"BIOEFFICACY OF NEW MOLECULES, OBERON 240EC (spiromesifen 240SC) AGAINST BROAD MITES, *Eusius sp.* AND FLUBENDIAMIDE 480SC AGAINST LEAF WEBBER CUM FRUIT BORER, *Pempelia morosalis* (Saalm Uller) IN *Jatropha curcas.*"

M.Sc. (Ag.) THESIS

by

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INDIRA GANDHI AGRICULTURAL UNIVERSITY
RAIPUR (C.G.)

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Submitted to the

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by

KANWAL SINGH SARATHI

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JUNE, 2011

CERTIFICATE – I

This is to certify that the thesis entitled **"BIOEFFICACY OF NEW MOLECULES, OBERON 240EC (spiromesifen 240SC) AGAINST BROAD MITES, *Eusius sp.* AND FLUBENDIAMIDE 480SC AGAINST LEAF WEBBER CUM FRUIT BORER, *Pempelia morosalis* (Saalm Uller) IN *Jatropha curcas.*"** submitted in partial fulfilment of the requirements for the degree of **"Master of Science in Agriculture"** of the Indira Gandhi Agricultural University, Raipur, is a record of the bonafide research work carried out by **KANWAL SINGH SARATHI** under my guidance and supervision. The subject of the thesis has been approved by Student's Advisory Committee and the Director of Instructions.

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

Dr. (Smt.) Jaya Laxmi Ganguli

(Chairman of the Advisory Committee)

THESIS APPROVED BY THE STUDENT'S ADVISORY COMMITTEE

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Member : Dr. Lalji Singh _____

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Member : Dr. R. N. Ganguli _____

CERTIFICATE - II

This is to certify that the thesis entitled **"BIOEFFICACY OF NEW MOLECULES, OBERON 240EC (spiromesifen 240SC) AGAINST BROAD MITES, *Eusius sp.* AND FLUBENDIAMIDE 480SC AGAINST LEAF WEBBER CUM FRUIT BORER, *Pempelia morosalis* (Saalm Uller) IN *Jatropha curcas.*"** submitted by **KANWAL SINGH SARATHI** to the Indira Gandhi Agricultural University, Raipur in partial fulfilment of the requirements for the degree of **M.Sc. (Ag.)** in the **Department of Entomology** has been approved by the External Examiner and Student's Advisory Committee after oral examination.

Date: 26.9.11

EXTERNAL EXAMINER

Major Advisor

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Director of Instructions

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CHAPTER-I

INTRODUCTION

Jatropha, a large soft-weeded deciduous shrub known as Ratanjyot in Hindi, is a wildly growing hardy plant in arid and semi-arid regions of the country on degraded soils having low fertility and moisture. It thrives well on stony, gravelly or shallow and even on calcareous soils having depth of about 2 feet, but cannot with stand heavy frost. Jatropha is not grazed by animals including goats hence serve as a live bio-fence around fields. It can be cultivated successfully in the regions having scanty to heavy rainfall with annual rainfall ranging from 500-1200 mm.

The bushy plant (3-4 meter high) of Jatropha bears numerous side branches arising from its main stem. The flowers are yellowish green in loose panicles. The flowering occurs twice in a year i.e. in March-April and in September-October. The ripe fruits are about 2-5 cm. large and ripen fruits are yellow in color. The seeds resemble with castor seed in shape either ovoid or oblong and are covered in a dull brownish black capsule. (Punia, 2007)

The seeds contain Jatropha oil which has a great potential to be used as biofuel in future. Like any other crop, Jatropha is also attacked by a number of insect pests which deteriorates the plant growth, vigour and also affects the quality and quantity of oil yield.

The use of *J. curcas* is varied and has ranged from serving as medicine to providing slow drying non edible oil known as 'curcas oil'. The wood and fruit of Jatropha can be used for numerous purpose including fuel. The seed of

Jatropha contains (50% by weight) viscous oil which can be used for the manufacture of candles and soaps in the cosmetic industry, for cooking and lighting by itself or as a diesel/ paraffin substitute which has important implications for meeting demand for rural energy services and exploring practical substitutes for fossil fuels to counter green house gas accumulation in the atmosphere.

The important and common insect pests found on Jatropha are leaf webber, semi looper, shield backed bug (*Scutelera nobilis fab.*) bloch miner, termite, aphid, Jassid and thrips. Among these shield- backed bugs is the key pest of Jatropha in Gujarat. The nymphs and adults suck the cell sap from leaves, tender parts of the plant, flowers and capsules (Shanker and Dhyani, 2006).

A number of insects have been reported on Jatropha from Chhattisgarh also, among which two species of scutellerid bug, namely *Chrysocoris purpureus* and *Scutellera nobilis* along with leaf webber cum fruit borer, *Pempelia morosalis* which cause damage to almost all parts of plant i.e. leaves, stem, inflorescence and fruits are regarded as major while coccids and thrips are minor pests. (Ganguli *et al.,* 2010).

Recently broad mites were observed as a severe pest in the Chhattisgarh (Ganguli *et al.,* 2010). High humidity (80 to 90 %) and temperatures above 25°C are favorable for feeding by the mite which may cause leaves to bronze and thicken, become brittle corky or cupped downward and narrower than

normal. Young stem growth may be distorted and stunted with dying of terminal buds and drop off. Severely damaged plants could also die.

Chemical control of broad mite is not difficult but problems are encountered because there are only a few miticides registered and most registered insecticides do not kill the egg stage or have enough residues to kill hatching larvae. Two applications are recommended at about five days apart to kill all stages, and the chlorinated chemical dicofol and abamectin were the most effective (www. Sardi. Home, 2010).

The leaf webber cum fruit borer, *Pempelia morosalis*(Saalm Uller) is regarded as one of the major pests of Jatropha in Chhattisgarh. The damage is due to dark green active larvae which cause webbing on leaves, apical stems, inflorescence and even bore into fruits in later stages.

Taking into consideration the above facts, detailed studies regarding the major and minor insect pests of Jatropha and new molecules have to be tested for bringing out effective control against broad mites, *Euseius sp*. and leaf webber cum fruit borer *Pempelia morosalis* (Saalm Uller).Hence the present studies were under taken with the following objectives-

1. Studies on pest succession of insect pests in *Jatropha curcas*.
2. Testing of bio-efficacy of a new molecule, Oberon 240 EC (Spiromesifen 240SC) against broad mites, *Euseius sp*.(Family: Phytoseiidae).
3. Testing of bio-efficacy of the new molecule flubendiamide 480 SC against leaf webber cum fruit borer, *Pempelia morosalis* (Saalm Uller).

CHAPTER-II

REVIEW OF LITERATURE

The available literature pertaining to the thesis entitled "**Bioefficacy of new molecules, Oberon 240EC (spiromesifen 240SC) against broad mites,** *Euseius sp.* (Family: Phytoseiidae) **and Flubendiamide 480SC against leaf webber cum fruit borer, *Pempelia morosalis* (Saalm Uller) in *Jatropha curcas***" are presented under the following heads:

2.1 Review of literature on *Jatropha curcas*

Jatropha, popularly known as Ratanjyot has immense oil producing potential, which finds multiple industrial uses. It is a large shrub, 3-4m high, which occurs almost throughout India and Andaman islands. In India, it flowers between Septembers to December. The fruits mature in two or four months, after flowering turning yellow. It can be grown over a wide range of arid and semi-arid climatic conditions. A hot and humid climate helps in the early germination of seeds. India has about 175 million hectares of wasteland, which needs re-vegetation and *Jatropha curcas* is well suited species as it is a wild growing hardy plant, well adapted to harsh conditions of soil and climate (Tewari, 1994).

Jatropha is planted around the crop fields or farmlands in order to prevent the access of wild animals (in village nearer to forests) and to reduce the insect and disease infestation. It is a common belief in Chhattisgarh that plantation of Jatropha is beneficial to keep the environment, disease and insect free (Oudhia, 2003).

Puri (2005) reported eight species of Jatropha *viz.*, *Jatropha panduraefolia*, *J. gossypiifolia*, *J. glauca*, *J. curcas*, *J. glandulifera*, *J. heterophylla*, *J. padagrica* and *J. multifida* from Chhattisgarh.

Banjo *et al.* (2006) in South Western Nigeria reported 13 species of insects on *J. curcas* which belonged to 7 orders. They had percentage abundance of Diptera (14.1%), Hymenoptera (32.7%), Coleoptera (39.5%), Orthoptera (3.8%), Lepidoptera (1.9%), Dictyoptera (0.1%) and Homoptera (8.0%). The Dipterans were *Nectivores nymenoptera* were only visitors while the most important pest *Oothela metabilis* of order Coleoptera feed on the leaves, flowers and sometimes the bark (Gubitz *et al.*, 1997).

2.2 Review of literature on oil content

According to Jain and Mahajan (1996), Jatropha is a major source of bio-diesel as in seed, the oil content ranges from 55-60 per cent of seed by weight. The kernel constitutes 55-60 per cent of seed by weight. The oil in the kernel ranges from 46-58 per cent and is white in colour.

Adebowale and Adedire (2006) studied on the chemical composition and insecticidal properties of *Jatropha curcas* L. seed using standard techniques. The oil content of the seed was quite high (66.4%). Jatropha seed oil at various serial dilution ranging from 0 to 2 per cent (v/w) at 0.5% intervals were evaluated for anti-ovipositional activity and long term protective ability of treated cowpea against the seed beetle *Callosobruchus maculatus*. The oil significantly ($p<0.05$) reduced oviposition by *C. maculatus*.

Puri *et al.*, (2006) conducted survey on potential areas for identification of superior planting material of *Jatropha curcas* and *Pongamia pinnata* by 31 and 10 participating centres respectively by NOVOD during 2005-06 in more than 140 districts of 21 states. More than 1758 superior trees having seed yielding 2.0 to 4.0 kg/plant and more than 30% oil content have been identified for *Jatropha curcas* and about 432 CPTS have been identified for *Pongamia pinnata*. The oil percentage in the selected CPTS of *Jatropha curcas* ranged from 28-48% and the test weight (100 seeds) ranged from 20.7 to 77.1 g.

Kaushik *et al.* (2006) reported that seed oil content varied from 25-44% and the kernel and seed coat ratio (K/SC) varied from 0.35-2.12. Total 328 plants having more than 35% seed oil content have been identified so far. Based on the percentage of high oil yielding plants, the State could be divided into seven groups. Screening of Indian germplasm of *Jatropha curcas* for selection of high oil yielding plants, more than one thousand samples of Jatropha seeds representing twelve states of India were on analysed for oil content and kernel seed coat ratio.

Murthy *et al.*, (2007) considered *Jatropha curcas* as a potent source for biodiesel. The oil obtained from the seeds of *Jatropha curcas* has been found to posses insecticidal effect on 2nd instar larvae of *Spodoptera litura* in the laboratory. *Jatropha curcas*, seed oil at 1.0%, 0.5% and 0.25%, brought 100% kill of 2nd instar larva of *S. litura* within 3 days. It also exhibited Juvenile hormone effect on the treated larvae.

Pant et *al.*, (2006). conducted studies to determine the variation in yield and oil content by taking composite sample of six Jatropha trees selected randomly from two cultural site condition *viz.* non-arable (T_1) , arable (T_2) and three altitudinal ranges E_1 (400-600m), E_2 (600-800m) and E_3 (800-1000) in Himachal Pradesh. The oil was extracted from the dried seed using steam distillation method of oil extraction. The highest oil was recovered in T_2E_2 (non – arable site with low altitude) various morphological and yield attributes like number of fruits/branch, number of fruits/tree number of seeds/tree were also studied. Arable site with high altitude (T_1 E_3) recorded the highest value for these parameters.

2.3 Review of literature on broad mites (*Euseius sp.*)

According to kavitha *et al.,* (2007) *Jatropha curcas* L, once considered as a border or fence plant in India, has recently attained a new economic dimension as a biofuel crop though this crop suffers less damage from pests and diseases. Some do cause a certain amount of injury as the phytophagous mites namely broad mite, *Polyphagotarsonemus latus* (Banks) and red spider mite, *Tetranychus urticae* Koch. The population of broad mite and of red spider mite was highest during November and October, respectively.

Broad mites are so small (0.3mm) that they are difficult to see even with a good hand lens but they tend to crowd in to crevices and buds. They can enter the crop undetected from nearby host plants or infested plants material imported in to the crop. Infested plants are usually not noticed until damage is

severe and by this time mites could have moved on to other plants. (Kavitha *et al.*, 2007)

Otino and Mwangi (2009) reported broad mite adults as very tiny with the females being about 0.2 to 0.3 mm in body length while males are about half that size. They secrete a plant growth regulator or toxin as they feed, and cause significant damage as distortions, shortening of internodes, blistering, shriveling and curling of leaves and leaf discoloration, much of this can be easily confused with viral disease, micro nutrient deficiency or herbicide injury.

According to Aguilar *et al.*, (2010) *Phagotarsonemus latus*, has become a true barrier in the development of Jatropha plants. In other words broad mites could be the limiting factor in the research of Jatropha biodiesel source in Costa Rica.

Broad mites are very sensitive to heat. They are more difficult to control in winter than in summer due to lower green house temperatures. Lowering infested plants in to water held at 111 degrees Farenheit for 15 minutes destroyed these mites without damaging the plants. Broad mites are also susceptible to various miticides and can be managed by using abamectin (avid) 0.15EC @ 4fl.oz per 100 gallons of water, biferthrin (talstar) 10% W.P. @ 1 to 5 teaspoons per gallon of water, bifenthrin (talstar) 7.9% flowable @1/2 teaspoons per gallon of water, endosulfan (thiodan) 24.2% EC @ 2 teaspoons per 9 gallon of water, lambda cyhalothrin (scimitar GC) 10% water soluble

packet @ 2 to 4 packets per 100 gallons of water, pyridaben (sanmite) 75% wp @ 2 to 4 ounces per 100 gallons of water for greenhouse. (Baker, 2010)

Broad mite (unidentified) is emerging as serious pest of *Jatrophra curcas* in Raipur, Chhattisgarh (Ganguli *et al.,* 2010). According to them in the past five years, the biodiversity of insect pests on *J. curcas* has shown an increasing trend as the species is being established in the area. Various insect pests which have been recorded on the plant from the present area are leaf and fruit webber *P. morosalis,* two species of scutellerid bugs, *C. purpureus*, and *S. nobilis*, coccids, blotch miner, *Stomphosistis thraustica* and white flies, *Bemicia sp.,* broad mites (unidentified) were observed for the first time during July- October; 2010.

Montasser *et al.,* (2010) evaluated field efficacies of seven pesticides against different stages of broad mites, *P. latus*. The study revealed that abamectin was the most effective followed by liquid sulfur (calcium polysulfide) Canola oil (2% erucic acid rapeseed oil) orange oil (*D.limonce*), azadirachtin and 4.5% matrine.

2.4 Review of literature on leaf webber cum fruit borer (*Pempelia morosalis*) (Saalm Uller)

Leaf webber cum fruit borer, *Pempelia morosalis* caused damage to the leaves inflorescence and apical stem of Jatropha by feeding the tender plant parts and making web along with excreta. It leads to poor and stunted growth of and effect fruit set, thus causing reduction in the production of oil considerably.

According to Regupathy and Ayyasamy, (2006) the male moth of *P.morosalis* was slightly smaller than female with pointed abdominal tip. The average developmental period from egg to adult emergence was of 24-34 days and the pupal period of 7-9 days in June to August.

Vanita (2000) reported some predatory spiders on leaf webber namely *Peucetia viridian, Plexippus paykulli, Agriope putcella, Thomisus sp* and *Oxyopes sp* on Jatropha. Chitra Shankar *et al*; (2006) reported that the inflorescnce and capsule borer, *Pempelia morosalis* also causes economic damage by webbing and feeding on inflorescence and in later stage bores in to the capsules .However, in Jhansi, it has been observed to be parasitized by the dipteran to an extent of 85%. Another natural control agent was the spider, *Stegodyphus sp* (Eresidae: Arachnida). Capsule borer and the bark eating caterpillar have been recorded as key pests for which a spray of endosulfan is advocated.

For management of *P.morosalis*, Tamil Nadu Agriculture University has recommend endosulfan (Paramathma *et al*., 2004). However, Regupathy and Ayyasamy, (2006) have opined that repeated use of chemicals may induce insecticide resistance; which should be taken care of in future.

Tamrakar *et al.,* (2007) in their studies on insect pests of multi-tier agro forestry and on various provenances of *J.curcas* conducted at Raipur, Chhattisgarh have also reported two species of blue bugs namely; *Chrysocoris purpureus* and *Scutellera nobilis*, leaf webber cum fruit borer, (*P.morosalis*)

and coccids in Jatropha as major insect pests while *Chrysoperla spp.*was observed as a natural enemy at Raipur, Chhattisgarh.

Baraiha *et al*; (2008) reported *Pempelia morosalis* (Saalm Uller) (Lepidoptera: Pyralidae) as one of the major pest of Jatropha causing damage to all parts of the plant. The dark green active larvae web the leaves, apical stems, inflorescence and bore into fruits feeding voraciously.

Further, Baraiha *et al;* (2009) reported a number of larval instars along with their length and width in their studies on the life cycle of leaf webber cum fruit borer, *Pempelia morosalis* (Saalm Uller). Eggs were laid in clusters mostly at the basal part of inflorescence. Larvae were dark green to brownish in color, full grown larvae measured 1.90 cm in length and 0.30 cm in width. Pre pupal stage lasted from one to three days. The pupae were dark brown in color. Mean length and width of the pupa was recorded to be 0.90 cm and 0.30 cm.

Otino and Mwangi (2009) reported, *P. morosalis* attacking Jatropha, and recommended endosulfan against the pest.They also reported a dipteran parasite and spider, *Stegodyphus sp* as a natural control agent in India.

Sharma *et al*; (2010) reported that the brown pupa of leaf webber cum fruit borer was usually found inside the silken web made of dried leaves and faecal pellets. Matured larvae were in prepupal stage for 26.29±0.71 and 26.50±0.91h and pupated to the extent of 35.00+ 2.45 and 40.56 + 5.79% during 2009 and 2010, respectively. Pupa measured 0.85 ± 0.03 cm lenth in 2009 to 0.84± 0.03 cm. in 2010 with the weight of 51.60 ± 1.10 and 51.14 ± 1.16mg respectively during both the years. Pupal period was about 7.33 days

during both the years.These observation are in close conformity with earlier report of Ambika (2005).

2.5 Review of literature on Blue bug (*Chrysocoris purpureus*) (Westw)

Blue bug *Chrysocoris purpureus* (Westw) is a polyphagous pest, attacking tender shoots and fruits of Jatropha. It was found sucking the sap from fruits due to which the colour of fruits changed from green to yellow.

Pillai and Gopi (1990) reported *Chrysocoris purpureus* as one of the insect pest of *Acacia nilotica* in Tamilnadu, while Meshram *et al.*, (1992) reported *C. purpureus* causing damage to nursery seedling of *Acacia auriculiformis*.

C. purpureus was also recorded on *Populus deltoides* during a periodic survey conducted at the silviculture nursery, TFRI, Jabalpur by Roychoudhary *et al.*, (1994).

In a comparative study conducted by Chinnaswami and Rajakumari (1997) on histo-biochemical and transpiration of the cuticle of *C. purpureus* and the lady bird beetle, *Henosepilachna vigintioctopunctata* for 40 days it was observed that the species was multi-voltine and female oviposited during rainy season.

Adult dispause in *C. purpureus* was reported by Roychoudhary (1998) at Jabalpur and showed that with the gradual increase in temperature (May) adults entered dispuase and with the decrease in temperature and increase in humidity dispause terminated by June. Again, Roychoudhary, (1999) found that occurrence of reproductive dispause in *C. purpureus* as a pest of *Populus*

deltoides. This occurred after adult eclosion during scorching heat in May, in both males and females.

Soman *et al*., (2006) and Tamrakar *et al.,* (2007) have also reported blue bug, *C. purpureus* as a pest of Jatropha from Chhattisgarh.

Chrysocoris sp. was also recorded as a pest of citrus in Assam, on litchi in Bihar (Nair, 1975) and on medicinal plants like *Costus speciosus* (Konig) and *Adhatoda vasica* (Nees) (Regupathy *et al*., 2003).

Ambika *et al*., (2007) studied on the biology of scutellerid bugs, *S. nobilis* and *C. purpureus* on Jatropha. The incubation period, nymphal period and adult longevity of *S. nobilis* was 5.92, 26.92 and 38.83 to 43.50 days, while that of *C. purpureus* was 5.75, 33.79 and 45-51 days, respectively.

Mishra *et al*., (2008) have also reported two species of Scutellarid bugs namely *S. nobilis* and *Chrysocoris purpureus* leaf webber, *Pempelia morosalis* and Blotch minor, *Stomposistos thraustica* as major pests from Chhattisgarh. Apart from this, coccids and thrips were reported as minor pests.

Avoidable losses and reduction in oil content of *Jatropha curcas* seeds due to the infestation of *Chrysocoris purpureus* was reported by Baraiha *et al*; (2008). According to them the oil content reduced significantly from 48.20% in healthy, 45.20% in low damaged, 39.20% in moderately damaged, 32.82% in highly damaged to 14.60% in severely damaged seeds. The avoidable loss in oil content due to the bug was estimated to be 6.22, 18.67, 31.91 and 69.71 per cent in low damaged, moderately damaged, highly damaged and severely damaged seeds respectively

2.6 Review of literature on other insects

Grimm (1999) reported about the leaf-footed bug, *Laptoglosus zonatus* (Dallas) (Heteroptera : Coreidae) reared in Niaragua on a diet consisting of upripe physic nut (*J. curcas* L. Euphorbiaceae) fruit only. The suitability of this host is described by mortalities in the developmental stages from egg to adult. Protein, oil and water content of fresh Physic nut fruit were measured throughout the whole year of study. The results show that physic nut is a highly suitable host plant, which can maintain populations of insect pests throughout the whole year as fruit are constantly present with only little fluctuation in their nutritional quality.

Grimm and Somarribaa (2007) reported the biology and life cycle of *Pachycoris klugii* Burmeister (Heteroptera : Scutelleridae) a key pest of physic nut *J. curcas* studied in the field and the laboratory. The species is multivoltine and each female oviposits repeatedly during rainy season. In the dry season adult go into hiding. Laboratory experiments do not confirm diapauses but indicate a preference for protected, dark habitats. During this phase the adults show no tolerance to food deprivation. Total development time for egg to adult under natural conditions was 40 days. Larval development stages could be distinguished by the width of the head capsule pronotum. Rearing on a natural diet is possible, and the survival rates obtained were favourable.

Ash weevil, *Myllocerus maculosus* (Fabricius) (Curculionidae : Coleoptera) a polyphagus insect damaging the crops in adult stage was documented for the first time in Jatropha at the three locations of survey recorded only at Coimbatore. The occurrence of this pest on various other

crops particularly on Euphorbiaceous plants like castor has been reported by (Ghos *et al.* 1921, Ganapathy *et al.*, 1990). The grub of this pest was also found to damage the roots; it may assume severe from under favorable environmental condition.

Of the different foliage feeder's leaf webber, *P. morosalis* was identified as the specific pest of Jatropha. *Tussock* Caterpiller, *Oryiga postica* and black hairy caterpillar, *Estigmene lactinea* were also found feeding on Jatropha in all the survey locations except Chennimali and Mettuppalayam, respectively in Tamil Nadu. Both these pests are highly polyphagous and have been reported on millets, oil seeds, pulses and vegetables (Nair, 1975; Regupathy *et al.,* 2003).

Spider mite, *Tetranychus urtica* and yellow mite, *Polyphagotarsonemus latus* were found to infest *J. curcas*. The spider mite, *T. uritica* has been reported as one of the important mite pests of vegetable crops and field crops (Gupta, 1985).

Ghosh *et al.,* (2008) was conducted in two studies at namely Experimental Research farm, Department of Forestry and Baronda farm, IGKV, Raipur, during and reported *Apis florae* belonging to family Apidae as the major pollinator of *Jatropha curcas* in the study area.

Among 20 species of insects that were recorded at various stages of *Jatropha curcas* during August 2006 to January 2007 at Jagdalpur, Raipur, Bhatapara region , only 4 species *viz*, Scutellerid bug (*Scutelleria nobilis*), *(Chrysocoris purpureus*), leaf webber (*Pempelia morosalis*) true bug

(*Pachycoris klugii)* , attained major pest status prevailing in a severe form for a long time. Some species Monarch butterfly and Tortois beetle , House fly were recorded only as stray pests during crop growth. The remaining some insect species *viz*, leaf hopper *Retithrips syriacus*, *Atractomorpha ranacea*, *Ferrisia virgata*, *Stegodyphus sp.,* Mantid, Yellow jacket wasp, Chrysopa and parasite of *Pempelia morosalis* like Ichneumonid, Broconid, Chalcid, Bracon hebetor and lizard were found associated with the pests of *Jatropha curcas (Kaushik, et al., 2008).*

Tamrakar, *et al;* (2007), Baraiha, *et al*; 2010; and Ganguli, *et al ;* 2010 have also reported coccids, blotch minor, thrips and white flies as minor pests of Jatropha, apart from scutellarid bugs and leaf webber cum fruit borer, from Chhattisgarh.

2.7 Review of literature on screening of *Jatropha curcas* against blue bug, *C. purpureus* and leaf Webber cum fruit borer, *P. morosalis*.

Screening of 47 provenances of *Jatropha curcas* against one of its major pests, webber, *P. morosalis* (Saalm Uller) (Lepidoptera: Pyralidae) was conducted at the observations were recorded at weekly intervals for the number of larvae/plants on two randomly selected plants per provenance. Results indicated that the provenance RJ117(A), Dehradoon, Jabalpur, NRCAF-15, Chandka, Taraipur, Kilkila, NRCAF-18 and Kalyanpur showed tolerance to the attack of webber, *P. morosalis* while the provenance Sagar-1 was found to be susceptible, whereas the provenances TNMS-5, Jagdalpur, APOS-2001, PKVJ-MKV-1 and Pendra Road were moderately susceptible.

CHAPTER-III

MATERIALS AND METHODS

The present investigation entitled "Bioefficacy of new molecules, Oberon 240EC (spiromesifen 240SC) against broad mites, *Euseius sp.* and Flubendiamide 480SC against leaf webber cum fruit borer, *Pempelia morosalis* (Saalm Uller) in *Jatropha curcas"* was conducted during September 2010 to June, 2011. The investigation was carried out to record the major and minor insect pests on various provenances of *Jatropha curcas* along with natural enemies for the pest succession studies in *J. curcas* throughout the experimental period.The experiment was conducted at the experimental research farm, Department of Forestry, IGAU, Raipur and in the laboratory of Department of Entomology.

Geographical location

Chhattisgarh state is situated in South-Eastern part of Madhya Pradesh and Raipur is situated in mid eastern part of Chhattisgarh and lies at 21°16' N latitude and 81°16' E longitude at an altitude of 298 m above mean sea level.

Climate

The climate of this region is sub-humid to semi arid, the average annual rainfall ranges from 1200-1400 mm, out of which 85 per cent rainfall is received during middle of June to end of September and very little during October to May.

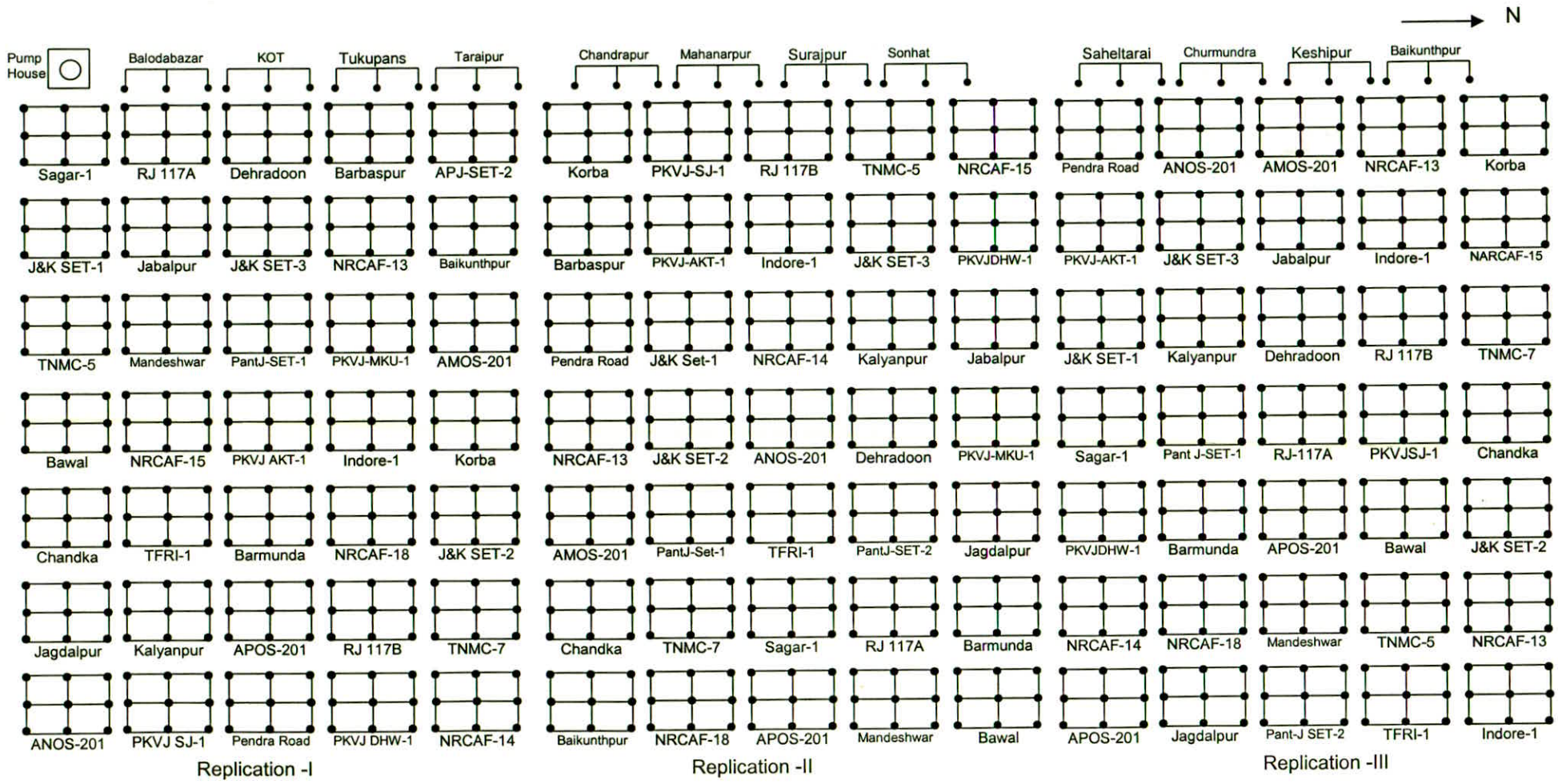

Fig. 3.1 : Layout plan of screening trail of *Jatropha curcas*

The maximum temperature goes as high as 48°C during summer months (May) and minimum as low as 6°C during winter months (December-January).

Experiment details

The experiment was conducted in Randomized Block Design with 47 provenances each replicated three times.

Design	:	RBD
Replication	:	Three
Number of provenance	:	47
Plot size	:	90 x 40 m^2
Age of plant	:	6 years
Treatments	:	8
Date of planting	:	27.02.2005

For recording observations, the whole experimental field was divided into 35 blocks, each block having nine plants. The observations was recorded at fortnightly interval for different types and number of insects from each block on two randomly selected plant from each provenance for number of nymphs and adults/plant in case of blue bug, *C. purpureus*, number of larvae/plant in case of leaf webber cum fruit borer, *Pempelia morosalis* and number of spiders/plant (*Oxyopes lineatipes*). In case of broad mites, *Euseius sp.,* the number of mites/leaf , percentage of damaged leaves along with the number of dead and live mites were also recorded. The data was analyzed in RBD applying transformations as per need.

3.1 Studies on pest succession of insect pests in *Jatropha curcas.*

To study the pest succession in various provenances of *Jatropha curcas* alongwith natural enemies, observations were recorded at fortnightly interval on two plants selected randomly from each provenance on the number of grass hopper/plant , number of nymphs and adults of the scutellerid bug, *C.purpureus* /plant, and number of larvae of leaf webber cum fruit borer, *P.morosalis/plants.* The various types and number of natural enemies occurring were also recorded.

List of provenances of *Jatropha curcas* are as follows:

S. No.	Name of provenances	S. No.	Name of provenances
1.	Sagar-1	25.	J&K Set 2
2.	RJ 117 (A)	26.	Jagdalpur
3.	Dehradoon	27.	Kalyanpur
4.	Barbuspur	28.	APOS-2001
5.	Pant J&K Set 2	29.	RJ 117 (B)
6.	J&K Set 1	30.	TNMC-7
7.	Jabalpur	31.	ANOS-201
8.	J&K Set 1	32.	PKVJ-SJ-1
9.	NRCAF-13	33.	Pendra Road
10.	Baikunthpur	34.	PKVJ-DHW-1
11.	TNMC-5	35.	NRCAF-14
12.	Mandeshwar	36.	Balodabazar
13.	Pant J&K Set 1	37.	Kot
14.	PKVJ-MKV-1	38.	Tukupoms
15.	AMOS-201	39.	Taraipur
16.	Bawal	40.	Kilkila
17.	NRCAF-15	41.	Chandrapur
18.	PKVJ-AKT-1	42.	Mahanrpur
19.	Indore-I	43.	Surajpur
20.	Korba	44.	Sonhat
21.	Chandka	45.	Saheltarai
22.	TFRI-1	46.	Churmundra
23.	Barmunda	47.	Keshipur
24.	NRCAF-18		

3.2 Testing of bio-efficacy of new molecule, Oberon 240EC (Spiromesifen 240SC) against broad mites, *Euseius sp.* (Family: Phytoseiidae)

For testing the bio-efficacy of the new molecule, Oberon 240EC (Spiromesifen 240SC) against broad mites, *Euseius sp.* in various provenances of *Jatropha curcas* was tested under three concentrations namely, Spiromesifen 240 SC (Oberon 240SC) 72 g.a.i./ha, Spiromesifen 240 SC (Oberon 240SC) 96 g.a.i./ha, Spiromesifen 240 SC (Oberon 240SC) 120 g.a.i./ha, Propargite 570 EC (Oomite 570 EC) 570 g.a.i./ha, Dicofol 18.5 EC (Fatal 18.5 EC) (standard check) 231 g.a.i./ha, along with Spiromesifen 240 SC (Oberon 240SC) 240 g.a.i./ha, Spiromesifen 240 SC (Oberon 240SC) 480 g.a.i./ha, which was tested for phytotoxicity. Observations were recorded on the number of broad mite damaged leaves and total leaves /branch /plant on five randomly tagged plants per treatment at pre treatment, 7 days, 14 days, 21 days 28 days and 35 days after treatment till persistence in efficacy was lost in each treatment. The per cent broad mite damaged leaves/treatment at each observation was worked out by counting the number of broad mites nymphs and adults from two random leaves per treatment by observing the leaves under trinocular digital microscope at pre treatment, 7 days, 14 days, 21 days, 28 days and 35 days after treatment till persistence in efficacy was lost in each treatment categories. Live and dead mites from each treatment at each observation was also counted for recording the per centage mortality. The treatment details are mentioned as per table 3.2.

Table 3.1: Treatment details of various acaricides tested against broad mites, *Euseius sp.*

Treatment		g.a.i./ha	Form. (ml)/3 litres water for 10 Jatropha plants
1	Untreated control		
2	Spiromesifen 240 SC (Oberon 240SC)	72	1.2
3	Spiromesifen 240 SC (Oberon 240SC)	96	1.6
4	Spiromesifen 240 SC (Oberon 240SC)	120	2.0
5	Propargite 570 EC (Oomite 570 EC)	570	4.0
6	Dicofol 18.5 EC (Fatal 18.5 EC) (standard check)	231	5.0
7	Spiromesifen 240SC (Oberon 240 SC)	240	4.0
8	Spiromesifen 240SC (Oberon 240 SC)	480	8.0

3.3 Testing of bio-efficacy of new molecule, Flubendiamide 480 SC (Fame 240SC) against leaf webber cum fruit borer, *Pempelia morosalis.*

The bio-efficacy of the new molecule, flubendiamide 480 SC against leaf webber cum fruit borer, *P.morosalis* on various provenances of *Jatropha curcas*, was tested under their concentrations namely Flubendiamide 240 SC (fame 240SC) 24 g.a.i./ha. Flubendiamide 240 SC (fame 240SC) 36 g.a.i./ha., Flubendiamide 240 SC (fame 240SC) 48 g.a.i./ha, Emamectin benzoate 5 SG (Proclaim 5% SG) 10 g.a.i./ha, Indoxacarb 14.5 EC (standard check) 60

g.a.i./ha, along with Flubendiamide 240 SC (fame 240SC) 96 g.a.i./ha and Flubendiamide 240 SC (fame 240SC) 192 g.a.i./ha, which was tested for phytotoxicity. Pre treatment observations were recorded prior to spraying. Number of small, medium and large size leaf webber cum fruit borer, *P.morosalis* larvae were recorded on five randomly tagged plants on leaves, stem and fruit / treatment at pre treatment, 3 days, 7 days,10 days and 14 days after treatment until persistence in efficacy was lost in each treatment . The treatment details are mentioned as per table 3.3.

Table 3.2: Treatment details of various insecticides tested against leaf webber cum fruit borer, *Pempelia morosalis*.

Treatment		g.a.i./ha	Form. (ml/g)/3 litres water /10 Jatropha plants
1	Untreated control		
2	Flubendiamide 240 SC (fame 240SC)	24	0.2
3	Flubendiamide 240 SC (fame 240SC)	36	0.3
4	Flubendiamide 240 SC (fame 240SC)	48	0.4
5	Emamectin benzoate 5 SG (Proclaim 5% SG)	10	0.8
6	Indoxacarb 14.5 EC (standard check)	60	1.6
7	Flubendiamide 240 SC (Fame 480 SC)	96	0.8
8	Flubendiamide 240 SC (Fame 480 SC)	192	1.6

3.4. Screening of various provenances of *Jatropha curcas* against blue bug*Chrysocoris purpureus* and leaf webber cum fruit borer, *Pempelia morosalis* (Saalm Uller).

Screening of 47 provenances of *Jatropha curcas* against blue bug *Chrysocoris purpureus* was conducted by recording the number of nymphs adults bugs/ plant, fortnightly in both season I (September to November) and season II (April to June) of the observation was computed and presented in table 4.12.

Similarly the screening the 47 provenances of *J. curcas* against leaf webber cum fruit borer, *P. morosalis* was conducted by recording the number of larvae/plant, fortnightly in both season I and season II; and the pooled analysis of all the observations were done presented in the table 4.13. No webber larvae were observed in season I.

CHAPTER IV

RESULTS AND DISCUSSION

The present investigation entitled "Bioefficacy of new molecules, Oberon 240EC (spiromesifen 240SC) against broad mites, *Euseius sp.* and Flubendiamide 480SC against leaf webber cum fruit borer, *Pempelia morosalis* (Saalm Uller) in *Jatropha curcas."* was conducted during September 2010 to June, 2011. The results are presented under following heads:

4.1 Studies on pest succession of insect pests in *Jatropha curcas*.

4.2 Testing of bio-efficacy of new molecule, Oberon 240EC (Spiromesifen 240SC) against broad mites, *Euseius sp*.

4.3 Testing of bio-efficacy of new molecule, Flubendiamide 480 SC against leaf webber cum fruit borer, *Pempelia morosalis* (Saalm Uller)

4.4 Screening of various provenances of *Jatropha curcas* against blue bug*Chrysocoris purpureus* and leaf webber cum fruit borer, *Pempelia morosalis* (Saalm Uller).

4.1 Studies on pest succession of insect pests in *Jatropha curcas.*

In the present investigation three insect pests were found damaging Jatropha namely blue bug *Chrysocoris purpureus* (Westw), broad mites, *Euseius sp.* and leaf webber cum fruit borer, *Pempelia morosalis* (Saalm uller) (Plate 4.8). Alongwith there some natural enemies like spider, *Oxyopes lineatipes* (Plate 4.10) and grass hopper (unidentified) (Plate 4.11) were also observed.

Plate 1 : Agro forestry field showing plantation of various provenances of Jatropha

Plate 2 : Observations being recorded in field on *J. curcas*

Plate 3 : Infested leaf of *J. curcas* due to broad mites, *Eusius sp.*

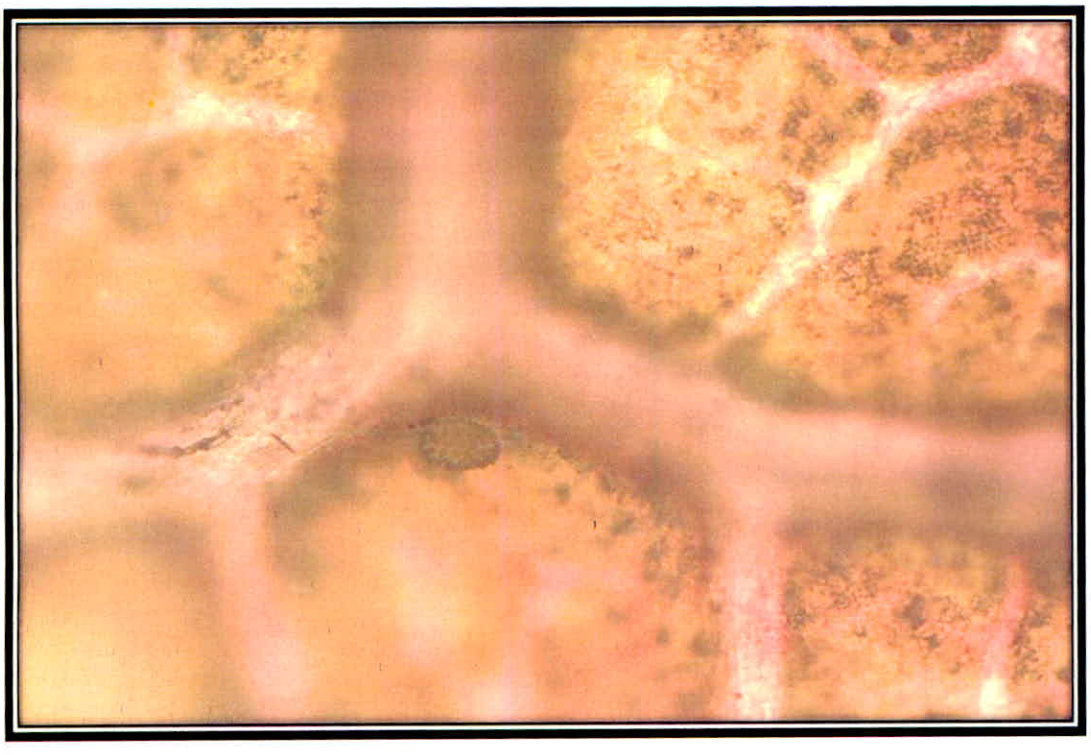

Plate 4 : Eggs of mite observed on leaf of *J. curcas*

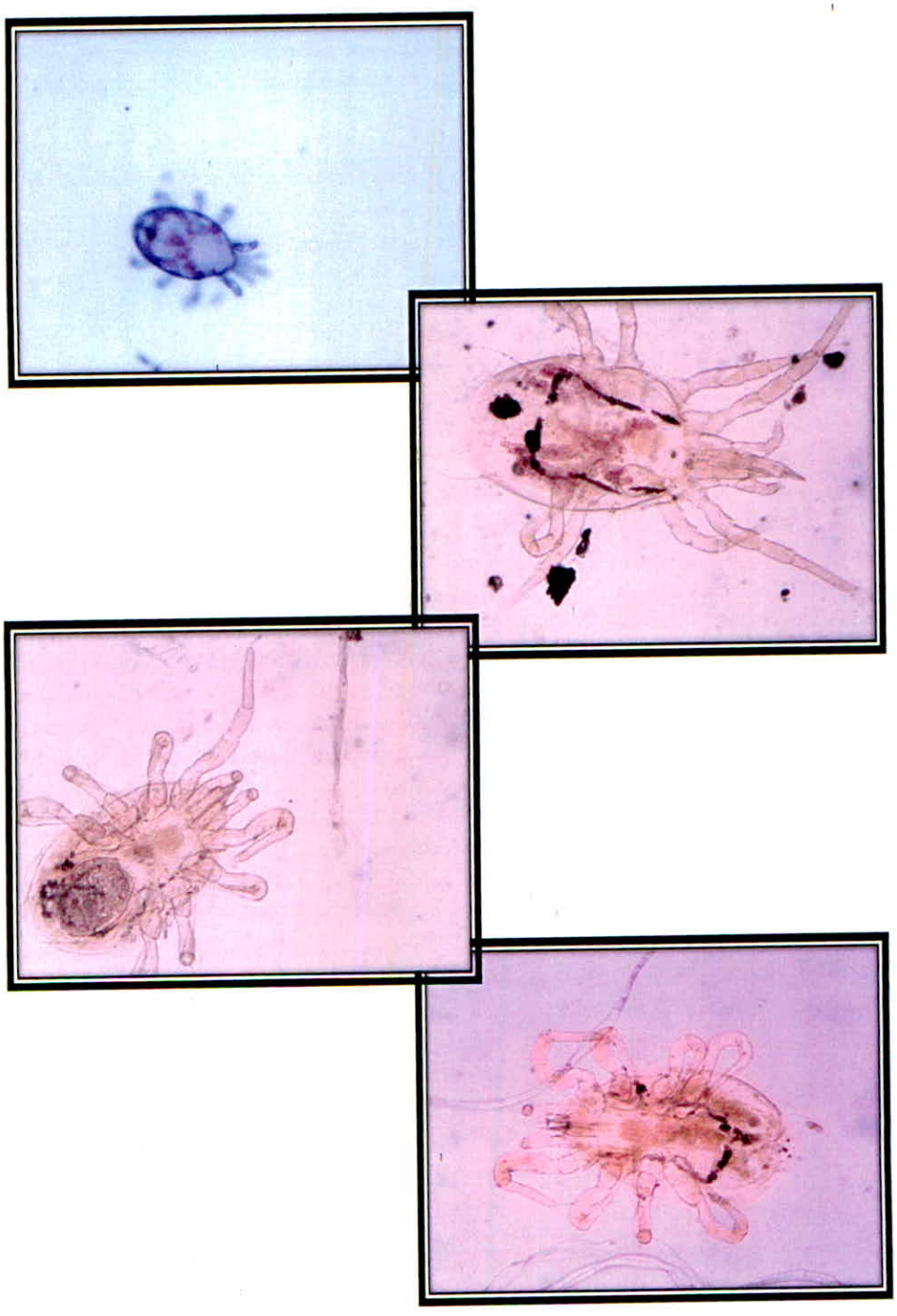

Plate 5 : Mites observed through trinocular microscope in Jatropha leaf

Plate 6 : Infested apical stem of *J. curcas* due to *P. morosalis*

Plate 7 : Infested leaf with leaf webber cum fruit borer, *P. morosalis*

Plate 8 : Adult bugs of *C. purpureus* of Jatropha

Plate 9 : **Spider** recorded on *Jatropha curcas*

Plate 10 : Predatory grass hopper recorded on *Jatropha curcas*

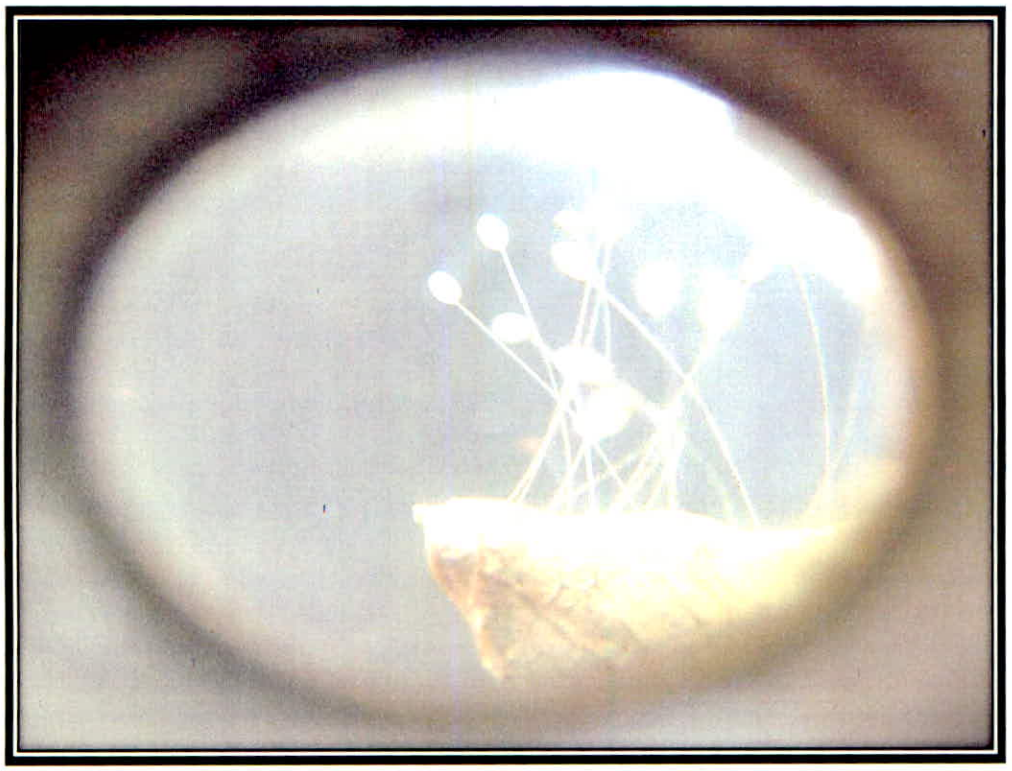

Plate 11 : Stalked eggs of *Chrysoperla carnea* on leaf of *J. curcas*

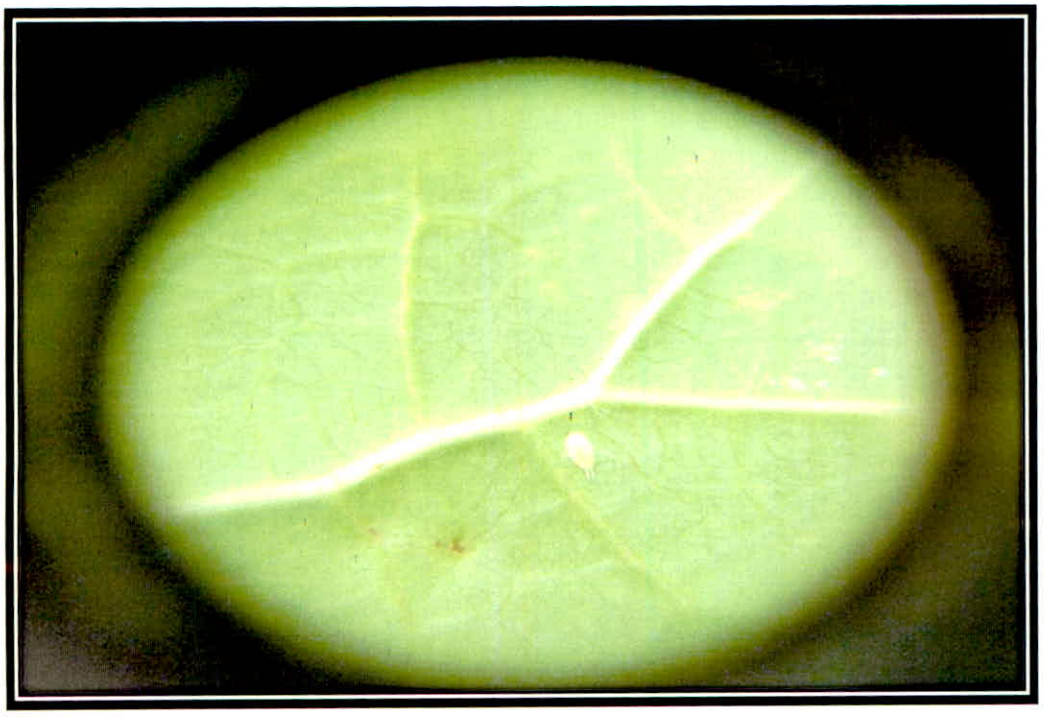

Plate 12 : **Coccid recorded on leaf of *J. curcas***

4.1 (i) Blue bug, *Chrysocoris purpureus* (Westw)

The blue bug, *C. purpureus* attacked mainly the tender shoots and fruits of Jatropha. It was found sucking the sap from fruits, due to which the color of fruits changed from green to yellow. In case of severe infestation the fruits turned brown.

The infestation adversely affected the quality of seed and oil and ultimately reduced the fruit and oil yield. The mean maximum population of bugs were observed in the month of September (I fortnight) *i.e.*42.49 bugs/plant and the minimum during the month of October (II fortnight) 18.35 bugs/plant in season I (pre-pruning) while mean The maximum population of bugs were observed in the month of June (II fortnight) *i.e.*32.38 bugs/plant and the minimum during the month of may (I fortnight) 15.09 bugs/plant in season II (after-pruning). (Table 4.1).

In the correlation analysis blue bug was found to have a positive correlation (0.509), (0.271) and (0.697) with minimum temperature, relative humidity (morning and evening) respectively, negative correlation (-0.101) with maximum temperature was observed. Significant positive correlation (0.867) between blue bug population at rainfall was observed during season I (Table 4.3).

In season II, the blue bug showed positive correlation (0.062), (0.434), (0.732) with minimum temperature, rainfall, relative humidity (morning) and relative humidity (evening) with significant value of (0.827), while with maximum temperature it was negative (-0.384).

Table 4.1: Fortnightly mean population of Blue bug (*C. purpureus*), leaf webber (*P. morosalis*), spiders and predatory grass hopper

Months	Fortnightly mean population			
	Blue bug (*Chrysocoris purpureus*)	**Webber (*Pempelia morosalis*)**	**Spider *(Oxyopes lineatipes)***	**Predatory grass hopper (un-identified)**
Season-I				
Sept. 1st FN	42.49	0.00	26.24	24.04
Sept. 2nd FN	27.30	0.00	14.21	15.32
Oct. 1st FN	19.75	0.00	10.45	9.35
Oct. 2nd FN	18.35	0.00	7.04	5.83
Nov. 1st FN	18.76	0.00	6.82	3.52
Nov. 2nd FN	21.29	0.00	9.91	1.76
Season-II				
April 1st FN	23.08	2.64	4.73	0.00
April 2nd FN	15.99	6.40	7.81	0.00
May 1st FN	15.09	9.70	9.80	0.00
May 2nd FN	17.09	17.09	8.03	0.00
June 1st FN	18.17	29.97	9.24	0.00
June 2nd FN	32.38	3.19	11.34	0.00

Table-4.2 Fortnightly mean population of various insects and natural enemies along with the weather parameters.

Months	Fortnightly mean population				Weather parameters				
	Blue bug (*Chrysocoris purpureus*)	Webber (*Pempelia morosalis*)	Spider *(Oxyopes lineatipes)*	Predatory grass hopper (unidentified)	Temperature (°C)		Rainfall (mm)	Relative humidity (%)	
					Max.	Min.		Morning	Evening
Season-I									
Sept. 1st FN	42.49	0.00	26.24	24.04	31.35	25.15	12.90	93.57	74.93
Sept. 2nd FN	27.30	0.00	14.21	15.32	31.20	24.60	10.49	92.57	63.14
Oct. 1st FN	19.75	0.00	10.45	9.35	34.20	25.21	0.73	94.29	61.57
Oct. 2nd FN	18.35	0.00	7.04	5.83	30.74	22.20	3.89	93.00	60.43
Nov. 1st FN	18.76	0.00	6.82	3.52	30.47	20.61	0.47	91.65	50.50
Nov. 2nd FN	21.29	0.00	9.91	1.76	31.65	18.42	00.00	88.57	40.07
Season-II									
April 1st FN	23.08	2.64	4.73	0.00	37.10	21.55	11.90	64.00	24.50
April 2nd FN	15.99	6.40	7.81	0.00	28.40	18.35	25.60	59.00	26.00
May 1st FN	15.09	9.70	9.80	0.00	41.39	24.76	1.39	67.86	15.79
May 2nd FN	17.09	17.09	8.03	0.00	41.90	27.86	1.33	52.57	23.57
June 1st FN	18.17	29.97	9.24	0.00	37.50	26.35	39.50	75.00	44.00
June 2nd FN	32.38	3.19	11.34	0.00	31.60	24.90	33.65	87.00	66.00

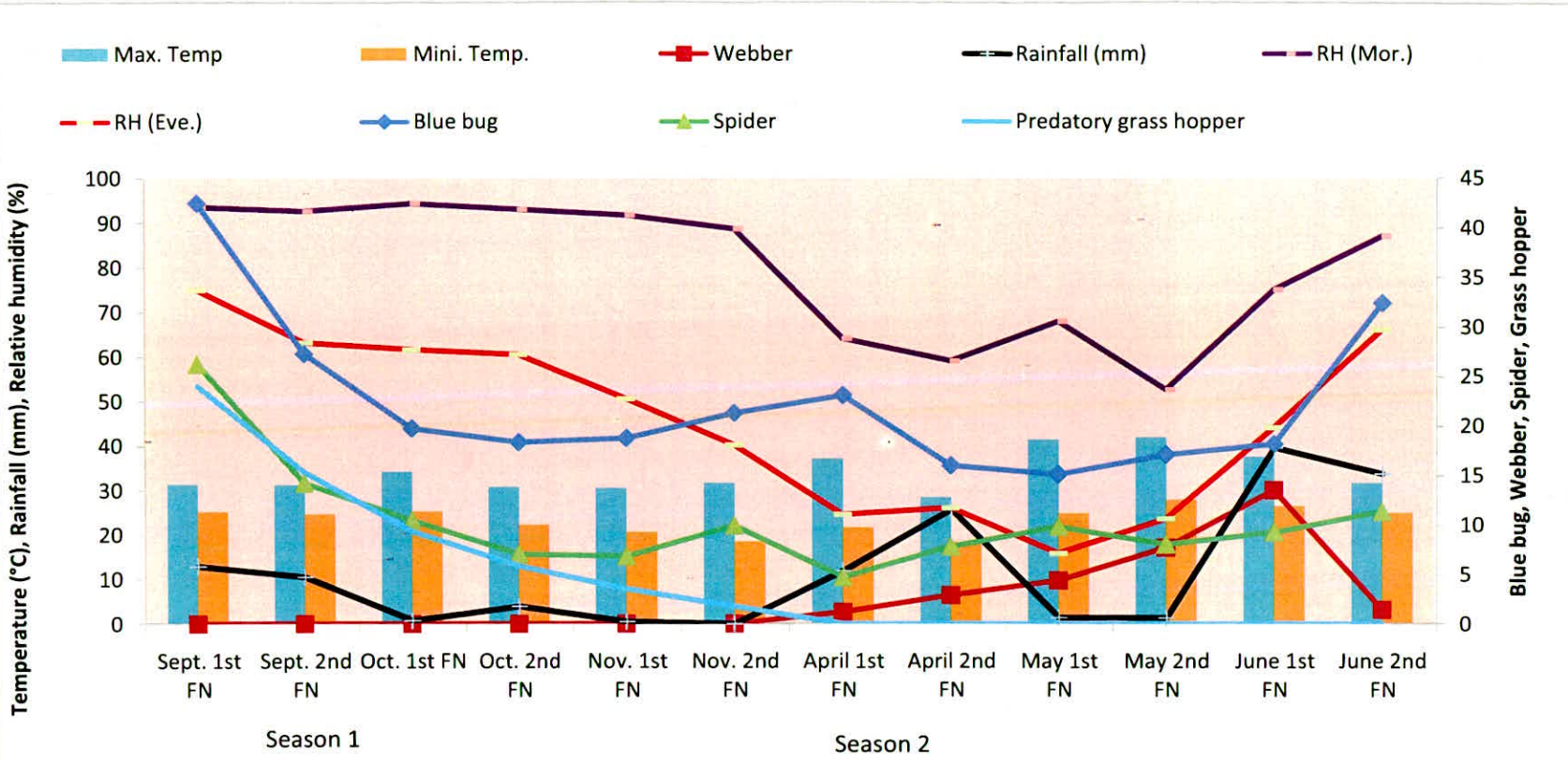

Fig. 4.1 :- Graph showing insect population in relation to weather parameters in Jatropha

Table-4.3 Correlation of Fortnightly mean population of various insects and natural enemies long with the weather parameters.

Weather parameters	Fortnightly mean population			
Season I	**Blue bug**	**Webber**	**Spider**	**Grass hopper**
Maximum Temperature (°C)	-0.1015	--	0.0314	0.0562
Minimum Temperature (°C)	0.5099	--	0.5665	0.8005
Rainfall (mm)	0.8678*	--	0.8401*	0.9255*
Relative humidity (Morning)	0.2710	--	0.3173	0.5881
Relative humidity (Evening)	0.6976	--	0.7159	0.8978*
Season II				
Maximum Temperature (°C)	-0.3848	0.4147	-0.1002	--
Minimum Temperature (°C)	0.0623	0.5889	0.4278	--
Rainfall (mm)	0.4341	0.2543	0.3489	--
Relative humidity (Morning)	0.7327	-0.0520	0.6387	--
Relative humidity (Evening)	0.8275*	0.0187	0.5808	--

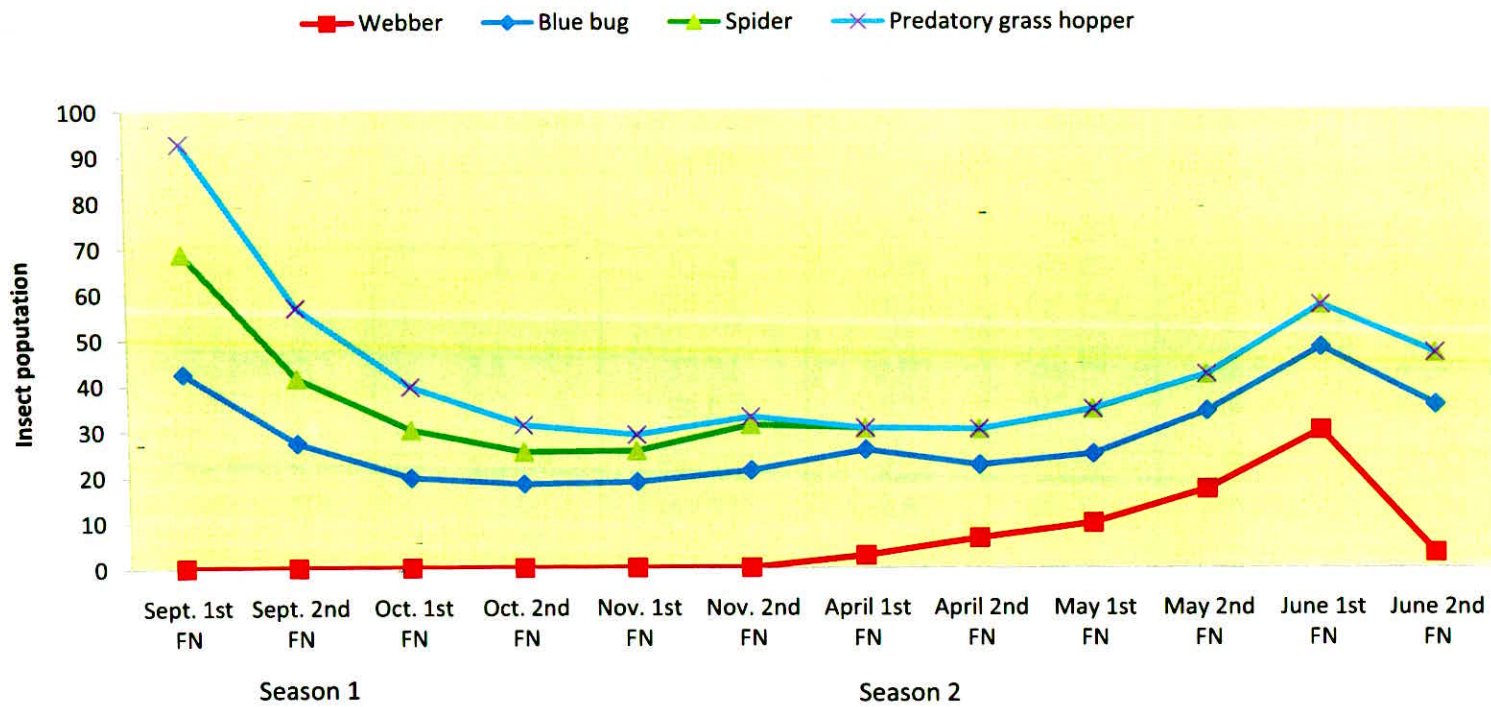

Fig 4.2 :- Population of predators, spiders and grass hopper with host insects, C. purpureus and P. morosalis

Table.4.4 : Showing per cent damaged leaves at pre treatment, 7 days, 14 days, 21 days, 28 days and 35 days after treatment on broad mites, *Euseius sp.*

S. No.	Treatment/ g.a.i./ha	Form.(ml/g)3 litres water/10 jatropha plants	Pre observation 1 day before treatment	7days after treatment	14days after treatment	21days after treatment	28days after treatment	35days after treatment
1	Untreated control (T1)		83.98 (68.17)	85.60 (69.72)	84.15 (69.49)	85.78 (72.32)	88.09 (76.89)	85.97 (72.33)
2	Spiromesifen 240SC (Oberon 240SC)/72 g.a.i. (T2)	1.2	83.98 (70.78)	79.69 (66.45)	80.92 (65.24)	75.86 (62.41)	74.72 (62.79)	75.00 (61.34)
3	Spiromesifen 240SC (Oberon 240SC)/96 g.a.i. (T3)	1.6	52.71 (46.65)	52.02 (46.26)	50.79 (45.60)	48.97 (44.29)	47.93 (43.67)	47.71 (43.63)
4	Spiromesifen 24SC (Oberon 240SC)/120 g.a.i. (T4)	2.0	58.94 (49.82)	58.24 (49.82)	57.94 (49.81)	57.33 (49.29)	57.20 (49.24)	56.38 (48.74)
5	Propargite 570 EC(Oomite 570 EC)/570 g.a.i. (T5)	4.0	74.24 (61.81)	73.40 (60.85)	67.75 (56.51)	67.80 (58.07)	66.82 (55.47)	63.51 (54.73)
6	Dicofol 18.5 EC (Fatal 18.5 EC) (standard check) /231 g.a.i. (T6)	5.0	84.15 (69.49)	83.23 (67.14)	78.29 (62.41)	80.66 (65.73)	85.87 (69.22)	86.13 (68.49)
	SEm±		1.17	1.35	1.71	1.51	1.72	1.66
	CD (5%)		3.39	3.90	4.95	4.37	4.98	4.82

Pillai and Gopi (1990) have reported *C. purpureus* as one of the insect pests of *Acacia nilotica* while Meshram *et al.,* (1992) reported damage by *C. purpureus* to nursery seedling of *Acacia nilotica*. Roychoudhary (1994) recorded *C. purpureus* in *Populus deltoides*, whereas the incidence of *C. purpureus* as an insect pest of *Delbergia sissoo* was reported by Shamila *et al.,* (1999) at TFRI Jabalpur. Soman *et al.,* (2006) and Tamrakar *et al.*, (2007) also reported blue bug (*C. purpureus*) on Jatropha from Chhattisgarh, causing damage to fruits of Jatropha.

4.1 (ii) leaf webber cum fruit borer, *Pempelia morosalis* (Saalm uller)

Leaf webber cum fruit borer, *Pempelia morosalis* (Saalm uller) caused damage to the leaves, inflorescence, fruits and apical stem of the Jatropha plant by making webs along with excreta, which causes economic damage. It also feeds on inflorescence and in later stages borer in to capsules, which leads to poor and stunted growth of Jatropha plants. The maximum population of larvae of webber was observed in the month of June (I fortnight) 29.97 larvae/ plant and the minimum populations were observed during the month of April (I fortnight) 2.64 larvae/plant. No population of webber larvae was observed in season (I) (Table 4.1).

In the correlation analysis webber was found to have a positive correlation (0.414), (0.588), (0.254) and (0.018) with maximum temperature, minimum temperature, rainfall relative humidity (evening) respectively and negative correlation (-0.052) with relative humidity (morning) in season II.

P. morosalis is emerging as a major problem in Tamil Nadu. Monoharan *et al.*, (2006) has stated that it is specific to Jatropha and reported to affect forest species like *Desmodium gangeticum*, *Flemingia* sp. and *Uraia lagopides*.

Soman *et al.*, (2006) and Tamrakar *et al.*, (2007) also reported webber as a pest of Jatropha in Chhattisgarh. Baraiha *et al.,* (2010) reported leaf webber cum fruit borer, *P. morosalis* as one of the major threats in bio-diesel production of Jatropha.

4.1 (iii) Coccids

Coccids (*Ferrisia virgata*) were observed sucking sap from leaves of *Jatropha curcas.* The population of this insect was very low during the period of studies.

4.1 (iv) Spiders, *Oxyopes lineatipes*

Spider, *Oxyopes lineatipes* (Plate) was seen preying mostly on moths, within striking distance. They play an important role by killing 2-3 moths daily thus preventing new generation of pest built up. The maximum population of this spider was recorded during the month of September 1st fortnight (26.24 spider/plant) and minimum the month of October 2nd fortnight (6.82 spider/plant) in (season I), respectively. In Season II, the maximum populations of spiders were observed in the month of June (II fortnight) *i.e.*11.34 spiders /plant and the minimum during the month of April (I fortnight) 4.73 spiders /plant respectively.

Baraiha *et al.,* (2010) also reported spider, *Oxyopes lineatipes* as a natural enemy in Jatropha.

In the correlation analysis spider was found to have a positive correlation (0.031), (0.566), (0.317) and (0.715) with the weather parameters i.e. maximum temperature, minimum temperature, relative humidity (morning and evening) respectively and positive significant correlation (0.840) during season I (Table 4.3).

In season II, the spider showed positive correlation (0.427), (0.348), (0.638), (0.580) with minimum temperature, rainfall, relative humidity (morning and evening) and negative non significant correlation with maximum temperature (-0.100).

4.1 (v) Predatory grass hoppers (unidentified)

Predatory grass hoppers (Plate) as natural enemies, play an important role by killing 2-3 harmful insect thus preventing new generation of pest built up. The maximum population of predatory grass hoppers were observed in (Season I) the month of September (I fortnight) *i.e.*24.04 grass hoppers/plant and the minimum during the month of November (II fortnight) 1.76 grass hoppers /plant. (Table 4.1). No predatory grass hoppers were recorded in season-II

In the correlation analysis grass hopper was found to have a positive correlation (0.056), (0.800) and (0.588) with maximum temperature, minimum temperature, relative humidity (morning) respectively and positive significant correlation (0.925), (0.897) with rainfall, relative humidity (evening) respectively in season II (Table 4.3).

4.1 (vi) Chrysopa, *Crysoperla carnea*

Stalked eggs of the natural enemy, *Crysoperla carnea* was observed randomly on leaves of *Jatropha curcas*. On an average of 14 eggs were seen on leaves (Plate-11)

4.2 (i) Testing of bioefficacy of a new molecule, Oberon 240EC (Spiromesifen 240SC) against broad mites, *Euseius sp.*

Pre treatment observation were recorded on five tagged plants from each provenance. Minimum broad mites damaged percentage of leaves was observed in (T3), (52.71 %) and maximum damaged leaf per cent was observed in the (T6) (84.15 %). In rest of the treatments, it was 83.98%, 83.98%, 58.98%, 74.24% i.e. in T1, T2, T4 and T5 respectively (Table 4.4).

After 7 days of spray, all the treatments showed significant result over control. Minimum broad mites damaged percentage of leaves were observed in the treatment, Spiromesifen 240 SC (Oberon 240SC) @ 96 g.a.i/ha (T3) (52.02 %). Spiromesifen 240 SC (Oberon 240SC) @ 120 g.a.i/ha (T4) (58.24%) was observed as the second best treatment followed by, Propargite 570 EC (Oomite 570 EC)@ 570 g.a.i/ha (T5) (73.40 %) , Spiromesifen 240 SC (Oberon 240SC) @ 72 g.a.i./ha (T2) (79.69 %), Dicofol 18.5 EC (Fatal 18.5 EC))@ 231 g.a.i/ha (T6) (83.23 %). Maximum damaged leaf per cent was observed in the untreated control (T1) i.e. (85.60 %). The efficacy in terms of leaf damaged per cent is as follows T3 < T4 < T5 < T2 < T6 < T1

After14 days of spray, results revealed that all the treatments again showed significant results over control. Minimum broad mites damaged per centage of leaves were observed in the treatment Spiromesifen 240 SC (Oberon 240SC) @ 96 g.a.i/ha (T3) (50.79 %). Spiromesifen 240 SC (Oberon 240SC) @ 120 g.a.i/ha (T4) (57.94%) was observed as the second best treatment followed by, Propargite 570 EC (Oomite 570 EC) @ 570 g.a.i/ha (T5) (67.75%) ,Dicofol 18.5 EC (Fatal 18.5 EC) @ 231 g.a.i/ha (T6) (78.29 %) and Spiromesifen 240 SC (Oberon 240SC) @ 72 g.a.i./ha (T2) (80.92 %), Maximum damaged leaf per cent was observed in the untreated control (T1) i.e. (84.15 %). The efficacy in terms of leaf damaged percent was T3 < T4 < T5 < T6 < T2 < T1.

After 21 days of treatment observation reveals that all the treatments varied significantly superior over control. Minimum broad mites damage per centage of leaves were observed in Spiromesifen 240 SC (Oberon 240SC) @ 96 g.a.i/ha (T3) treated plants (48.97 %). Spiromesifen 240 SC (Oberon 240SC) @ 120 g.a.i/ha (T4) (57.33%) was observed as the second best treatment followed by, Propargite 570 EC (Oomite 570 EC)@ 570 g.a.i/ha (T5) (67.80 %) , Spiromesifen 240 SC (Oberon 240SC) @ 72 g.a.i./ha (T2) (75.86 %) and Dicofol 18.5 EC (Fatal 80.66 EC) @ 231 g.a.i/ha (T6) (83.23 %) , maximum damaged leaf percent was observed in the Untreated Control (T1) i.e. (85.78 %). The efficacy in terms of leaf damaged percent was T3 < T4 < T5 < T2 < T6 < T1.

After 28 days of treatment, results again showed that all the treatments were significantly superior over control. Minimum broad mites damage per centage of leaves were observed in the treatment Spiromesifen 240 SC (Oberon 240SC) @ 96 g.a.i/ha (T3) (47.93 %). Spiromesifen 240 SC (Oberon 240SC) @ 120 g.a.i/ha (T4) (57.20%) was observed as the second best treatment followed by, Propargite 570 EC (Oomite 570 EC)@ 570 g.a.i/ha (T5) (66.82 %) , Spiromesifen 240 SC (Oberon 240SC) @ 72 g.a.i./ha (T2) (74.72 %), Dicofol 18.5 EC (Fatal 80.66 EC))@ 231 g.a.i/ha (T6) (85.87 %) , Maximum damaged leaf percent was observed in the untreated control (T1) i.e. (88.09 %). The ascending of efficacy in terms of leaf damaged percent was T3 < T4 < T5 < T2 < T6 < T1.

35 days after treatment, results presented in table (4.4) reveals that all the treatments differed significantly among themselves. Minimum broad mites damaged per centage of leaves were observed in the treatment, Spiromesifen 240 SC (Oberon 240SC)@ 96 g.a.i/ha (T3) (47.71 %). Spiromesifen 240 SC (Oberon 240SC)@ 120 g.a.i/ha (T4) (56.38 %) was observed as the second best treatment followed by, Propargite 570 EC (Oomite 570 EC)@ 570 g.a.i/ha (T5) (63.51 %) , Spiromesifen 240 SC (Oberon 240SC) @ 72 g.a.i./ha (T2) (75.00 %) and untreated control (T1) (85.92 %) . Maximum damaged leaf percent was observed in Dicofol 18.5 EC (Fatal 18.5 EC) @ 231 g.a.i/ha (T6) (86.13 %). The ascending of efficacy in terms of damaged leaf percent was T3 < T4 < T5 < T2< T1 < T6.

Table.4.5: Showing number of live and dead mites along with percentage mortality at various treatments

S.	Treatment/ g.a.i./ha	Pre treatment	7 days			14 days			21 days			28 days			35 days		
			L	D	M%	L	D	M%	L	D	M%	L	D	M%	L	D	M%
1	Untreated control (T1)	6.67	6.83	-0.16	-2.39	6.67	0.00	0.00	6.17	0.50	7.50	4.83	1.84	27.59	4.83	1.84	27.58
2	Spiromesifen 240SC (Oberon 240SC)/72 g.a.i. (T2)	6.83	6.33	0.50	7.32	5.83	1.00	14.64	5.33	1.50	21.96	4.50	2.33	34.11	5.33	1.50	21.96
3	Spiromesifen 240SC (Oberon 240SC)/96 g.a.i. (T3)	4.83	3.67	1.16	24.02	3.67	1.16	24.02	3.33	1.50	31.06	2.83	2.00	41.41	2.67	2.16	44.72
4	Spiromesifen 24SC (Oberon 240SC)/120 g.a.i. (T4)	5.17	3.67	1.50	29.01	2.67	2.50	48.36	3.33	1.84	35.59	2.67	2.50	48.36	1.50	3.67	29.01
5	Propargite 570 EC(Oomite 570 EC)/570 g.a.i. (T5)	4.33	3.33	1.00	23.09	3.50	0.83	19.17	3.50	0.83	19.17	2.50	1.83	42.26	1.50	2.83	65.36
6	Dicofol 18.5 EC (Fatal 18.5 EC) (standard check)/231 g.a.i.(T6)	4.83	4.67	0.16	3.31	3.50	1.33	27.54	4.00	0.83	17.18	3.50	1.33	27.54	2.00	2.83	58.59
	SEm±	0.40	0.25			0.27			0.22			0.28			0.38		
	CD (5%)	1.16	0.72			0.77			0.63			0.81			1.10		

Thus,from the above results it can be concluded that Spiromesifen 240 SC (Oberon 240SC)@ 96 g.a.i/ha (T3) was found to be the best, in the impact of showing minimum per cent damaged leaves after 7days, 14days, 21days, 28days and 35days after treatment.

4.2 (ii) Percentage mortality of broad mites after various treatments

Numbers of live and dead mites were counted by observing the treated leaves under trinocular digital microscope at pre treatment, 7days, 14days, 21days, 28days and 35days after treatment. Percentage mortality was computed by the formula given below and presented in (Table 4.5).

$$\text{Percentage mortality} = \frac{\text{Total mites} - \text{Live mites}}{\text{Total mites}} \text{X100}$$

After 7 days of treatment, highest percentage of mortality was recorded in T4 Spiromesifen 240 SC (Oberon 240SC) @ 120 g.a.i/ha, followed by T3(24.02%), T5 (23.09 %) , T2 (7.32%) and T6 (3.31 %). No mortality, rather an increase in population of mites was observed in control a.i. T1.

After 14 days of treatment, almost similar trend of mortality percentage of mites was observed. It was highest in T4 (48.36 %), followed by T6(27.54%), T3 (24.02 %), T5 (19.17%) and T2 (14.64 %) . No mortality, (0.00%) was recorded in T1, control.

21 days after treatment also T4 with 35.59 percent mortality remained at highest level, followed by T3 (31.06%), T2 (21.96 %), T5 (19.17%) and T6 (17.18 %) and least percentage of mortality was again observed in control ie T1 with 7.50 per cent.

Table. 4.6: Effect of various insecticides at pre treatment, 3 days, 7 days, 10 days and 14 days after treatment on larvae of leaf webber cum fruit borer, *P.morosalis* in Jatropha

S. No.	Treatment/g.a.i./ha	Form.(ml/g)3 litres water/10 jatropha plants	Pre observation 1 day before treatment	3 days after treatment	7 days after treatment	10 days after treatment	14 days after treatment
1	Untreated control (T1)		2.40 (1.70)	2.40 (170)	2.87 (1.83)	1.73 (1.46)	0.00 (0.71)
2	Flubendiamide 240sc (fame 240sc)/24 g.a.i. (T2)	0.2	2.53 (1.74)	2.27 (1.65)	1.53 (1.37)	1.13 (1.27)	0.00 (0.71)
3	Flubendiamide 240sc (fame 240sc)/36 g.a.i. (T3)	0.3	2.78 (1.81)	2.87 (1.83)	1.80 (1.48)	1.13 (1.27)	0.00 (0.71)
4	Flubendiamide 240sc (fame 240sc)/48 g.a.i. (T4)	0.4	2.67 (1.78)	1.67 (1.46)	1.27 (1.33)	0.93 (1.15)	0.00 (0.71)
5	Emamectin benzoate 52sg(proclaim 5%sg)/10 g.a.i. (T5)	0.8	2.13 (1.95)	1.87 (1.54)	1.27 (1.33)	0.87 (1.05)	0.00 (0.71)
6	Indoxacarb 14.5ec (standard check)/60 g.a.i. (T6)	1.6	2.20 (1.62)	2.07 (1.19)	1.93 (1.46)	1.53 (1.35)	0.00 (0.71)
	SEm±		0.21	0.24	0.17	0.21	0.00
	CD (5%)		0.61	0.69	0.51	0.60	0.00

Similar trend of mortality was observed even 28 days after treatment.T4 again showed highest percentage mortality of mites (48.36%) followed by T5 (42.26%), T3 (41.41 %), T2 (34.11%) and T1 (27.59 %). Lowest percentage of mortality was recorded in T6 (27.54%) which was at par with T1 control (27.59%).

35 days after treatment, trend of percentage mortality of mites showed slightly different pattern from the previous observations. Maximum percentage of mortality was recorded in T5 (65.36%), followed by T6 (58.59%), T3 (44.72 %), T4 (29.01%) and T1 (27.58 %) with minimum in T2 (21.96%).

Looking to the above results, it can be concluded that up to four weeks (28 days) of application of various acaricides, T4 Spiromesifen 240 SC (Oberon 240SC) @ 120 g.a.i/ha proved to be the best treatment, after which its efficacy reduced. After 35 days (5 weeks) of treatment, T5 Propargite 570 EC (Oomite 570 EC) @ 570 g.a.i./ha proved to be better, but as far as its concentration was concerned it was more than three times than T4 i.e. Spiromesifen @ 120 g.a.i./ha, hence the latter can be judged as the best treatment.

4.3 (i) Testing of bioefficacy of new the molecule, Flubendiamide 480SC against leaf webber cum fruit borer, *Pempelia morosalis* (Saalm Uller)

For the above mentioned experiment, five plants were selected and tagged among the ten plants taken from each treatment as one replication. Thus, in each treatment there were 30 plants comprising of three replications. Pre treatment observations depicts that maximum number of larvae were

observed in T3 (2.78/plant) and minimum in T5 (2.13/plant) on tagged plants. In the remaining treatments T1, T2, T4 and T6 the mean number of larvae observed were 2.40, 2.53, 2.67 and 2.20 larvae/plant respectively. (Table-4.6)

3 days after treatments, results revealed that all the treatments varied significantly over control. Mean minimum leaf webber larvae was observed in T4 i.e. Flubendiamide 240 SC (fame 240SC) @ 48 g.a.i/ha (1.67 larvae/plant). Emamectin benzoate 5 SG (Proclaim 5% SG) @ 10 g.a.i/ha (T5) (1.87 larvae/plant) was observed as the second best treatment followed by, Indoxacarb 14.5 EC (standard check) @ 60 g.a.i/ha (T6) (2.07 larvae/plant), Flubendiamide 240 SC (fame 240SC) @ 24 g.a.i./ha (T2) (2.27 larvae/plant) and untreated control (T1) (2.40 larvae/plant). Mean maximum leaf webber larvae/plants were observed in Flubendiamide 240 SC (fame 240SC) @ 36 g.a.i/ha (T3) treated plant (2.87 larvae/plant). The ascending of efficacy in terms of number of larvae/plant, can be ranked as T4 < T5 < T6 < T2 < T1 < T3.

7 days after treatment also all the treatments varied significantly over control. Mean minimum leaf webber larvae was observed in the treatment, Flubendiamide 240 SC (fame 240SC) @ 48 g.a.i/ha (T4) (1.27 larvae/plant). The Emamectin benzoate 5 SG (Proclaim 5% SG) @ 10 g.a.i/ha (T5) (1.27 larvae/plant) was observed as the second best treatment followed by, Flubendiamide 240 SC (fame 240SC) @ 24 g.a.i./ha (T2) (1.53 larvae/plant), Flubendiamide 240 SC (fame 240SC) @ 36 g.a.i/ha (T3) (1.80 larvae/plant), Indoxacarb 14.5 EC (standard check) @ 60 g.a.i/ha (T6) (1.93 larvae/plant)

Table.4.7: Showing number of live and dead webber along with percentage mortality at various treatments

S.	Treatment/ g.a.i./ha	Pre treatment	3 days			7 days			10days			14days		
			L	D	M%	L	D	M%	L	D	M%	L	D	M%
1	Untreated control (T1)	2.40	2.40	0.00	0.00	2.87	-0.47	-19.58	1.73	0.67	27.92	0.00	0.00	0.00
2	Flubendiamide 240sc (fame 240sc)/24 g.a.i (T2)	2.53	2.27	0.26	10.28	1.53	1.00	39.53	1.13	1.40	55.34	0.00	0.00	0.00
3	Flubendiamide 240sc (fame 240sc)/36 g.a.i (T3)	2.87	2.78	0.09	3.14	1.80	1.07	37.28	1.13	1.74	60.63	0.00	0.00	0.00
4	Flubendiamide 240sc (fame 240sc)/48 g.a.i (T4)	2.67	1.67	1.00	37.45	1.27	1.40	52.43	0.93	1.74	65.17	0.00	0.00	0.00
5	Emamectin benzoate 52sg(proclaim 5%sg)/10 g.a.i (T5)	2.13	1.87	0.26	12.2	1.27	0.86	40.38	0.87	1.26	59.15	0.00	0.00	0.00
6	Indoxacarb 14.5ec (standard check)/60 g.a.i (T6)	2.20	2.07	0.13	5.99	1.93	0.27	12.27	1.53	0.67	12.27	0.00	0.00	0.00
	SEm±	0.21	0.24			0.17			0.21			0.00		
	CD (5%)	0.61	0.69			0.51			0.60			0.00		

.Mean maximum leaf webber larvae was observed in untreated control (T1) (2.87 larvae/plant). The ascending of efficacy in terms of number of larvae/plant, can be aaranged as T4 < T5 < T2 < T3 < T6 < T1.

Even 10 days after treatment all the treatments varied significantly over control. Mean minimum leaf webber larvae was observed in the treatment (T5) Emamectin benzoate 5 SG (Proclaim 5% SG) @ 10 g.a.i/ha (0.87 larvae/plant), followed by Flubendiamide 240 SC (fame 240SC) @ 48 g.a.i/ha (T4) (0.93 larvae/plant) as the second best treatment. These were followed by Flubendiamide 240 SC (fame 240SC) @ 24 g.a.i./ha (T2) (1.13 larvae/plant), Flubendiamide 240 SC (fame 240SC) @ 36 g.a.i/ha (T3) (1.13 larvae/plant) and Indoxacarb 14.5 EC (standard check) @ 60 g.a.i/ha (T6) (1.53 larvae/plant). Mean maximum leaf webber larvae was observed in untreated control (T1) (1.73 larvae/plant). The ascending of efficacy in terms of number of larvae/plant, can be grouped as T5 < T4 < T2 < T3 < T6 < T1.

Thus, Flubendiamide 240 SC (fame 240SC) @ 48 g.a.i/ha (T4) can be ranked as the best treatment, since even 10 days after treatment; it recorded mean minimum number (1.27 larvae/plant).

14 days after treatment, no larvae was detected in any of the treatments (Table-4.6).

4.3 (ii) Percentage mortality of leaf webber due to various treatments.

Number of live and dead larvae of leaf webber cum fruit borer, *Pempelia morosalis* were counted by observing at pre treatment 3days, 7days,

10days and 14 days after treatment, percentage mortality was computed by the formula given below, presented in table 4.7

$$\text{Percentage mortality} = \frac{\text{Total Larvae} - \text{Live Larvae}}{\text{Total Larvae}} X100$$

After 3 days of treatment, highest percentage of mortality was recorded in T4 (37.45%), Flubendiamide 240 SC (fame 240SC) @ 48 g.a.i/ha, followed by T5 (12.20%), T2 (10.28 %), T6 (5.99%) and T3 (0.09 %). No larval mortality was observed in control T1.

After 7 days of treatment, highest percentage of mortality was again recorded in T4 (52.43%), Flubendiamide 240 SC (fame 240SC) @ 48 g.a.i/ha, followed by T5 (40.38%), T2 (39.53 %) , T3 (37.28%) and T6(12.27 %). Negative mortality (-19.58) is population build up was recorded in control T1.

10 days after treatment also T4 with 65.17% mortality remained at highest level, followed by T3 (60.63%), T5 (59.15 %), T2 (50.34%) and T1 (27.92 %) lowest percentage of mortality recorded in T6. No insects were recorded 14 days after treatment.

4.4 (i) Screening of various provenances of *Jatropha curcucs* against blue bug *Chrysocoris purpureus*.

Pooled analysis of the fortnightly population of blue bug , *Chrysocoris purpureus* recorded on 47 provenances of *Jatropha curcas* was computed and presented in table 4.12 . Data depicts that in season I, the mean population of nymphs and adults bugs / plant was non significant; but in season II it was significant between each other. Minimum population of *C. purpureus* were recorded in the provenances , Chandrapur (0.13), PKVJ – DHW – 1 (0.13) ,

Tokupons (0.18) and Chandka (0.18) which can be regarded as provenances showing some level of tolerance while Pant J&K Set 2 with 0.76 and Jabalpur with (0.73) nymphs & adult/ plant can be regarded as susceptible provenance.

4.4 (ii) Screening of various provenances of *Jatropha curcas* against leaf webber cum fruit borer, *Pempelia morosalis*.

Pooled analysis of the fortnightly population of leaf webber cum fruit borer, *P. morosalis* was computed and presented in table 4.13. Data revealed that the mean number of larvae showed significant differences among various provenances. Provenances Jagdalpur and ANOS-201 recorded (0.00) number of larvae and can be considered as provences showing tolerance against *P. morosalis* where as Sagar -1 and Pant J&K set - I with 0.59 and 0.46 larvae / plant can be regarded as susceptible .

The above results are in agreement with Tamrakar *et al.*, 2009, who also reported Sagar- 1 as susceptible against *P. morosalis*.

Table 4.8: Population of blue bug recorded fortnightly on various provenances of *J. curcas*.

S. No.	Name of the provenances	Dates											
		15/09/10	29/09/10	14/10/10	29/10/10	15/11/10	29/11/10	05/04/11	20/04/11	06/05/11	21/05/11	05/06/11	20/06/11
1.	Sagar-1	0.77 (1.13)	3.11 (1.90)	1.11 (1.26)	1.11 (1.26)	0.55 (1.02)	0.66 (1.08)	0.55 (1.02)	0.33 (0.91)	0.22 (0.85)	0.00 (0.71)	0.33 (0.91)	1.22 (1.31)
2.	RJ 117 (A)	1.11 (1.26)	1.11 (1.26)	0.77 (1.13)	0.55 (1.02)	0.33 (0.91)	0.00 (0.71)	0.77 (1.13)	0.00 (0.71)	0.00 (0.71)	0.33 (0.91)	0.77 (1.13)	1.11 (1.26)
3.	Dehradoon	1.66 (1.47)	0.88 (1.17)	0.88 (1.17)	0.33 (0.91)	0.11 (0.78)	0.00 (0.71)	0.66 (1.08)	0.66 (1.08)	0.22 (0.85)	0.44 (0.97)	0.77 (1.13)	1.22 (1.31)
4.	Barbuspur	2.22 (1.65)	0.77 (1.13)	0.33 (0.91)	1.11 (1.26)	0.00 (0.71)	0.22 (0.85)	0.33 (0.91)	0.00 (0.71)	0.55 (1.02)	0.44 (0.97)	0.88 (1.17)	0.88 (1.17)
5.	Pant J&K Set 2	1.66 (1.47)	0.22 (0.85)	0.22 (0.85)	1.11 (1.26)	0.11 (0.78)	1.11 (1.26)	1.66 (1.47)	0.22 (0.85)	0.22 (0.85)	1.22 (1.31)	0.11 (0.78)	1.11 (1.26)
6.	J&K Set 1	0.88 (1.17)	1.33 (1.35)	0.11 (0.78)	0.22 (0.85)	0.55 (1.02)	1.55 (1.43)	0.11 (0.78)	0.33 (0.91)	0.44 (0.97)	0.00 (071)	0.00 (0.71)	1.22 (1.31)
7.	Jabalpur	0.88 (1.17)	0.33 (0.91)	0.44 (0.97)	0.33 (0.91)	1.33 (1.35)	0.22 (0.85)	0.11 (0.78)	0.33 (0.91)	0.22 (0.85)	1.33 (1.35)	1.22 (1.31)	1.22 (1.31)
8.	J&K Set 1	1.11 (1.27)	1.66 (1.47)	0.55 (1.02)	0.44 (097)	0.00 (0.71)	2.22 (1.65)	0.00 (0.71)	0.11 (0.78)	00.11 (0.78)	0.22 (0.85)	0.66 (1.08)	0.77 (1.13)
9.	NRCAF-13	1.11 (1.26)	1.11 (1.26)	0.77 1.13)	0.22 (0.85)	0.00 (0.71)	0.00 (0.71)	0.33 (0.91)	0.11 (0.78)	0.55 (1.03)	0.88 (1.17)	0.66 (1.08)	0.88 (1.17)
10.	Baikunthpur	1.66 (1.47)	0.22 (0.85)	0.22 (0.85)	1.11 (1.26)	1.11 (1.26)	1.11 (1.26)	1.66 (1.47)	0.22 (0.85)	0.22 (0.85)	0.11 (0.78)	1.11 (1.26)	1.22 (1.31)
11.	TNMC-5	0.66 (1.08)	1.22 (1.31)	0.77 (1.13)	0.66 (1.08)	0.00 (0.71)	0.77 (1.13)	0.00 (0.71)	0.77 (1.13)	0.00 (0.71)	0.66 (1.08)	0.77 (1.13)	1.11 (1.26)
12.	Mandeshwar	2.22 (1.65)	0.33 (0.91)	0.22 (0.85)	0.00 (0.71)	0.00 (0.71)	0.22 (0.85)	0.11 (0.78)	0.00 (0.71)	0.00 (0.71)	1.22 (1.31)	0.22 (0.85)	0.44 (0.94)
13.	Pant J&K Set 1	0.66 (1.08)	0.22 (0.85)	0.11 (0.78)	0.00 (0.71)	0.00 (0.71)	0.55 (1.02)	1.11 (1.26)	0.33 (0.91)	0.00 (0.71)	0.44 (0.97)	0.66 (1.08)	0.88 (1.17)
14.	PKVJ-MKV-1	1.22 (1.31)	0.11 (0.78)	0.00 (0.71)	0.00 (0.71)	1.22 (1.31)	0.44 (0.97)	0.44 (0.97)	0.11 (0.78)	0.00 (0.71)	0.00 (0.71)	0.77 (1.13)	0.88 (1.17)
15.	AMOS-201	1.22 (1.31)	0.00 (0.71)	0.55 (1.02)	0.22 (0.85)	0.11 (0.78)	0.22 (0.85)	0.00 (0.71)	0.44 (0.97)	0.55 (1.02)	1.11 (1.26)	0.00 (0.71)	1.33 (1.35)
16.	Bawal	1.22 (1.31)	0.22 (0.85)	0.44 (0.97)	0.00 (0.71)	0.55 (1.02)	0.44 (0.97)	0.11 (0.78)	0.55 (1.02)	0.00 (0.71)	0.00 (0.71)	0.33 (0.91)	0.44 (0.97)
17.	NRCAF-15	0.66 (1.08)	0.33 (0.91)	0.88 (1.17)	0.00 (0.71)	0.77 (1.13)	0.77 (1.13)	0.66 (1.08)	1.22 (1.31)	1.11 (1.26)	0.44 (0.97)	0.33 (0.91)	0.11 (0.78)

S. No.	Name of the provenances	Dates											
		15/09/10	29/09/10	14/10/10	29/10/10	15/11/10	29/11/10	05/04/11	20/04/11	06/05/11	21/05/11	05/06/11	20/06/11
18.	PKVJ-AKT-1	0.44 (0.97)	1.11 (1.26)	1.11 (1.26)	0.11 (0.78)	0.22 (0.85)	0.00 (0.71)	0.66 (1.08)	0.77 (1.13)	0.33 (0.91)	0.11 (0.78)	0.22 (0.85)	0.66 (1.08)
19.	Indore-I	0.88 (1.17)	0.66 (1.08)	0.11 (0.78)	0.11 (0.78)	0.66 (1.08)	0.66 (1.08)	2.22 (0.85)	0.00 (0.71)	0.44 (0.97)	0.00 (0.71)	0.44 (0.97)	1.11 (1.26)
20.	Korba	0.88 (1.17)	0.33 (0.91)	0.66 (1.08)	0.22 (0.85)	0.44 (0.97)	0.00 (0.71)	0.11 (0.78)	0.22 (0.85)	0.66 (1.08)	0.00 (0.71)	0.33 (0.91)	0.66 (1.08)
21.	Chandka	1.11 (1.26)	0.22 (0.85)	0.22 (0.85)	0.33 (0.91)	0.22 (0.85)	0.55 (1.02)	0.33 (0.91)	0.00 (0.71)	0.33 (0.91)	0.00 (0.71)	0.22 (0.85)	0.22 (0.85)
22.	TFRI-1	0.33 (0.91)	0.00 (0.71)	0.00 (0.71)	0.11 (0.78)	0.44 (0.97)	0.88 (1.17)	0.00 (0.71)	0.00 (0.71)	0.55 (1.02)	0.22 (0.85)	0.11 (0.78)	1.11 (1.26)
23.	Barmunda	0.11 (0.78)	0.77 (1.13)	0.00 (0.71)	0.44 (0.97)	0.55 (1.02)	0.00 (0.71)	0.66 (1.08)	1.11 (1.26)	0.22 (0.85)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)
24.	NRCAF-18	0.88 (1.17)	0.22 (0.85)	0.33 (0.91)	0.44 (0.97)	0.00 (071)	0.11 (0.78)	0.44 (0.97)	0.44 (0.97)	0.22 (0.85)	0.00 (0.71)	0.11 (0.78)	0.55 (1.02)
25.	J&K Set 2	0.77 (1.13)	0.11 (0.78)	0.00 (0.71)	0.44 (0.97)	1.66 (1.47)	0.33 (0.91)	0.66 (1.08)	0.55 (1.02)	0.22 (0.85)	1.11 (1.26)	0.00 (0.71)	0.33 (0.91)
26.	Jagdalpur	0.88 (1.17)	0.77 (1.13)	0.11 (1.78)	0.00 (0.71)	0.22 (0.78)	1.33 (1.35)	0.22 (0.85)	0.22 (0.85)	0.11 (0.78)	0.00 (0.71)	0.22 (0.85)	1.33 (1.35)
27.	Kalyanpur	0.66 (1.08)	0.00 (0.71)	0.22 (0.85)	0.11 (0.78)	0.00 (0.71)	0.33 (0.91)	1.33 (1.35)	0.22 (0.85)	0.88 (1.17)	0.33 (0.91)	0.11 (0.78)	0.00 (0.71)
28.	APOS-2001	0.55 (1.02)	0.00 (0.71)	0.00 (0.71)	0.22 (0.85)	0.11 (0.78)	0.11 (0.78)	0.44 (0.97)	1.11 (1.26)	0.00 (0.71)	1.11 (1.26)	0.00 (0.71)	0.77 (1.13)
29.	RJ 117 (B)	0.88 (1.17)	0.33 (0.91)	0.11 (0.78)	0.22 (0.85)	0.55 (1.02)	1.33 (1.35)	0.11 (0.78)	0.33 (0.91)	0.44 (0.97)	0.00 (0.71)	0.00 (0.71)	1.22 (1.31)
30.	TNMC-7	0.77 (0.70)	0.44 (0.97)	1.22 (1.31)	0.00 (0.71)	0.11 (0.78)	0.33 (0.91)	0.66 (1.08)	0.55 (1.02)	0.55 (1.03)	0.11 (0.78)	0.22 (0.85)	0.33 (0.91)
31.	ANOS-201	0.11 (1.13)	1.66 (1.47)	0.33 (0.91)	0.00 (0.71)	0.22 (0.85)	0.22 (0.85)	0.11 (0.78)	0.11 (1.78)	0.55 (1.02)	0.44 (0.97)	0.33 (0.91)	0.44 (0.97)
32.	PKVJ-SJ-1	0.44 (0.97)	1.11 (1.26)	1.11 (1.26)	0.44 (0.97)	0.22 (0.85)	0.11 (0.78)	0.00 (0.71)	0.00 (0.71)	0.11 (0.78)	0.33 (0.91)	0.77 (1.13)	0.33 (0.91)
33.	Pendra Road	0.88 (1.17)	0.22 (0.85)	0.66 (1.08)	0.22 (0.85)	0.44 (0.97)	0.00 (0.71)	1.22 (1.31)	0.22 (0.85)	0.66 (1.08)	0.00 (0.71)	0.33 (0.91)	0.66 (1.08)
34.	PKVJ-DHW-1	1.33 (1.35)	0.22 (0.85)	0.22 (0.85)	1.11 (1.26)	0.00 (0.71)	0.22 (0.85)	0.00 (0.78)	0.00 (0.71)	0.11 (0.78)	0.00 (0.71)	0.33 (0.91)	0.33 (0.91)
35.	NRCAF-14	0.55 (1.02)	0.22 (0.85)	0.11 (0.78)	0.11 (0.78)	1.11 (1.26)	0.44 (0.97)	0.33 (0.91)	0.44 (0.97)	0.77 (1.13)	0.00 (0.71)	0.11 (0.78)	0.11 (0.78)

S. No.	Name of the provenances	Dates											
		15/09/10	29/09/10	14/10/10	29/10/10	15/11/10	29/11/10	05/04/11	20/04/11	06/05/11	21/05/11	05/06/11	20/06/11
36.	Balodabazar	0.55 (1.02)	0.11 (0.78)	0.11 (0.78)	0.00 (0.71)	0.55 (1.02)	0.55 (1.02)	0.22 (0.85)	0.55 (1.02)	0.00 (0.71)	0.00 (0.71)	0.66 (1.08)	0.44 (0.97)
37.	Kot	0.66 (1.08)	0.55 (1.02)	0.11 (0.78)	0.33 (0.91)	0.00 (0.71)	0.00 (0.71)	1.33 (1.35)	0.22 (0.85)	1.11 (1.26)	0.44 (0.97)	0.66 (1.08)	0.55 (1.02)
38.	Tukupoms	0.88 (1.17)	0.33 (0.91)	0.44 (0.97)	0.33 (0.91)	0.00 (0.71)	0.00 (0.71)	0.11 (0.78)	0.00 (0.71)	0.22 (0.85)	0.00 (0.71)	0.55 (1.02)	0.22 (0.85)
39.	Taraipur	0.33 (0.91)	0.11 (0.78)	0.22 (0.85)	0.11 (0.78)	0.33 (0.91)	0.44 (0.97)	0.11 (0.78)	0.33 (0.91)	0.00 (0.70)	0.66 (1.08)	0.44 (0.97)	0.00 (0.71)
40.	Kilkila	1.22 (1.31)	0.55 (1.02)	0.22 (0.85)	1.11 (1.26)	0.00 (0.71)	0.11 (0.78)	0.00 (0.71)	0.22 (0.85)	0.44 (0.97)	0.33 (0.91)	0.11 (0.78)	0.55 (1.02)
41.	Chandrapur	0.66 (1.08)	0.44 (0.97)	1.22 (1.31)	1.66 (1.47)	0.22 (0.85)	0.55 (1.02)	0.33 (0.91)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.22 (0.85)	0.22 (0.85)
42	Mahanrpur	0.66 (1.08)	0.66 (1.08)	1.11 (1.26)	0.33 (0.91)	0.55 (1.02)	0.55 (1.02)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.44 (0.97)	0.22 (0.85)	1.11 (1.26)
43.	Surajpur	0.88 (1.17)	0.11 (0.78)	0.00 (0.71)	0.00 (0.71)	0.66 (1.08)	0.11 (0.78)	0.55 (1.02)	0.33 (0.91)	0.33 (0.91)	0.00 (0.71)	0.00 (0.71)	0.55 (1.02)
44.	Sonhat	1.11 (1.26)	1.66 (1.47)	0.22 (0.85)	0.11 (0.78)	0.55 (1.02)	0.44 (0.97)	0.11 (0.78)	0.33 (0.91)	0.00 (0.71)	0.88 (1.17)	0.44 (0.97)	0.55 (1.02)
45.	Saheltarai	0.33 (0.91)	0.11 (0.78)	0.22 (0.85)	1.11 (1.26)	0.33 (0.91)	0.44 (0.97)	1.33 (1.35)	0.33 (0.91)	0.00 (0.71)	0.66 (1.08)	0.44 (0.97)	0.00 (0.71)
46.	Churmundra	0.66 (1.08)	1.11 (1.26)	0.88 (1.17)	1.22 (1.31)	1.11 (1.26)	0.00 (0.71)	0.66 (1.08)	0.00 (0.71)	0.33 (0.91)	0.22 (0.85)	0.00 (0.71)	0.55 (1.02)
47.	Keshipur	1.22 (1.31)	0.00 (0.71)	0.11 (0.78)	0.00 (0.71)	0.55 (1.02)	0.66 (1.08)	0.22 (0.85)	0.33 (0.91)	0.00 (0.71)	0.44 (0.97)	0.55 (1.02)	0.44 (0.97)
	SEm±	0.14	0.12	0.85	0.58	0.11	0.10	0.09	0.10	0.13	0.09	0.08	0.90
	CD (5%)	0.39	0.34	NS	NS	0.32	NS	NS	NS	0.35	NS	NS	NS

Note : Figures in parentheses are square root transformed value

Table 4.9: Population of leaf webber cum fruit borer, *Pempelia morosalis* recorded fortnightly on various provenances of *J. curcas*.

S. No.	Name of the provenances	Dates					
		05/04/11	20/04/11	06/05/11	21/05/11	05/06/11	20/06/11
1.	Sagar-1	0.00 (0.71)	1.22 (1.31)	0.33 (0.91)	0.44 (0.97)	1.55 (1.43)	0.00 (0.71)
2.	RJ 117 (A)	0.00 (0.71)	0.00 (0.71)	0.33 (0.91)	0.33 (0.91)	0.77 (1.13)	0.00 (0.71)
3.	Dehradoon	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.88 (1.17)	0.00 (0.71)	0.33 (0.91)
4.	Barbuspur	0.00 (0.71)	0.44 (0.97)	0.44 (0.97)	0.55 (1.02)	0.00 (0.71)	0.00 (0.71)
5.	Pant J&K Set 2	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.88 (1.17)	0.00 (0.71)	0.00 (0.71)
6.	J&K Set 1	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.88 (1.17)	0.00 (0.71)
7.	Jabalpur	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.77 (1.13)	0.00 (0.71)
8.	J&K Set 1	0.00 (0.71)	0.00 (0.71)	0.55 (1.02)	0.77 (1.13)	0.33 (0.97)	0.00 (0.71)
9.	NRCAF-13	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.77 (1.13)	0.00 (0.71)
10.	Baikunthpur	0.00 (0.71)	0.44 (0.97)	0.00 (0.71)	0.00 (0.71)	0.77 (1.13)	0.00 (0.71)
11.	TNMC-5	0.11 (0.78)	0.11 (0.78)	0.44 (0.97)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)
12.	Mandeshwar	0.77 (1.13)	0.22 (0.85)	0.00 (0.71)	0.44 (0.97)	0.00 (0.71)	0.00 (0.71)
13.	Pant J&K Set 1	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	2.77 (1.81)	0.00 (0.71)
14.	PKVJ-MKV-1	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.88 (1.17)	0.00 (0.71)
15.	AMOS-201	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	1.33 (1.35)	0.00 (0.71)
16.	Bawal	0.00 (0.71)	0.00 (0.71)	0.88 (1.17)	1.11 (1.26)	0.00 (0.71)	0.88 (1.17)
17.	NRCAF-15	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	1.22 (1.31)	0.00 (0.71)

S. No.	Name of the provenances	Dates					
		05/04/11	20/04/11	06/05/11	21/05/11	05/06/11	20/06/11
18.	PKVJ-AKT-1	0.00	0.11	0.66	0.33	1.55	0.00
		(0.71)	(0.78)	(1.08)	(0.91)	(1.43)	(0.71)
19.	Indore-I	0.00	0.00	0.00	0.33	1.88	0.00
		(0.71)	(0.71)	(0.71)	(0.91)	(1.55)	(0.71)
20.	Korba	0.66	0.55	0.88	0.11	0.66	0.66
		(1.08)	(1.02)	(1.17)	(0.78)	(1.08)	(1.08)
21.	Chandka	0.00	0.00	0.00	0.44	0.44	0.00
		(0.71)	(0.71)	(0.71)	(0.97)	(0.97)	(0.71)
22.	TFRI-1	0.33	0.00	0.00	0.00	0.00	0.00
		(0.91)	(0.71)	(0.71)	(0.71)	(0.71)	(0.71)
23.	Barmunda	0.00	0.00	0.00	0.55	0.55	0.00
		(0.71)	(0.71)	(0.71)	(1.02)	(1.02)	(0.71)
24.	NRCAF-18	0.00	0.00	0.33	0.00	1.22	0.00
		(0.71)	(0.71)	(0.91)	(0.71)	(1.31)	(0.71)
25.	J&K Set 2	0.00	0.00	0.00	0.55	0.00	0.00
		(0.71)	(0.71)	(0.71)	(1.02)	(0.71)	(0.71)
26.	Jagdalpur	0.00	0.00	0.00	0.00	0.00	0.00
		(0.71)	(0.71)	(0.71)	(0.71)	(0.71)	(0.71)
27.	Kalyanpur	0.00	0.00	0.00	0.77	0.00	0.00
		(0.71)	(0.71)	(0.71)	(1.13)	(0.71)	(0.71)
28.	APOS-2001	0.00	0.00	0.00	0.44	0.77	0.00
		(0.71)	(0.71)	(0.71)	(0.97)	(1.13)	(0.71)
29.	RJ 117 (B)	0.00	0.00	0.77	0.00	0.00	0.00
		(0.71)	(0.71)	(1.13)	(0.71)	(0.71)	(0.71)
30.	TNMC-7	0.00	0.33	0.11	0.00	0.44	0.00
		(0.71)	(0.91)	(0.78)	(0.71)	(0.97)	(0.71)
31.	ANOS-201	0.00	0.00	0.00	0.00	0.00	0.00
		(0.71)	(0.71)	(0.71)	(0.71)	(0.71)	(0.71)
32.	PKVJ-SJ-1	0.00	0.00	0.00	0.44	0.00	0.00
		(0.71)	(0.71)	(0.71)	(0.97)	(0.71)	(0.71)
33.	Pendra Road	0.00	0.00	0.00	0.88	0.77	0.00
		(0.71)	(0.71)	(0.71)	(1.17)	(1.13)	(0.71)
34.	PKVJ-DHW-1	0.00	0.00	0.00	0.33	0.00	0.00
		(0.71)	(0.71)	(0.71)	(0.91)	(0.71)	(0.71)
35.	NRCAF-14	0.00	0.00	0.00	0.33	0.00	0.00
		(0.71)	(0.71)	(0.71)	(0.91)	(0.71)	(0.71)

S. No.	Name of the provenances	Dates					
		05/04/11	20/04/11	06/05/11	21/05/11	05/06/11	20/06/11
36.	Balodabazar	0.55 (1.02)	0.22 (0.85)	0.66 (1.08)	0.66 (1.08)	2.88 (1.84)	0.33 (0.91)
37.	Kot	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.33 (0.91)	0.44 (0.97)	0.00 (0.71)
38.	Tukupoms	0.22 (0.85)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	1.55 (1.43)	0.22 (0.85)
39.	Taraipur	0.00 (0.71)	0.00 (0.71)	2.44 (1.72)	0.00 (0.71)	0.44 (0.97)	0.00 (0.71)
40.	Kilkila	0.00 (0.71)	0.44 (0.97)	0.55 (1.02)	0.66 (1.08)	0.11 (0.78)	0.00 (0.71)
41.	Chandrapur	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	1.33 (1.35)	0.00 (0.71)
42	Mahanrpur	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	1.33 (1.35)	0.00 (0.71)	0.00 (0.71)
43.	Surajpur	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	1.33 (1.35)	0.00 (0.71)
44.	Sonhat	0.00 (0.71)	1.33 (1.35)	0.00 (0.71)	2.88 (1.84)	3.22 (1.93)	0.77 (1.13)
45.	Saheltarai	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)
46.	Churmundra	0.00 (0.71)	0.11 (0.78)	0.33 (0.91)	0.33 (0.91)	0.00 (0.71)	0.00 (0.71)
47.	Keshipur	0.00 (0.71)	0.88 (1.17)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)
	SEm±	0.07	0.09	0.21	0.32	0.41	0.22
	CD (5%)	NS	NS	NS	NS	NS	NS

Note : Figures in parentheses are square root transformed value

Table 4.10 : Population of Spider, *Oxyopes lineatipes* recorded fortnightly on various provenances of *J. curcas*.

S. No.	Name of the provenances	Dates											
		15/09/10	29/09/10	14/10/10	29/10/10	15/11/10	29/11/10	05/04/11	20/04/11	06/05/11	21/05/11	05/06/11	20/06/11
1.	Sagar-1	0.88 (1.17)	0.22 (0.85)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.33 (0.91)	0.00 (0.71)	0.00 (0.71)	0.11 (0.78)	0.00 (0.71)	0.11 (0.78)	0.11 (0.78)
2.	RJ 117 (A)	0.77 (1.13)	0.55 (1.02)	0.00 (0.71)	0.33 (0.91)	0.11 (0.78)	0.77 (1.13)	0.11 (0.78)	0.00 (0.71)	0.55 (1.02)	0.22 (0.85)	0.11 (0.78)	0.33 (0.91)
3.	Dehradoon	0.88 (1.17)	0.44 (0.97)	0.00 (0.71)	0.11 (0.78)	0.22 (0.85)	0.11 (0.78)	0.11 (0.78)	0.11 (0.78)	0.22 (0.85)	0.22 (0.85)	0.00 (0.71)	0.00 (0.71)
4.	Barbuspur	1.22 (1.31)	0.55 (1.02)	0.22 (0.85)	0.11 (0.78)	0.44 (0.97)	0.22 (0.85)	0.44 (0.97)	0.77 (1.13)	0.33 (0.91)	0.44 (0.97)	0.00 (0.71)	0.00 (0.71)
5.	Pant J&K Set 2	0.88 (1.17)	0.33 (0.91)	0.00 (0.71)	0.22 (0.85)	0.22 (0.85)	0.00 (0.71)	0.22 (0.85)	0.11 (0.78)	0.33 (0.91)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)
6.	J&K Set 1	0.44 (0.97)	0.22 (0.85)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.55 (1.02)	0.11 (0.78)	0.00 (0.71)	0.22 (0.85)	0.00 (0.71)	0.00 (0.71)	0.11 (0.78)
7.	Jabalpur	0.33 (0.91)	0.11 (0.78)	0.33 (0.91)	0.22 (0.85)	0.22 (0.85)	0.55 (1.02)	0.11 (0.78)	0.00 (0.71)	0.00 (0.71)	0.33 (0.91)	0.11 (0.78)	0.33 (0.91)
8.	J&K Set 1	0.44 (0.97)	0.33 (0.91)	0.33 (0.91)	0.00 (0.71)	0.44 (0.97)	0.11 (0.78)	0.11 (0.78)	0.33 (0.91)	0.00 (0.71)	0.00 (0.71)	0.33 (0.91)	0.22 (0.85)
9.	NRCAF-13	0.33 (0.91)	0.55 (1.02)	0.00 (0.71)	0.66 (1.08)	0.00 (0.71)	0.00 (0.71)	0.22 (0.85)	0.11 (0.78)	0.00 (0.71)	0.33 (0.91)	0.22 (1.85)	0.55 (1.02)
10.	Baikunthpur	0.77 (1.13)	0.33 (0.91)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.11 (0.78)	0.11 (0.78)	0.11 (0.78)	0.33 (0.91)	0.22 (0.85)	0.11 (0.78)	0.00 (0.71)
11.	TNMC-5	0.55 (1.02)	0.22 (0.85)	0.11 (0.78)	0.22 (0.85)	0.11 (0.78)	0.00 (0.71)	0.11 (0.78)	0.11 (0.78)	0.33 (0.91)	0.00 (0.71)	0.00 (0.71)	0.44 (0.97)
12.	Mandeshwar	0.77 (1.13)	0.11 (0.78)	0.00 (0.71)	0.00 (0.71)	0.11 (0.78)	0.00 (0.71)	0.00 (0.71)	0.33 (0.91)	0.00 (0.71)	0.11 (0.78)	0.11 (0.78)	0.55 (1.02)
13.	Pant J&K Set 1	0.88 (1.17)	0.11 (0.78)	0.00 (0.71)	0.22 (0.85)	0.11 (0.78)	0.00 (0.71)	0.11 (0.78)	0.00 (0.71)	0.22 (0.85)	0.33 (0.91)	0.33 (0.91)	0.22 (0.85)
14.	PKVJ-MKV-1	0.88 (1.17)	0.11 (0.78)	0.00 (0.71)	0.55 (1.02)	0.00 (0.71)	0.00 (0.71)	0.11 (0.78)	0.33 (0.91)	0.00 (0.71)	0.33 (0.91)	0.33 (0.91)	1.11 (1.27)
15.	AMOS-201	0.44 (0.97)	0.11 (0.78)	0.22 (0.85)	0.55 (1.02)	0.33 (0.91)	0.44 (0.97)	0.11 (0.78)	0.00 (0.71)	0.00 (0.71)	0.22 (0.85)	0.33 (0.91)	0.55 (1.02)
16.	Bawal	0.33 (0.91)	0.00 (0.71)	0.11 (0.78)	0.00 (0.71)	0.11 (0.78)	0.11 (0.78)	0.11 (0.78)	0.33 (0.91)	0.00 (0.71)	0.00 (0.71)	0.44 (0.97)	0.00 (0.71)
17.	NRCAF-15	0.11 (0.78)	0.44 (0.97)	0.11 (0.78)	0.22 (0.85)	0.00 (0.71)	0.22 (0.85)	0.11 (0.78)	0.22 (0.85)	0.11 (0.78)	0.00 (0.71)	0.33 (0.91)	0.11 (0.78)

S. No.	Name of the provenances	Dates											
		15/09/10	29/09/10	14/10/10	29/10/10	15/11/10	29/11/10	05/04/11	20/04/11	06/05/11	21/05/11	05/06/11	20/06/11
18.	PKVJ-AKT-1	0.44 (0.97)	0.33 (0.91)	1.33 (1.35)	0.11 (0.78)	0.22 (0.85)	0.44 (0.97)	0.33 (0.91)	0.00 (0.71)	0.77 (1.13)	0.55 (1.02)	0.88 (1.17)	0.00 (0.71)
19.	Indore-I	0.44 (0.97)	0.00 (0.71)	0.11 (0.78)	0.00 (0.71)	0.00 (0.71)	0.22 (0.85)	0.00 (0.71)	0.11 (0.78)	0.11 (0.78)	0.00 (0.71)	0.00 (0.71)	0.22 (0.85)
20.	Korba	1.55 (1.43)	0.11 (0.78)	0.11 (0.78)	0.33 (0.91)	0.00 (0.71)	0.00 (0.71)	0.11 (0.78)	0.22 (0.85)	0.00 (0.71)	0.11 (0.78)	0.33 (0.91)	0.44 (0.97)
21.	Chandka	0.33 (0.91)	0.33 (0.91)	1.11 (1.27)	0.22 (0.85)	0.22 (0.85)	0.33 (0.91)	0.00 (0.71)	0.11 (0.78)	0.44 (0.97)	0.00 (0.71)	0.55 (1.02)	0.55 (1.02)
22.	TFRI-1	0.77 (1.13)	0.55 (1.02)	1.11 (1.27)	0.00 (0.71)	0.44 (0.97)	0.44 (0.97)	0.22 (0.85)	0.11 (0.78)	0.22 (0.85)	0.00 (0.71)	0.44 (0.97)	0.00 (0.71)
23.	Barmunda	0.33 (0.91)	0.22 (0.85)	0.44 (0.97)	0.00 (0.71)	0.44 (0.97)	0.00 (0.71)	0.11 (0.78)	0.33 (0.91)	0.00 (0.71)	0.44 (0.97)	0.11 (0.78)	0.33 (0.91)
24.	NRCAF-18	0.55 (1.02)	0.88 (1.17)	0.00 (0.71)	0.44 (0.97)	0.00 (0.71)	0.00 (0.71)	0.11 (0.78)	0.11 (0.78)	0.22 (0.85)	0.00 (0.71)	0.44 (0.97)	0.44 (0.97)
25.	J&K Set 2	0.33 (0.91)	0.66 (1.08)	1.33 (1.35)	0.00 (0.71)	0.22 (0.85)	0.00 (0.71)	0.11 (0.78)	0.22 (0.85)	0.11 (0.78)	0.11 (0.78)	0.00 (0.71)	0.00 (0.71)
26.	Jagdalpur	0.22 (0.85)	0.00 (0.71)	0.22 (0.85)	0.00 (0.71)	0.44 (0.97)	0.00 (0.71)	0.11 (0.78)	0.22 (0.85)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.22 (0.85)
27.	Kalyanpur	0.66 (1.08)	0.66 (1.08)	0.00 (0.71)	0.00 (0.71)	0.55 (1.02)	0.00 (0.71)	0.00 (0.71)	0.33 (0.91)	0.33 (0.91)	0.44 (0.97)	0.22 (0.85)	0.33 (0.91)
28.	APOS-2001	0.22 (0.85)	1.11 (1.26)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.11 (0.78)	0.44 (0.97)	0.00 (0.71)	0.33 (0.91)
29.	RJ 117 (B)	0.55 (1.02)	0.22 (0.85)	0.00 (0.71)	0.00 (0.71)	0.11 (0.78)	0.44 (0.97)	0.00 (0.71)	0.22 (0.85)	0.77 (1.13)	0.00 (0.71)	0.00 (0.71)	0.22 (0.85)
30.	TNMC-7	1.11 (1.26)	0.11 (0.78)	0.22 (0.85)	0.55 (1.02)	0.55 (1.02)	0.11 (0.78)	0.11 (0.78)	0.44 (0.97)	0.22 (0.85)	0.11 (0.78)	0.22 (0.85)	0.22 (0.85)
31.	ANOS-201	0.44 (0.97)	0.11 (0.78)	0.22 (0.85)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.11 (0.78)	0.22 (0.85)	0.00 (0.71)	0.44 (0.97)	0.00 (0.71)	0.00 (0.71)
32.	PKVJ-SJ-1	0.55 (1.02)	0.66 (1.08)	0.00 (0.71)	0.22 (0.85)	0.00 (0.71)	0.00 (0.71)	0.11 (0.78)	0.00 (0.71)	0.44 (0.97)	0.22 (0.85)	0.33 (0.91)	0.22 (0.85)
33.	Pendra Road	0.33 (0.91)	0.11 (0.78)	0.44 (0.97)	0.11 (0.77)	0.11 (0.78)	0.33 (0.91)	0.00 (0.71)	0.33 (0.91)	0.33 (0.91)	0.11 (0.78)	0.00 (0.71)	0.22 (0.85)
34.	PKVJ-DHW-1	0.66 (1.08)	0.66 (1.08)	0.00 (0.71)	0.00 (0.71)	0.11 (0.78)	0.33 (0.91)	0.00 (0.71)	0.00 (0.71)	0.11 (0.78)	0.33 (0.91)	0.44 (0.97)	0.44 (0.97)
35.	NRCAF-14	0.55 (1.02)	0.33 (0.91)	0.00 (0.71)	0.11 (0.78)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.55 (1.02)	0.88 (1.17)	0.33 (0.91)	0.00 (0.71)	0.00 (0.71)

S. No.	Name of the provenances	z											
		15/09/10	29/09/10	14/10/10	29/10/10	15/11/10	29/11/10	05/04/11	20/04/11	06/05/11	21/05/11	05/06/11	20/06/11
36.	Balodabazar	0.88 (1.18)	0.44 (0.97)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.88 (1.17)	0.22 (0.85)	0.11 (0.78)	0.22 (0.85)	0.22 (0.85)	0.00 (0.71)	0.33 (0.91)
37.	Kot	0.55 (1.02)	0.11 (0.78)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.88 (1.17)	0.11 (0.78)	0.22 (0.85)	0.11 (0.78)	0.77 (1.13)	0.00 (0.71)	0.77 (1.13)
38.	Tukupoms	1.22 (1.31)	0.22 (0.85)	0.00 (0.71)	0.00 (0.71)	0.22 (0.85)	0.11 (0.78)	0.11 (0.78)	0.88 (1.17)	0.22 (0.85)	0.33 (0.91)	0.33 (0.91)	0.00 (0.71)
39.	Taraipur	0.55 (1.02)	1.11 (1.26)	1.11 (1.26)	0.44 (0.97)	0.33 (0.91)	0.00 (0.71)	0.00 (0.71)	0.22 (0.85)	0.66 (1.08)	0.11 (0.78)	0.44 (0.97)	0.33 (0.91)
40.	Kilkila	0.77 (1.13)	0.11 (0.78)	0.44 (0.97)	0.11 (0.78)	0.22 (0.85)	0.00 (0.71)	0.11 (0.78)	0.22 (0.85)	0.11 (0.78)	0.11 (0.78)	0.33 (0.91)	0.11 (0.78)
41.	Chandrapur	0.33 (0.91)	0.22 (0.85)	0.00 (0.71)	0.11 (0.78)	0.00 (0.71)	0.22 (0.85)	0.11 (0.78)	0.00 (0.71)	0.22 (0.85)	0.11 (0.78)	0.33 (0.91)	0.22 (0.85)
42	Mahanrpur	0.11 (0.78)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.33 (0.91)	0.11 (0.78)	0.00 (0.71)	0.00 (0.71)	0.11 (0.78)	0.44 (0.97)	0.00 (0.71)
43.	Surajpur	0.11 (0.78)	0.33 (0.91)	0.11 (0.78)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.11 (0.78)	0.00 (0.71)	0.11 (0.78)	0.11 (0.78)	0.22 (0.85)	0.00 (0.71)
44.	Sonhat	0.22 (0.85)	0.44 (0.97)	0.11 (0.78)	0.00 (0.71)	0.00 (0.71)	1.11 (1.26)	0.00 (0.71)	0.33 (0.91)	1.33 (1.35)	0.22 (0.85)	0.00 (0.71)	0.11 (0.78)
45.	Saheltarai	0.33 (0.91)	0.22 (0.85)	0.33 (0.91)	0.11 (0.78)	0.22 (1.85)	0.22 (0.85)	0.22 (0.85)	0.11 (0.78)	0.22 (0.85)	0.33 (0.91)	0.33 (0.91)	0.11 (0.78)
46.	Churmundra	1.22 (1.31)	0.77 (1.13)	0.22 (0.85)	0.66 (1.08)	0.22 (0.85)	0.66 (1.08)	0.11 (0.78)	0.22 (0.85)	0.44 (0.97)	0.99 (1.22)	0.11 (0.78)	0.77 (1.13)
47.	Keshipur	1.11 (1.26)	0.22 (0.85)	0.00 (0.71)	0.33 (0.91)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.11 (0.78)	0.22 (0.85)	0.11 (0.78)	0.44 (0.97)
	SEm±	0.17	0.12	0.10	0.11	0.10	0.13	0.08	0.11	0.15	0.15	0.12	0.13
	CD (5%)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Note: Figures in parentheses are square root transformed value

Table 4.11: Population of predatory grass hopper recorded fortnightly on various provenances of *J. curcas*.

S. No.	Name of the provenances	Dates					
		15/09/10	29/09/10	14/10/10	29/10/10	15/11/10	29/11/10
1.	Sagar-1	1.33 (1.35)	0.88 (1.17)	0.44 (0.97)	0.22 (0.85)	0.11 (0.78)	0.00 (0.71)
2.	RJ 117 (A)	1.11 (1.26)	0.11 (0.78)	0.22 (0.85)	0.00 (0.71)	0.11 (0.78)	0.00 (0.71)
3.	Dehradoon	0.22 (0.85)	0.44 (0.97)	0.44 (0.97)	0.33 (0.91)	0.00 (0.71)	0.00 (0.71)
4.	Barbuspur	0.55 (1.02)	0.55 (1.02)	0.33 (0.91)	0.22 (0.85)	0.11 (0.78)	0.11 (0.78)
5.	Pant J&K Set 2	0.00 (0.71)	0.66 (1.08)	0.66 (1.08)	0.00 (0.71)	0.00 (0.71)	0.22 (0.85)
6.	J&K Set 1	0.66 (1.08)	1.11 (1.26)	0.11 (0.78)	0.33 (0.91)	0.11 (0.78)	0.22 (0.85)
7.	Jabalpur	0.11 (0.78)	0.22 (0.85)	0.44 (0.97)	0.33 (0.91)	0.22 (0.85)	0.00 (0.71)
8.	J&K Set 1	0.22 (0.85)	0.66 (1.08)	0.22 (0.85)	0.22 (0.85)	0.55 (1.02)	0.00 (0.71)
9.	NRCAF-13	1.33 (1.35)	0.11 (0.78)	0.00 (0.71)	0.66 (1.08)	0.00 (0.71)	0.00 (0.71)
10.	Baikunthpur	0.55 (1.02)	0.00 (0.71)	0.33 (0.91)	0.11 (0.78)	0.11 (0.78)	0.00 (0.71)
11.	TNMC-5	0.33 (0.91)	0.22 (0.85)	0.22 (0.85)	0.00 (0.71)	0.11 (0.78)	0.00 (0.71)
12.	Mandeshwar	0.44 (0.97)	0.55 (1.02)	0.77 (1.13)	0.22 (0.85)	0.11 (0.78)	0.11 (0.78)
13.	Pant J&K Set 1	0.11 (0.78)	0.00 (0.71)	0.00 (0.71)	0.11 (0.78)	0.00 (0.71)	0.00 (0.71)
14.	PKVJ-MKV-1	0.88 (1.17)	0.33 (0.91)	0.00 (0.71)	0.33 (0.91)	0.11 (0.78)	0.00 (0.71)
15.	AMOS-201	0.44 (0.97)	1.11 (1.26)	0.11 (0.78)	0.11 (0.78)	0.00 (0.71)	0.00 (0.71)
16.	Bawal	0.11 (0.78)	0.11 (0.78)	0.33 (0.91)	0.00 (0.71)	0.11 (0.78)	0.00 (0.71)
17.	NRCAF-15	0.33 (0.91)	0.55 (1.02)	0.33 (0.91)	0.22 (0.85)	0.00 (0.71)	0.00 (0.71)

S. No.	Name of the provenances	Dates					
		15/09/10	29/09/10	14/10/10	29/10/10	15/11/10	29/11/10
18.	PKVJ-AKT-1	0.66 (1.08)	0.33 (0.91)	0.11 (0.78)	0.11 (0.78)	0.00 (0.71)	0.00 (0.71)
19.	Indore-I	0.88 (1.17)	0.55 (1.02)	0.33 (0.91)	0.22 (0.85)	0.00 (0.71)	0.11 (0.78)
20.	Korba	0.44 (0.97)	0.22 (0.85)	0.11 (0.78)	0.11 (0.78)	0.00 (0.71)	0.00 (0.71)
21.	Chandka	1.11 (1.26)	0.00 (0.71)	0.22 (0.85)	0.00 (0.71)	0.11 (0.78)	0.00 (0.71)
22.	TFRI-1	1.22 (1.31)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.11 (0.78)
23.	Barmunda	0.11 (0.78)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.11 (0.78)	0.00 (0.71)
24.	NRCAF-18	0.11 (0.78)	0.55 (1.02)	0.55 (1.02)	0.44 (0.97)	0.00 (0.71)	0.00 (0.71)
25.	J&K Set 2	0.55 (1.02)	0.44 (0.97)	0.00 (0.71)	0.00 (0.71)	0.11 (0.78)	0.11 (0.78)
26.	Jagdalpur	0.88 (1.17)	1.11 (1.26)	0.00 (0.71)	0.00 (0.71)	0.11 (0.78)	0.00 (0.71)
27.	Kalyanpur	0.11 (0.78)	0.22 (0.85)	0.11 (0.78)	0.00 (0.71)	0.22 (0.85)	0.00 (0.71)
28.	APOS-2001	0.44 (0.97)	0.11 (0.78)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.11 (0.78)
29.	RJ 117 (B)	0.33 (0.91)	0.00 (0.71)	0.00 (0.71)	0.11 (0.78)	0.00 (0.71)	0.00 (0.71)
30.	TNMC-7	0.44 (0.97)	0.33 (0.91)	0.11 (0.78)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)
31.	ANOS-201	1.33 (1.35)	0.55 (1.02)	0.22 (0.85)	0.00 (0.71)	0.11 (0.78)	0.00 (0.71)
32.	PKVJ-SJ-1	0.55 (1.02)	0.00 (0.71)	0.33 (0.91)	0.33 (0.91)	0.00 (0.71)	0.00 (0.71)
33.	Pendra Road	0.11 (0.78)	0.11 (0.78)	0.22 (0.85)	0.11 (0.78)	0.11 (0.78)	0.00 (0.71)
34.	PKVJ-DHW-1	0.88 (1.17)	0.22 (0.85)	0.11 (0.78)	0.11 (0.78)	0.00 (0.71)	0.00 (0.71)
35.	NRCAF-14	0.55 (1.02)	0.11 (0.78)	0.00 (0.71)	0.11 (0.78)	0.00 (0.71)	0.22 (0.85)

S. No.	Name of the provenances	Dates					
		15/09/10	29/09/10	14/10/10	29/10/10	15/11/10	29/11/10
36.	Balodabazar	0.00	0.55	0.55	0.11	0.00	0.00
		(0.71)	(1.02)	(1.02)	(0.78)	(0.71)	(0.71)
37.	Kot	0.66	0.22	0.11	0.11	0.00	0.22
		(1.08)	(0.85)	(0.78)	(0.78)	(0.71)	(0.85)
38.	Tukupoms	0.22	0.00	0.00	0.00	0.33	0.00
		(0.85)	(0.71)	(0.71)	(0.71)	(0.91)	(0.71)
39.	Taraipur	1.11	0.22	0.22	0.11	0.00	0.00
		(1.26)	(0.85)	(0.85)	(0.78)	(0.71)	(0.71)
40.	Kilkila	0.33	0.11	0.11	0.00	0.00	0.11
		(0.91)	(0.78)	(0.78)	(0.71)	(0.71)	(0.78)
41.	Chandrapur	1.11	0.11	0.66	0.11	0.22	0.11
		(1.26)	(0.78)	(1.08)	(0.78)	(0.85)	(0.78)
42	Mahanrpur	0.55	0.00	0.00	0.11	0.11	0.00
		(1.02)	(0.71)	(0.71)	(0.78)	(0.78)	(0.71)
43.	Surajpur	0.11	0.00	0.33	0.00	0.00	0.00
		(0.78)	(0.71)	(0.91)	(0.71)	(0.71)	(0.71)
44.	Sonhat	0.00	0.66	0.00	0.00	0.00	0.00
		(0.71)	(1.08)	(0.71)	(0.71)	(0.71)	(0.71)
45.	Saheltarai	0.33	0.33	0.00	0.11	0.00	0.00
		(0.91)	(0.91)	(0.71)	(0.78)	(0.71)	(0.71)
46.	Churmundra	0.11	0.55	0.00	0.11	0.22	0.00
		(0.78)	(1.03)	(0.71)	(0.78)	(0.85)	(0.71)
47.	Keshipur	0.11	0.11	0.00	0.00	0.00	0.00
		(0.78)	(0.78)	(0.71)	(0.71)	(0.71)	(0.71)
	SEm±	0.82	0.07	0.08	0.06	0.03	0.02
	CD (5%)	NS	NS	NS	NS	NS	NS

Note : Figures in parentheses are square root transformed value

Table 4.12: Pooled analysis of blue bug on various provenances of *J. curcas*

S. No.	Name of the provenances	Season-I	Season-II
1.	Sagar-1	1.21 (1.31)	0.44 (0.97)
2.	RJ 117 (A)	0.65 (1.07)	0.44 (0.97)
3.	Dehradoon	0.48 (0.99)	0.66 (1.08)
4.	Barbuspur	0.66 (1.08)	0.51 (1.01)
5.	Pant J&K Set 2	0.70 (1.09)	0.76 (1.12)
6.	J&K Set 1	0.77 (1.13)	0.35 (0.92)
7.	Jabalpur	0.59 (1.04)	0.73 (1.11)
8.	J&K Set 1	1.00 (1.22)	0.31 (0.90)
9.	NRCAF-13	0.54 (1.02)	0.57 (1.03)
10.	Baikunthpur	0.91 (1.19)	0.92 (0.19)
11.	TNMC-5	0.68 (1.09)	0.55 (1.02)
12.	Mandeshwar	0.50 (1.00)	0.33 (0.97)
13.	Pant J&K Set 1	0.26 (0.87)	0.57 (1.03)
14.	PKVJ-MKV-1	0.50 (1.00)	0.37 (0.93)
15.	AMOS-201	0.39 (0.94)	0.57 (1.03)
16.	Bawal	0.48 (0.99)	0.24 (0.86)
17.	NRCAF-15	0.57 (1.03)	0.65 (1.07)
18.	PKVJ-AKT-1	0.50 (1.00)	0.46 (0.98)
19.	Indore-I	0.51 (1.01)	0.70 (1.09)
20.	Korba	0.42 (0.96)	0.33 (0.91)
21.	Chandka	0.44 (0.97)	0.18 (0.82)
22.	TFRI-1	0.29 (0.89)	0.33 (0.91)
23.	Barmunda	0.31 (0.90)	0.33 (0.91)
24.	NRCAF-18	0.33 (0.91)	0.29 (0.89)
25.	J&K Set 2	0.55	0.48

S. No.	Name of the provenances	Season-I	Season-II
		(1.02)	(0.99)
26.	Jagdalpur	0.55	0.35
		(1.02)	(0.92)
27.	Kalyanpur	0.22	0.48
		(0.85)	(0.99)
28.	APOS-2001	0.17	0.57
		(0.81)	(1.03)
29.	RJ 117 (B)	0.57	0.35
		(1.03)	(0.92)
30.	TNMC-7	0.48	0.40
		(0.99)	(0.95)
31.	ANOS-201	0.42	0.33
		(0.96)	(0.91)
32.	PKVJ-SJ-1	0.57	0.26
		(1.03)	(0.87)
33.	Pendra Road	0.40	0.51
		(0.94)	(1.01)
34.	PKVJ-DHW-1	0.55	0.13
		(1.02)	(0.79)
35.	NRCAF-14	0.42	0.29
		(0.96)	(0.89)
36.	Balodabazar	0.31	0.44
		(0.90)	(0.97)
37.	Kot	0.28	0.72
		(0.88)	(1.10)
38.	Tukupoms	0.33	0.18
		(0.91)	(0.82)
39.	Taraipur	0.18	0.26
		(0.82)	(0.87)
40.	Kilkila	0.54	0.27
		(1.01)	(0.88)
41.	Chandrapur	0.79	0.13
		(1.14)	(0.79)
42	Mahanrpur	0.55	0.30
		(1.02)	(0.89)
43.	Surajpur	0.29	0.29
		(0.89)	(0.88)
44.	Sonhat	0.68	0.39
		(1.09)	(0.94)
45.	Saheltarai	0.42	0.46
		(0.96)	(0.98)
46.	Churmundra	0.83	0.28
		(1.15)	(0.88)
47.	Keshipur	0.42	0.33
		(0.96)	(0.91)
	SEm±	0.08	0.06
	CD (5%)	NS	0.29

Figure in parentheses are square root transformed value

Table 4.13: Pooled analysis of leaf webber on various provenance of *J. curcas*

S. No.	Name of the provenances	leaf webber
1.	Sagar-1	0.59 (1.04)
2.	RJ 117 (A)	0.24 (0.86)
3.	Dehradoon	0.20 (0.84)
4.	Barbuspur	0.24 (0.86)
5.	Pant J&K Set 2	0.15 (0.81)
6.	J&K Set 1	0.15 (0.81)
7.	Jabalpur	0.13 (0.79)
8.	J&K Set 1	0.28 (0.88)
9.	NRCAF-13	0.13 (0.79)
10.	Baikunthpur	0.20 (0.84)
11.	TNMC-5	0.09 (0.77)
12.	Mandeshwar	0.24 (0.86)
13.	Pant J&K Set 1	0.46 (0.98)
14.	PKVJ-MKV-1	0.15 (0.81)
15.	AMOS-201	0.22 (0.85)
16.	Bawal	0.48 (0.99)
17.	NRCAF-15	0.20 (0.84)
18.	PKVJ-AKT-1	0.44 (0.97)
19.	Indore-I	0.37 (0.93)
20.	Korba	0.59 (1.04)
21.	Chandka	0.15 (0.81)
22.	TFRI-1	0.06 (0.74)
23.	Barmunda	0.18 (0.82)
24.	NRCAF-18	0.26 (0.87)
25.	J&K Set 2	0.09

S. No.	Name of the provenances	leaf webber
		(0.77)
26.	Jagdalpur	0.00
		(0.71)
27.	Kalyanpur	0.13
		(0.79)
28.	APOS-2001	0.20
		(0.84)
29.	RJ 117 (B)	0.13
		(0.79)
30.	TNMC-7	0.15
		(0.81)
31.	ANOS-201	0.00
		(0.71)
32.	PKVJ-SJ-1	0.07
		(0.75)
33.	Pendra Road	0.28
		(0.88)
34.	PKVJ-DHW-1	0.06
		(0.74)
35.	NRCAF-14	0.06
		(0.74)
36.	Balodabazar	0.88
		(1.17)
37.	Kot	0.13
		(0.79)
38.	Tukupoms	0.33
		(0.91)
39.	Taraipur	0.48
		(0.99)
40.	Kilkila	0.29
		(0.89)
41.	Chandrapur	0.22
		(0.85)
42	Mahanrpur	0.22
		(0.85)
43.	Surajpur	0.22
		(0.85)
44.	Sonhat	1.37
		(1.37)
45.	Saheltarai	0.00
		(0.71)
46.	Churmundra	0.13
		(0.79)
47.	Keshipur	0.15
		(0.81)
	SEm±	0.07
	CD (5%)	0.22

Figure in parentheses are square root transformed value

Table 4.14 : Pooled analysis of spider on various provenance of *J. curcas*

S. No.	Name of the provenances	Season-I	Season-II
1.	Sagar-1	0.24	0.06
		(0.86)	(0.74)
2.	RJ 117 (A)	0.42	0.22
		(0.95)	(0.85)
3.	Dehradoon	0.29	0.11
		(0.89)	(0.78)
4.	Barbuspur	0.46	0.33
		(0.98)	(0.91)
5.	Pant J&K Set 2	0.28	0.11
		(0.88)	(1.78)
6.	J&K Set 1	0.20	0.07
		(0.84)	(0.75)
7.	Jabalpur	0.29	0.15
		(0.89)	(0.81)
8.	J&K Set 1	0.28	0.17
		(0.88)	(0.82)
9.	NRCAF-13	0.26	0.24
		(0.87)	(0.86)
10.	Baikunthpur	0.20	0.15
		(0.84)	(0.81)
11.	TNMC-5	0.20	0.17
		(0.84)	(0.82)
12.	Mandeshwar	0.17	0.18
		(0.82)	(0.83)
13.	Pant J&K Set 1	0.22	0.20
		(0.85)	(0.84)
14.	PKVJ-MKV-1	0.26	0.37
		(0.83)	(0.93)
15.	AMOS-201	0.35	0.20
		(0.92)	(0.84)
16.	Bawal	0.13	0.15
		(0.79)	(0.81)
17.	NRCAF-15	0.18	0.15
		(0.82)	(0.81)
18.	PKVJ-AKT-1	0.48	0.42
		(0.99)	(0.95)
19.	Indore-I	0.13	0.07
		(0.79)	(0.75)
20.	Korba	0.35	0.20
		(0.92)	(0.84)
21.	Chandka	0.42	0.28
		(0.95)	(0.88)
22.	TFRI-1	0.55	0.17
		(1.02)	(0.82)
23.	Barmunda	0.24	0.22
		(0.86)	(0.85)
24.	NRCAF-18	0.31	0.22
		(0.90)	(0.85)
25.	J&K Set 2	0.42	0.09

S. No.	Name of the provenances	Season-I	Season-II
		(0.95)	(0.77)
26.	Jagdalpur	0.15	0.09
		(0.81)	(0.77)
27.	Kalyanpur	0.31	0.28
		(0.90)	(0.88)
28.	APOS-2001	0.22	0.13
		(0.85)	(0.79)
29.	RJ 117 (B)	0.22	0.20
		(0.85)	(0.84)
30.	TNMC-7	0.46	0.22
		(0.98)	(0.85)
31.	ANOS-201	0.13	0.13
		(0.79)	(0.79)
32.	PKVJ-SJ-1	0.24	0.22
		(0.86)	(0.85)
33.	Pendra Road	0.24	0.17
		(0.86)	(0.82)
34.	PKVJ-DHW-1	0.29	0.22
		(0.89)	(0.85)
35.	NRCAF-14	0.17	0.29
		(0.82)	(0.89)
36.	Balodabazar	0.37	0.18
		(0.93)	(0.83)
37.	Kot	0.26	0.33
		(0.87)	(0.91)
38.	Tukupoms	0.29	0.31
		(0.89)	(0.90)
39.	Taraipur	0.59	0.29
		(1.04)	(0.89)
40.	Kilkila	0.28	0.17
		(0.88)	(0.81)
41.	Chandrapur	0.15	0.17
		(0.81)	(0.81)
42	Mahanrpur	0.07	0.11
		(0.75)	(0.78)
43.	Surajpur	0.09	0.09
		(0.77)	(0.77)
44.	Sonhat	0.31	0.33
		(0.90)	(0.91)
45.	Saheltarai	0.24	0.22
		(0.86)	(0.85)
46.	Churmundra	0.63	0.44
		(1.06)	(0.97)
47.	Keshipur	0.28	0.15
		(0.88)	(0.81)
	SEm±	0.15	0.09
	CD (5%)	NS	NS

Figure in parentheses are square root transformed value

Table 4.15: Pooled analysis of predatory grass hopper on various provenance of *J. curcas*

S. No.	Name of the provenances	grass hopper
1.	Sagar-1	0.49 (0.99)
2.	RJ 117 (A)	0.26 (0.87)
3.	Dehradoon	0.24 (0.86)
4.	Barbuspur	0.31 (0.90)
5.	Pant J&K Set 2	0.26 (0.87)
6.	J&K Set 1	0.42 (0.95)
7.	Jabalpur	0.22 (0.85)
8.	J&K Set 1	0.31 (0.90)
9.	NRCAF-13	0.35 (0.92)
10.	Baikunthpur	0.18 (0.82)
11.	TNMC-5	0.15 (0.81)
12.	Mandeshwar	0.37 (0.93)
13.	Pant J&K Set 1	0.04 (0.73)
14.	PKVJ-MKV-1	0.28 (0.88)
15.	AMOS-201	0.29 (0.89)
16.	Bawal	0.11 (0.78)
17.	NRCAF-15	0.24 (0.86)
18.	PKVJ-AKT-1	0.20 (0.84)
19.	Indore-I	0.35 (0.92)
20.	Korba	0.15 (0.81)
21.	Chandka	0.24 (0.86)
22.	TFRI-1	0.22 (0.85)
23.	Barmunda	0.04 (0.73)
24.	NRCAF-18	0.28 (0.88)

S. No.	Name of the provenances	grass hopper
25.	J&K Set 2	0.20 (0.84)
26.	Jagdalpur	0.35 (0.92)
27.	Kalyanpur	0.11 (0.78)
28.	APOS-2001	0.11 (0.78)
29.	RJ 117 (B)	0.07 (0.75)
30.	TNMC-7	0.15 (0.81)
31.	ANOS-201	0.37 (0.93)
32.	PKVJ-SJ-1	0.20 (0.84)
33.	Pendra Road	0.11 (0.78)
34.	PKVJ-DHW-1	0.22 (0.85)
35.	NRCAF-14	0.17 (0.82)
36.	Balodabazar	0.20 (0.84)
37.	Kot	0.22 (0.85)
38.	Tukupoms	0.09 (0.77)
39.	Taraipur	0.28 (0.88)
40.	Kilkila	0.11 (0.78)
41.	Chandrapur	0.39 (0.94)
42	Mahanrpur	0.13 (0.79)
43.	Surajpur	0.07 (0.75)
44.	Sonhat	0.11 (0.78)
45.	Saheltarai	0.13 (0.79)
46.	Churmundra	0.17 (0.82)
47.	Keshipur	0.04 (0.73)
	SEm± CD (5%)	0.08 0.24

Figure in parentheses are square root transformed value

Summary, Conclusion & Suggestions for Further work

CHAPTER-V

SUMMARY, CONCLUSION AND SUGGESTIONS FOR FURTHER WORK

Jatropha curcas L. commonly known as Ratanjyot belongs to the family Euphorbiaceae is one of the most promising species as far as production of bio diesel in concerned. Government of Chhattisgarh is emphasising large scale plantation of *J. curcas* as the species is best suited for (low rainfall) barren or no productive land and can thrive well in under nourished soil. It is a fast growing species and starts bearing from the second year of plantation. The oil content in the seeds ranges from 55 to 60 per cent). The species is attacked by a number of insect pests which retard the growth and vigour of the plants reduce fruiting and oil content causing economic loss. Keeping the above facts in mind the present investigation entitled "Screening of various provenances of *Jatropha curcas* against its major pests, the scutellerid bug, *Chrysocoris purpureus* ,broad mites, *Euseius sp.* and ieaf webber cum fruit borer, *Pempelia morosalis* was conducted with the following objectives:

1. Studies on pest succession of insect pests in *Jatropha curcas*.
2. Testing of bio-efficacy of new molecule, Oberon 240 EC (Spiromesifen 240SC) against broad mites, *Euseius sp.*(Family: Phytoseiidae)
3. Testing of bio-efficacy of new molecule flubendiamide 480 SC against leaf webber cum fruit borer, *Pempelia morosalis*(Saalm Uller)

4. Screening of various provenances of *Jatropha curcas* against blue bug *Chrysocoris purpureus* and leaf webber cum fruit borer, *Pempelia morosalis* (Saalm Uller).

1. Studies on pest succession of insect pests in *Jatropha curcas*.

In the present investigation three insect pests were found damaging Jatropha, namely blue bug, *Chrysocoris purpureus* (Westw), broad mites, *Euseius sp.* And leaf webber cum fruit borer, *Pempelia morosalis* (Saalm uller). Alongwith this some natural enemies like spider's, *Oxyopes lineatipes* and predatory grass hopper (unidentified) were also observed.

The incidence of *C.purpueus* was found throughout the period of study. Maximum population of bugs were observed in the month of September (I fortnight) *i.e.*42.49 bugs/plant and the minimum population were observed during the month of October (II fortnight) 18.35 bugs/plant in season I while maximum population of bugs were observed in the month of June (II fortnight) *i.e.*32.38 bugs/plant and the minimum population were observed during the month of May (I fortnight) 15.09 bugs/plant in season II. The activity of this particular insect was observed in both season I and season II during the month of September first fortnight and continued till the month of June. The maximum population of webber, *P.morosalis* observed in the month of June (I) fortnight (29.97 larvae/ plant) and the minimum during the month of April (I) fortnight (2.64 larvae/plant). No population of webber larvae was observed in season I.

Spiders (*Oxyopes lineatipes*) was observed throughout the year with the maximum activety a during the month of September 1st fortnight (26.24 spider/plant) and minimum during the month of October 2nd fortnight (6.82 spider/plant) in season I. In Season II, the maximum populations of spiders were observed in the month of June (II fortnight) *i.e.*11.34 spiders /plant and the minimum during the month of April (I fortnight) 4.73 spiders /plant.

The incidence of predatory grass hoppers (unidentified) was observed the maximum population during September (I fortnight) *i.e.*24.04 grass hoppers/plant and the minimum population were observed during the month of November (II fortnight) with 1.76 grass hoppers /plant. No predatory grass hoppers were recorded in season-II

2. Testing of bio-efficacy of new molecule, Oberon 240 EC (Spiromesifen 240SC) against broad mites, *Euseius sp.* (Family: Phytoseiidae)

On testing the bioefficacy of the new molecule against broad mite, *Euseius sp.* Spiromesifen 240 SC (Oberon 240SC) 96 g.a.i./ha(T3) was found to be the best treatment, as it recorded minimum percentage of damaged leaves after 7 days, 14 days, 21 days, 28 days and 35 days after treatment.

As far as the mortality percentage of mites was concerned, Spiromesifen 240 SC (Oberon 240SC) 120 g.a.i./ha proved to be the best treatment, as it recorded maximum percentage of mortality of 29.01%, 48.36%, 35.59% and 48.36% at 7 days, 14 days, 21 days and 28 days after treatment. However 35 days and 28 days after treatment Propargite 570 EC (Oomite 570 EC) 570 g.a.i./ha, was recorded to show maximum percentage mortality of 65.36%.

3. Testing of bio-efficacy of new molecule, Flubendiamide 480 SC (Fame 240SC) against leaf webber cum fruit borer, *Pempelia morosalis*.

On testing of bio-efficacy of new molecule, Flubendiamide 480 SC (Fame 240SC) against leaf webber cum fruit borer, *Pempelia morosalis* at various concentration along with other insecticides revealed that Flubendiamide 240 SC (fame 240SC) 48 g.a.i./ha (T4) was found to be the best treatment with minimum mean number of larvae in 1.67, 1.27 and 0.93 after 3 days, 7 dys and 10 days after treatment respectively.As par as the per cent mortality was concerned it was also maximum in T4 Flubendiamide 240 SC (fame 240SC) 48 g.a.i./ha with maximum percentage mortality of 37.45%, 52.43%, 65.17%, after 3 days, 7 days and 10 days of treatment respectively

5. Screening of various provenances of *Jatropha curcas* against blue bug *Chrysocoris purpureus* and leaf webber cum fruit borer, *Pempelia morosalis* (Saalm Uller).

Screening of 47 provenances of *J. curcas* against blue bug, *Chrysocoris purpureus* revealed that provenances Chandnapur, PKVJ-DHW-1, Tokupoms and Chandka with minimum population of 0.13, 0.13, 0.18 and 0.18 nymphs and adults/plant respectively can be considered as provenances having some level of tolerance, while pant J &K Set 2 and Jabalpur with 0.76 and 0.73 nymphs and adults / plant can be grouped as susceptible.

Screening of 47 provenances of *J. curcas* against leaf webber cum fruit borer, *Pempelia morosalis* resulted Jagdalpur and ANOS – 201 as tolerant as it recorded no larval population ie (0.00) throughout the period of study,while

Sagar - 1 and Pant J & K Set 1 with mean larval population of 0.59 and 0.46 larvae / plant can be regarded as susceptible.

Conclusion

The findings of the investigation entitled "Bioefficacy of new molecules, Oberon 240EC (spiromesifen 240SC) against broad mites, *Phagotarsonemus latus* and Flubendiamide 480SC against leaf webber cum fruit borer, *Pempelia morosalis* (Saalm Uller) in *Jatropha curcas."*are as mentioned below:

1. Three species of insect pests observed on Jatropha (*J. curcas*) were blue bug, *Chrysocoris purpureus* (Westw), broad mites, *Euseius sp.* And leaf webber cum fruit borer, *Pempelia morosalis* (Saalm uller) alongwith two natural enemies namely spider, *Oxyopes lineatips* and Predatory grass hoppers (unidentified).

   The population of blue bug and Leaf webber cum fruit borer showed a negative significant correlationship with maximum temperature, minimum temperature, rainfall, relative humidity (morning and evening). Spiders showed positive significant correlation ship with all the weather parameters *viz.*, maximum temperature, minimum temperature, rainfall, relative humidity morning and evening.

2. Testing of bio-efficacy of new molecule, Oberon 240 EC (Spiromesifen 240SC) against broad mites, *Euseius sp.* resulted Spiromesifen 240 SC (Oberon 240SC) @ 96 g.a.i. /ha as the best treatment in reducing percentage

leaves and Spiromesifen 240 SC (Oberon 240SC) 120 g.a.i./ha proved to be the best in showing maximum percentage mortality.

3. Testing of bio-efficacy of new molecule, Flubendiamide 480 SC (Fame 240SC) against leaf webber cum fruit borer, *Pempelia morosalis*. Resulted (T4) Flubendiamide 480 SC (fame 240SC) @ 48 g.a.i./ha in maximum reduction of number of larvae and maximum percent of larval mortality.

Suggestions for further work

1. Detailed life cycle of mites and leaf webber cum fruit borer should be studied.
2. Economics on the various acaricides and insecticides tested should be worked out.

"Bioefficacy of new molecules, Oberon 240EC(spiromesifen 240SC) against broad mites, *Euseius sp.*(family:Phytoseiidae) and Flubendiamide 480SC against leaf webber cum fruit borer, *Pempelia morosalis* (Saalm Uller) in *Jatropha curcas.*"

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ABSTRACT

The investigation entitled "Bioefficacy of new molecules, Oberon 240EC(spiromesifen 240SC) against broad mites, *Euseius sp.* and Flubendiamide 480SC against leaf webber cum fruit borer, *Pempelia morosalis* (Saalm Uller) in *Jatropha curcas"* was conducted at the Department of Entomology, College of Agriculture, I.G.K.V., Raipur during September 2010 to June 2011.

In the present studies three insect pests *viz.*, blue bug, *Chrysocoris purpureus* (Westw), leaf webber cum fruit borer, *Pempelia morosalis* (Saalm uller) and broad mites, *Euseius sp* were recorded as major pests. Alongwith these few predators namely spider, *Oxyopes lineatips* and predatory grass hopper were recorded as natural enemies. The pest succession studies revealed that mean maximum and minimum population of *C. purpureus* was recorded in 1st fortnight of September (42.49) and 1st fortnight of May (15.09), nymph and adult / plant, respectively. Mean maximum population of webber was recorded in the month of June 1st fortnight (29.97) and minimum in the month of April 1st fortnight (2.64) in season (II).

Testing of bio-efficacy of the new molecule, Oberon 240EC (Spiromesifen 240SC) against broad mites, in resulted Spiromesifen 240 SC (Oberon 240SC) @ 96 g.a.i./ha (T3) as the best treatment as far as minimum percent of damaged leaf was concerned. Spiromesifen 240 SC (Oberon 240SC) @ 120 g.a.i/ha proved to be the best treatment, as it recorded maximum percentage of mortality of 29.01%, 48.36%, 35.59% and 48.36% at 7 days, 14days, and 21days and after treatment.

Screening of 47 provenances against *C. purpureus* revealed that Chandnapur, PKVJ- DHW-1 Tokupoms and Chandka as tolerant and Pant J & K Set -2 and Jabalpur as susceptible, while against *P. morosalis*, Jagdalpur and ANOS – 201 were judged as tolerant whereas Sagar – 1 and J & K Set -1 were recorded as susceptible.

Testing of bio-efficacy of the new molecule, Flubendiamide 480 SC against leaf webber cum fruit borer, *Pempelia morosalis*, revealed Flubendiamide 480 SC (fame 240SC) @ 48 g.a.i/ha (T4) as the best among the various treatments, as it recorded number of i.e. 1.67, 1.27 and 0.93 after 3 days, 7 days and 10 days of treatment respectively. As far as percent mortality of larvae was concerned, it was also maximum in T_4, Flubendiamide 480 SC (fame 240SC) @ 48 g.a.i/ha with maximum mean percentage mortality of 37.45%, 52.43%, 65.17% after 3 days, 7days and 10 days of treatment respectively.

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