3 sprays of systemic insecticide phosphamidon 85 SL (Dimecron®) @ 2 ml $l^{-1}$of water, at intervals of 12-15 days , commencing from the time of appearance of blister beetles, usually in the month of September with the onset of flowering, proved highly effective in controlling the beetles, killing a majority of the beetles within an hour of spray. Ultimately, this resulted in higher seed yield (3500 kg ha^{-1}).

Chandel and Sood (1996) studied the effect of insecticides cypermethrin (0.002 per cent), fenvalerate (0.002 per cent), deltamethrin (0.002 per cent), carbaryl (0.1 per cent) malathion (0.05 per cent), monocrotophos (0.05 per cent), fenitrothion (0.05 per cent), endosulfan (0.05 per cent), methyl (0.05 per cent), quinalphos (0.05 per cent) and a neem product 'Achook' (5 g l^{-1} water) for the control of *M. macilenta* on rajmash (*Phaseolus vulgaris*). Pyrethroids were superior to other insecticides. However, cypermethrin was highly effective and beetle activity was not recorded in treated plots upto 20 days after spraying. Crop yield was also greater in plots treated with pyrethroids.

Durairaj and Ganapathy (1996) studied the susceptibility of beetles (*M. pustulata, M. thunbergii* and *Mylabris* sp.) to insecticides on ‘Vamban 1’ pigeonpea plants in flowering. The results revealed that mortality in *M. pustulata* was 100 per cent after 6 h in fenevalerate 0.02 per cent and cypermethrin 0.025 per cent, whereas carbaryl 0.05 per cent caused 100 per cent mortality after 12 h. Endosulfan and methyl-o-demeton were least effective even after 12 h (26.7 and 33.3 per cent mortality only). Complete beetle mortality (*M. thunbergii*) was observed in chlorpyriphos and cypermethrin after 6 h, whereas dichlorvos, carbaryl and malathion caused 100 per cent mortality after 12 h, with endosulfan being least effective (55.3 per cent). In the case of *Mylabris* sp., 100 per cent mortality was caused by the dichlorvos, chlorpyriphos, fenevalerate and cypermethrin after 6 h whereas endosulfan, dimethoate, methyl-o-demeton and malathion caused 100 per cent mortality after 12 h. Among the 3 blister beetle species, *M. pustulata* was more cosmopolitan with a wider host range and thus was exposed to more insecticides. Hence, this species was least susceptible to most insecticides except pyrethroids. In case of other 2 species, *M. thunbergii* and *Mylabris* sp. have recently been recorded (Durairaj and Ganapathy, 1996) on pigeonpea. Since these two species have been exposed to insecticidal environment recently, their susceptibility was also more. Of the three species, *Mylabris* sp. was very susceptible to dichlorvos, carbaryl, chlorpyriphos, fenevalerate, cypermethrin, endosulfan, dimethoate, methyl-o-demeton and melathion. *M. pustulata* was susceptible only to the two pyrethroids. Hence, it is evident that *M. pustulata* developed higher level of resistance to insecticides while *M. thunbergii* showed moderate level of resistance, and *Mylabris* sp. was highly susceptible to commonly used insecticides in pigeonpea. Thus, the selection of insecticide depends more on the prevalence of specific blister beetle species in pigeonpea.

Verma *et al* (1997) observed complete control of *M. pustulata* was achieved by spraying with 0.075 per cent methyl parathion (Metacid 50 EC) in the saplings of *Paulownia tomentosa*

Prasad and Dimri (1998) studied the efficacy of some insecticides for the control of blister beetle, *Mylabris* spp. on okra and studies revealed that decamethrin (0.025 per cent) and monocrotophos (0.05 per cent) gave good control of this pest.

Durairaj and Ganapathy (1999) evaluated the toxicity of nine insecticides (endosulfan, dichlorvos, carbaryl, chlorpyrifos, dimethoate, methyl-O-demeton [demeton-O-methyl], malathion, fenvalerate and cypermethrin) towards *Mylabris* sp., *M. pustulata* and *M. thunbergii* under laboratory conditions on the Vamban 1 variety of pigeonpea. *Mylabris* sp. was very suspectible to all insecticides, whereas *M. pustulata* was suspectible to fenvalerate and cypermethrin only. *M. thunbergii* showed moderate levels of resistance.

Oudhia (2000) studied the effect of aqueous leaf extracts (1:10 w/v) of 20 plants against *Zonabris pustulata* [*M. pustulata*]. Maximum mortality (45 per cent) was noted for *Euphorbia hirta* leaf extract. Extracts of *Lantana camara*, *Cassia tora*, *Acalypha hispida*, *Croton sparsiflorus*, *Calliandra haemetocephala* and *Polyanthus tuberose* caused mortality levels ranging from 23 to 35 per cent. *Calotropis gigantea*, *Datura stramonium, Sida acuta*, *Tephrosia purpurea*, *Achyranthes aspera*, *Jasminum sambac* and *Psidium guajava* leaf extracts did not cause significant *M. pustulata* mortality.

Dikshit *et al* (2001) studied the effect of insecticides beta-cyfluthrin @ 18.75 g a.i. ha^{-1}, deltamethrin @ 20 g a.i. ha^{-1}, endosulfan @ 700 g a.i. ha^{-1} and neem Azal (Azadirachtin 50000 ppm) @ 500 ml ha^{-1} when sprayed on sponge gourd (*Luffa cylindrica*). The results showed that deltamethrin @ 20 g a.i. ha^{-1} sprayed on okra at the fruiting stage caused 76.2 per cent reduction over control. However, beta-cyfluthrin and deltamethrin treatments were at par for their efficacy after 8 and 12 days of spraying against *M. pustulata*.

CHAPTER III

MATERIAL AND METHODS

The investigations on the crop losses by blister beetle, *Mylabris pustulata* on pigeonpea and mungbean and its management were carried out under caged as well as field conditions during *kharif* 2010 and 2011. Studies on the seasonal abundance and management of blister beetle on pigeonpea and mungbean were conducted at Entomological Research Farm, Department of Entomology and Research Farms of Pulses Section, Department of Plant Breeding and Genetics. Experiments on host preference of *M. pustulata* towards different pulse crops were conducted at Entomological laboratory of Pulses Section, Punjab Agricultural University, Ludhiana.

3.1 Seasonal abundance of blister beetle on pigeonpea and mungbean

A field experiment was carried out at research farms of Pulses Section, Department of Plant Breeding and Genetics, Punjab Agricultural University, Ludhiana during *kharif* 2011. The experiment was laid out in a factorial randomized block design (RBD) with five replications. Pigeonpea variety PAU 881 and mungbean variety PAU 911 were sown in an area of 250 sq. m. each as per recommended agronomic practices (Anonymous 2012a). The data on seasonal abundance of blister beetle were recorded by observing the population density of beetles on pigeonpea (Plate 1) and mungbean crop (Plate 2) at weekly interval from 10 randomly selected rows each of 4 meter length in pigeonpea and 10 quadrates of 1 sq. m. area each in mungbean. To observe diurnal variation in beetle population, data were recorded during morning (6 – 8 AM), noon (12 – 2 PM) and evening hours (4 – 6 PM) on both the crops.

3.2 Crop losses under field conditions

A field trial was conducted at Entomological Research Farm, Department of Entomology, Punjab Agricultural University, Ludhiana during *kharif* 2011. The experiment was laid out by using student’s-test’ with five replications. Pigeonpea variety PAU 881 and mungbean variety PAU 911 were sown in replicated five plots, each measuring 10 m x 10 m as per recommended agronomic practices (Anonymous 2012a). Pigeonpea and mungbean crops were sprayed with spinosad 45 SC @ 150 ml ha^{-1}, recommended for the control of pod borer at flower initiation of crop. In case of pigeonpea, 10 shoots from each replication were randomly tagged and covered with muslin bags to protect them from blister beetle damage (Plate 3). However, to compare the losses (due to blister beetle alone), another set of 10 shoots from each replication were tagged in which the beetles were allowed to feed freely from the initiation to the termination of flowering.

In case of mungbean, 10 plants from each replication were randomly tagged and covered with muslin bags at flowering to protect them from any damage by blister beetle

Plate 1: Seasonal abundance of *M. pustulata* on pigeonpea

Plate 2: Seasonal abundance of *M. pustulata* on mungbean

Plate 3: Crop losses by *M. pustulata* on pigeonpea under field conditions

Plate 4: Crop losses by *M. pustulata* on mungbean under field conditions

(Plate 4). To compare the crop losses by blister beetle in mungbean, another set of 10 randomly selected plants were tagged from each of the five replications in which beetles were allowed to feed freely from initiation to termination of flowers.

Number of flowers damaged:

In the unprotected crop, the population of blister beetle was recorded regularly at flower initiation to record the number of flowers damaged by blister beetle and compared with protected crop by visual observation. The data were analyzed on per plant basis.

Number of flowers developed into pods:

The number of flowers developed into pods was counted from the tagged shoots (not covered with muslin) and compared with shoots covered by muslin bags. The data were analyzed on per plant basis.

Number of seeds per pod:

The numbers of seeds per pod were counted after harvesting all the pods from the tagged shoots (not covered with muslin) and compared with shoots covered with muslin bags. The data were analyzed on per plant basis.

Grain yield:

Harvesting of the pods from both protected and unprotected plants were carried out at crop maturity. For each treatment, total number of pods was counted replication-wise. The number of seeds per pod and total seed weight of all the pods per plant were calculated from each of the five replications of both protected and unprotected plants. To work out losses in grain (seed) yield due to blister beetle, the yield from both protected and unprotected plants were recorded separately.

Pest population:

The pest population was recorded from tagged plants by counting the number of adult beetles per plant from both the crops.

3.3 Crop losses under net house/caged conditions

A.) Pigeonpea

The experiment was laid out in a randomized block design (RBD). The 100 plants of pigeonpea variety PAU 881 were treated as one plot. At bud initiation stage, each plot was separately caged with a net house measuring 8m x 6m x 3m made up of plastic wire mesh. At the time of 50 per cent flowering, field collected adult beetles of *M. pustulata* (starved for 3 hours) were released in each cage @ 100 and 200 beetles per cage. Dead beetles were replaced with live ones until the completion of flowering period to maintain uniform density of one and two beetles per plant inside net house (Plate 5). Each treatment consisted of five replications. One plot was kept as control (without beetle population). Pigeonpea crop was raised as per recommended agronomic practices (Anonymous 2012a).

B.) Mungbean

A nylon plastic wire mesh cage measuring 80 cm x 55 cm was placed on individual plant. The plants in different treatments were exposed to field collected beetles @ 1, 2, and 4 beetles per cage at flowering. Three cages for each population (one plant per cage) were maintained until completion of flowering period (Plate 6). One plot was kept as control without beetle population. Each treatment had four replications. Mungbean crop was raised as per recommended agronomic practices (Anonymous 2012a).

At harvesting, the following observations were recorded from both the crops:

(i) Total number of mature pods

(ii) Total number of seeds per pod

(iii) Grain yield (g plant^{-1})

(iv) Pest population (per plant)

The data were compared with observations collected from control plots to record the per cent reduction in pod setting, seed setting and losses in yield.

3.4 Feeding preference by blister beetle on different pulse crops

An experiment was carried out to study the feeding preference of beetles on different pulse crops at Entomological Laboratory of Pulses Section, Department of Plant Breeding and Genetics, Punjab Agricultural University, Ludhiana during *kharif* 2011. Pigeonpea varieties (PAU 881 and AL 201), mungbean varieties (PAU 911 and ML 818) and urdbean varieties (Mash 114 and Mash 338) were sown on an area of 600 sq m (100 sq m for each variety) at research farms of Pulses Section, Department of Plant Breeding and Genetics, Punjab Agricultural University, Ludhiana to get continuous supply of flowers of these varieties. Ten flowers of each variety were plucked along with petiole and kept in Petri dish on 3 per cent agar-agar medium to maintain freshness of flowers, which were further kept in insect rearing tub covered with muslin at equi-distance from center (Plate 7). A total of five beetles were released in each tub in the center. Fresh flowers were provided to the beetles after every six hours thrice a day. Each treatment was replicated thrice. The same procedure was followed after 15 days in the month of September and October during the entire crop season. Factorial completely randomized design (CRD) was used to analyze the data.

The observations were made after 6 hours of release and data were recorded on the total number of flowers eaten or damaged by the beetles in each variety of pigeonpea, mungbean and urdbean (Plate 8).

3.5 Management of blister beetle

The experiments for the management of blister beetle on pigeonpea and mungbean were conducted at Pulses Section, Department of Plant Breeding and Genetics, Punjab

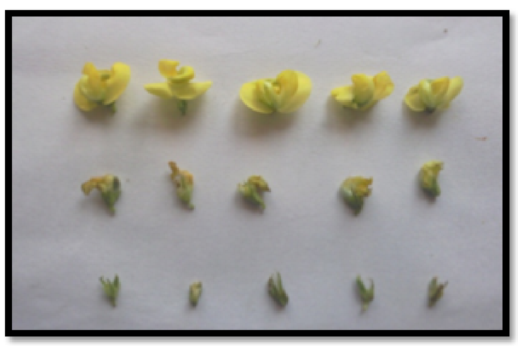
Plate 5: Crop losses by *M. pustulata* on pigeonpea under net house conditions

Plate 6: Crop losses by *M. pustulata* on mungbean under caged conditions

Plate 7: Feeding preference of *M. pustulata* on pigeonpea, mungbean and urdbean

(a) Pigeonpea

(b) Mungbean



(c) Urdbean

Plate 8: Flower damage by *M. pustulata* on different pulse crops

Agricultural University, Ludhiana. The experiment was laid out in a randomized block design (RBD) having three replications for both pigeonpea and mungbean.

Pigeonpea variety PAU 881 and mungbean variety PAU 911 was sown in an area of 1000 sq m each using recommended agronomic practices (Anonymous 2012a). The area were divided into 42 equal plots each of size of 5x4 sq. m. Mechanical control with hand picking and destruction of the beetles in the morning hours were done starting at initiation of flowers at weekly interval. Chemical control with different doses of insecticides were applied at the appearance of the pest by using 250-300 liters of water/ acre on both pigeonpea and mungbean crop. One blanket spray of spinosad 45 SC @ 150 ml ha^{-1} was also done for the control of pod borers on pigeonpea and mungbean and triazophos 40 EC @ 1500 ml ha^{-1} against white fly in mungbean at bud initiation stage**.** The observations on number of beetles per 4 m row length in pigeonpea and per 1 sq m quadrate in mungbean were recorded at 3, 7 and 10 days after spray (DAS). At harvesting the grain yield were recorded for each treatment and compared with control plots.

Treatments:

1) Mechanical control: Hand picking and destruction.
2) Cypermethrin 25 EC @ 125 ml ha^{-1}
3) Cypermethrin 25 EC @ 187.5 ml ha^{-1}
4) Cypermethrin 25 EC @ 250 ml ha^{-1}
5) Deltamethrin 2.8 EC @ 375 ml ha^{-1}
6) Deltamethrin 2.8 EC @ 437.5 ml ha^{-1}
7) Deltamethrin 2.8 EC @ 500 ml ha^{-1}
8) Indoxacarb 14.5 SC @ 375 ml ha^{-1}
9) Indoxacarb 14.5 SC @ 437.5 ml ha^{-1}
10) Indoxacarb 14.5 SC @ 500 ml ha^{-1}
11) Chlorpyriphos 20 EC @ 2500 ml ha^{-1}
12) Chlorpyriphos 20 EC @ 3750 ml ha^{-1}
13) Endosulfan 35 EC @ 2500 ml ha^{-1}
14) Water spray (control).

CHAPTER IV

RESULTS AND DISCUSSION

Studies were conducted on the crop losses and management of blister beetle, (*Mylabris pustulata* Thunberg) on pigeonpea and mungbean at Research Farm and in the Entomological laboratory of Pulses Section, Department of Plant Breeding & Genetics, Punjab Agricultural University, Ludhiana. The results of the present investigations have been presented and discussed under the following headings:

4.1. Seasonal abundance of blister beetle.

4.2. Crop losses by blister beetle in pigeonpea and mungbean under field conditions.

4.3. Crop losses by blister beetle in pigeonpea and mungbean under net house/ caged conditions.

4.4. Study of feeding preference of beetles towards different pulse crops.

4.5. Management of blister beetle on pigeonpea and mungbean.

4.1 Seasonal abundance of blister beetle

In this experiment, the seasonal incidence and activity period of blister beetle was observed during the flowering period of pigeonpea and mungbean crop. The data was taken regularly at weekly intervals during August, September, October and November months. The experiment was conducted under field conditions during different months of the crop season and results are summarized in Table 1 and Table 2.

4.1.1 Seasonal abundance of blister beetle on pigeonpea (Week basis)

The data from Table 1 revealed that the adults of blister beetle started appearing on pigeonpea crop in the end of 3rd week of August (0.01 beetles/ 4 meter row length). An increasing trend in the population of blister beetle was observed with the peak period of activity registered during the 4th week of September (21.04 beetles/ 4 meter row length). The activity of *M. pustulata* lasted until 4th week of October coinciding with the maximum flowering of pigeonpea during crop season.

The data on pooled mean revealed that highest number of beetles was observed during 4th week of September (13.90 beetles/4 meter row length) followed by 3rd week of September (10.64 beetles/4 meter row length). However, after 4th week of September, the beetle population started declining (Fig. 1). On an average, the total number of beetles recorded per 4 meter row length was 0.12 during August, 8.21 during September and 5.04 during October on pigeonpea. The present study is in agreement with Mahal *et al* (1989) who observed that the adults of blister beetle started appearing on pigeonpea in late August under

Punjab conditions. The beetles were observed feeding on the floral parts and damage the terminal portion of the unopened flower buds and different parts of flowers, including keel of corolla and petals until the end of October and the peak activity of blister beetle was in the last week of September.

Table 1 Seasonal abundance of *M. pustulata* on pigeonpea

Month of observation	Week of observation	Mean of population of blister beetle/ 4 meter row length			Mean
		Morning (6-8 AM)	Noon (12-2 PM)	Evening (4-6 PM)	
August	1st - 3rd	0 (1.00)	0 (1.00)	0 (1.00)	0 (1.00)
	4th	0.59 (1.26)	0.01 (1.01)	0.88 (1.37)	0.49 (1.21)
	Mean	0.30 (1.13)	0.005 (1.003)	0.44 (1.19)	
C.D. (p = 0.05) (Week) = 0.02 C.D. (p = 0.05) (Time) = 0.02 C.D. (p = 0.05) (Interaction)= 0.04					
September	1st	2.16 (1.78)	0.20 (1.10)	4.69 (2.38)	2.35 (1.75)
	2nd	7.23 (2.87)	0.30 (1.14)	10.29 (3.36)	5.94 (2.46)
	3rd	14.37 (3.92)	0.36 (1.17)	17.18 (4.26)	10.64 (3.12)
	4th	20.23 (4.61)	0.43 (1.20)	21.04 (4.69)	13.90 (3.50)
	Mean	10.99 (3.29)	0.32 (1.15)	13.30 (3.68)	
C.D. (p = 0.05) (Week) = 0.05 C.D. (p = 0.05) (Time) = 0.04 C.D. (p = 0.05) (Interaction) = 0.08					
October	1st	16.20 (4.15)	0.37 (1.17)	13.94 (3.87)	10.17 (3.06)
	2nd	11.03 (3.47)	0.33 (1.15)	8.60 (3.10)	6.65 (2.57)
	3rd	5.03 (2.46)	0.25 (1.12)	2.89 (1.97)	2.72 (1.85)
	4th	1.41 (1.55)	0.03 (1.01)	0.46 (1.21)	0.63 (1.26)
	Mean	8.42 (2.91)	0.25 (1.11)	6.47 (2.54)	
C.D. (p = 0.05) (Week) = 0.04 C.D. (p = 0.05) (Time) = 0.03 C.D. (p = 0.05) (Interaction) = 0.06					

Figures in parentheses are ($\sqrt{n+1}$) transformations

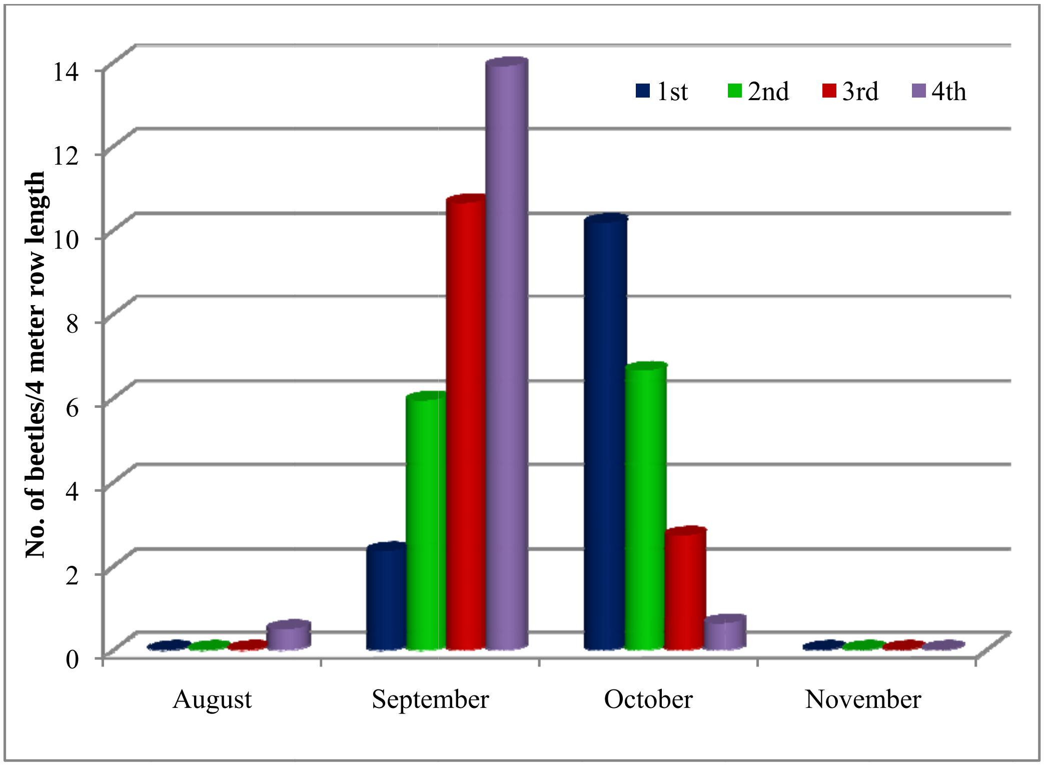


Fig. 1 Population dynamics of *M. pustulata* on pigeonpea (Weekly basis)

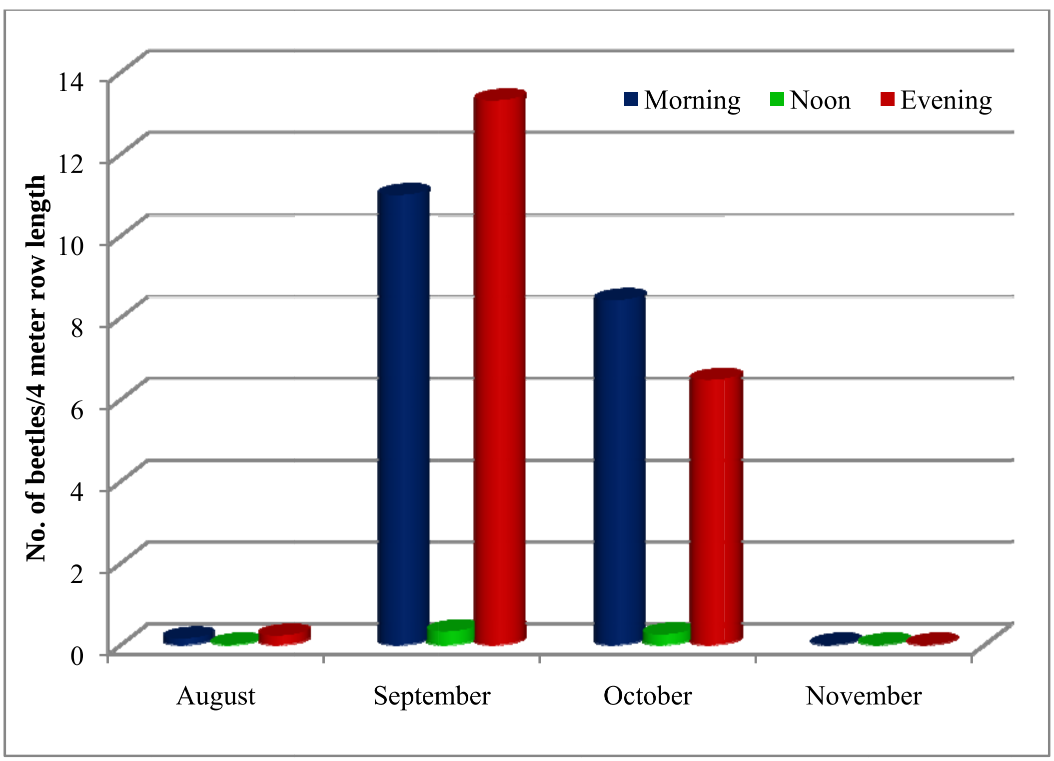


Fig. 2 Population dynamics of *M. pustulata* on pigeonpea (Time basis)

The present investigations also in agreement with Durairaj and Ganapathy (1996) who reported that due to the continuous availability of hosts viz. green gram, black gram, cowpea and pigeonpea, blister beetle occurs throughout the year with a peak incidence (12.3-19.4 beetles per plant) between August and October, which coincides with the flowering period of pigeonpea. It was also observed that pigeonpea was the most preferred host crop followed by cowpea, black gram, and green gram.

4.1.2 Seasonal abundance of blister beetle on pigeonpea (Time basis)

The studies carried out on studying the activity time of blister beetle on pigeonpea revealed that the beetles were more active in the morning and evening hours (Table 1) and the average population of blister beetle was 6.52 and 6.66 beetles/4 meter row length, respectively. The population at noon hours was relatively low (0.19 beetles/4 meter row length) and the beetles preferred to feed on the lower branches, preferably opposite the direction of the sun. The beetle population during morning, noon and evening times differed statistically from each other.

Pooled data of entire crop season of pigeonpea revealed that maximum blister beetle population in the morning was 20.23 beetles/4 meter row length during the 4th week of September while in case of evening hours, the maximum blister beetle population was 21.04 beetles/4 meter row length during the 4th week of September (Fig. 2). Results showed that the activity of blister beetle was low during noon hours, reaching maximum upto 0.43 beetles/4 meter row length. Our study is in agreement with Mahal *et al* (1989) who reported that the activity of blister beetle was more in the morning and evening hours on pigeonpea. Similarly, Mann and Dhooria (1993) also reported that the feeding activity of blister beetle was highest between 9 AM and 10 PM and again between 4 PM and 5 PM. Between these two periods of the day, feeding activity was comparatively lower.

4.1.3 Seasonal abundance of blister beetle on mungbean (Week basis)

The data presented in Table 2 revealed that the adults of blister beetle started appearing on mungbean crop from the end of 4th week of August (0.31 beetles/1 sq. meter quadrate) during *kharif* 2011. An increasing trend in the population of blister beetle was observed with the peak activity period registered during the 4th week of September (8.06 beetles/1 sq. meter quadrate). The activity of *M. pustulata* lasted until 3rd week of October with the peak coinciding with the maximum flowering of mungbean during crop season.

The pooled mean of the data revealed that highest number of beetles was recorded on 4th week of September (5.48 beetles/1 sq. meter quadrate) followed by 3rd week of September (4.62 beetles/1 sq. meter quadrate). However, after 4th week of September, the beetle population started declining (Fig. 3). On an average, the total number of beetles recorded per

1 sq. meter quadrate was 0.07 during August, 3.50 during September and 1.65 during October on mungbean.

Table 2 Seasonal abundance of *M. pustulata* on mungbean

Month of observation	Week of observation	Mean of population of blister beetle/ 1 sq. meter quadrate			Mean
		Morning (6-8 AM)	Noon (12-2 PM)	Evening (4-6 PM)	
August	1^{st} -3^{rd}	0 (1.00)	0 (1.00)	0 (1.00)	0 (1.00)
	4^{th}	0.31 (1.14)	0.03 (1.01)	0.45 (1.20)	0.26 (1.12)
	Mean	0.15 (1.07)	0.015 (1.01)	0.23 (1.10)	
C.D. (p = 0.05) (Week) = 0.02 C.D. (p = 0.05) (Time) = 0.02 C.D. (p = 0.05) (Interaction)= 0.03					
September	1^{st}	1.44 (1.56)	0 (1.00)	1.81 (1.68)	1.08 (1.41)
	2^{nd}	3.69 (2.17)	0.22 (1.10)	4.57 (2.36)	2.83 (1.88)
	3^{rd}	6.60 (2.76)	0.33 (1.15)	6.92 (2.81)	4.62 (2.24)
	4^{th}	8.04 (3.01)	0.33 (1.15)	8.06 (3.02)	5.48 (2.39)
	Mean	4.94 (2.37)	0.22 (1.10)	5.34 (2.47)	
C.D. (p = 0.05) (Week) = 0.02 C.D. (p = 0.05) (Time) = 0.02 C.D. (p = 0.05) (Interaction) = 0.03					
October	1^{st}	7.38 (2.89)	0.38 (1.17)	5.94 (2.63)	4.57 (2.23)
	2^{nd}	3.47 (2.11)	0.17 (1.08)	2.33 (1.82)	1.99 (1.67)
	3^{rd}	0.12 (1.06)	0 (1.00)	0 (1.00)	0.04 (1.02)
	4^{th}	0 (1.00)	0 (1.00)	0 (1.00)	0 (1.00)
	Mean	2.74 (1.77)	0.14 (1.06)	2.07 (1.61)	
C.D. (p = 0.05) (Week) = 0.04 C.D. (p = 0.05) (Time) = 0.04 C.D. (p = 0.05) (Interaction) = 0.07					

Figures in parentheses are ($\sqrt{n+1}$) transformations

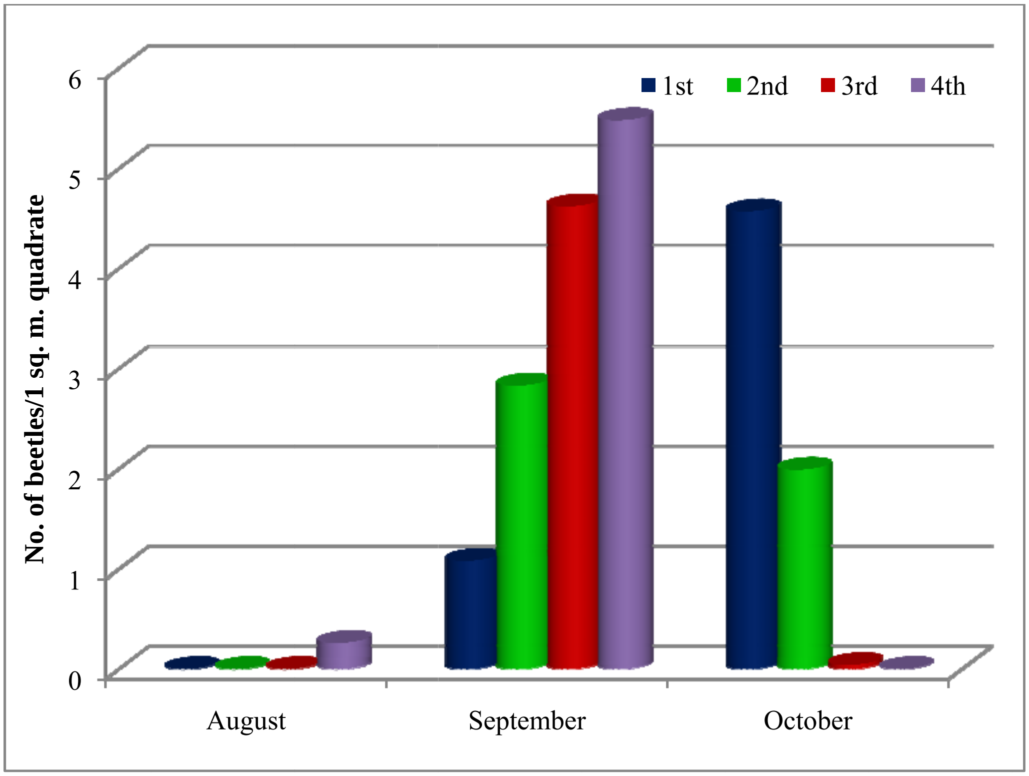


Fig. 3 Population dynamics of *M. pustulata* on mungbean (Weekly basis)

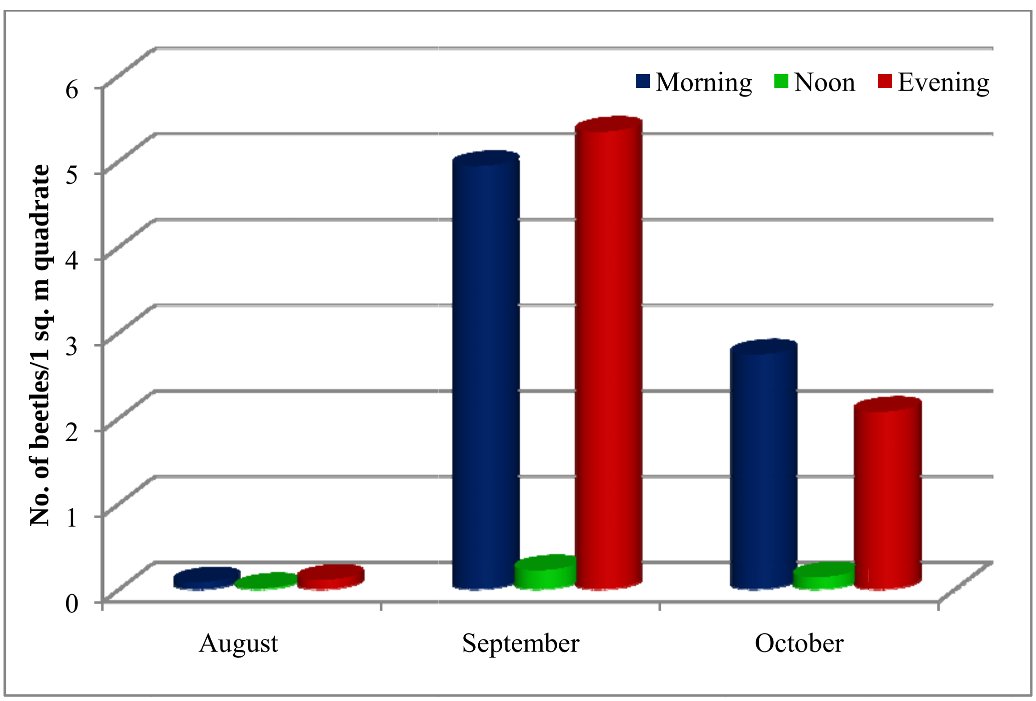


Fig. 4 Population dynamics of *M. pustulata* on mungbean (Time basis)

4.1.4 Seasonal abundance of blister beetle on mungbean (Time basis)

The studies made on activity time of blister beetle on mungbean revealed that the blister beetles were more active in the morning and evening hours (Table 2) with the average population of blister beetle being 2.59 and 2.51 beetles/1 sq. meter quadrate, respectively. The population at noon hours was relatively low at 0.12 beetles/1 sq. meter quadrate and the beetles preferred to feed on the lower branches, preferably opposite the direction of the sun. The beetle population during morning, noon and evening times differed statistically from each other.

Pooled data of entire crop season of mungbean revealed that maximum blister beetle population in the morning was 8.04 beetles/1 sq. meter quadrate during the 4th week of September while in case of evening hours, the maximum blister beetle population was 8.06 beetles/1 sq. meter quadrate during the 4th week of September (Fig. 4). Results showed that the activity of blister beetle was low at noon hours reaching maximum up to 0.33 beetles/1 sq. meter quadrate.

4.2 Crop losses by blister beetle under field conditions

4.2.1 Crop losses by blister beetle in pigeonpea

The studies on crop losses due to blister beetle in pigeonpea crop under field conditions revealed that the flower damaged by blister beetle was 36.20 per cent in unprotected conditions as compared to the protected ones (Table 3). The average number of flowers developed into pods was 90.36 in unprotected and 135.76 in protected plants. The average number of seeds per pod was 3.45 in unprotected and 4.39 in protected conditions. The grain yield per plant was 21.54 g per plant in unprotected and 40.47 g per plant in protected conditions. The pest population under unprotected conditions was 1.96 beetles per plant. Overall, the blister beetle resulted in 53.22 per cent losses in yield of pigeonpea crop under field conditions (Fig. 5). The differences between protected and unprotected conditions for various parameters viz. average number of flowers developed into pods per plant, average number of seeds per pod and grain yield per plant (g) were statistically significant. The findings of the study differ from Mann and Dhooria (1993) who reported that 29 per cent of the buds and 14 per cent of the flowers of pigeonpea were eaten wholly or partially by the beetles. The variations might be due to the differences in genotypes as well as the agroclimatic conditions.

Table 3 Crop losses by *M. pustulata* on pigeonpea under field conditions

Treatment	Number of flowers damaged (%)	Average number of flowers developed into pods per plant	Average number of seeds per pod	Grain yield per plant(g)	Pest population per plant	Yield losses (%)
Unprotected	36.20	90.36	3.45	21.54	1.96	53.22
Protected	0.00	135.76	4.39	40.47	0.00	-
t-test value	-	19.55	13.68	14.13	-	-
p		< 0.05	< 0.05	< 0.05	-	-
S.D.		24.17	0.50	10.17	-	-
S.E.		7.65	0.16	3.22	-	-

4.2.2 Crop losses by blister beetle in mungbean

The study on crop losses done by blister beetle in mungbean crop under field conditions revealed that the percentage of flowers damaged was 15.80 per cent in unprotected conditions as compared to the protected ones (Table 4). The average number of flowers developed was 13.22 in unprotected and 17.94 in protected plants. The average number of seeds per pod was 9.15 in unprotected and 10.63 in protected conditions. The grain yield per plant was 5.16 g per plant in unprotected and 8.05 g per plant in protected conditions. The pest population was 1.3 beetles per plant in unprotected conditions. Overall, the blister beetle caused 35.90 per cent yield losses in mungbean under field conditions (Fig. 6). The differences between protected and unprotected conditions for various parameters viz. average number of flowers developed into pods per plant, average number of seeds per pod and grain yield per plant (g) were statistically significant.

Table 4 Crop losses by *M. pustulata* on mungbean under field conditions

Treatment	Number of flowers damaged (%)	Number of flowers developed into pods per plant	Number of seeds per pod	Grain yield per plant (g)	Pest population per plant	Yield losses (%)
Unprotected	15.80	13.22	9.15	5.16	1.3	35.90
Protected	0.00	17.94	10.63	8.05	0.00	-
t-test value	-	13.01	6.82	13.24	-	-
p	-	< 0.05	< 0.05	< 0.05	-	-
S.D.	-	2.54	0.84	1.56	-	-
S.E.	-	0.80	0.27	0.49	-	-

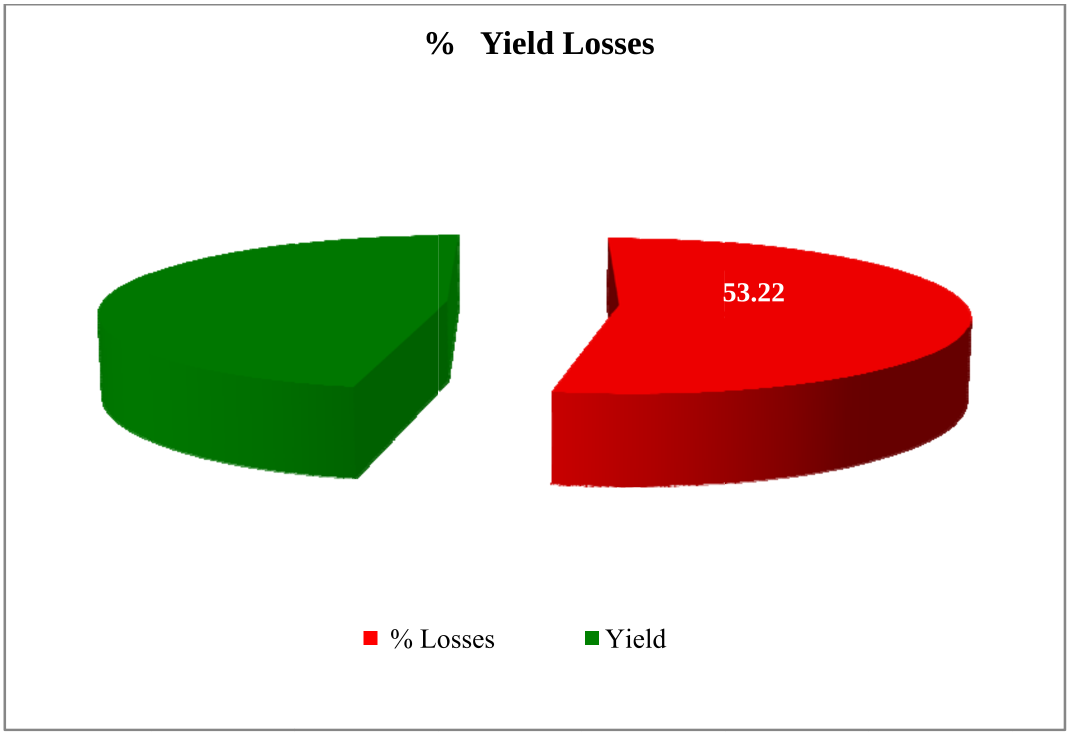


Fig. 5 Per cent yield losses in pigeonpea by *M. pustulata* in unprotected conditions

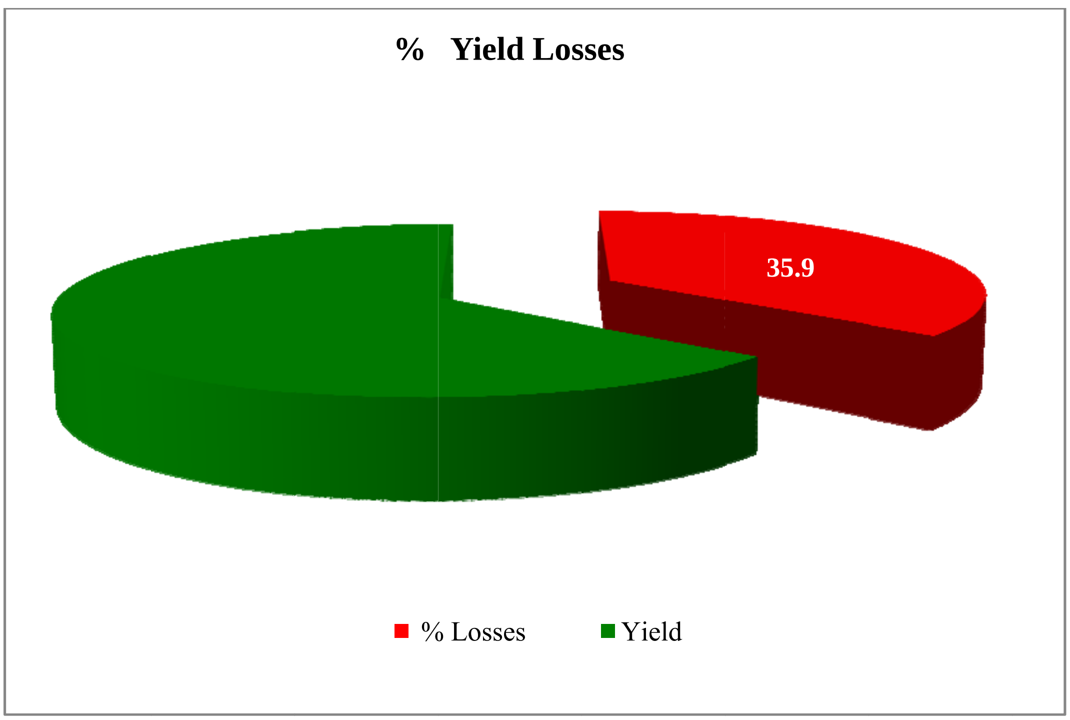


Fig. 6 Per cent yield losses in mungbean by *M. pustulata* in unprotected conditions

4.3 Crop losses by blister beetle under net house/ caged conditions

4.3.1 Crop losses by blister beetle in pigeonpea

Data presented in Table 5 revealed that the per cent yield loss in pigeonpea under net house conditions was 37.74 per cent at beetle density of 1 beetle per plant, while the yield loss was 65.00 per cent when beetle density was 2 beetles per plant. The mean numbers of mature pods per plant were 86.60 in case where the pest density was 1 beetle per plant and 56.60 in case where the pest density was 2 beetles per plant. In case of control plot, the mean number of mature pods per plant was 123.54. This showed the per cent reduction in pod setting was 30.71 at beetle density of 1 beetle per plant and 54.18 per cent reduction when beetle density was 2 beetles per plant. The mean number of seeds per pod developed was 3.78 in case where the pest density was 1 beetle per plant and 3.21 in case where the pest density was 2 beetles per plant. In case of control plot, the mean number of seeds per pod was 4.02. The per cent reduction in seed setting was observed to be 5.97 per cent at beetle density of 1 per plant and 20.15 when density was 2 beetles per plant. The grain yield per plant was 21.58 g per plant in case where the pest density was 1 beetle per plant and 12.14 g per plant in case where the pest density was 2 beetles per plant. In case of control plot, the grain yield was 34.57 g per plant (Fig. 7).

Table 5 Crop losses by *M. pustulata* in pigeonpea under net house conditions

Beetle density	Mean number of mature pods per plant	Per cent reduction in pod setting	Mean number of seeds per pod	Per cent reduction in seed setting	Grain yield per plant (g)	Pest population	Yield losses (%)
100 beetles/ cage	85.60 (9.30)	30.71	3.78 (2.19)	5.97	21.58	1 beetle/ plant	37.64
200 beetles/ cage	56.60 (7.59)	54.18	3.21 (2.05)	20.15	12.14	2 beetles/ plant	65.00
Control (Without beetle)	123.54 (11.16)	-	4.02 (2.24)	-	34.57	0 beetle/ plant	-
C.D. at 5 %	0.19	-	0.04	-	2.20	-	
C.V.	0.99	-	1.35	-	6.63	-	-

Figures in parentheses are (√n+1) transformations

The present study is in close agreement with the experiments conducted by Durairaj and Ganapathy (2000) at Vamban. Yield losses caused by *Mylabris* sp. in two short duration pigeonpea cultivars (Vamban 1 and ICPL 86012) at three beetle densities (50,100, and 150

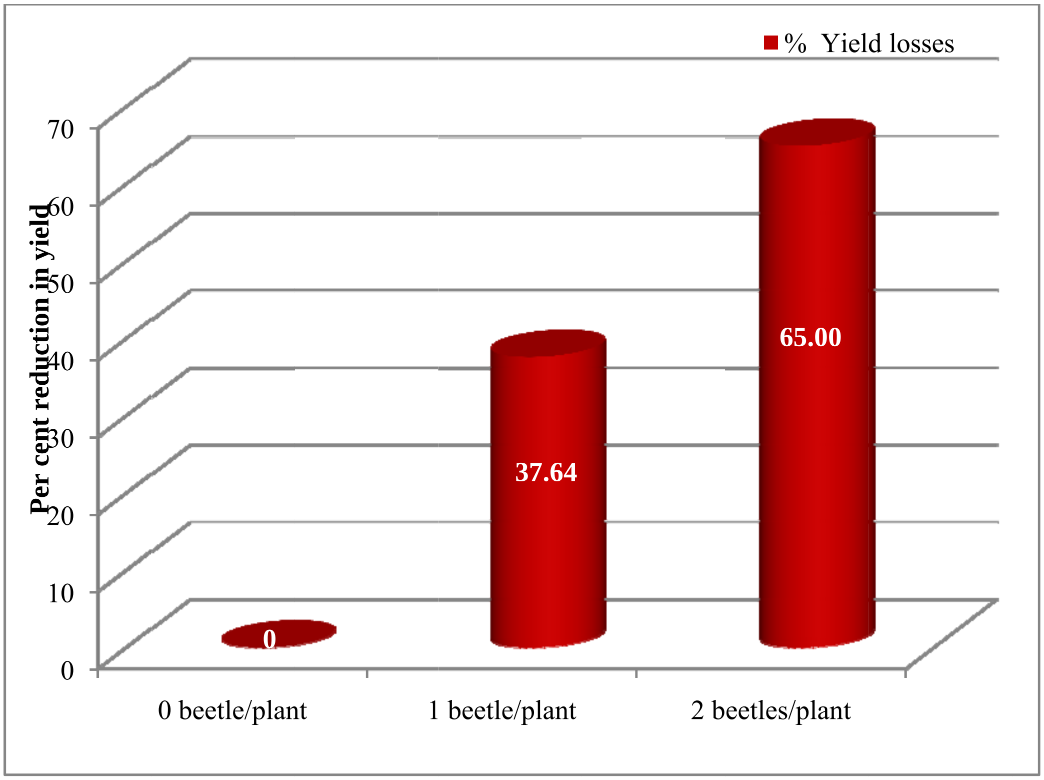


Fig. 7 Per cent yield losses in pigeonpea at various beetle densities

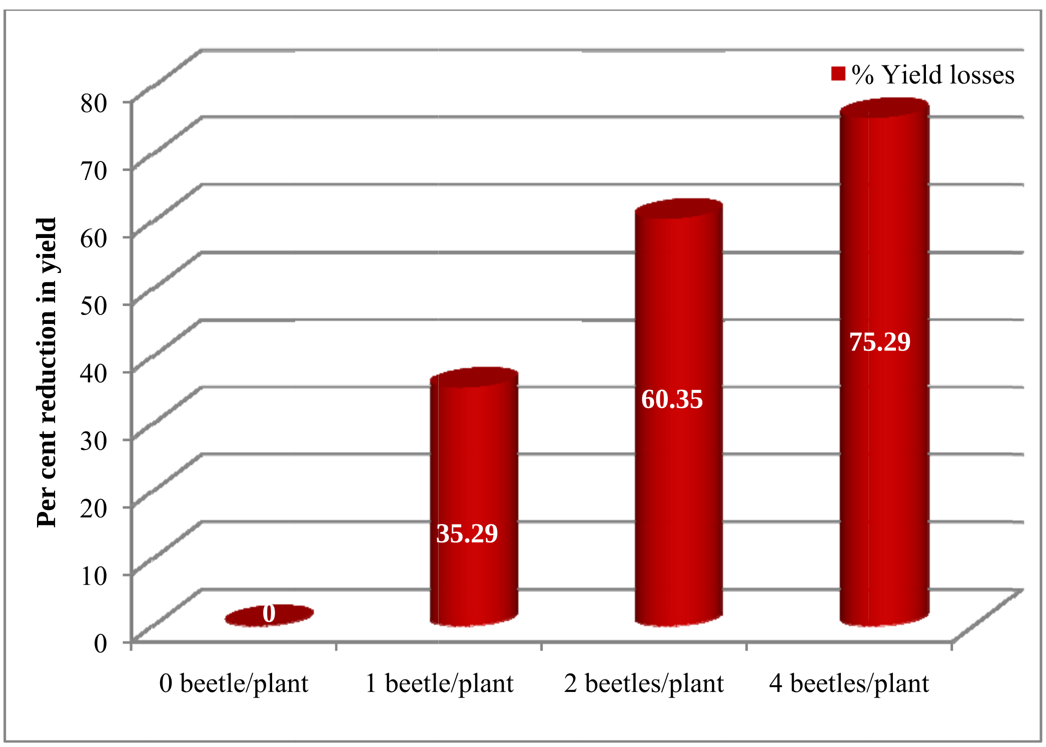


Fig. 8 Per cent yield losses in mungbean at various beetle densities

per 50 plants) were assessed under caged conditions in the field. In both the cultivars, the number of pods set, number of seeds, and seed yield varied inversely with the beetle densities. In Vamban 1, at the lowest beetle density of 50 beetles (one beetle per plant), the number of pods set and the number of seeds per plant were higher (23.9 and 70.0, respectively) with the resultant yield loss of 15.1 per cent. At the highest beetle density of 150 beetles (three beetles per plant), the above parameters showed the minimum levels (2.7 and 7.3, respectively) with the maximum yield loss of 89.5 per cent. In the control, the pod numbers, seed numbers and seed yield per plant were 33.2, 86.0, and 6.0 g, respectively. Similarly in ICPL 86012, at the lowest beetle density (one beetle per plant), pod numbers and seed numbers were higher (23.5 and 52.9, respectively) with comparatively higher seed yield of 5.7 g per plant compared to the control. The variation in seed losses in these two cultivars was not greater, as these two cultivars have a uniform duration of 110 days with almost identical plant architecture with respect to terminal flower clusters. Singh *et al* (1992) also recorded 80 per cent yield loss due to *Mylabris* sp. in pigeonpea. The differences in findings of our study may be due to different varieties of the crop and environmental conditions.

4.3.2 Crop losses by blister beetle in mungbean

The results presented in Table 6 revealed that the mean number of mature pods per plant were 12.25 in case where the pest density was 1 beetle per plant, 8.75 in case where the pest density was 2 beetles per plant and 5.75 in case where the pest density was 4 beetles per plant.

Table 6 Crop losses by *M. pustulata* in mungbean under caged conditions

Beetle density	Mean number of mature pods per plant	Per cent reduction in pod setting	Mean number of seeds per pod	Per cent reduction in seed setting	Grain yield per plant (g)	Pest population	Yield losses (%)
1 beetles/ cage	12.25 (3.64)	30.00	10.24 (3.35)	5.88	5.50	1 beetle/ plant	35.29
2 beetles/ cage	8.75 (3.12)	50.00	9.02 (3.17)	17.10	3.37	2 beetles/ plant	60.35
4 beetles/ cage	5.75 (2.59)	67.14	7.98 (2.99)	26.65	2.10	4 beetles/ plant	75.29
Control (Without beetle)	17.50 (4.30)	-	10.88 (3.45)	-	8.50	0 beetle/ plant	-
C.D. at 5 %	0.11	-	0.03	-	0.17	-	-
C.V.	1.97	-	0.51	-	2.13	-	-

Figures in parentheses are ($\sqrt{n+1}$) transformations

In case of control plot, the mean number of mature pods was 17.50 per plant. This showed the per cent reduction in pod setting was 30.00 per cent at beetle density of 1 beetle per plant, 50.00 per cent reduction when beetle density was 2 beetles per plant and 67.14 per cent reduction when the beetle density was 4 beetles per plant. The mean number of seeds developed per pod was 10.24 in case where the pest density was 1 beetle per plant, 9.02 in case where the pest density was 2 beetles per plant and 7.98 in case where the pest density was 4 beetles per plant. In case of control plot, the mean number of seeds per pod was 10.88.

The per cent reduction in seed setting was observed to be 5.88 per cent at beetle density of 1 beetle per plant, 17.10 per cent reduction when beetle density was 2 beetles per plant and 26.65 per cent reduction when the beetle density was 4 beetles per plant of mungbean. The grain yield per plant was recorded to be 5.50 g per plant in case where the pest density was 1 beetle per plant, 3.37 g per plant in case where the pest density was 2 beetles per plant and 2.10 g per plant in case where the pest density was 4 beetles per plant. In case of control plot, the grain yield was 8.50 g per plant (Fig. 8).

4.4 Study of feeding preference of beetles on different pulse crops

The feeding preference of *M. pustulata* was studied on different varieties of pigeonpea, mungbean and urdbean during entire flowering period of these crops at 15 days interval starting from 1st fortnight of September and October. The results presented in Table 7 showed that the blister beetles preferred to feed upon flowers of pigeonpea crop followed by urdbean and mungbean.

Our study is in agreement with Yadava *et al* (1988) and Durairaj (2000) who concluded that among the major pulse crops, pigeonpea is the highly preferred host followed by cowpea, urdbean and mungbean by the blister beetle.

<u>Pigeonpea</u>

Pigeonpea variety AL 201 was more preferred by *M. pustulata* at different intervals of the day (Table 7) as the flowers eaten after 6 hours of release were 96.67 per cent while in case of PAU 881, the flowers eaten were 83.33 per cent. The trend in the feeding of flowers was same even after 12 hours of release i.e., significantly higher in AL 201 (93.33 per cent) and significantly less in PAU 881 (83.33 per cent). After 18 hours of release, AL 201 variety was preferred more (90.00 per cent flowers eaten) as compared to variety PAU 881 (73.33 per cent flowers eaten) during the 1st fortnight of September. In the 2nd fortnight of September, the flowers of pigeonpea variety AL 201 eaten after 6 hours of release were 96.67 per cent while in case of PAU 881 flowers eaten were 83.33. The trend in the feeding of flowers was same even after 12 hours of release i.e., significantly more in AL 201 (96.67 per cent) and less in PAU 881 (86.67 per cent). After 18 hours of release AL 201 variety was

Table 7 **Feeding preference of *M. pustulata* on pigeonpea, mungbean and urdbean**

Month interval	Time interval	Per cent flowers eaten or damaged by *M. pustulata* under laboratory conditions								
		Pigeonpea			Mungbean			Urdbean		
		PAU 881	**AL 201**	**Mean**	**PAU 911**	**ML 818**	**Mean**	**Mash 114**	**Mash 338**	**Mean**
September (1st fortnight)	After 6 hours	83.33 (66.12)	96.67 (83.82)	90.00 (74.97)	26.67 (30.98)	40.00 (39.13)	33.33 (35.06)	46.67 (43.06)	60.00 (50.75)	53.33 (46.90)
	After 12 hours	83.33 (66.12)	93.33 (77.68)	88.33 (71.90)	26.67 (30.98)	36.67 (37.21)	31.67 (34.10)	40.00 (39.13)	56.67 (48.83)	48.33 (43.98)
	After 18 hours	73.33 (59.68)	90.00 (74.97)	81.67 (76.33)	23.33 (28.77)	33.33 (35.20)	28.33 (31.99)	33.33 (34.91)	50.00 (44.98)	41.67 (39.95)
	Mean	79.99 (63.97)	93.33 (78.82)		25.56 (30.25)	36.67 (37.18)		40.00 (39.03)	55.56 (48.19)	
		C.D. (p = 0.05) (Time) = NS C.D. (p = 0.05) (Varieties) = 10.01 C.D. (p = 0.05) (Interaction) = NS			C.D. (p = 0.05) (Time) = NS C.D. (p = 0.05) (Varieties) = 4.26 C.D. (p = 0.05) (Interaction) = NS			C.D. (p = 0.05) (Time) = NS C.D. (p = 0.05) (Varieties) = 5.58 C.D. (p = 0.05) (Interaction) = NS		
September (2nd fortnight)	After 6 hours	83.33 (66.61)	96.67 (83.82)	90.00 (75.22)	26.67 (30.98)	33.33 (34.91)	30.00 (32.95)	36.67 (37.21)	50.00 (44.98)	43.34 (41.10)
	After 12 hours	86.67 (68.83)	96.67 (83.82)	91.67 (76.32)	26.67 (30.77)	36.67 (37.21)	31.67 (33.99)	33.33 (35.21)	46.67 (43.06)	40.00 (39.13)
	After 18 hours	83.33 (66.11)	96.67 (83.82)	90.00 (74.97)	23.33 (28.77)	30.00 (33.20)	26.67 (30.98)	33.33 (35.21)	46.67 (43.06)	40.00 (39.13)
	Mean	84.44 (67.19)	96.67 (83.82)		25.56 (30.18)	33.33 (35.11)		34.44 (35.87)	47.48 (43.70)	
		C.D. (p = 0.05) (Time) = NS C.D. (p = 0.05) (Varieties) = 8.96 C.D. (p = 0.05) (Interaction) = NS			C.D. (p = 0.05) (Time) = NS C.D. (p = 0.05) (Varieties) = 4.35 C.D. (p = 0.05) (Interaction) = NS			C.D. (p = 0.05) (Time) = NS C.D. (p = 0.05) (Varieties) = 4.02 C.D. (p = 0.05) (Interaction) = NS		

Contd…

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Month interval	Time interval	Per cent flowers eaten or damaged by *M. pustulata* under laboratory conditions								
		Pigeonpea			Mungbean			Urdbean		
		PAU 881	**AL 201**	**Mean**	**PAU 911**	**ML 818**	**Mean**	**Mash 114**	**Mash 338**	**Mean**
October	After 6 hours	80.00 (63.90)	96.67 (83.82)	88.34 (73.83)	26.67 (30.98)	36.67 (37.21)	31.67 (34.10)	40.00 (39.22)	46.67 (43.06)	43.34 (41.14)
	After 12 hours	76.67 (61.69)	93.33 (77.68)	85.00 (69.68)	26.67 (30.98)	36.67 (37.21)	31.67 (34.10)	36.67 (37.13)	50.00 (44.98)	43.34 (41.05)
	After 18 hours	73.33 (58.98)	86.67 (68.83)	80.00 (63.90)	23.33 (28.77)	33.33 (35.20)	28.33 (31.99)	30.00 (32.99)	46.67 (43.06)	38.34 (38.02)
	Mean	76.67 (61.52)	92.22 (76.78)		25.56 (30.25)	35.56 (36.54)		35.56 (36.44)	47.78 (43.70)	
		C.D. (p = 0.05) (Time) = NS C.D. (p = 0.05) (Varieties) = 8.29 C.D. (p = 0.05) (Interaction) = NS			C.D. (p = 0.05) (Time) = NS C.D. (p = 0.05) (Varieties) = 3.76 C.D. (p = 0.05) (Interaction) = NS			C.D. (p = 0.05) (Time) = NS C.D. (p = 0.05) (Varieties) = 5.55 C.D. (p = 0.05) (Interaction) = NS		

Figures in parentheses are angular transformations more preferred (96.67 per cent flowers eaten) as compared to variety PAU 881 (83.33 per cent flowers eaten). In the month of October the flowers of pigeonpea variety AL 201 eaten after 6 hours of release were 96.67 per cent while in case of PAU 881 flowers eaten were 80.00 per cent. The trend in the feeding of flowers was same even after 12 hours of release i.e., significantly more in AL 201 (93.33 per cent) and less in PAU 881 (76.67 per cent). After 18 hours of release, AL 201 variety was more preferred (86.67 per cent flowers eaten) as compared to variety PAU 881 (73.33 per cent flowers eaten).

However, the data recorded at different intervals after release of beetles i.e. after 6 hours, 12 hours and 18 hours after release during different months were statistically at par with each other. The differences were non-significant showing that the beetles feed upon the flowers of both varieties of pigeonpea during different intervals of the day under laboratory conditions.

Mungbean

The mungbean variety ML 818 was more preferred by *M. pustulata* at different intervals of the day (Table 7). The flowers of mungbean variety ML 818 eaten after 6 hours of release were 40.00 per cent while in case of PAU 911 flowers eaten were 26.67. The trend in the feeding of flowers was same even after 12 hours of release i.e., significantly more in ML 818 (36.67 per cent) and less in PAU 911 (26.67 per cent). After 18 hours of release ML 818 variety was more preferred (33.33 per cent flowers eaten) as compared to variety PAU 911 (23.33 per cent flowers eaten) during the 1st fortnight of September. In the 2nd fortnight of September, the flowers of mungbean variety ML 818 eaten after 6 hours of release were 33.33 per cent while in case of PAU 911 flowers eaten were 26.67 per cent. The trend in the feeding of flowers was same after 12 hours of release i.e., significantly more in ML 818 (36.67 per cent) and comparatively less in PAU 911 (26.67 per cent). After 18 hours of release ML 818 variety was more preferred (30.00 per cent flowers eaten) as compared to variety PAU 911 (23.33 per cent flowers eaten). In the month of October the flowers of mungbean variety ML 818 eaten after 6 hours of release were 36.67 per cent while in case of PAU 911 flowers eaten were 26.67 per cent. The trend in the feeding of flowers was same after 12 hours of release i.e., significantly more in ML 818 (36.67 per cent) and comparatively less in PAU 911 (26.67 per cent). After 18 hours of release ML 818 variety was more preferred (33.33 per cent flowers eaten) as compared to variety PAU 911 (23.33 per cent flowers eaten).The data recorded at different intervals after release of beetles i.e. after 6 hours, 12 hours and after 18 hours of release during different months were statistically at par with each other. The differences were non-significant showing that the beetles fed upon the flowers of both varieties of mungbean during different intervals of the day under laboratory conditions.

Urdbean

Urdbean variety Mash 338 was more preferred by *M. pustulata* at different intervals of the day (Table 7). The flowers of urdbean variety Mash 338 eaten after 6 hours of release were 60.00 per cent while in case of Mash 114 flowers eaten were 46.67 per cent. The trend in the feeding of flowers was same after 12 hours of release i.e., statistically more in Mash 338 (56.67 per cent) and comparatively less in Mash 114 (40.00 per cent). After 18 hours of release Mash 338 variety was more preferred (50.00 per cent flowers eaten) as compared to variety Mash 114 (33.33 per cent flowers eaten) during the 1st fortnight of September. In the 2nd fortnight of September, the flowers of urdbean variety Mash 338 eaten after 6 hours of release were 50.00 per cent while in case of Mash 114 flowers eaten were 36.67 per cent. The trend in the feeding of flowers was same after 12 hours of release i.e., statistically more in Mash 338 (46.67 per cent) and comparatively less in Mash 114 (33.33 per cent). After 18 hours of release, Mash 338 variety was more preferred (46.67 per cent flowers eaten) as compared to variety Mash 114 (33.33 per cent flowers eaten). In the month of October the flowers of urdbean variety Mash 338 eaten after 6 hours of release were 46.67 per cent while in case of Mash 114 flowers eaten were 40.00 per cent. The trend in the feeding of flowers was same after 12 hours of release i.e., statistically more in Mash 338 (50.00 per cent) and comparatively less in Mash 114 (36.67 per cent). After 18 hours of release Mash 338 variety was more preferred (46.67 per cent flowers eaten) as compared to variety Mash 114 (30.00 per cent flowers eaten).The data recorded at different intervals after release of beetles i.e. after 6 hours, 12 hours and after 18 hours of release during different months were statistically at par with each other. The differences were non-significant showing that the beetles fed upon the flowers of both varieties of urdbean during different intervals of the day under laboratory conditions.

The results recorded on the per cent of flowers eaten by blister beetle under laboratory conditions showed that pigeonpea crop was more preferred by the beetle among the other pulses tested in the laboratory (Table 8). The data revealed that 80.37 per cent flowers of pigeonpea variety PAU 881 were eaten by the beetle whereas 94.07 per cent flowers of variety AL 201 were eaten during different months of crop season. In case of mungbean, the data revealed that the flowers of variety PAU 911 were eaten less (25.56 per cent) but in variety ML 818 the flowers eaten were 35.19 per cent during different months of crop season. Urdbean variety Mash 114 was preferred less as 36.67 per cent flowers were eaten while variety Mash 338 was more preferred as 50.37 percent flowers were eaten during the different months of crop season.

The data in the Table 8 also showed that the mean number of flowers eaten in pigonpea crop were 87.22 per cent followed by urdbean (43.52 per cent) and mungbean (30.38 per cent). The present study differ from Durairaj (2000) who reported 47.93 per cent flower damage in pigeonpea, 26.67 per cent flower damage in urdbean and 17.53 per cent flower damage in mungbean under laboratory conditions. The study also differs from Dhakla *et al* (2010) who reported that flower damage in different genotypes of pigeonpea varied significantly and ranged from 16.6 to 27.5 per cent under laboratory conditions. The variation might be due to the differences in genotypes as well as in agro-climatic conditions.

Table 8 Extent of flower damage by *M. pustulata* in pigeonpea, mungbean and urdbean under laboratory conditions

*Per cent flowers eaten or damaged by *M. pustulata* (Between crops)					
Crop	Var. 1		Var. 2		Mean
Pigeonpea	PAU 881	80.37(63.70)	AL 201	94.07(76.08)	87.22
Mungbean	PAU 911	25.56(30.35)	ML 818	35.19(36.36)	30.38
Urdbean	Mash 114	36.67(37.23)	Mash 338	50.37(45.19)	43.52

C.D. (p = 0.05) = 3.41
Figures in parentheses are angular transformations
*Average of three observations taken in September and October months

4.5 Management of blister beetle

Pigeonpea

The data in Table 9 represent the relative efficacy of different treatments against *M. pustulata.* The incidence of blister beetle, 3 days after spray ranged from 0.77-6.85 beetles/ m^2 in various treatments as compared to 7.83 beetles/ m^2 in control. Treatment deltamethrin 2.8 EC @ 500 ml ha^{-1} recorded the lowest population and the treatments cypermethrin 25 EC @ 250 ml ha^{-1}, deltamethrin 2.8 EC @ 437.5 ml ha^{-1} and chlorpyriphos 20 EC @ 3750 mlha^{-1} were statistically at par with it at 3 DAS. After 7 days of spray, the incidence of blister beetle varied from 2.11-10.01 beetles/ m^2 in various treatments as compared to 10.77 beetles/ m^2 in control. Treatment deltamethrin 2.8 EC @ 500 ml ha^{-1} recorded the lowest population and the treatments cypermethrin 25 EC @ 250 ml ha^{-1} and chlorpyriphos 20 EC @ 3750 ml ha^{-1} were at par with it at 7 DAS. The beetle incidence 10 days after spray ranged from 3.66 - 14.20 beetles/ m^2 in various treatments and 14.97 beetles/ m^2 in control. Treatment deltamethrin 2.8 EC @ 500 ml ha^{-1} showed maximum control followed by cypermethrin 25 EC @ 250 ml ha^{-1} and chlorpyriphos 20 EC @ 3750 ml ha^{-1} were at par with deltamethrin 2.8 EC @ 500 ml ha^{-1}. Grain yield in different treatments varied from 845.5 – 1397.3 kg ha^{-1}

and in control grain yield was 793.3 kg ha^{-1}. Maximum yield was obtained in treatment deltamethrin 2.8 EC @ 500 ml ha^{-1}. The present study is in agreement with Kakar *et al* (1990) who reported that minimum infestation of beetles was recorded in plots sprayed with deltamethrin and fenitrothion followed by those sprayed with fenvalerate, permethrin and cypermethrin. Durairaj and Ganapathy (1999) also reported that the susceptibility of *M. pustulata* was more to fenvalerate and cypermethrin.

Table 9 Management of *M. pustulata* on pigeonpea

S. No.	Treatments	Dose ml ha^{-1}	Mean no. of blister beetles per m^2			Yield (kg ha^{-1})
			3 DAS	7 DAS	10 DAS	
1.	Mechanical control: Hand picking and destruction (During morning hours only)	–	6.85 (2.80)	10.01 (3.33)	14.20 (3.87)	845.5
2.	Cypermethrin 25 EC	125	5.42 (2.53)	7.66 (2.94)	9.10 (3.18)	860.2
3.	Cypermethrin 25 EC	187.5	3.38 (2.09)	3.66 (2.16)	6.92 (2.81)	1009.9
4.	Cypermethrin 25 EC	250	0.91 (1.38)	2.43 (1.85)	4.10 (2.26)	1326.2
5.	Deltamethrin 2.8 EC	375	3.88 (2.18)	4.77 (2.40)	6.11 (2.66)	933.6
6.	Deltamethrin 2.8 EC	437.5	2.01 (1.73)	3.22 (2.05)	4.88 (2.43)	1090.0
7.	Deltamethrin 2.8 EC	500	0.77 (1.33)	2.11 (1.76)	3.66 (2.16)	1397.3
8.	Indoxacarb 14.5 SC	375	5.19 (2.48)	6.99 (2.82)	8.88 (3.14)	850.7
9.	Indoxacarb 14.5 SC	437.5	4.64 (2.37)	6.84 (2.80)	8.04 (3.00)	930.8
10.	Indoxacarb 14.5 SC	500	4.10 (2.25)	5.80 (2.61)	6.75 (2.78)	1066.9
11.	Chlorpyriphos 20 EC	2500	1.77 (1.66)	5.42 (2.53)	7.37 (2.89)	922.3
12.	Chlorpyriphos 20 EC	3750	1.33 (1.52)	2.99 (1.99)	4.54 (2.35)	1268.9
13.	Endosulfan 35 EC	2500	6.74 (2.78)	9.64 (3.26)	10.85 (3.35)	896.1
14	Water spray(Control)		7.83 (2.97)	10.77(3.43)	14.97 (3.99)	793.3
	C.D. at 5%		(0.32)	(0.26)	(0.26)	18.72

Figures in parentheses are $\sqrt{n+1}$ transformations
Mean pre-treatment beetle population was 10 beetles/ m^2, the differences being non-significant

Mungbean

The incidence of blister beetle, on mungbean crop 3 days after spray ranged from 0.59-4.81 beetles/ m^2 in various treatments as compared to 5.24 beetles/ m^2 in control (Table 10). Treatment deltamethrin 2.8 EC @ 500 ml ha^{-1} recorded the lowest population and the treatments cypermethrin 25 EC @ 250 ml ha^{-1} and chlorpyriphos 20 EC @ 3750 ml ha^{-1} were at par with it. After 7 days of spray, the incidence varied from 0.66-6.99 beetles in various treatments as compared to 7.18 beetles/ m^2 in control. Treatment deltamethrin 2.8 EC @ 500 ml ha^{-1} recorded lowest population and the treatments chlorpyriphos 20 EC @ 3750 ml ha^{-1} and cypermethrin 25 EC @ 250 ml ha^{-1} were at par with it. The beetle incidence 10 days after spray ranged from 1.00 -8.04 beetles/ m^2 in various treatments and 8.31 beetles/ m^2 in control. Treatment deltamethrin 2.8 EC @ 500 ml ha^{-1} showed maximum control followed by cypermethrin 25 EC @ 250 ml ha^{-1} and chlorpyriphos 20 EC @ 3750 ml ha^{-1} which were at par. Grain yield in different treatments varied from 790.5 – 1301.0 kg ha^{-1} and in control grain yield was 765.0 kg ha^{-1}. Maximum yield was obtained in treatment deltamethrin 2.8 EC @ 500 ml ha^{-1} (Table 10).

Table 10 Management of *M. pustulata* on mungbean

S. No.	Treatments	Dose ml ha^{-1}	Mean no. of blister beetles per m^2			Yield (kg ha^{-1})
			3 DAS	7 DAS	10 DAS	
1.	Mechanical control: Hand picking and destruction (During morning hours only)	–	4.81 (2.41)	6.99 (2.83)	8.02 (3.00)	790.5
2.	Cypermethrin 25 EC	125	3.78 (2.19)	5.67 (2.58)	7.38 (2.89)	839.6
3.	Cypermethrin 25 EC	187.5	1.30 (1.52)	3.11 (2.03)	4.00 (2.24)	1020.8
4.	Cypermethrin 25 EC	250	0.73 (1.31)	0.92 (1.39)	1.26 (1.50)	1277.4
5.	Deltamethrin 2.8 EC	375	2.59 (1.89)	3.18 (2.04)	3.98 (2.23)	945.4
6.	Deltamethrin 2.8 EC	437.5	1.22 (1.49)	1.99 (1.73)	2.44 (1.85)	1093.7
7.	Deltamethrin 2.8 EC	500	0.59 (1.26)	0.66 (1.29)	1.00 (1.41)	1301.0
8.	Indoxacarb 14.5 SC	375	4.02 (2.24)	5.28 (2.50)	6.63 (2.76)	896.8
9.	Indoxacarb 14.5 SC	437.5	3.44 (2.10)	5.00 (2.45)	6.11 (2.67)	967.9
10.	Indoxacarb 14.5 SC	500	3.09 (2.02)	3.17 (2.04)	3.78 (2.19)	1121.1
11.	Chlorpyriphos 20 EC	2500	1.33 (1.52)	1.89 (1.69)	2.21 (1.79)	1087.3
12.	Chlorpyriphos 20 EC	3750	0.87 (1.37)	0.87 (1.37)	1.30 (1.51)	1293.0
13.	Endosulfan 35 EC	2500	4.19 (2.28)	6.87 (2.80)	8.04 (3.00)	822.4
14	Water spray (Control)		5.24 (2.49)	7.18 (2.86)	8.31 (3.05)	765.0
	C.D. at 5%		(0.25)	(0.16)	(0.10)	9.44

Figures in parentheses are ($\sqrt{n+1}$) transformations
Mean pre-treatment population was 8 beetles/ m^2, the differences being non-significant

The present investigation is in agreement with Kakar *et al* (1990) who reported that minimum infestation of beetles was recorded in plots sprayed with deltamethrin and fenitrothion followed by those sprayed with fenvalerate, permethrin and cypermethrin. Durairaj and Ganapathy (1999) also reported that the susceptibility of *M. pustulata* was more to fenvalerate and cypermethrin.

CHAPTER V

SUMMARY

Studies on the crop losses by blister beetle, *Mylabris pustulata* on pigeonpea and mungbean and its management were carried out under caged as well as field conditions. The detailed investigations on the seasonal abundance and management of blister beetle on pigeonpea and mungbean were conducted at Entomological Research Farm, Department of Entomology and Research Farms of Pulses section, Department of Plant Breeding and Genetics, Punjab Agricultural University, Ludhiana. Experiments on host preference by *M. pustulata* towards different pulse crops were conducted at Entomological laboratory of Pulses Section, Punjab Agricultural University, Ludhiana during *kharif 2010* and 2011.

Pigeonpea variety PAU 881 and mungbean variety PAU 911 were sown in an area of 250 sq. m each as per recommended agronomic practices (Anonymous 2012a) and seasonal abundance of blister beetle were observed by recording the population density of beetle on pigeonpea and mungbean crop twice in a week. To observe any diurnal variation in beetle population, data were recorded during morning (6 – 8 AM), noon (12 – 2 PM) and evening hours (4 – 6 PM) on both the crops. The results showed that the blister beetle started appearing in late August under Punjab conditions. During the crop season its activity increased and reached at its peak in the end of September (13.90 beetles/ 4 meter row length) coincided with the maximum flowering on pigeonpea. Activity of blister beetle started declining afterwards and almost diminished in the month of November due to the termination of flowers. The activity of blister beetle was more in the morning (20.23 beetles/ 4 meter row length) and evening hours (21.04 beetles/ 4 meter row length) as compared to the noon hours (0.43 beetles/ 4 meter row length).

In case of mungbean, results showed that the blister beetle started appearing in 4th of August (0.26 beetles/1 sq. meter quadrate) under Punjab conditions. During the crop season, its activity increased and reached at its peak in the end of September (5.48 beetles/1 sq. meter quadrate) coincided with the maximum flowering on mungbean and afterwards it started declining. The activity of blister beetle is more in the morning (8.04 beetles/ 1 sq. meter quadrate) and evening hours (8.06 beetles/ 1 sq. meter quadrate) as compared to the noon hours (0.33 beetles/ 1 sq. meter quadrate).

Pigeonpea variety PAU 881 and mungbean variety PAU 911 were sown in five replicated plots. 10 shoots of pigeonpea and 10 plants of mungbean were tagged randomly from each raplication to record the damage done by blister beetle to the crop. However, to compare the losses (due to blister beetle alone), another set of 10 shoots in pigeonpea and 10 plants in mungbean from each replication were also tagged in which the beetles were allowed to feed freely from the initiation to the termination of flowering. The study on the crop losses under field conditions revealed that blister beetle caused reduction in pod formation and subsequently in the seed setting in pods. This reduction results in about 53.22 per cent yield loss to the pigeonpea crop having beetle population of 1.96 beetles/ plant. Similar observations were made on mungbean crop and the results showed that blister beetle caused reduction in pod as well as seed setting resulting in about 35.90 per cent yield loss to the crop in unprotected conditions, with beetle population of 1.3 beetle/ plant.

At bud initiation stage, three plots (each having 100 plants) of pigeonpea, were separately caged with a net house of 8m x 6m x 3m, made up of plastic wire mesh. At the time of 50 per cent flowering, field collected adult beetles of *M. pustulata*, (starved for 3 hours) were released in each cage @ 0, 100 and 200 beetles per cage. In mungbean, a nylon plastic wire mesh cage of size 80 cm x 55 cm was placed on individual plant and field collected beetles were released @ 0, 1, 2 and 4 beetles per cage at flowering. The observations regarding the crop losses to pigeonpea and mungbean crops under net house conditions by *M. pustulata* concluded that the blister beetle caused considerable crop losses to both pigeonpea and mungbean crops. The data on pod setting in pigeonpea crop showed that blister beetle caused 30.71 per cent reduction in pod setting @ 1 beetle/ plant density and 54.18 per cent reduction @ 2 beetles/ plant density. The data on seed setting per pod revealed that the beetle caused 5.97 per cent reduction in pod setting @ 1 beetle/ plant density while it caused 20.15 per reduction in seed setting when the beetle density were 2 beetles/ plant. There were yield losses of 37.64 and 65 per cent to the crop, when beetle density was 1 and 2 beetles/ plant, respectively.

The data on pod setting in mungbean crop showed that blister beetle caused 30.00 per cent reduction in pod setting @ 1 beetle/ plant density, 50.00 per cent reduction @ 2 beetles/ plant density and 67.14 per cent reduction @ 4 beetles/ plant density. The data on seed setting per pod revealed that the beetle caused 5.88 per cent reduction in seed setting @ 1 beetle/ plant density, 17.10 per reduction in seed setting when the beetle density was 2 beetles/ plant and 26.65 per cent reduction in seed setting @ 4 beetles/ plant density. There were yield losses of 35.29, 60.35 and 75.29 per cent to the crop, when beetle density was 1, 2 and 4 beetles/ plant, respectively.

To observe the feeding preference of blister beetle to various pulse crops, ten flowers of each variety (PAU 881 and AL 201 of Pigeonpea; PAU 911 and ML 818 of Mungbean; Mash 114 and Mash 338 of Urdbean) were plucked along with petiole and kept in Petri dish on 3 per cent agar-agar medium to maintain freshness of flowers, which were further kept in insect rearing tub at equi-distance from center. Fresh flowers were provided to the beetles after every six hours thrice a day. The same procedure was followed after every 15 days in the month of September and October during the entire crop season. The data on the host preference of different pulse crops under laboratory conditions revealed that *M. pustulata* prefered to feed upon pigeonpea crop followed by urdbean among the three pulse crops. Mungbean crop was least preferred by *M. pustulata*. The observations were recorded thrice in a day after every 6 hours, the data revealed that a total of 87.22 per cent flowers were eaten in pigeonpea, 30.38 per cent in mungbean and 43.52 per cent in urdbean. The study also revealed that Pigeonpea variety AL 201, mungbean variety ML 818 and urdbean variety Mash 338 were more preferred than other varieties of these pulse crops

In the management of blister beetle, mechanical control by hand picking and destruction of the beetles in the morning hours were done at initiation of flowers at weekly interval. Chemical control with different doses of insecticides were applied at the appearance of the pest by using 250-300 liters of water ha^{-1} on both pigeonpea and mungbean crop. The results revealed that the incidence of blister beetle, 3 days after spray ranged from 0.77-6.85 beetles/ m^2 in various treatments as compared to 7.83 beetles/ m^2 in control. Treatment deltamethrin 2.8 EC @ 500 ml ha^{-1} recorded the lowest population and the treatments cypermethrin 25 EC @ 250 ml ha^{-1}, deltamethrin 2.8 EC @ 437.5 ml ha^{-1} and chlorpyriphos 20 EC @ 3750 $mlha^{-1}$ were statistically at par with it at 3 DAS. After 7 days of spray, the incidence of blister beetle varied from 2.11-10.01 beetles/ m^2 in various treatments as compared to 10.77 beetles/ m^2 in control. Treatment deltamethrin 2.8 EC @ 500 ml ha^{-1} recorded the lowest population and the treatments cypermethrin 25 EC @ 250 ml ha^{-1} and chlorpyriphos 20 EC @ 3750 ml ha^{-1} were at par with it at 7 DAS. The beetle incidence 10 days after spray ranged from 3.66 -14.20 beetles/ m^2 in various treatments and 14.97 beetles/ m^2 in control. Treatment deltamethrin 2.8 EC @ 500 ml ha^{-1} showed maximum control followed by cypermethrin 25 EC @ 250 ml ha^{-1} and chlorpyriphos 20 EC @ 3750 ml ha^{-1} were at par with deltamethrin 2.8 EC @ 500 ml ha^{-1}. Grain yield in different treatments varied from 845.5–1397.3 kg ha^{-1} and in control grain yield was 793.3 kg ha^{-1}. Maximum yield was obtained in treatment deltamethrin 2.8 EC @ 500 ml ha^{-1}.

In case of mungbean crop, the incidence of blister beetle, on mungbean crop 3 days after spray ranged from 0.59-4.81 beetles/ m^2 in various treatments as compared to 5.24 beetles/ m^2 in control (Table 10). Treatment deltamethrin 2.8 EC @ 500 ml ha^{-1} recorded the lowest population and the treatments cypermethrin 25 EC @ 250 ml ha^{-1} and chlorpyriphos 20 EC @ 3750 ml ha^{-1} were at par with it. After 7 days of spray, the incidence varied from 0.66-6.99 beetles in various treatments as compared to 7.18 beetles/ m^2 in control. Treatment deltamethrin 2.8 EC @ 500 ml ha^{-1} recorded lowest population and the treatments chlorpyriphos 20 EC @ 3750 ml ha^{-1} and cypermethrin 25 EC @ 250 ml ha^{-1} were at par with it. The beetle incidence 10 days after spray ranged from 1.00-8.04 beetles/ m^2 in various treatments and 8.31 beetles/ m^2 in control. Treatment deltamethrin 2.8 EC @ 500 ml ha^{-1} showed maximum control followed by cypermethrin 25 EC @ 250 ml ha^{-1} and chlorpyriphos 20 EC @ 3750 ml ha^{-1} which were at par. Grain yield in different treatments varied from 790.5 – 1301.0 kg ha^{-1} and in control grain yield was 765.0 kg ha^{-1}. Maximum yield was obtained in treatment deltamethrin 2.8 EC @ 500 ml ha^{-1}.

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APPENDIX-I

Meteorological data during the experimental period

Months	Air Temperature (°C)				Relative humidity				Rainfall (mm)	Mean Sunshine (h)	Wind speed (km h^{-1})
	Maximum		Minimum		Maximum		Minimum				
	Range	Mean	Range	Mean	Range	Mean	Range	Mean			
August, 2010	28.4-35.2	33.1	24.8-28.5	26.5	76-98	91	54-98	71	105.8	5.6	4.9
September, 2010	28.6-35.4	31.7	20.0-27.6	23.5	74-98	93	44-100	72	127.5	6.8	3.6
October, 2010	28.0-33.8	31.6	11.6-22.5	18.9	70-98	91	32-98	51	8.8	5.5	2.0
November, 2010	22.4-30.0	27.1	7.0-14.0	11.4	84-97	92	32-42	40	0.0	7.2	1.7
August, 2011	25.4-36.2	32.4	21.4-28.4	26.1	78-100	92	36-98	72	513.4	5.1	5.0
September, 2011	23.6-34.8	31.8	21.6-27.6	24.1	87-100	94	53-100	73	177.1	6.3	2.9
October, 2011	29.0-34.6	32.1	12.4-22.8	17.5	86-95	91	29-66	42	0.0	8.5	2.4
November, 2011	23.4-30.8	27.6	7.8-16.4	12.5	80-100	95	27-65	45	0.0	7.1	2.0

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