EVALUATION OF SOME PLANT EXTRACTS AGAINST MAJOR PESTS OF SOYBEAN

THESIS

Submitted to
Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola
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(AGRICULTURAL ENTOMOLOGY)

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DECLARATION OF STUDENT

I hereby declare that the experimental work and its interpretation of the Thesis entitled **"EVALUATION OF SOME PLANT EXTRACTS AGAINST MAJOR PESTS OF SOYBEAN"** or part thereof has neither been submitted for any other degree or diploma of any university, nor the data have been derived from any thesis / publication of any university or scientific organization. The source of material used and all assistance received during the course of investigation have been duly acknowledged.

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CERTIFICATE

This is certify that thesis entitled **"EVALUATION OF SOME PLANT EXTRACTS AGAINST MAJOR PESTS OF SOYBEAN"** submitted in partial fulfillment of the requirement for the degree of **"Master of Science in Agriculture (Agricultural Entomology)"** of the Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola is a record of bonafide research work carried out by Nagarale Sumit Vitthal under my guidance and supervision.

The subject of the thesis has been approved by the Students Advisory Committee.

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(Nagarale Sumit Vitthal)

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(D) LIST OF ABBREVIATIONS

%	--	Per cent
/	--	Per
@	--	At the rate
a.i.	--	Active ingredient
C.D.	--	Critical difference
C.V.	--	Coefficient of variation
DAE	--	Days after emergence
DAS	--	Days after spraying
EC	--	Emulsifiable concentrate
ETL	--	Economic Threshold Level
et al.	--	et alia (and others)
etc.	--	et cet era
Fig.	--	Figure
g	--	gram (s)
ha	--	Hectare
ICBR	--	Incremental cost benefit ratio
i.e.	--	id est (that is)
LBB	--	Lady bird beetle
m	--	meter
NSE	--	Neem Seed Extract
q	--	Quintal
RBD	--	Randomized block design
Rs.	--	Rupees
S.E. (m) ±	--	Standard error of mean
Sig.	--	Significant
viz.	--	vide licet (namely)

(E) THESIS ABSTRACT

a)	Title of the thesis	:**"EVALUATION OF SOME PLANT EXTRACTS AGAINST MAJOR PESTS OF SOYBEAN".**
b)	Full name of student	: Nagarale Sumit Vitthal
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Abstract

Soybean is an important oilseed crop and is reported to be attacked by number of pests among which tobacco leaf eating caterpillar, green semilooper and hairy caterpillar are major pests. Tobacco leaf eating caterpillar and green semilooper need to be managed in time to avoid heavy losses. So in the present study efforts were made to evaluate the efficacy of some plant

extracts against major pests of soybean and to study the cost effectiveness of these treatments.

An experiment was carried out in Field of Department of Entomology, Dr.PDKV, Akola. The experiment was conducted in RBD with eight treatments replicated thrice. Soybean variety JS-335 was sown at 30X8 cm^2 spacing. The parameters used for evaluation of per cent larval reduction of tobacco leaf eating caterpillar, green semilooper and hairy caterpillar and grain yield. To study economics, ICBR of each treatment was worked out separately and compared.

The results revealed that on the basis of per cent larval reduction of tobacco leaf eating caterpillar, green semilooper and hairy caterpillar at three, seven and fourteen days after spray, treatments Quinalphos 25 EC 0.05%, Neem seed extract 5%, Neem leaves extract 5% were found to be most effective in order of merit.

As regards to the soybean yield, Quinalphos 25 EC, and Neem seed extract , were found to be most effective treatments recording yield of 2013 and 1666 kg/ha respectively.

As far as economics of the treatments is concerned, Quinalphos 25 EC and Neem seed extract are most economic treatments and recorded an ICBR of 1:7.69 and 1:5.41 respectively.

From the farmer's point of view, Quinalphos 25 EC and neem products like Neem seed extract and Neem leaves extract were most effective in terms of net monitary returns.

From the seed production point of view, Quinalphos 25 EC and Neem seed extract were most effective in recording highest yield. Over all, Quinalphos 25 EC was found most effective in terms of recording maximum per cent larval reduction of tobacco leaf eating caterpillar, green semilooper and hairy caterpillar and recorded highest ICBR of 1:7.69.

CHAPTER I

INTRODUCTION

1.1. Background information

Soybean (*Glycine max* L.) is one of the miracle 'Golden bean' of the 20th century. It is originated in China as per the first written record in ancient Chinese book "Pen Tsao Kong Mu" (Materia Medica) which is about 5000 year old. In India soybean was first time introduced as food in 1935(Sharma, 2004)

It is generally considered that, the soybean is a native of Eastern Asia. The species originated in China proper, probably in the north and central regions. Historical and geographical evidence points to the eastern half of North China, as the area where soybean was first domesticated, around the 11th century. These were used in preparation of a large variety of fresh, fermented and dried food products considered indispensible in the diet of oriental people. Large quantities of soybeans were crushed to extract the oil for food and industrial purposes. Meal remaining after extraction of oil was used primarily for fertilizer and as animal feed, especially for cattle. Use of soybean as specific remedy for the proper functioning of the heart, liver, kidneys and stomach, as well as the value of soybean sauce, milk, curd, paste and sprouts, not only for food but also to treat various diseases and body ailments. The principal early use of soybean was as a forage crop (Probst and Judd, 1973).

Soybean possess a very high nutritional value, on an average it contains 20 per cent oil, 40 per cent protein, Vit A, B, C,D, E and K along with 0.69 per cent phosphorus, 0.112 per cent iron and 0.024 per cent calcium. It has high calorific value releasing 420 calories from 100g. Soybean protein provides all the nine essential amino acids. Pattern of soya protein is virtually equivalent to that of milk and egg (Bishnoi ,2005).

Edible soy proteins are one of the world's least expensive and high quality protein source. Soybean is recognized as valuable food material. The values as per 100g of edible soybean are protein (43.2g), Fat (19.5g), Calcium (240mg), Iron (11.5mg), Carbonate (426mg), Thiamine

(0.73mg), Riboflavin (0.39mg), Niacin (3.20mg) and Energy (432Cal). Commercial methods of use of soy proteins are soy flour (less than 65 % protein), soy protein concentrate (65 to 89 % protein) and soy protein isolate (90 % or more protein) (Pandya, 1988).

Soybean is one of the plants that provides complete protein with minimum saturated fat. On the global scale, it becomes top on the list of oilseed crop. It is introduced as oilseed crop in India to increase the edible oil resources in the country due to it's high yield potential. It contributes 21 per cent of Indian vegetable oil pool in 2003-04 (Hedge, 2005). Soybean agro ecosystem is being adopted rapidly by farmers of Vidarbha and it becomes second major kharif crop. As a result many oil industries are established to provide employment in the region.

During kharif 2009 area sown under soybean in Maharashtra was 30.320 lakh ha. The estimated yield per hectare and total production of soybean would be around 982 kg and 29.774 lakh MT. And during kharif 2009 area sown under soybean in Vidarbbha region was 18.951Lakh ha and the estimated yield per hectare was 996.5 kg and total production of soybean would be around 18.976 lakh MT (Anonymous, 2009).

India has to spend lot of foreign exchange on importation of edible oil due to it's low production in the country. All efforts are being made by the government to increase edible oil production in the country. Several workers (Gangrade,1974 and Singh and Singh,1990), reported the loss in yield of soybean to the extent of 1 to 37 percent and infestation to a tune of 5 to 78 per cent due to various pests.

The luxuriant growth of soybean accompanied by green, soft and succulent foliage provides unlimited source of food, space and shelter to insects (Jayappa et al, 2003). Farmers are facing severe problem of Lepidopteran and other major pests on soybean. With the extensive rise in area under soybean cultivation, the pest problems have also increased seriously and became one of the reasons for low yield. This crop is attacked by 88 insect pest species belonging to six different orders and mites. Most economic injury caused by 25 insects belong to order Lepidoptera and Hemiptera. Insect pests associated with crop are Aphid *Aphis gossypii, Aphis craccivora*, Whitefly *Bemisia tabaci*, Green

semilooper *Diachrysia orichalcea*, Bihar Hairy caterpillar *Spilosoma obliqua*, Leaf roller *Bilobata subsecivella*, Girldle beetle *Obereopsis brevis*, Stem fly *Melanagromyza sojae*, Tobacco leaf eating caterpillar *Spodoptera litura*, Leaf miner *Aproaerema modicella*, Grasshopper *Atractomorpha crenulata*, Grey weevil *Mylocerus undecimpustulatus* (Singh and Singh,1990).

1.2 Importance and need of the study

At present, synthetic insecticides have been used extensively to overcome the pest problem but indiscriminately used, resulting in number of problems viz, the development of insect resistance to insecticide , induced resurgence of pests and adverse effect on non-target organism such as natural enemies of insect pest(Dodia et al,2008).

Some plants are rich sources of bio-active organic compounds. These organic compounds show various pesticidal effects like antifeedant, repellent, oviposition deterrent and insecticidal etc. (Metcalf and Metcalf,1992).

Botanical pesticides are good alternatives to chemical pesticides. Botanical pesticides are eco-friendly, economical, target specific and biodegradable, Neem based botanical pesticides have been used traditionally for many years. There are many other trees which are also useful as source of botanical pesticides.

Plant products are one of the eco-safe tools of the IPM, botanical pesticides have less side effects and more insect control properties. In view of many environmental problems caused by chemical pesticides, farmers should use these ecofriendly pest management tactics.

Farmers are facing severe problem of Lepidopteran and other major pests on soybean. They generally use chemical pesticides to control the pest problem. However, it gives a hazardous effect on natural ecosystem. Therefore the promotion and development of microbial control agents and botanicals are the ecofriendly and economical method of pest management which helps to minimize the use of synthetic pesticides.

1.3 Objectives:

With the view of foregoing information, it was envisaged to carry out the present investigations by using some plant extracts with the following objectives.

1. To study the efficacy of plant extracts against major pests of soybean, viz
   i) Tobacco leaf eating caterpillar *Spodoptera litura*
   ii) Green Semilooper *Thysanoplusia orichalcea*
   iii) Hairy caterpillar *Spilosoma obliqua*
2. To study the effect of plant extracts on natural enemies and yield of soybean.

1.4 Scope and Limitations

There is large scope for developing ecofriendly safe and effective pest management approach because the indiscriminate use of chemical insecticides disturbs the natural balance of pest, leading to resurgence of pest and pollution in crop ecosystem from this angle, botanicals have become more attractive and are considered to provide an eco-friendly alternative (Dodia et al, 2008).

Botanical insecticide can play an important role in crop protection and other uses in future. Botanicals have to face tremendous competition after invention of newer generation of synthetic insecticides with minimum risk to non-target organism.

On the other hand in organic farming, plant originated insecticides have market with high demand for growers and consumers they will not accept conventional insecticidal spray for agricultural produce. It should be free from toxic residues of chemical pesticides and the safety of environment and sustainability of farm production be ensured.

At present there is growing market all over the world for organically produced fruits, vegetable, spices and grain etc. and farmers are getting higher rates for such produce.

Limitations

Botanical insecticides not easily available everywhere.

Low adoption of botanical insecticides by grower.

Seasonal availability of plant products indicates the need for their storage.

1.5 Hypothesis

Detailed insight study of evaluation of plant extract against major pests of soybean will help in selection of most effective control measure against major pests of soybean like lepidopteran pests. Plant products are organic in nature so there is less chance of development of resistance to botanicals because they are biodegradable and they have no residual action.

CHAPTER II

REVIEW OF LITERATURE

The soybean belongs to family Leguminosae and the cultivated form is *Glycine max* L. It is important oilseed crop recently introduced in Vidarbha region of Maharashtra state. This crop suffers serious losses due to infestation of several pests viz., tobacco leaf eating caterpillar *Spodoptera litura* (Fab.), Hairy caterpillar *Spilosoma obliqua* (Walker) and Green semilooper *Thysanoplusia orichalcea* (Hub.) are considered very important and during the course of this experiment, the crop was attacked by all these pests.

The critical review of major insect pests of soybean crop and different plant protection measures for the management of these pests are presented below. In present study efforts were made to ascertain the evaluation of some plant extracts against major pests of soybean (*Glycine max* L.). The information pertaining to them on the soybean crop are summarized under following heads.

2.1 Seasonal incidence of major insect pests on soybean.

2.2 Management of major insect pests of soybean through application of botanicals and their biosafety.

2.3 Management of major insect pests of soybean through application of insecticides.

2.1 Seasonal incidence of major insect pests on soybean.

Gangrade (1974) reported the infestation of *Diacrisia obliqua* Walk on soybean in first week of September till October.

Sachan and Gangwar (1980) recorded the incidence of green semilooper *Plusia signata* Fab. on soybean and were actively found during July to September.

Kumar et al.(1981) investigated the occurrence of 59 different species of insects on soybean crop. Among them the pink pod borer, *Cydia*

ptychora Meyr, the groundnut leaf miner, *Aproaerema modicella* Zellar, the green semilooper, *Cerynea* sp., the tobacco caterpillar, *Spodoptera litura* Fab., Bihar hairy caterpillar, *Diacrisia obliqua* Walk, were serious on the crop at Dharwad.

Upadhyay and Nikhare (1984) surveyed the incidence of *Diacrisia obliqua* on blackgram, greengram and sesamum and observed low population during August and in September. There was further built up of the pest population on these crops and some larval population was also observed on groundnut and soybean. A severe outbreak of these pests occurred in October on blackgram, soybean, groundnut and sesamum.

Singh and Singh (1987) reported the incidence of green semilooper, *Chrysodeixis acuta* on soybean during the first week of August and the maximum population was observed on 14th September. Damage to flowers and pods occurred mainly from 18th August to 1st September and during the 2nd week of September, respectively.

Singh and Singh (1990) reported 20 insect pests infesting seed, seedlings, roots and nodules of soybean in India. Also recorded the economic threshold level for green semilooper, *Chrysodeixis acuta* at flowering and podding stage at 4 and 3 larvae/ m respectively. Losses to soybean by green semilooper, *Chrysodeixis acuta* at flowering and podding stage (50.21%).

Singh and Singh (1991) reported that, increase the incidence of *Chrysodeixis acuta* per meter row length at 45 days after emergence (flower stage) and at 66 days after emergence (pod filling stage), resulted in reduction of 593 and 662 kg/ha in grain yield, respectively.

Tambe (1992) recorded the larvae of green semilooper *Plusia signata* on soybean crop in the 34th meteorological week (20 to 26 August, 1991) and it was noted the pest disappeared in the 36 meteorological week (3 to 9 September, 1991).

Kumar et al. (1998) reported the population density of *Spodoptera litura* (Fab.) during the crop growth period, which was maximum around the second half of October.

Singh (2001) studied the intensity of *Spodoptera litura* on soybean. The average plant and leaf damage and larval population ranged from 88 to 100 per cent, 72 to 98 per cent and 6.1 to 8.2 larvae per row, respectively. The damaged plants were defoliated and had small and shriveled pods with very small grains.

Jayappa et al. (2003) observed the caterpillar of *Thysanoplusia orichalcea* from 30 to 75 days after germination (DAG) and its population ranged from 1.6 to 3.5 larvae per meter row.

2.2 Management of major insect pests of soybean through application of botanicals and their biosafety.

Chopra et al. (1949) stated that Neem, Karanj, beshram, garadi, tobacco are the common plants throughout India and almost every part of plant is used for medicinal purpose. These are poisonous to insects and other cold blooded animals and harmless to man.

Gujar and Mehrotra (1983) studied *Azadirachtin* and other Neem products like methanolic Neem kernel extract and Neem oil on growth and development of *Spodoptera litura*. Neem product showed varying deleterious effects on growth and development.

Geetanjali et al. (1987) extracted separately and successfully seeds of Karanj and leaves of *Chloroxylon sweitenia* with methanol and various fractions were assumed for antifeedant and insecticidal activity and Karanj seed showed good antifeedant action against *Spodoptera litura*.

More et al. (1989) studied antifeeding properties of ten indigenous plants namely *Ipomaea carnea, Parthenium hysterophorus, Azadirachta indica, Vitex negundo, Euphorbia sp., Mentha arvensis, Calatropis gigantea, Cathranthus roseus, Ervatamia coronaria* and *Ocimum sanctum* against *Spodoptera litura*. It was revealed that 3 and 4 per cent concentration of aqueous extracts of *Euphorbia* sp. and *Ervatamia coronaria, I. carnea* and *P. hysterophorus* and 4% concentration of *Mentha*

arvensis and *A. indica* were found significantly superior in respect of antifeeding effect against *Spodoptera litura.*

Jothi et al. (1991) tested oils and extracts of Neem (*A. indica*) Mahuwa (*Basia latifolia*) and Karanj (*P. pinnata*) against *Toxiptera citridus* on lime. On the basis of the effectiveness and cost of the treatment Mahuwa and pongamia oils at 1% and Neem and pongamia seed extract at 2% were recommended for control of the pest.

Mukhtar Ahmed et al. (1991) tested extracts of air dried powders of rhizomes of *Acorus calamus* and leaves of *Lantena camera* var. *Adhatoda vesica* and *Melia azedarcae* obtained using ethanol, acetone and ether as solvents were effective in killing *Alianthus* webworm, *Attera fabricila. Ethanolic extracts* were the most effective 0.5% ethanolic extract *Acorus calamus* caused 100% mortality of *Attera fabriciella* while 5% extracts of *Lantana camera*, *Adhatoda vesica* and *Melia azedracae* caused 66.66, 76.66 and 66.66 per cent mortality respectively.

Thakar et al. (1992) compared the effectiveness of aqueous extracts (5 and 10%) and ether extracts (2%) of some plants including *Ipomaea carnea* and *A. indica* against *Heliothis armigera* and stated that aqueous Neem extracts (at 10%) gave comparable damage reduction.

Ambadkar and Khan (1994) have tested *Lantana* extracts into the choice chamber under fresh and dried leaf-disc tests and reported that 70 per cent insects were repelled in dried leaf-disc test whereas, fresh leaf-disc test exhibited 80 per cent repellent action against adult Cigarette beetles *L.erricorne.*

Prabhakar and Rao (1994) evaluated the relative toxicity of 4 botanical extracts against 2nd instar larvae of *Aproaerema modicella* in the laboratory. Product based on *A. indica* and garlic were more effective than a product based on Annona.

Bhalkare (1995) reported 46.06 per cent reduction of grey weevil due to application of Neemark and ICBR of 1:0.73.

Ganeshan et al. (1995) reported that, Neem extract 1.0 per cent caused larval mortality of *Earias vitella, Helicoverpa armigera* and *Spodoptera litura* as 57.89, 100 and 27.7 per cent respectively.

Meshram (1995) evaluated the antifeedant property of *Calotropis procera* aqueous leaf extracts against teak Skeletonizer, *Eutectona machaeralis* larvae. He reported that 24 hrs after treatment, the leaf area consumed by 3rd instar larvae was very low (0%) as against 39.07 per cent area consumed in untreated control.

Behera and Satapathy (1996) reported insecticidal property of *C. procera* leaf extract against foliage feeder like larvae of *S. litura*. The larval mortality under the influence of 5% leaf extract was 60.00 per cent as against no mortality in untreated control after 24 hrs of exposure in teak skeletonizer, whereas the treated plants caused 50 per cent mortality of *S. litura*.

Choudhari and Singh (1997) reported 40 per cent mortality of *Spodoptera litura* due to Neem formation Nimba 0.1 per cent.

Prakash and Rao (1997) *Azadirachtin* has no side effects on birds and other animals. There is no toxic residue left to contaminate the environment and insects do not develop resistance to Neem.

Babu (1998) reported, Neem seed kernel extract (NSKE) alone and higher antifeedant effect against *Spodoptera litura* larvae.

Das et al. (1998) evaluated Neem derivatives against *M. obtusa* and *H. armigera* infesting medium maturing pigeonpea and found that the ICBR was higher for chemical insecticides followed by Neem seed kernel extract 5 per cent.

Shahayaraj and Paulraj (1998) evaluated water extract of four plants using various concentrations (0.5, 1, 2, 4 and 6%) against last instar larvae of the groundnut pest *S. litura*. They reported that *Calotropis gigentiea* was found to be the most toxic plant product followed by *Vitex negundo, A. indica* and *Pongamia glabra*.

Shankar et al. (1998) tested effective concentration of different aza. A rich powder concentration inhibiting feeding of 5th instar larvae of *Spodoptera litura* in a leaf disc-choice assay.

Narabenchi and Sannaveerappannavar (1999) evaluated the effect of aqueous Neem seed kernel extract on larval development of tobacco cutworm, *Spodoptera litura* (Fab.) and found that, the NSKE at all the concentrations (0.05 to 4%) tested was highly detrimental to first instar larvae.

Murugan et al. (1999) evaluated toxic effects of crude ethanolic extracts of *C. gigantean* leaf extract have been causing 67 to 98 per cent mortality of larvae.

Raman et al. (2000) studied the field evaluation of custard apple and Neem formulation against castor semi-looper (*Achaea janata*) and indicated reduction in the larval population at 24 and 72 hrs after treatment respectively.

Men et al. (2002) stated that formulation like Neemark and Neem leaf extract were safer to *Diaeretiella rapae*.

Kumar et al. (2002) stated that excellent oviposition deterrent action has been reported at higher concentrations (i.e. 7.5 and 10 per cent) Pongamia, when used either as oil, methanolic seed extract, aceton leaf extract, aqueous seed extract or as chloroform seed extract against the insect pests, it was found to be effective as ovipsoition deterrent or antifeedant.

Sahayaraj (2002) reported that the extract of *C. gigantea* can also be used in combination with biocontrol agents, because it is safer to them. Leaf extract at 3% was tested against groundnut pests viz. *Spodoptera litura* and *A. modicella* in combination with a general predator *Rhynocoris marginatus*. When plant products were integrated with reduvid predator in the field the mean population of *S. litura* and *A. modicella* larvae was reported to be 1.10 and 1.66 per plant, respectively as against 4.11 and 2.03 larvae in control.

Purwar and Yadav (2002) reported that Neem seed kernel extract (NSKE) at 4 and 6 per cent against leaf folder (*Nacoleia* spp.) was found effective.

Ahmed et al. (2003) stated that Neem formulations like Neem oil and Neem seed kernel extract sprayed on eggs of *Chrysoperla carnea* and *Coccinella sexmaculata* reduced hatching per cent.

Anonymous (2003) stated that *C. gigantea* extract has exhibited antifeedant effects against *Spodoptera litura*.

Basappa and Singh (2003) evaluated bio-pesticides on *Spodoptera litura* and found that NSKE (5%) gaves 35.5 per cent mortality at 4 DAT.

Burman et al. (2003) evaluated aqueous extract of *L. camera* in 3 different concentration (20, 50 and 75%) along with recommended insecticide (Quinalphos 0.05%) was tested for its effect on emergence of egg parasitoid, *Trichogramma japonicum*. Two tests were made for the purpose i.e. cards were sprayed and parasitoid exposed for oviposition and in another set cards were first exposed for egg laying and then sprayed with plant extract. It is reported that significantly higher number of parasitoids emerged from the plant extract treated cards as against cards treated with Quinalphos. It is also reported that application of plant extracts after parasitization showed higher adult emergence of parasitoids.

Dwivedi and Seema Garg (2003) evaluated the efficacy of *L. camera* flower extract in acetone solvent; assessed on development, grain damage and population management of *Corcyra cephalonica*.

Innacone and Lamas (2003) stated that parasitoids *Trichogramma pintoi* were found to be sensitive to Neem, recording more mortality of adults and immature stage at higher doses.

Patel et al. (2003) conducted field experiment to know the toxic effects of *L. camera* plant extracts and chemical pesticide on predatory fauna of *Aphis gossypii* infesting plantago. The reports on safety index revealed that the population of aphidophagous insects in various

plots treated with lantana leaf extracts at 10% showed non significant difference and the number of predators was as good as that found in control.

Purwar and Yadav (2003) recorded mean larval population per meter row of tobacco caterpillar on soybean with NSKE 4 per cent before 1 days of first spray (8.00), after 1 day of first spray (2.00), after 3 days of first spray (0.00) after 7 days of first spray (0.00), before 1 day of second spray (6.67), after 1 day of second spray (1.67), after 3 days of second spray (5.67) and after 7 days of second spray (0.67), NSKE 4 per cent and NSKE 6% found effective in reducing the population of *S. litura*.

Reena and Singh (2003) reported ovicidal action of Karanj *P. pinnata* seed extract against *H. armigera*. The ovicidal action was reported to be more than 70 per cent with 10 per cent seed extract of matured and immature seed extracts.

Singh (2003) stated that seeds of Khesari can be effectively protected from the pulse beetle *Callosobruchus chinensis* (L) by mixing dried powder of Neem leaf (NLP) at the rate of 50 mg to 2 mg/100 g seed. It provides good result in respect of toxic effect, safety and economy.

Balikai and Lingappa (2004) stated that plant products like *Vinca rosea* leaves 5%, *P. pinnata* leaves 5%, *A. indica*, kernels 5%, *Vitex negundo* leaves 5% and *Adhatoda vasica* leaves 5% were safe to natural enemies and locally available in sufficient quantities.

Abhilash (2006) carried out investigations of soybean pod borer, *Cydia ptychora* and found that NSKE 5 per cent to be best among botanicals for the effective management of pod borer.

Arulprakash and Veeravel (2006) stated that the whole plant powder of *C. gigantea* was found to be very effective causing 47.08 per cent mortality of pulse beetles *C. maculatus* 7 days after treatment in cowpea.

2.3 Management of major insect pests of soybean through application of insecticides.

Singh and Singh (1983) found out effectiveness of insecticides, viz., methamidophos 0.05%, fenvalerate 0.01%, Quinalphos 0.05%, BPMC 0.1%, phosphamidon 0.03%, monocrotophos 0.04%, endosulfan 0.07%, methyl parathion 0.03% and sevimol 0.01% against the larvae of *Aproaerema modicella* after 24 hours of sprayings. Among these insecticides Quinalphos recorded highest mortality (96.50%) followed by methyl parathion dust (94%) and monocrotophos (93.30%) respectively.

Singh and Singh (1988) found out the toxicity of 11 insecticides viz., Quinalphos 0.025%, monocrotophos 0.030%, malathion 0.05%, triazophos 0.04%, phosalane 0.035%, decamethrin 0.002%, cypermethrin 0.001, fenvalerate 0.01% and permethrin 0.005% against grey semilooper, *Rivula* spp. in the field conditions. Fenvalerate and Quinalphos were found to be highly toxic as the crop treated with these insecticides remained free from larval population of *Rivula* sp. upto 15 days after treatment and also yielded highest quantity of grain (17.00 q/ha).

Shivankar et al. (2008) evaluated the field bio-efficacy of chemical, botanical and bio-pesticides against *Spodoptera litura* in Sugarbeet. Spraying of Quinalphos 25 EC @ 0.05% recorded the maximum (97.2%) reduction of *Spodoptera litura* followed by chlorpyriphos 20 EC @ 0.1% (94.1%) *T. chilonis* @ 50000/ha and spraying of azadirachtin 3000 ppm (5 ml/lit) gave 89.7 and 89.3% reduction of larval population of *Spodoptera litura* and found effective and safe treatment to control the sugerbeat pests.

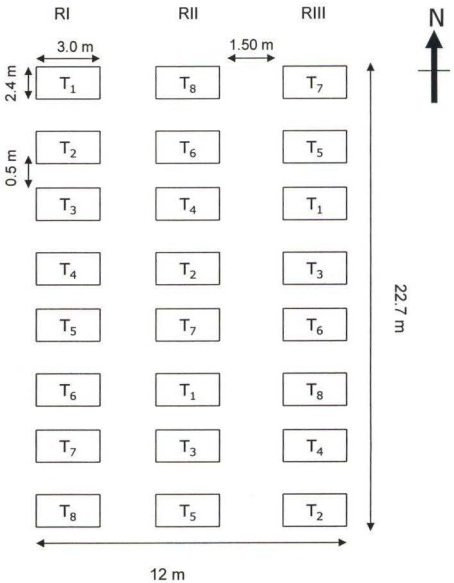


Fig. 1: Plan of layout

Plate No. 1 View of experimental field

CHAPTER III

MATERIAL AND METHODS

The present investigation entitled "Evaluation of some plant extracts against major pests of soybean" was planned to carry out the studies on the effect of different plant extracts against major pests on soybean under field condition at Department of Agricultural Entomology, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra, India during *kharif* season 2009.

Details of materials used and the methods followed during the course of studies are described herewith.

3.1 Material

For conducting these studies, land, soybean seed (JS-335), plant products, agricultural implements, manures and fertilizers, knapsack sprayer, measuring tape, rope, pegs, tags, bullock pair, labours, polythene bags, weighing balance etc. were utilized.

3.2 Methods

3.2.1 Details of experiment

1. Design	: Randomized Block Design (RBD)
2. Date of sowing	: 01.07.2009
3. Season	: *Kharif* 2009
4. Number of treatments	: Eight (8)
5. Number of replications	: Three (3)
6. Total number of plots	: 24
7. Variety	: JS-335
8. Fertilizer dose	: 30:75:00 kg NPK/ha
9. Plot size	: Gross = 3 m x 2.4 m
	Net = 2.40 m x 2.24 m
10. Total experimental area	: 22.7 m x 12 m
11. Spacing	: Row to Row = 30 cm
	Plant to plant = 8 cm
12. Marginal spacing	: Between replication = 1.5 m
	Between treatments = 0.5 m

Table 1. Treatment details

Treatment No.	Treatments	Dosage
T_1	*Pongamia pinnata* (Karanj) leaves extract + dispersing agent	5%
T_2	*Azadirachta indica* (Neem) leaves extract + dispersing agent	5%
T_3	*Calotropis procera* (Rui) leaves extract + dispersing agent	5%
T_4	*Lantana camera* (Ghaneri) leaves extract + dispersing agent	5%
T_5	Karanj seed extract + dispersing agent	5%
T_6	Neem seed extract + dispersing agent	5%
T_7	Quinalphos 25 EC	0.05%
T_8	Untreated control	

3.2.2 Cultural operations

3.2.2.1 Land preparation

The field was uniformly prepared during summer followed by two harrowings. Then cleaned the field by picking the stubbles of previous crop. Well decomposed farm yard manure was added to the soil and thoroughly mixed by giving repeated harrowings. Before sowing, the layout was made in the field in accordance with experimental design with the help of measuring tape, nylon string and wooden pegs.

3.2.2.2 Sowing

Seed treatment with thiram @ 3 g/kg and Rhizobium @ 2.50 g/kg of seed was done. The sowing of shed dried seed after treatment was done in already marked plots.

3.2.2.3 Thinning

Thinning was done when the crop was at 15 days old so as to maintain proper plant population per plot.

3.2.2.4 Application of fertilizers

The fertilizers were applied @ 30:75:00 NPK kg/ha half dose of nitrogen and full dose of phosphorus was applied at the time of sowing and remaining half dose of nitrogen applied a month after sowing.

3.2.3 Preparation of spray solution

The spray solution of desired concentration was freshly prepared before application. The required quantity of water for spraying each plot was estimated by spraying plain water on control plot. The required quantity of botanicals for each respective treatment was worked out and spray solution was prepared by mixing them in water with 2 g/lit dispersing agent (Nirma powder).

The spray solution of desired concentration was prepared by using the following formula.

$$V = \frac{C \times A}{\% \text{ of a.i.}}$$

Where,

V = Volume of commercial insecticide in ml

C = Required concentration of spray solution

A = Total quantity of solution to be prepared

% a.i. = Percentage of active ingredient in commercial formulation.

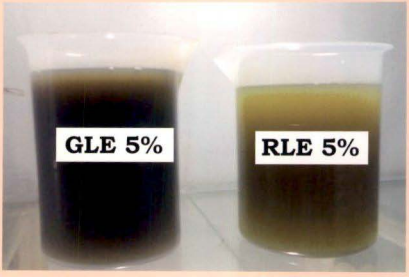
3.2.3.1 Preparation of 5 per cent Neem seed extract

The required quantity of dried Neem seed was taken i.e. 500 gm seeds in 10 lit of water to make stock solution.

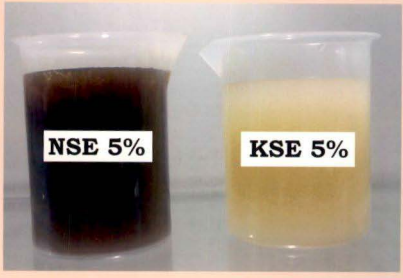
The weighed seeds were ground well into fine powder and was put into a vessel containing sufficient quantity of water and kept overnight one day prior to spraying.

The next day morning the extract was decanted through muslin cloth and the process was repeated with washing till the complete extraction was ensured. Thus the obtained suspension was adjusted for its volume by adding remaining quantity of water. To this extract, Nirma powder @ 0.2 per cent (2 g/lit water) was added as spreading agent to have better coverage of botanical on the crop.

Neem leaves extract and Karanj laeves extract



Ghaneri leaves extract and Rui leaves extract



Neem seed extract and Karanj seed extract

Plate No.2 Botanical insecticides

3.2.3.2 Preparation of Neem, Karanj, Rui and Ghaneri 5% leaves water extract

The 5% water extract of Neem, Karanj, Rui, Ghaneri was prepared separately by following procedure. Fresh leaves was taken and weighted for 5 % i.e. 250 g of fresh leaves in 5 lit of water. The weighed leaves were ground well in mixer and put it into vessel containing sufficient quantity of water over night.

The next day morning the extract was decant through muslin cloth and the process was repeated with washing till the complete extraction was ensured. Thus the obtained suspension was adjusted for its volume by adding remaining quantity of water. To this extract, the Nirma powder (dispersing agent) @ 0.2 per cent (2 g/lit water) was added to have a better coverage of botanical on the crop.

3.2.3.3 Application of spray solution

The knapsack sprayer was used for spraying operations. After every treatment, sprayer nozzles, hose were washed twice thoroughly with clean water every care was taken to minimize drift and contamination of adjacent plot at the time of spraying. The spraying details are as under.

Sr. No.	Spray number	Days after emergence	Date of sprayings
1	First	20	25.07.2009
2	Second	35	09.08.2009
3	Third	50	24.08.2009

3.2.3.4 Methods of recording observation

The observation on major pest of soybean and natural enemies was recorded as follows.

1. Major pest of soybean

The observations on leaf eating caterpillar viz., tobacco leaf eating caterpillar, green semilooper, hairy caterpillar etc. was recorded on randomly selected one meter row length at five places from each plot, before 24 hours and after 3rd, 7th and 14th days after application of treatment.

2. Natural enemies

The populations of natural enemies were recorded on 5 randomly selected plants from each plot, before 24 hrs and after 3rd, 7th and 14th days after application of treatment.

3. Post harvest observation

The yield of soybean from each net plot was recorded to know the influence of the different treatments.

3.3 Economics of the treatments

The yield data from each treated plot were used to calculate economics of spraying. The cost of insecticide, botanical, cost of spray applications i.e. labour charges prevailing during the course of investigations were taken into consideration to work out the cost of each treatment per hectare. Similarly, income obtained from the sale of soybean as per the prevailing market rates was also calculated for each treatment to workout the cost benefit ratio.

3.4 Statistical analysis

The field data collected during the course of experimentation were subjected to statistical analysis after appropriate transformation for interpretation of results. Randomized block design used in order to test level of significance among the various treatments as per Gomez and Gomez (1984).

CHAPTER IV

RESULTS AND DISCUSSION

In the present study, 'Evaluation of some plant extracts against major pests of soybean" eight treatments consisting of Karanj leaves extract 5%, Neem leaves extract 5%, Rui leaves extracts 5%, Ghaneri leaves extract 5%, Karanj seed extract 5%, Neem seed extract 5%, Quinalphos 25 EC 0.05% and untreated control were evaluated for their efficacy against major pests of soybean i.e. tobacco leaf eating caterpillar, green semilooper and hairy caterpillar. The per cent larval reduction of major pest on soybean was observed after 3, 7 and 14 days from spray application. The experiment was laid out in RBD as shown in Fig. 1. The trial was conducted during *kharif* season of 2009-10.

The per cent reductions of the pests in each treatment were worked out. Then data were transformed into corresponding arc sin and square root values and was subjected to statistical analysis. The efficacy of the above mentioned botanicals and insecticides was evaluated on the basis of per cent larval reduction of Tobacco leaf eating caterpillar, green semilooper and hairy caterpillar at 3, 7 and 14 days after spray and the results are presented in Table 2 to 10.

4.1 Efficacy of some botanicals and insecticides against major pests of soybean

4.1.1 Per cent larval reduction of tobacco leaf eating caterpillar after first spray

A) At three days after spraying (3 DAS)

The data presented in Table 2 and depicted in Fig.2 indicate that all the treatments were significantly superior over the untreated control in per cent larval reduction of Tobacco leaf eating caterpillar. The treatment Quinalphos 25 EC 0.05% recorded significantly maximum per cent larval reduction (85.34%) of tobacco leaf eating caterpillar and was at par with Neem seed extract 5% in which 80.47 per cent larval reduction was recorded.

Table 2. Per cent larval reduction of tobacco leaf eating caterpillar after first spray

Tr. No.	Treatment	Dosage (%)	3 DAS	7 DAS	14 DAS
1	*Pongamia pinnata* (Karanj) leaves extract	5	48.55 (44.17)	34.39 (35.91)	28.29 (32.13)
2	*Azadirachta indica* (Neem) leaves extract	5	69.02 (56.18)	59.83 (50.67)	42.49 (40.68)
3	*Calotropis procera* (Rui) leaves extract	5	55.90 (48.39)	45.69 (42.53)	25.63 (30.41
4	*Lantana camera* (Ghaneri) leaves extract	5	48.83 (44.33)	32.53 (34.78)	25.13 (30.09)
5	Karanj seed extract	5	56.94 (48.99)	51.37 (45.79)	33.23 (35.20)
6	Neem seed extract	5	80.47 (63.78)	66.03 (54.35)	49.09 (44.48)
7	Quinalphos 25 EC	0.05	85.34 (67.49)	75.07 (60.05)	61.55 (51.68)
8	Untreated control		19.58 (26.28)	18.90 (25.77)	23.68 (29.12)
	'F' test		Sig.	Sig.	Sig.
	SE(m)±		4.08	3.07	1.81
	CD at 5%		12.39	9.32	5.50
	CV %		14.15	12.16	8.56

(Figures in parentheses are corresponding values of arc sin transformation)

The minimum per cent larval reduction (19.58%) was observed in untreated control.

Whereas the remaining treatments viz. Neem leaves extract 5%, Rui leaves extract 5%, Ghaneri leaves extract 5% and Karanj leaves extract 5% recorded 69.02,55.90,48.83 and 48.55 per cent larval reduction at 3 DAS and these were found at par with Karanj seed extract 5% exhibited 56.94% larval reduction of tobacco leaf eating caterpillar respectively.

In present findings Quinalphos 25 EC 0.05% recorded maximum per cent larval reduction of tobacco leaf eating caterpillar. Similar results was recorded by Shivankar et al. (2008) and in case of Neem seed extract 5% similar results were also recorded by Gujar and Mehrotra (1983), Babu (1998), Narabenchi and Sannaveerappannavar (1999) and in case of Karanj seed extract same results were obtained by Geetanjali et al. (1987) and Reena and Singh (2003). Therefore, these findings are in agreement with the findings of present investigation and support the data.

B) At seven days after spraying (7 DAS)

The data presented in Table 2 and depicted in Fig. 2 indicate that all the treatments were significantly superior over the untreated control in per cent larval reduction of tobacco leaf eating caterpillar. The treatment with Quinalphos 25 EC 0.05% recorded significantly maximum per cent larval reduction (75.07%) and was at par with Neem seed extract 5% recorded 66.03 per cent larval reduction, respectively.

The next best treatment was Neem leaves extract 5% recorded 59.83% larval reduction and found at par with Karanj seed extract 5% in which 51.37 per cent larval reduction was recorded respectively. From the remaining group of treatments, untreated control was least significant and observed minimum per cent (18.90%) larval reduction, and also significantly inferior to the treatment Rui leaves extract 5%, Karanj leaves extract 5% and Ghaneri leaves extract 5% where 45.69,34.39 and 32.53 per cent larval reduction was recorded.

Similar findings were reported by Shivankar et al. (2008) in Quinalphos 25 EC 0.05% where highest per cent larval reduction was observed and in case of Neem seed extract 5% and Karanj seed extract 5% maximm per cent larval reduction were also recorded by More et al. (1989), Ganeshan et al. (1995), Purwar and Yadav (2003) and Mukesh Kumar et al. (2002). Therefore these findings are in agreement with the findings of present study and support the data.

C) At fourteen days after spraying (14 DAS)

The data presented in Table 2 at 14 DAS and depicted in Fig.2 revealed that all the treatments were significantly superior over untreated control in recording maximum per cent larval reduction.

Quinalphos 25 EC 0.05% recorded maximum (61.55) per cent larval reduction of tobacco leaf eating caterpillar and was significantly superior over all the treatments. Treatments Neem seed extract 5% and Neem leaves extract 5% were second in order of merit recording 49.09 and 42.49 per cent larval reduction. The untreated control was least significant recording minimum (23.68%) larval reduction and was at par with Ghaneri leaves extract 5%, Rui leaves extract 5% and Karanj leaves extract 5% in which 25.13,25.63 and 28.29% larval reduction were recorded respectively.

In present investigation highest per cent larval reduction recorded in Quinalphos 25 EC 0.05% and it followed by Neem seed extract, Neem leaves extract, Karanj seed extract, Karanj leaves extract 5% and Rui leaves extract 5% similar findings are also reported by Shivankar et al. (2008). In case of Neem seed extract and Neem leaves extract similar results were found by More et al. (1989), Choudhari and Singh (1997), Basappa and Singh (2003). In case of Karanj seed and leaves extract similar results were found by Geetanjali et al. (1987) and Balikai and Lingappa (2004) in case of Rui leaves extract similar results were found by Behera and Satapathy (1996) and Sahayaraj (2002).Therefore, these findings are in agreement with present investigation and gave strong support to the present data.

4.1.2 Per cent larval reduction of tobacco leaf eating caterpillar after second spray

A) At three days after spraying (3 DAS)

The data presented in Table 3 and depicted in Fig.3 indicates that all the treatments were significantly superior over the untreated control in per cent larval reduction of tobacco leaf eating caterpillar. The treatment Quinalphos 25 EC 0.05% recorded significantly maximum per cent larval reduction (66.52%) and was at par with Neem seed extracts 5% in which 64.83 per cent larval reduction was recorded.

However, the next best treatments viz., Neem leaves extract 5% Karanj seed extract 5%, Karanj leaves extract 5%, Rui leaves extract 5% and Ghaneri leaves extract 5% were at par with each other and recording 48.25, 42.73, 40.27, 39.41 and 37.49 per cent larval reduction

respectively. Significantly minimum per cent larval reduction (0) was observed in untreated control.

Similar findings are also reported by Shivankar et al. (2008) in maximum per cent larval reduction in Quinalphos 25 EC In case of Neem seed and leaves extract similar results were found by Ganeshan et al. (1995), Babu (1998), Bassappa and Singh (2003). In case of Karanj seed and leaves extract similar results were found by Reena and Singh (2003), Mukesh Kumar et al. (2002) and in case of Rui leaves extract similar results were found by Sahayaraj (2002), More et al. (1984) and Behra and Satapathy (1996). In case of Ghaneri leaves extract Ambadkar and Khan (1994) have obtained 80 per cent repellent action against adult Cigarette beetle *L. serricorne*. So these findings gave support to the present data.

Table 3. Per cent larval reduction of tobacco leaf eating caterpillar after second spray

Tr. No.	Treatment	Dosage (%)	3 DAS	7 DAS	14 DAS
1	*Pongamia pinnata* (Karanj) leaves extract	5	40.27 (39.39)	22.31 (28.19)	21.76 (27.81)
2	*Azadirachta indica* (Neem) leaves extract	5	48.25 (44.00)	28.80 (32.46)	26.15 (30.76)
3	*Calotropis procera* (Rui) leaves extract	5	39.41 (38.89)	24.66 (29.78)	22.50 (28.32)
4	*Lantana camera* (Ghaneri) leaves extract	5	37.49 (37.46)	26.23 (30.81)	19.72 (26.37)
5	Karanj seed extract	5	42.73 (40.82)	27.84 (31.85)	22.47 (28.30)
6	Neem seed extract	5	64.83 (53.63)	31.85 (34.36)	26.24 (30.82)
7	Quinalphos 25 EC	0.05	66.52 (54.65)	35.41 (36.52)	33.52 (35.38)
8	Untreated control		0.00 (0.00)	17.64 (24.84)	17.24 (24.54)
	'F' test		Sig.	Sig.	Sig.
	SE(m)±		2.57	2.17	1.75
	CD at 5%		7.80	6.59	5.31
	CV %		11.52	12.10	10.44

(Figures in parentheses are corresponding values of arc sin transformation)

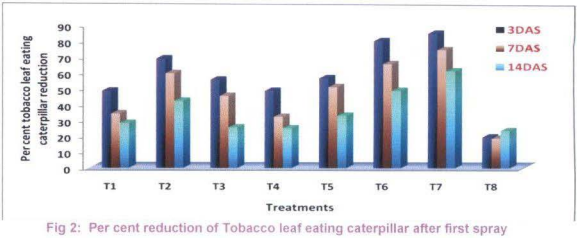


Fig 2: Per cent reduction of Tobacco leaf eating caterpillar after first spray

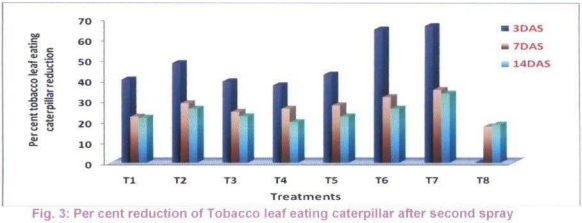


Fig. 3: Per cent reduction of Tobacco leaf eating caterpillar after second spray

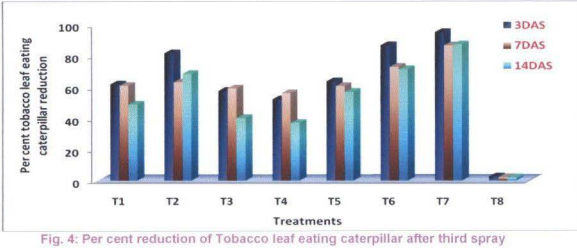


Fig. 4: Per cent reduction of Tobacco leaf eating caterpillar after third spray

T_1 Karanj leaves extract 5%	T_5 Karanj seed extract 5%
T_2 Neem leaves extract 5%	T_6 Neem seed extract 5%
T_3 Rui leaves extract 5%	T_7 Quinolphos 25 EC 0.05%
T_4 Ghaneri leaves extract 5%	T_8 Untreated control

B) At seven days after spraying (7 DAS)

The data presented in Table 3 and depicted in Fig.3 indicate that all the treatments were superior over untreated control in per cent larval reduction of tobacco leaf eating caterpillar. The treatment Quinalphos 25 EC 0.05% recorded significantly highest per cent larval reduction (35.41%) and was at par with Neem seed extract 5%, Neem leaves extract 5%, Karanj seed extract 5% and Ghaneri leaves extract 5% recording 31.85, 28.80, 27.84 and 26.23 per cent larval reduction respectively. These treatments were also followed by Rui leaves extract and Karanj leaves extract 5% in which 24.66% and 22.31% larval reduction was noticed. However the treatment untreated control was least significant and found lowest 17.64 per cent larval reduction at 7 DAS.

The results of Quinalphos 25 EC 0.05% are in consistence with the results of Shivankar et al. (2003) where maximum per cent larval reduction was recorded. In case of Neem seed and leaves extract same results were recorded by Choudhari and Singh (1997), Bassappa and Singh (2003) and. In case of Karanj seed and leaves extract same results was obtained by Geetanjali et al. (1987) and Mukesh Kumar et al. (2002). In case of Rui leaves extract same results were obtained by Sahayaraj and Paulraj (1998) and Sahayaraj (2002). Therefore the data were comparable with the findings of above researchers.

C) At fourteen days after spraying (14 DAS)

It is evident from the data presented in Table 3 and depicted in Fig.3 revealed that all the treatments were significantly superior over untreated control in recording maximum per cent larval reduction at 14 days after second spray. Amongst the different treatments Quinalphos 25 EC 0.05% recorded maximum (33.52) per cent larval reduction of tobacco leaf eating caterpillar and was found significantly superior over all the treatments.

The next better treatments viz., Neem seed extract 5%, Neem leaves extract 5%, Karanj seed extract 5%, Rui leaves extract 5%, Karanj leaves extract and Ghaneri leaves extract 5% recorded 26.24, 26.15, 22.47, 22.50, 21.76 and 19.72 per cent larval reduction respectively and these

treatments were also found at par with each other. The minimum per cent larval reduction was observed in untreated control (17.24%).

In case of Quinalphos 25 EC similar results were obtained by Shivankar et al. (2008). In case of Neem seed extract and leaves extracts similar results were recorded by Gujar and Mahrotra (1983), Ganeshan et al. (1995) and Purwar and Yadav (20030. In case of Rui leaves extract similar results were obtained by More et al. (1989) and Sahayraj (2002). In case of Karanj seed extract similar results were obtained by Mukesh Kumar et al. (2002) and Reena and Singh (2003). Therefore, these results are in agreement with the results of present experiment and support the data.

4.1.3 Per cent larval reduction of tobacco leaf eating caterpillar after third spray

A) At three days after spraying (3 DAS)

The data presented in Table 4 and depicted in Fig.4 indicated that all the treatments were significantly superior over untreated control in per cent larval reduction of tobacco leaf eating caterpillar. The treatment with Quinalphos 25 EC 0.05% recorded significantly maximum per cent larval reduction (94.97%) and was at par with Neem seed extract 5% and Neem leaves extract 5% in which 86.69 and 81.69 per cent larval reduction was recorded. The second effective group of treatments viz., Karanj seed extract 5% Karanj leaves extract 5%, Rui leaves extract 5% and Ghaneri leaves extract 5% were at par with each other and recording 63.69, 61.77, 57.63 and 52.26 per cent larval reduction respectively. Untreated control treatment was least significant in which 2.44 per cent larval reduction was observed.

In the study conducted by Shivankar et al. (2008) recorded similar results in Quinalphos 0.05% and in case of Neem seed extract and Neem leaves extract similar findings were reported by Babu (1998), Bassappa and Singh (2003). In case of Karanj seed extract and Karanj leaves extract similar results were found by Mukesh Kumar et al. (2002) and Reena and Singh (2003). In case of Ghaneri leaves extract Mukthar Ahmed et al. (1991) observed that *Lantana camera* at 5% extract cause 66.66 per cent mortality. Therefore these findings are in analogous with the findings of present investigation and gave strong support to the data.

B) At seven days after spraying (7 DAS)

The data presented in Table 4 and depicted in Fig.4 indicated that all the treatments were significantly superior over untreated control in per cent larval reduction of tobacco leaf eating caterpillar. Treatment Quinalphos 25 EC 0.05% was significantly superior over all the treatments, recorded significantly maximum per cent larval reduction (86.68%) and found at par with Neem seed extract 5% in which 72.96 per cent larval reduction was observed.

Table 4. Per cent larval reduction of tobacco leaf eating caterpillar after third spray

Tr. No.	Treatment	Dosage (%)	3 DAS	7 DAS	14 DAS
1	*Pongamia pinnata* (Karanj) leaves extract	5	61.77 (51.81)	60.95 (51.33)	48.98 (44.42)
2	*Azadirachta indica* (Neem) leaves extract	5	81.69 (64.67)	63.19 (52.65)	68.56 (55.90)
3	*Calotropis procera* (Rui) leaves extract	5	57.63 (49.39)	59.30 (50.36)	40.23 (39.37)
4	*Lantana camera* (Ghaneri) leaves extract	5	52.26 (46.30)	56.26 (48.60)	37.07 (37.51)
5	Karanj seed extract	5	63.69 (52.95)	60.75 (54.79)	57.01 (49.03)
6	Neem seed extract	5	86.69 (68.61)	72.96 (58.67)	71.39 (57.67)
7	Quinalphos 25 EC	0.05	94.97 (77.04)	86.68 (68.60)	87.30 (69.13)
8	Untreated control		2.44 (9.00)	2.09 (8.33)	1.93 (8.00)
	'F' test		Sig.	Sig.	Sig.
	SE(m)±		4.19	4.24	3.44
	CD at 5%		12.73	12.87	10.46
	CV %		13.86	14.96	13.23

(Figures in parentheses are corresponding values of arc sin transformation)

However the treatment viz., Neem seed extract 5%,Neem leaves extract 5%, Karanj seed extract 5%, Karanj leaves extracts, Rui leaves extract 5% and Ghaneri leaves extract 5% was second in order of merit for maximum per cent larval reduction in which 72.96, 60.75, 63.19,

60.95, 59.30 and 56.26 per cent larval reduction observed respectively. And these treatments were also found at par with each other. Treatment untreated control was least significant and exhibited lowest (2.09%) larval reduction of tobacco leaf eating caterpillar.

In case of Quinalphos 25 EC above findings are similar to the findings represented by Shivankar et al. (2008) in per cent reduction and gave strong support to the present data of investigation. In case of Neem seed extract and Neem leaves extract same results were obtained by Gujar and Mehrotra (1983), More et al. (1989), Purwar and Yadav (2003). In case of Karanj seed extract and Karanj leaves extracts similar results, were obtained by Reena and Singh (2003) and Balikai and Lingappa (2004). In case of Rui leaves extract similar results were obtained by More et al. (1989), Sahayraj (2002). Therefore these findings are in agreement with the present data.

C) At fourteen days after spraying (14 DAS)

It is evident from the data presented in Table 4 and depicted in Fig. 4 that the data were statistically significant. All the treatments were found significantly superior over untreated control in per cent larval reduction of tobacco leaf eating caterpillar at 14 days after third spray. Amongst them treatment Quinalphos 25 EC 0.05% recorded highest 87.30 per cent larval reduction of tobacco leaf eating caterpillar and found significantly superior over others. The next best treatments such as Neem seed extract 5%, Neem leaves extract 5% and Karanj seed extract 5% were at par with each other and recording 71.79, 68.56 and 57.01% larval reduction respectively. From the remaining group of treatments Karanj leaves extract 5%,Rui leaves extract 5% and Ghaneri leaves extract 5% were at par with each other and recorded 48.98, 40.23 and 37.07 per cent larval reduction. However these treatments were significantly superior to the Ghaneri leaves extract 5% and recorded 37.07% larval reduction. Significantly lowest per cent larval reduction (1.93) was recorded in untreated control.

In case of Quinalphos 25 EC similar results was obtained by Shivankar et al. (2008). In case of Neem seed extract and Neem leaves extract. Similar results obtained by Gujar and Mehrotra (19983), Ganeshan et al. (1948) and Purwar and Yadav (2003). In case of results were obtained by Mukesh Kumar et al. (2002) and Reena and Singh (2003). Therefore these findings gave strong support to the data of present investigation.

4.1.4 Per cent larval reduction of green semilooper after first spray

A) At three days after spraying (3 DAS)

The data presented in Table 5 and depicted in Fig.5 indicated that all the treatments were significantly superior over untreated control in per cent larval reduction of green semilooper. The treatment Quinalphos 25 EC 0.05% was most recorded significantly superior over all the treatments and recorded maximum (75.46) per cent larval reduction and was at par with Neem seed extract 5% with recording of 60.90 per cent larval reduction at 3 days after spraying. Amongst the plant extracts Neem seed extract 5% was at par with Neem leaves extract 5% found significantly superior to the treatments recorded of 60.90 and 57.13 per cent larval reduction of green semilooper. The treatment Rui leaves extract 5% and Ghaneri leaves extract 5% recording 33.16 and 28.25 per cent larval reduction respectively. Significantly minimum per cent larval reduction (4.67%) was observed in untreated control.

In Quinalphos 25 EC 0.05% similar observations on larval reduction of green semilooper was recorded by Singh and Singh (1988). In case of Neem seed extract and Karanj seed extract Jothi et al. (1991) are recommended for the control of green semilooper at 2% extract. So these findings gave support to the data while the other treatments could not be compared due to want of literature.

Table 5. Per cent larval reduction of green semilooper after spray

Tr. No.	Treatment	Dosage (%)	3 DAS	7 DAS	14 DAS
1	*Pongamia pinnata* (Karanj) leaves extract	5	51.16 (45.67)	37.48 (37.75)	30.20 (33.34)
2	*Azadirachta indica* (Neem) leaves extract	5	57.13 (49.10)	47.47 (43.55)	38.93 (38.61)
3	*Calotropis procera* (Rui) leaves extract	5	33.16 (35.16)	32.32 (34.65)	25.56 (30.37)
4	*Lantana camera* (Ghaneri) leaves extract	5	28.25 (32.11)	22.81 (28.53)	22.89 (28.59)
5	Karanj seed extract	5	55.83 (48.35)	43.30 (41.15)	36.40 (37.11)
6	Neem seed extract	5	60.90 (51.30)	59.81 (50.66)	47.41 (43.52)
7	Quinalphos 25 EC	0.05	75.46 (60.31)	83.80 (66.27)	66.64 (54.72)
8	Untreated control		4.67 (12.49)	4.69 (12.52)	3.44 (10.70)
	'F' test		Sig.	Sig.	Sig.
	SE(m)±		3.03	2.87	2.49
	CD at 5%		9.18	8.72	7.56
	CV %		12.54	12.65	12.47

(Figures in parentheses are corresponding values of arc sin transformation)

B) At seven days after spraying (7 DAS)

The data presented in Table 5 and depicted in Fig. 5 indicated that all the treatments were significantly superior over the untreated control in per cent larval reduction of green semilooper at 7DAS. The treatment Quinalphos 25 EC 0.05% was highly significant over all the treatments and recorded maximum per cent larval reduction (83.80%) of green semilooper on soybean. Neem seed extract5% and Neem leaves extract 5% were second in order of merit and found at par with each other

Tobacco leaf eating caterpillar

Green semilooper

Hairy caterpillar

Plate No. 3 Major pests of Soybean

with recording of 59.81 and 47.47 per cent larval reduction. However, these treatments were also significantly superior to the treatments Karanj seed extract 5%, Karanj leaves extract 5%, Rui leaves extract and Ghaneri leaves extract in which 43.30, 37.48, 32.32 and 22.81% larval reduction was observed respectively. Further the treatment with Rui leaves extract 5% and Ghaneri leaves extract 5% were at par with each other recording 32.32 and 22.81 per cent larval reduction.Significantly minimum per cent larval reduction (4.69%) was observed in untreated control.

In case of Quinalphos 25 EC similar results was obtained by Singh and Singh (1988) and in Neem seed extract 5% Raman et al. (2000) found similar results reduction in larval population of green semilooper. Therefore these findings are in agreement with the present data and support the result. But other treatments could not be compared due to want of literature.

C) At fourteen days after spraying (14 DAS)

Data presented in Table 5 and depicted in Fig. 5 all the treatments were significantly superior over untreated control in recording maximum per cent larval reduction of green semilooper at 14 days after first spray. Treatment Quinalphos 25 EC 0.05% was most significantly superior with (66.64) per cent larval reduction of green semilooper. However the treatments Neem seed extract 5%, Neem leaves extract 5%, Karanj seed extract 5% and Karanj leaves extract 5% were at par with each other in which 47.41, 38.93, 36.40, and 30.20 per cent larval reduction respectively. Significantly minimum per cent larval reduction (3.44%) was recorded in untreated control.

In case of Quinalphos 25 EC similar results was noticed by Singh and Singh (1988) and for spray of Neem seed extract and Neem leaves extract Jothi et al. (1991) stated that Neem and pongamia seed extract 2% were recommended for the control of pest. So these findings are analogous to the results of present investigation. While the other treatments could not be compared due to want of literature.

4.1.5 Per cent larval reduction of green semilooper after second spray

A) At three days after spraying (3 DAS)

The data presented in Table 6 and depicted in Fig.6 indicated that all the treatments were significantly superior over untreated control in per cent larval reduction of green semilooper. The treatment Quinalphos 25 EC 0.05% recorded significantly maximum per cent larval reduction (83.36%) and found superior over rest of the treatments. However all the plant extracts such as Neem seed extract 5%, Neem leaves extract 5%, Karanj seed extract 5%, Karanj leaves extract 5%, Rui leave extracts, Ghaneri leaves extract 5% were at par with each other and recording 67.23, 62.85, 61.09, 58.83, 55.72, and 53.60 per cent larval reduction respectively. Whereas the significantly minimum per cent larval reduction (9.33%) was recorded in untreated control.

In present study indicated that Quinalphos 25 EC 0.05% recorded maximum per cent larval reduction also noted by Singh and Singh (1988). In case of Neem seed extract Raman et al. (2000) found similar result in reduction of larval population of green semilooper. So the results of these treatments are companion to the findings of present study but the results of other treatments could not be compared due to want of literature.

Seven days after spraying (7 DAS)

The data presented in Table 6 and depicted in Fig.6 indicated that all the treatments were significantly superior over the untreated control in per cent larval reduction of green semilooper. The treatment Quinalphos 25 EC 0.05% recorded significantly maximum per cent larval reduction (72.26%) and was at par with Neem seed extract 5%, Neem leaves extract 5% and Karanj seed extract 5% in which 60.03, 58.88 and 58.33 per cent larval reduction recorded respectively. These treatments was also significantly superior to the forwarded treatment viz., Karanj seed extract 5%, Karanj leaves extract 5% and Rui leaves extract 5% recording 58.33, 52.19 and 51.95 per cent larval reduction respectively, whereas minimum per cent larval reduction was observed in untreated control (2.47%).

Table 6. Per cent larval reduction of green semilooper after second spray

Tr. No.	Treatment	Dosage (%)	3 DAS	7 DAS	14 DAS
1	*Pongamia pinnata* (Karanj) leaves extract	5	58.83 (50.09)	52.19 (46.26)	46.99 (43.28)
2	*Azadirachta indica* (Neem) leaves extract	5	62.85 (52.45)	58.88 (50.12)	52.23 (46.28)
3	*Calotropis procera* (Rui) leaves extract	5	55.72 (46.29)	51.95 (46.12)	39.74 (39.08)
4	*Lantana camera* (Ghaneri) leaves extract	5	53.60 (47.07)	40.42 (39.48)	37.44 (37.73)
5	Karanj seed extract	5	61.09 (51.41)	58.33 (49.80)	50.03 (45.02)
6	Neem seed extract	5	67.23 (55.08)	60.03 (50.79)	52.28 (46.31)
7	Quinalphos 25 EC	0.05	83.36 (65.93)	72.26 (58.22)	63.93 (53.09)
8	Untreated control		2.62 (9.33)	2.47 (9.06)	2.31 (8.76)
	`F' test		Sig.	Sig.	Sig.
	SE(m)±		2.85	3.41	2.44
	CD at 5%		8.67	10.35	7.40
	CV %		10.41	13.51	10.58

(Figures in parentheses are corresponding values of arc sin transformation)

The study conducted by Singh and Singh (1988) Quinalphos 25 EC 0.05% found maximum per cent larval reduction and Jothi et al. (1991) studied and recommended the application of Neem seed extract 5% and Neem leaves extract 2% for the control of pest. Therefore these findings are compared to the data of present findings.

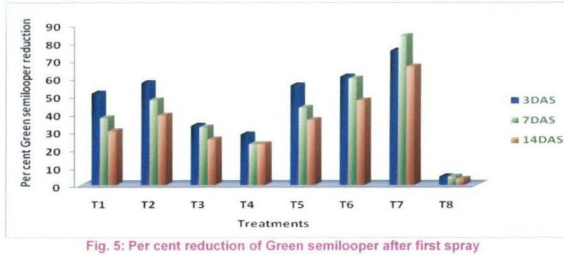


Fig. 5: Per cent reduction of Green semilooper after first spray

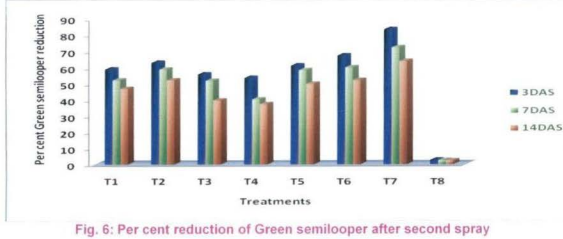


Fig. 6: Per cent reduction of Green semilooper after second spray

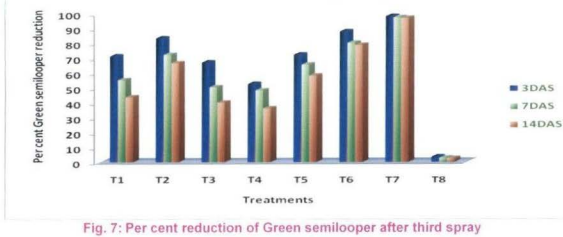


Fig. 7: Per cent reduction of Green semilooper after third spray

T_1 Karanj leaves extract 5%	T_5 Karanj seed extract 5%
T_2 Neem leaves extract 5%	T_6 Neem seed extract 5%
T_3 Rui leaves extract 5%	T_7 Quinolphos 25 EC 0.05
T_4 Ghaneri leaves extract 5%	T_8 Untreated control

C) At fourteen days after spray (14 DAS)

Data presented in Table 6 and depicted in Fig.6 revealed that all the treatment were found significantly superior over untreated control in recording maximum per cent larval reduction at 14 days after second spray.

Amongst all treatments Quinalphos 25 EC 0.05% recorded maximum (63.93) per cent larval reduction of green semilooper and was significantly at par with Neem seed extract 5% and Neem leaves extract 5% in which 52.28 and 52.23 per cent larval reduction were recorded. These treatments were also significantly superior to the forward treatments viz., Karanj seed extract 5%, Karanj leaves extract 5%, Rui leaves extract 5% and Ghaneri leaves extract 5% and recorded 50.03, 46.99, 39.74 and 37.44 per cent larval reduction respectively.

The treatment untreated control was least significant and recorded minimum per cent larval reduction (2.31%).

In Quinalphos 25 EC recorded highest per cent reduction in green semilooper similar findings also reported by Singh and Singh (1988) in respect of per cent larval reduction. While in case of plant products Neem seed extract 5% observations was similar to the findings of Raman et al (2000). So the results are companion with the findings of above investigation and gave support to the data.

4.1.6 Per cent larval reduction of green semilooper after third spray

A) At three days after spraying (3 DAS)

The data presented in Table 7 and depicted in Fig.7 explained that all the treatments were significantly superior over the untreated control in per cent larval reduction of green semilooper. The treatment Quinalphos 25 EC at 0.05% recorded significantly highest per cent larval reduction (98.15%) and was significantly superior over all the treatments. Treatment Neem seed extract 5% was second in order of merit in which 87.91 % larval reduction and was at par with Neem leaves extract 5% and recorded 83.32% larval reduction. The next best treatments Karanj seed extract 5%, Karanj leaves extract 5% and Rui leaves extract were significantly at par with each other and recording 72.23, 71.20 and 67.03 per cent larval reduction at 3 DAS respectively. These treatments were also

significantly superior to Ghaneri leaves extract 5% recorded 52.52% larval reduction. Significantly lowest 3.47 per cent larval reduction was observed in untreated control.

Table 7. Per cent larval reduction of green semilooper after third spray

Tr. No.	Treatment	Dosage (%)	3 DAS	7 DAS	14 DAS
1	*Pongamia pinnata* (Karanj) leaves extract	5	71.20 (57.55)	55.26 (48.02)	43.73 (41.40)
2	*Azadirachta indica* (Neem) leaves extract	5	83.32 (65.90)	72.23 (58.20)	66.64 (54.72)
3	*Calotropis procera* (Rui) leaves extract	5	67.03 (54.96)	50.47 (45.27)	40.11 (39.30)
4	*Lantana camera* (Ghaneri) leaves extract	5	52.52 (46.45)	48.32 (44.04)	36.16 (36.97)
5	Karanj seed extract	5	72.23 (58.20)	65.55 (54.06)	58.18 (49.71)
6	Neem seed extract	5	87.91 (69.66)	80.29 (63.65)	78.80 (62.59)
7	Quinalphos 25 EC	0.05	98.15 (82.20)	97.42 (80.76)	97.00 (80.04)
8	Untreated control		3.47 (10.75)	2.72 (9.51)	2.45 (9.01)
	`F' test		Sig.	Sig.	Sig.
	SE(m)±		3.59	2.95	2.64
	CD at 5%		10.89	8.95	8.03
	CV %		11.16	10.13	9.81

(Figures in parentheses are corresponding values of arc sin transformation)

A similar finding of the presented investigation was also noticed by Singh and Singh (1988) in application of Quinalphos 25 EC against green semilooper. In case of plant products Neem seed extract 5% and Neem leaves extract 5% and Neem leaves extract 5% were the best in per cent reduction in larvae. Similar findings are also companion with the

results by Jothi et al (1995) for controlling of pests and gave strong support to the data of present experiment.

B) At seven days after spraying (7 DAS)

The data presented in Table 7 and exhibited in Fig. 7 indicating that all the treatments were significantly superior over the untreated control in per cent larval reduction of green semilooper. The treatment Quinalphos 25 EC 0.05% recorded significantly maximum per cent larval reduction (97.42%) and found significantly superior over rest of all treatments. The treatment untreated control was least significant and recorded minimum (2.72%) larval reduction.

However Neem seed extract 5% and Neem leaves extract 5% were at par with each other and found second in order of merit with possessing 80.29 and 72.23 per cent larval reduction. The next best groups of the treatments such as Karanj seed extract 5%, Karanj leaves extract 5% and Rui leaves extract 5%were at par with each other and recorded 65.55, 55.26 and 50.47 per cent larval reduction respectively. Whereas from the remaining treatments of plant products, Ghaneri leaves extract 5% was least significant recording 48.32 per cent larval reduction and it was at par with Rui leaves extract and Karanj leaves extract 5% in which 50.47 per cent larval reduction respectively. Significantly minimum per cent larval reduction 2.72% was recorded in untreated control.

In present findings Quinalphos 25 EC 0.05% was similar with the results of Singh and Singh (1988) and in case of Neem seed extract Raman et al (2000), found similar results in reduction of larval population of green semilooper and gave support to the data of present investigation. While the other treatments could not be compared due to want of literature.

C) At fourteen days after spray (14 DAS)

It is evident from the data presented in Table 7 and depicted in Fig.7 that the data was significantly superior over untreated control in recording maximum per cent larval reduction at 14 days after third spray.

Amongst all the treatments Quinalphos 25 EC 0.05% recorded (97.00%) maximum per cent larval reduction of green semilooper and was found significantly superior over all the treatments. In plant products Neem seed extract 5% and Neem leaves extract 5% recorded

78.80 and 66.64 per cent larval reduction, were significantly at par with each other and followed by Karanj seed extract 5%in which 58.18%larval reduction was observed. In next group of treatments Karanj leaves extract 5% was at par with Rui leaves extract 5% and Ghaneri leaves extract 5% and recorded 43.73, 40.11 and 36.16 per cent larval reduction respectively.

Significantly minimum per cent larval reduction 2.45% was recorded in untreated control.

Similar trend of the results was observed at 14 DAS in per cent larval reduction as recorded in 3 and 7 DAS. The maximum per cent larval reduction was observed in Quinalphos 25 EC in present investigation and was similar to the findings reported by Singh and Singh (1988).

In case of Neem seed extract and Neem leaves extract Jothi et al (1991) stated Neem and Karanj seed extract 2% were effective and recommended for the control of the soybean pests and support the data. While the other treatments could not compared due to want of literature.

4.1.7 Per cent larval reduction of hairy caterpillar after first spray

A) At three days after spraying (3 DAS)

The data presented in Table 8 and depicted in Fig. 8 indicated that all the treatments were significantly superior over the untreated control in per cent larval reduction of hairy caterpillar. The treatment Quinalphos 25 EC recorded significantly highest (80.72) per cent larval reduction and was at par with Neem seed extract 5% recording 75.55% larval reduction.

However Neem leaves extract 5% recording 67.26% larval reduction and was at par with former treatment Neem seed extracts 5%. Whereas the remaining treatments of plant products Karanj seed extract 5%, Karanj leaves extract 5%, Rui leaves extract 5% and Ghaneri leaves extract 5% were third in order of merit and recording 60.75, 59.31, 50.48 and 48.86 per cent larval reduction respectively. Significantly minimum per cent larval reduction 8.00% was recorded in untreated control.

Quinalphos 25 EC 0.05% recorded highest per cent larval reduction of hairy caterpillar at 3 DAS of first application and in plant products Neem seed extract 5% and Neem leaves extract 5% exhibited highest % larval reduction than others. But it could not be compare due to want of literature.

Table 8. Per cent larval reduction of hairy caterpillar after first spray

Tr. No.	Treatment	Dosage (%)	3 DAS	7 DAS	14 DAS
1	*Pongamia pinnata* (Karanj) leaves extract	5	59.31 (50.37)	48.51 (44.15)	35.64 (37.66)
2	*Azadirachta indica* (Neem) leaves extract	5	67.26 (55.10)	56.47 (48.72)	41.14 (39.90)
3	*Calotropis procera* (Rui) leaves extract	5	50.48 (45.28)	47.27 (43.44)	33.77 (35.53)
4	*Lantana camera* (Ghaneri) leaves extract	5	48.86 (44.35)	44.73 (41.98)	34.83 (36.17)
5	Karanj seed extract	5	60.75 (51.21)	50.27 (45.16)	39.31 (38.83)
6	Neem seed extract	5	75.55 (60.37)	57.63 (49.39)	43.16 (41.07)
7	Quinalphos 25 EC	0.05	80.72 (63.96)	78.76 (62.56)	63.83 (53.03)
8	Untreated control		8.00 (16.44)	6.90 (15.24)	7.06 (15.42)
	'F' test		Sig.	Sig.	Sig.
	SE(m)±		2.54	2.80	2.55
	CD at 5%		7.73	8.51	7.74
	CV %		9.12	11.09	11.89

(Figures in parentheses are corresponding values of arc sin transformation)

B) At seven days after spraying (7 DAS)

From the data presented in Table 8 and depicted in Fig. 8 expressed that all the treatments were significantly superior over the untreated control in per cent larval reduction of hairy caterpillar. The treatment Quinalphos 25 EC 0.05% recorded significantly highest (78.76) per cent larval reduction and found significantly superior over all the treatments.

However all the plant products viz., Neem seed extract 5% ,Neem leaves extract 5%, Karanj seed extract, Karanj leaves extract 5%, Rui leaves extract 5% and Ghaneri leaves extract 5% were significantly at par with each other and recorded 57.63, 56.47, 50.27, 47.27 and 44.73 per cent larval reduction respectively. Whereas the minimum (6.90) per cent larval reduction was observed in untreated control.

The results of the present investigations could not be compared due to unavailability of literature.

C) At fourteen days after spraying (14 DAS)

It is evident from the data exhibited in Table 8 and depicted in Fig. 8. explained that all the treatments were significantly superior over untreated control in recording maximum per cent larval reduction at 14 days after first spray.

Treatment Quinalphos 25 EC recorded maximum (63.83) per cent larval reduction of hairy caterpillar and it found significantly superior to rest of the treatments. Similar trend of the results of 14 DAS was also noticed in 7 DAS. All the treatments of plant products, such as Neem seed extract 5%, Neem leaves extract 5%, Karanj seed extract 5%, Karanj leaves extract 5%, Rui leaves extract 5% and Ghaneri leaves extract 5% were at par with each other and recording 43.16, 41.14, 39.31, 35.64, 33.77 and 34.83 per cent larval reduction respectively. While the minimum 7.06 per cent larval reduction was recorded in untreated control.

The above results could not be discussed for the want of literature.

4.1.8 Per cent larval reduction of hairy caterpillar after second spray

A) At three days after spraying (3 DAS)

The data presented in Table 9 and depicted in Fig. 9 revealed that all the treatments were significantly superior over untreated control in per cent larval reduction of hairy caterpillar. At 3 DAS second spray of Quinalphos 25 EC 0.05% recorded significantly maximum (81.56) per cent larval reduction and was significantly superior over all treatments.

Table 9. Per cent larval reduction of hairy caterpillar after second spray

Tr. No.	Treatment	Dosage (%)	3 DAS	7 DAS	14 DAS
1	*Pongamia pinnata* (Karanj) leaves extract	5	60.29 (50.94)	48.27 (44.01)	47.59 (43.62)
2	*Azadirachta indica* (Neem) leaves extract	5	62.68 (52.35)	60.27 (50.93)	55.50 (48.16)
3	*Calotropis procera* (Rui) leaves extract	5	52.05 (46.18)	46.61 (43.06)	46.35 (42.91)
4	*Lantana camera* (Ghaneri) leaves extract	5	49.35 (44.63)	40.32 (39.42)	39.34 (38.85)
5	Karanj seed extract	5	61.65 (51.74)	54.74 (47.72)	47.67 (43.67)
6	Neem seed extract	5	66.62 (54.71)	66.17 (54.44)	60.31 (50.95)
7	Quinalphos 25 EC	0.05	81.56 (64.57)	76.54 (61.03)	66.39 (54.57)
8	Untreated control		3.92 (11.42)	2.09 (8.32)	2.09 (8.32)
	`F' test		Sig.	Sig.	Sig.
	SE(m)±		2.99	2.70	2.58
	CD at 5%		9.09	8.19	7.83
	CV %		11.03	10.72	10.81

(Figures in parentheses are corresponding values of arc sin transformation)

However from the plant products viz., Neem seed extract 5% Neem leaves extract 5%, Karanj seed extract 5%, Karanj leaves extract 5% and Rui leaves extract 5% were first in superiority and found significantly at par with each other in which 66.62, 62.68, 61.65, 60.29 and 52.05 per cent larval reduction respectively. However Ghaneri leaves extract 5% was least significant recording 49.35% larval reduction and was at par with former treatment Rui leaves extract; Karanj leaves extract, Karanj seed extract and Neem leaves extract 5% respectively.

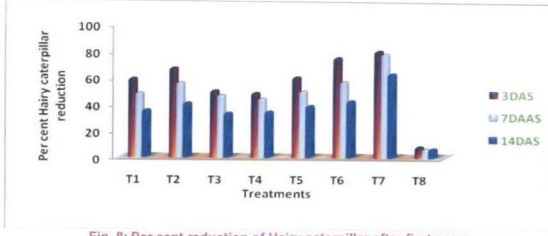


Fig. 8: Per cent reduction of Hairy caterpillar after first spray

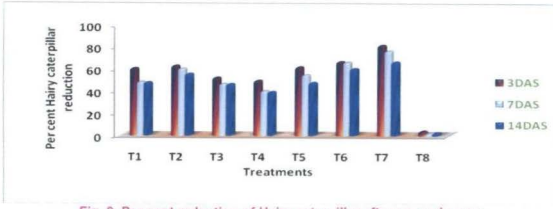


Fig. 9: Per cent reduction of Hairy caterpillar after second spray

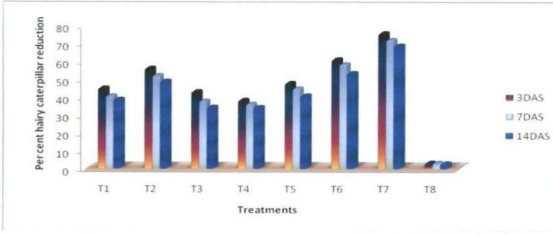


Fig. 10: Per cent reduction of Hairy caterpillar after third spray

T_1 Karanj leaves extract 5%	T_5 Karanj seed extract 5%
T_2 Neem leaves extract 5%	T_6 Neem seed extract 5%
T_3 Rui leaves extract 5%	T_7 Quinolphos 25 EC 0.05
T_4 Ghaneri leaves extract 5%	T_8 Untreated control

Significantly minimum per cent larval reduction 3.92% was recorded in untreated control.

Results of the present investigation on management of hairy caterpillar could not be compared due to unavailability of literature.

B) At seven days after spraying (7 DAS)

The data presented in Table 9 and depicted in Fig.9 that all the treatments were significantly superior over the untreated control in per cent larval reduction of hairy caterpillar. The treatment Quinalphos 25 EC 0.05% recorded significantly maximum (76.54) per cent larval reduction and was at par with Neem seed extract in which 66.17% larval reduction was recorded.

The next significantly effective group of treatments such as Neem leaves extract 5%, Karanj seed extract 5%, Karanj leaves extract 5% and Rui leaves extract at 5% water extract were at par with each other and recording 60.27, 54.74, 48.27,and 46.61 per cent larval reduction. However the treatments were also significantly superior to Ghaneri leaves extract in which 40.32% larval reduction was observed.

Significantly minimum per cent larval reduction 2.09% was recorded in untreated control.

The above results of the present experiment on per cent larval reduction of hairy caterpillar could not be compared due to unavailability of literature on hairy caterpillar.

C) At fourteen days after spraying (14 DAS)

It is evident from the data presented in Table 9 and depicted in Fig. 9 explained that all the treatments were found significantly superior over untreated control in recording maximum per cent larval reduction at 14 days after second spray.

Amongst all the treatments Quinalphos 25 EC 0.05% recorded significantly maximum (66.39) per cent larval reduction of hairy caterpillar and was at par with Neem seed extract 5% and Neem leaves extract 5% in which 60.31 and 55.50 per cent larval reduction was recorded. However the Karanj seed extract 5%, Karanj leaves extract 5%, Rui leaves extract 5% and Ghaneri leaves extract 5% were second in order of merit and found at par with each other in which 47.67, 47.59, 46.35 and 39.34

per cent larval reduction was recorded respectively. Amongst these treatments Rui leaves extract 5% were at par with the former treatment viz., Karanj leaves extract 5%, Karanj seed extract 5% and Neem leaves extract 5% respectively. Significantly minimum per cent larval reduction 2.09% was recorded in untreated control.

But this result of the present investigation could not be compare due to unavailability of literature on management of hairy caterpillar through botanicals.

4.1.9 Per cent larval reduction of hairy caterpillar after third spray

A) At three days after spraying (3 DAS)

The data presented in Table 10 and depicted in Fig. 10 indicated that all the treatments were significantly superior over the untreated control in per cent larval reduction of hairy caterpillar at 3 DAS. The treatment Quinalphos 25 EC 0.05% recorded significantly maximum (75.46) per cent larval reduction and was at par with Neem seed extract 5% in which 60.90 per cent larval reduction was observed.

The next best treatments were, Neem leaves extract 5%, Karanj seed extract 5% and Karanj leaves extract 5% and Rui leaves extract 5% were recorded 55.83, 47.64, 44.84 and 42.92 per cent larval reduction and at par with each other. The treatment Ghaneri leaves extract 5% was least significant and recorded 38.12% larval reduction. Whereas the significantly minimum per cent larval reduction 3.10% was recorded in untreated control.

In present investigation Quinalphos 25 EC was best in recording maximum per cent larval reduction due to application of Quinalphos 25 EC 0.05% and in plant products Neem seed extracts and Neem leaves extracts were best in recording maximum per cent of larval reduction. But it could not be discussed due to want of literature.

Table 10. Per cent larval reduction of hairy caterpillar after third spray

Tr. No.	Treatment	Dosage (%)	3 DAS	7 DAS	14 DAS
1	*Pongamia pinnata* (Karanj) leaves extract	5	44.84 (42.04)	40.54 (39.55)	38.59 (38.41)
2	*Azadirachta indica* (Neem) leaves extract	5	55.83 (48.35)	51.91 (46.10)	48.81 (44.32)
3	*Calotropis procera* (Rui) leaves extract	5	42.92 (40.93)	37.68 (37.87)	34.28 (35.84)
4	*Lantana camera* (Ghaneri) leaves extract	5	38.12 (38.13)	36.03 (36.89)	34.21 (34.80)
5	Karanj seed extract	5	47.64 (43.65)	44.70 (41.96)	40.76 (39.68)
6	Neem seed extract	5	60.90 (51.30)	58.21 (49.73)	53.31 (46.90)
7	Quinalphos 25 EC	0.05	75.46 (60.31)	71.77 (57.91)	68.60 (55.92)
8	Untreated control		3.10 (10.15)	3.10 (10.15)	2.84 (9.71)
	`F' test		Sig.	Sig.	Sig.
	SE(m)±		3.11	2.83	3.02
	CD at 5%		9.43	8.60	9.17
	CV %		12.87	12.28	13.71

(Figures in parentheses are corresponding values of arc sin transformation)

B) At seven days after spraying (7 DAS)

The data presented in Table 10 and depicted in Fig.10 indicated that all the treatments were significantly superior over the untreated control in per cent larval reduction of hairy caterpillar. The treatment Quinalphos 25 EC 0.05% was most significantly superior over all the treatments and recorded maximum (71.77) per cent larval reduction. It was also found at par with Neem seed extract 5% in which 58.21 per cent larval reduction was observed.

The next best treatments Neem leaves extract 5% in which 51.91 % larval reduction was recorded and it significantly superior to the forward treatment Karanj seed extract 5%, Karanj leaves extract 5%, Rui leaves extract 5% and Ghaneri leaves extract 5% in which 44.70, 40.54, 37.68 and 36.03 per cent larval reduction was recorded respectively and were at par with each other. Significantly minimum per cent larval reduction 3.10% was recorded in untreated control.

But the present findings could not be compare due to want of literature.

C) At fourteen days after spraying (14 DAS)

From the data presented in Table 10 and depicted in Fig. 10 that all the treatments were significantly superior over untreated control in recording maximum per cent larval reduction at 14 days after third spray.

Significantly maximum (68.60%) larval reduction of hairy caterpillar was observed due to application of Quinalphos 25 EC 0.05% and was at par with Neem seed extract in which 53.31% larval reduction was observed. The next best treatments viz., Neem leaves extract 5%, Karanj seed extract 5% and Karanj leaves extract 5% and Rui leaves extract 5% recording 48.81, 40.76, 38.59 and 34.28 per cent larval reduction respectively and found significantly at par with each other. However these treatments were also significantly superior to Ghaneri leaves extract 5% and untreated control in which 34.21 and 2.84% larval reduction were observed. Significantly minimum per cent larval reduction 2.84% was recorded in untreated control.

Above results could not be discussed due to want of literature.

4.2 Effect of different treatments on average population of natural enemy

4.2.1 Effects of different treatments on average population of lady bird beetle after first spray

A) At three days after spray (3 DAS)

The data presented in Table 11 indicate that all the treatments did not affect the population of lady bird beetle. Amongst the various treatments maximum population (10.65/5 plants) of lady bird beetle other than untreated control was found in Ghaneri leaves extract 5%

followed by Rui leaves extract 5%, Karanj leaves extract 5% and Karanj seed extract 5% and Neem leaves extract 5% in which 8.70, 8.33, 7.83 and 6.69 average population of lady bird beetle was recorded. Further treatments viz., Neem seed extract and Quinalphos 25 EC 0.05% shows minimum population of lady bird beetle i.e. 5.15 and 4.55 /5 plants.

In case of Neem seed extract, a similar result was observed by Ahmed et al. (2003) and reported Neem seed extract sprayed on eggs of *Chrysoperla carnea* and *Coccinella sexmaculata* reduced hatching percentage and gave support to the present data.

Table 11. Effect of different treatments on average population of lady bird beetle after first spray

Tr. No.	Treatment	Average population of LBB/5plants		
		3 DAS	7 DAS	14 DAS
1	*Pongamia pinnata* (Karanj) leaves extract	8.33 (2.87)	8.55 (2.91)	9.25 (3.03)
2	*Azadirachta indica* (Neem) leaves extract	6.69 (2.57)	7.09 (2.65)	8.03 (2.82)
3	*Calotropis procera* (Rui) leaves extract	8.70 (2.94)	9.66 (3.10)	10.02 (3.16)
4	*Lantana camera* (Ghaneri) leaves extract	9.72 (3.11)	10.14 (3.18)	11.17 (3.33)
5	Karanj seed extract	7.83 (2.78)	8.01 (2.82)	8.50 (2.90)
6	Neem seed extract	5.15 (2.27)	5.67 (2.28)	6.10 (2.46)
7	Quinalphos 25 EC	4.55 (2.12)	4.70 (2.16)	4.18 (2.04)
8	Untreated control	10.65 (3.25)	11.11 (3.33)	12.10 (3.47)
	'F' test	Sig.	Sig.	Sig.
	SE(m)±	0.17	0.16	0.18
	CD at 5%	0.53	0.48	0.54
	CV %	11.20	9.79	10.71

(Figures in parentheses are square root transformation values)

Whereas in case of Ghaneri leaves extract, similar results was observed by Patel et al. (2003) and reported that in *L. camera* treated plot shows maximum number of predator other than control. Therefore

these findings support the data of present investigation. Rest of the treatments could not compare due to want of literature.

B) At seven days after spraying (7 DAS)

The data presented in Table 11 indicate that all the treatments did not affect the population of lady bird beetle. However, among the various treatments significantly maximum population of lady bird beetle (10.14/5 plants) other than control was found in Ghaneri leaves extract 5% followed by Rui leaves extract 5%, Karanj leaves extract 5% and Karanj seed extract 5%. Further treatments viz., Neem leaves extract, Neem seed extract and Quinalphos 25 EC shows minimum population of lady bird beetle and were at par with each other. Quinalphos 25 EC shows minimum population of lady bird beetle (4.70).

In case of Neem seed extract and Neem leaves extract similar results were reported by Innacone and Lamas (2003) and they stated that parasitoid *T. pintoi* sensitive to Neem formulation and recorded more mortality at higher dose.

In case of Ghaneri leaves extract similar results were reported by Burman et al. (2003) they reported that significantly higher number of parasitoids emerged from the plant extract treated trichocards as against cards treated with Quinalphos 25 EC.

Therefore this finding gives support to the data of present investigation. But these findings could not be compared due to want of literature on lady bird beetle.

C) At fourteen days after spraying (14 DAS)

The data presented in Table 11 indicate that all the treatments, did not affect the population of lady bird beetle. However, among the various treatments maximum population (11.17/5 plants) of lady bird beetle other than control was found in Ghaneri leaves extract 5% and it was at par with Rui leaves extract 5%, Karanj leaves extract 5%, Karanj seed extract 5% and Neem leaves extract 5% and they were found significantly superior to treatments Neem seed extract 5% and Quinalphos 25 EC in which 6.10 and 4.18 lady bird beetle population was observed.

In the study conducted by Ahmed et al. (2003) reported that Neem seed extract sprayed on eggs of *C.carnea* and *C.sexmaculata* and

observed reduction in hatching percentage of eggs i.e. it express the ovicidal activity.

Whereas in case of Ghaneri leaves extract reported by Patel et al. (2003) they found that in *L. camera* treated plot showed number of predator was good as that found in control.

Hence the results of the present findings are analogues to the results of above scientist and gave support to the data. While the other treatments could not compare due to want of literature.

4.2.2 Effects of different treatments on average population of lady bird beetle after second spray

A) At three days after spray (3 DAS)

The data presented in table 12 indicate that all the treatments did not affect the population of lady bird beetle. However among the different treatments maximum population (7.12/5 plants) of lady bird beetle other than control was found in Ghaneri leaves extract 5% and found at par with Rui leaves extract 5%, Karanj leaves extract 5%, Karanj seed extract 5% and Neem leaves extract 5%. Whereas minimum population of lady bird beetle was recorded in Neem seed extract 5% (4.60/5plants) and Quinalphos 25 EC (3.66/5plants).

In the study conducted by Ahmed et al. (2003) reported that Neem seed extract sprayed on eggs of *C.carnea* and *C.sexmaculata* and observed reduction in hatching percentage of eggs i.e. it express the ovicidal activity.

In case of Ghaneri leaves extract similar results were reported by Burman et al. (2003) they reported that, significantly higher number of parasitoids emerged from the plant extract treated trichogramma cards as against cards treated with Quinalphos 25 EC.

Therefore this finding gives support to the data and present investigation. While in case of other treatment could not be compare due to want of literature.

Table 12. Effect of different treatments on average population of lady bird beetle after second spray

Tr. No.	Treatment	Average population of LBB/5plants		
		3 DAS	7 DAS	14 DAS
1	*Pongamia pinnata* (Karanj) leaves extract	5.37 (2.31)	5.31 (2.29)	6.07 (2.46)
2	*Azadirachta indica* (Neem) leaves extract	4.91 (2.21)	5.01 (2.23)	5.63 (2.37)
3	*Calotropis procera* (Rui) leaves extract	6.02 (2.45)	5.88 (2.42)	6.31 (2.51)
4	*Lantana camera* (Ghaneri) leaves extract	7.12 (2.66)	6.96 (2.62)	7.03 (2.64)
5	Karanj seed extract	5.13 (2.26)	5.23 (2.28)	5.87 (2.41)
6	Neem seed extract	4.60 (2.13)	4.58 (2.13)	5.18 (2.27)
7	Quinalphos 25 EC	3.66 (1.90)	3.84 (1.95)	4.06 (2.01)
8	Untreated control	8.35 (2.87)	7.51 (2.74)	7.84 (2.80)
	'F' test	Sig.	Sig.	Sig.
	SE(m)±	0.17	0.15	0.13
	CD at 5%	0.50	0.46	0.41
	CV %	12.37	11.27	9.62

(Figures in parentheses are square root transformation values)

Seven days after spraying (7 DAS)

The data presented in Table 12 indicate that all treatments did not affect the population of lady bird beetle. However, among the different treatments maximum population of lady bird beetle other than control was found in Ghaneri leaves extract 5% (6.96/5plants) and was at par with Rui leaves extract 5%(5.88/5plants),Karanj leaves extract 5% (5.31/5plants), Karanj seed extract 5% (5.23/5plants) Neem leaves extract 5% in which maximum population of lady bird beetle were recorded. Treatments Quinalphos 25 EC 0.05% shows minimum population of lady

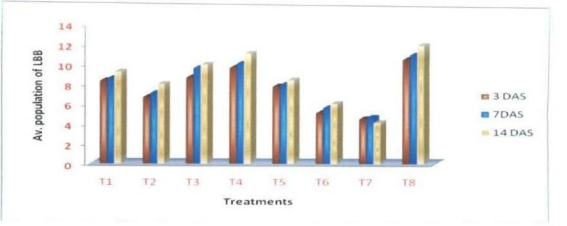


Fig. 11: Average population of Lady bird beetle after first spray

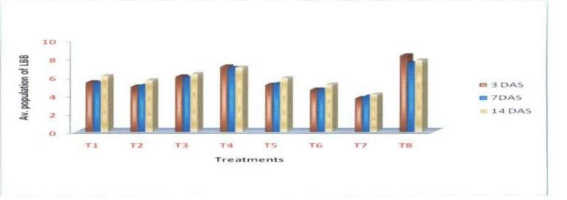


Fig. 12: Average population of Lady bird beetle after second spray

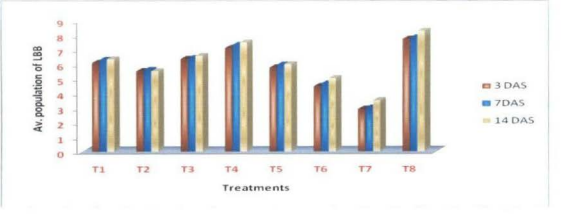


Fig. 13: Average population of Lady bird beetle after third spray

T_1 Karanj leaves extract 5%	T_5 Karanj seed extract 5%
T_2 Neem leaves extract 5%	T_6 Neem seed extract 5%
T_3 Rui leaves extract 5%	T_7 Quinolphos 25 EC 0.05
T_4 Ghaneri leaves extract 5%	T_8 Untreated control

bird beetle (3.84/5plants) and was at par with Neem seed extract 5% in which 4.58/5plants population was observed.

In case of Neem seed extract similar results was found by Patel et al. (2003) they reported that in *L. camera* treated plot number of predator was found as that found in control. In case of Neem seed extract, similar results were found by Ahmed et al. (2003) they reported Neem seed extract sprayed on eggs of *C.carnea* and *C.sexmaculata* reduced hatching percentage.

Hence these findings are in agreement with the results of present investigation and gave strong support to the present data. While the other treatments could not be compared due to want of literature.

C) At fourteen days after spraying (14 DAS)

The data presented in Table 12 indicate that all the treatments did not affect the population of lady bird beetle. However, among the different treatments maximum population of lady bird beetle other than control was found in Ghaneri leaves extract 5% (7.03/5plants) and was at par with Rui leaves extract 5%,Karanj leaves extract 5%, Karanj seed extract 5%,Neem leaves extract 5% and Neem seed extract 5% in which maximum population of lady bird beetle was recorded. The treatment Quinalphos 25 EC at 0.05% shows minimum population of lady bird beetle (4.06/5plants).

In case of Neem seed extract, similar results were found by Ahmed et al. (2003) they reported Neem seed extract sprayed on they reported Neem seed extract sprayed on eggs of *C. carnea* and *C. sexmaculata* reduced hatching percentage.

In case of Ghaneri leaves extract similar result, was found by Patel et al. (2003) they reported that in *L. camera* treated plot number of predator was found as that found in control.

Hence it supports the present data while the other treatments could not be compared due to want of literature.

4.2.3 Effects of different treatments on average population of lady bird beetle after third spray

A) At three days after spray (3 DAS)

The data presented in Table 13 indicate that all the treatments did not affect the population of lady bird beetle. However, among the different treatments maximum population of lady bird beetle other than control was found in Ghaneri leaves extract 5% (7.12/5plants) was at par with Rui leaves extract 5%, Karanj leaves extract 5%, Karanj seed extract 5% and Neem leaves extract 5% in which maximum population of lady bird beetle was recorded. Amongst further treatments, Quinalphos 25 EC at 0.05% shows minimum population of lady bird beetle (2.92/5plants).

Table 13. Effect of different treatments on average population of lady bird beetle after third spray

Tr. No.	Treatment	Average population of LBB/5 plant		
		3 DAS	7 DAS	14 DAS
1	*Pongamia pinnata* (Karanj) leaves extract	6.10 (2.47)	6.30 (2.51)	6.35 (2.52)
2	*Azadirachta indica* (Neem) leaves extract	5.52 (2.34)	5.60 (2.36)	5.52 (2.35)
3	*Calotropis procera* (Rui) leaves extract	6.37 (2.52)	6.42 (2.53)	6.58 (2.56)
4	*Lantana camera* (Ghaneri) leaves extract	7.12 (2.65)	7.33 (2.69)	7.51 (2.73)
5	Karanj seed extract	5.77 (2.39)	5.96 (2.42)	6.00 (2.43)
6	Neem seed extract	4.48 (2.11)	4.66 (2.15)	5.04 (2.24)
7	Quinalphos 25 EC	2.92 (1.69)	3.00 (1.72)	3.52 (1.86)
8	Untreated control	7.74 (2.78)	7.83 (2.80)	8.30 (2.83)
	'F' test	Sig.	Sig.	Sig.
	SE(m)±	0.13	0.13	0.12
	CD at 5%	0.41	0.41	0.38
	CV %	9.93	9.86	9.03

(Figures in parentheses are square root transformation values)

In case of Neem seed extract and Neem leaves extract similar result, were reported by Innacone and Lamas (2003) they stated that parasitoid *T. pintoi* sensitive to Neem formulation and recorded more mortality at higher dose.

In case of Ghaneri leaves extract similar results were reported by Burman *et al.* (2003) they reported that significantly higher number of parasitoids emerged from the plant extract treated trichogrmama cards as against cards treated with Quinalphos 25 EC. Therefore they support the data of present findings.

B) At seven days after spraying (7DAS)

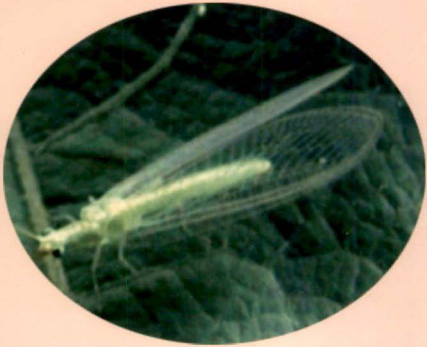
The data presented in Table 13 indicate that all the treatments did not affect the population of lady bird beetle. However, among the various treatments maximum population of lady bird beetle other than untreated control was found in Ghaneri leaves extract 5%and was at par with Rui leaves extract 5%, Karanj leaves extract 5%, Karanj seed extract 5% and Neem leaves extract 5% in which maximum population of lady bird beetle was recorded. While in the remaining treatments Quinalphos 25 EC 0.05% shows minimum population of lady bird beetle (3.00/5plants) and it was at par with Neem seed extract 5% (4.66/5plants). But the results of the present findings could not be compare due to unavailability of literature.

C) At fourteen days after spraying (14 DAS)

The data presented in Table 13 indicate that all the treatments did not affect the population of lady bird beetle. However, among the different treatments maximum population of lady bird beetle other than control was found in Ghaneri leaves extract 5%(7.51/5plants) and was at par with Rui leaves extract 5%, Karanj leaves extract 5%, Karanj seed extract 5% and Neem leaves extract 5% in which maximum population of lady bird beetle was recorded. From the remaining treatment Quinalphos 25 EC at 0.05% shows minimum population of lady bird beetle (3.52/5plants) and found at par with Neem seed extract 5% in which 5.04/5plants population of lady bird beetle was recorded.

But the findings of present investigation could not be compared due to want of literature.

Lady bird beetle



Chrysopa

Plate No. 4 Natural enemies on soybean

4.2.4 Effects of different treatments on average population of Chrysopa after first spraying

A) At three days after spray (3 DAS)

The data presented in Table 14 indicate that all the treatments did not affect the population of chrysopa. However, among the various treatments maximum population of chrysopa other than control was found in Ghaneri leaves extract 5%, Rui leaves extract 5%, Karanj leaves extract 5% and Karanj seed extract 5% were recorded maximum population of chrysopa. Whereas in treatment Quinalphos 25 EC at 0.05% shows lowest population of chrysopa (1.00).

Table 14. Effect of different treatments on average population of chrysopa after first spray

Tr. No.	Treatment	Average population of chrysopa/5plant		
		3 DAS	7 DAS	14 DAS
1	*Pongamia pinnata* (Karanj) leaves extract	2.96 (1.49)	2.36 (1.52)	2.22 (1.47)
2	*Azadirachta indica* (Neem) leaves extract	1.65 (1.28)	1.70 (1.30)	1.75 (1.32)
3	*Calotropis procera* (Rui) leaves extract	2.31 (1.47)	2.47 (1.57)	2.50 (1.53)
4	*Lantana camera* (Ghaneri) leaves extract	2.43 (1.55)	2.58 (1.59)	2.63 (1.61)
5	Karanj seed extract	1.93 (1.36)	1.95 (1.37)	1.98 (1.38)
6	Neem seed extract	1.23 (1.10)	1.47 (1.20)	1.54 (1.24)
7	Quinalphos 25 EC	1.00 (0.80)	1.23 (1.10)	1.33 (1.15)
8	Untreated control	3.98 (1.99)	4.15 (2.03)	4.22 (2.05)
	`F' test	Sig.	Sig.	Sig.
	SE(m)±	0.20	0.15	0.15
	CD at 5%	0.63	0.45	0.47
	CV %	25.96	17.61	18.26

(Figures in parentheses are square root transformation values)

In case of Neem seed extract, similar results were found by Ahmed et al. (2003) they reported Neem seed extract sprayed on they reported Neem seed extract sprayed on eggs of *Chrysoperla carnea* and *C. sexmaculata* reduced hatching percentage.

In case of Ghaneri leaves extract similar results was found by Patel et al. (2003) they reported that in *L. camera* treated plot number of predator was good as that found in control.

While the other treatments could not be compared due to want of literature.

B) At seven days after spraying (7 DAS)

The data presented in Table 14 indicates the similar trend of results of Table 12 at 3 DAS the treatments did not affect the population of Chrysopa. The maximum population (2.58/5plants) of chrysopa other than control was found in Ghaneri leaves extract 5%, Rui leaves extract 5%, Karanj leaves extract 5%, Karanj seed extract 5% and Neem leaves extract 5 % in which maximum population of Chrysopa was observed. In case of Quinalphos 25 EC at 0.05% shows minimum population of chrysopa.

Similar results were also reported by Innacone and Lamas (2003) they stated that parasitoid *T. pintoi* sensitive to Neem formulation and recorded more mortality at higher dose.

In case of Ghaneri leaves extract Burman et al. (2003) they reported that significantly higher number of parasitoid emerged from the plant extract treated trichocards as against card treated with Quinalphos 25 EC. But these findings could not be compared due to want of literature on Chrysopa.

C) At fourteen days after spraying (14 DAS)

The data presented in Table 14 indicate that all the treatments did not affect the population of chrysopa. However, among the various treatments maximum population of chrysopa other than control was found in Ghaneri leaves extract 5%.and was at par with Rui leaves extract 5%, Karanj leaves extract 5%, Karanj seed extract 5% and Neem leaves extract 5% in which maximum population of Chrysopa was recorded.

While the treatments Quinalphos 25 EC at 0.05% shows minimum population of Chrysopa (1.33)

In case of Ghaneri leaves extract similar results was found by Patel et al. (2003) they reported that in *L. camera* treated plot number of predator was good as that fond in control.

But the results of other treatments could not be compared due to want of literature.

4.2.5 Effects of different treatments on average population of Chrysopa after second spraying

A) At three days after spray (3 DAS)

The data presented in Table 15 indicate that all the treatments did not affect the population of chrysopa. However, among the various treatments maximum population of chrysopa other than control was found in Ghaneri leaves extract 5% (2.48/5plants) and was at par with Rui leaves extract 5%, Karanj leaves extract 5%, Karanj seed extract 5% and Neem seed extract 5% in which maximum population of Chrysopa was observed. While the Chrysopa population in Quinalphos 25 EC 0.05% shows minimum population of Chrysopa (1.23/5plants).

In case of Ghaneri leaves extract similar results was found by Patel et al. (2003) they reported that in *L. camera* treated plot, number of predator was good as that found in control. So this finding could support the present data. While other treatments could not be compared due to want of literature.

B) At seven days after spraying (7 DAS)

The data presented in Table 15 indicate that all the treatments did not affect the population of chrysopa. However among the various treatments maximum population of chrysopa other than control was found in Ghaneri leaves extract 5% (2.53/5plants) and was at par with Rui leaves extract 5%, Karanj leaves extract 5%, Karanj leaves extract 5% and Neem leaves extract 5% recorded maximum population of chrysopa.

Table 15. Effect of different treatments on average population of chrysopa after second spray

Tr. No.	Treatment	Average population of chrysopa/5 plants		
		3 DAS	7 DAS	14 DAS
1	*Pongamia pinnata* (Karanj) leaves extract	2.02 (1.39)	1.98 (1.38)	2.17 (1.44)
2	*Azadirachta indica* (Neem) leaves extract	1.61 (1.27)	1.70 (1.30)	1.85 (1.36)
3	*Calotropis procera* (Rui) leaves extract	2.22 (1.45)	2.14 (1.43)	2.33 (1.49)
4	*Lantana camera* (Ghaneri) leaves extract	2.48 (1.57)	2.53 (1.58)	2.63 (1.61)
5	Karanj seed extract	1.83 (1.33)	1.85 (1.35)	1.96 (1.38)
6	Neem seed extract	1.50 (1.22)	1.43 (1.18)	1.61 (1.26)
7	Quinalphos 25 EC	1.23 (1.10)	1.18 (1.08)	1.33 (1.15)
8	Untreated control	3.74 (1.93)	3.67 (1.91)	3.94 (1.98)
	`F' test	Sig.	Sig.	Sig.
	SE(m)±	0.15	0.14	0.14
	CD at 5%	0.45	0.43	0.43
	CV %	18.41	17.61	17.05

(Figures in parentheses are square root transformation values)

Whereas the treatments Quinalphos 25 EC at 0.05% shows minimum population of chrysopa (1.18/5plants).

But the data of the present findings could not be compared due to unavailability of literature.

C) At fourteen days after spraying (14 DAS)

The data presented in Table 15 indicate that all the treatments did not affect the population of chrysopa. However among the various treatments maximum population of chrysopa other than control was found in Ghaneri leaves extract 5% (2.63/5plants) and it was at par with Rui leaves extract 5%, Karanj leaves extract 5%, Karanj seed extract 5% and Neem leaves extract 5% recorded maximum population of chrysopa.

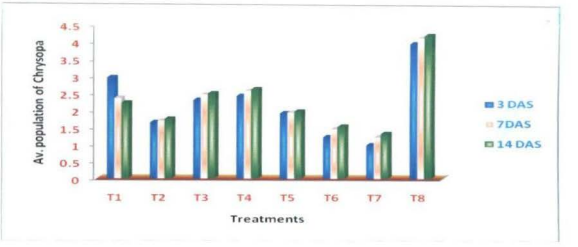


Fig. 14: Average population of Chrysopa after first spray

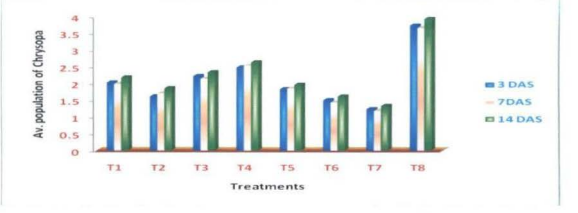


Fig. 15: Average population of Chrysopa after second spray

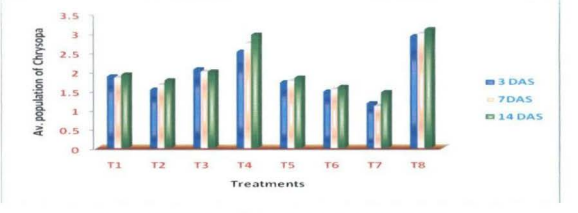


Fig. 16: Average population of Chrysopa after third spray

T_1 Karanj leaves extract 5%	T_5 Karanj seed extract 5%
T_2 Neem leaves extract 5%	T_6 Neem seed extract 5%
T_3 Rui leaves extract 5%	T_7 Quinolphos 25 EC 0.05
T_4 Ghaneri leaves extract 5%	T_8 Untreated control

Whereas the treatments Quinalphos 25 EC at 0.05% shows minimum population of chrysopa (1.33/5plants)

But the results of the present findings could not be compared due to unavailability of literature.

4.2.6 Effects of different treatments on average population of Chrysopa after third spraying

A) At three days after spraying (3 DAS)

The data presented in Table 16 indicate that all the treatments did not affect the population of Chrysopa. However among the different treatment maximum population of Chrysopa other than control was found in Ghaneri leaves extract 5% (2.52/5plants) and was at par with Rui leaves extract 5%, Karanj leaves extract 5%, Karanj seed extract 5% and Neem leaves extract 5% in which maximum population of Chrysopa was recorded.

Table 16. Effect of different treatments on average population of Chrysopa after third spray

Tr. No.	Treatment	Average population of Chrysopa/5 plant		
		3 DAS	7 DAS	14 DAS
1	*Pongamia pinnata* (Karanj) leaves extract	1.87 (1.34)	1.84 (1.33)	1.92 (1.36)
2	*Azadirachta indica* (Neem) leaves extract	1.53 (1.23)	1.65 (1.28)	1.77 (1.33)
3	*Calotropis procera* (Rui) leaves extract	2.06 (1.42)	2.00 (1.39)	2.00 (1.38)
4	*Lantana camera* (Ghaneri) leaves extract	2.52 (1.58)	2.74 (1.64)	2.96 (1.77)
5	Karanj seed extract	1.72 (1.30)	1.76 (1.31)	1.84 (1.34)
6	Neem seed extract	1.48 (1.21)	1.54 (1.23)	1.60 (1.26)
7	Quinalphos 25 EC	1.17 (1.08)	1.10 (1.05)	1.46 (1.20)
8	Untreated control	2.92 (1.70)	2.99 (1.72)	3.10 (1.77)
	'F' test	Sig.	Sig.	Sig.
	SE(m)+	0.11	0.13	0.12
	CD at 5%	0.36	0.41	0.36
	CV %	15.25	15.30	14.60

(Figures in parentheses are square root transformation values)

The treatments Neem seed extract 5% and Quinalphos 25 EC at 0.05% shows minimum population of Chrysopa and found at par with each other.

In case of Neem seed extract, similar results were found by Ahmed et al. (2003),where minimum population was recorded and in case of Ghaneri leaves extract similar result were also noticed by Patel et al. (2003) and reported that in *L. camera* treated plot, number of predator was good as that found in control.

So these treatments could support the data of present findings. While the other treatments results could not be compare due to want of literature.

B) At seven days after spraying (7 DAS)

The data presented in Table 16 indicate that all the treatments did not affect the population of chrysopa. However among the different treatments maximum population of chrysopa other than control was found in Ghaneri leaves extract 5% (2.74/5 plants) and was at par with Rui leaves extract 5%, Karanj leaves extract 5%, Karanj seed extract 5%, Neem leaves extract 5% and Neem seed extract 5% in which maximum population of Chrysopa was recorded.

Whereas the treatment Quinalphos 25 EC at 0.05% shows minimum population of chrysopa (1.10/5plants).

But the results of the present investigation on Chrysopa could not be compared due to want of literature.

C) At fourteen days after spraying (14 DAS)

The data presented in Table 16 indicate that all the treatments did not affect the population of chrysopa. However, amongst all the different treatments maximum population of chrysopa other than control was found in Ghaneri leaves extract 5% (2.96/5 plants) and was at par with Rui leaves extract 5%, Karanj leaves extract 5%, Karanj seed extract 5%,Neem leaves extract 5% and Neem seed extract 5% in maximum population of Chrysopa was recorded. While the treatments Quinalphos 25 EC at 0.05% shows minimum population of chrysopa (1.46/5plants).

In case of Ghaneri leaves extract similar results was found by Patel et al. (2003) they reported that in *L. camera* treated plot, number

of predator was good as that found in control and they reported good population of predaters in treatment Ghaneri leaves extract. Therefore these findings gave support to the data of present investigation. But the other treatments could not be compared due to want of literature.

Hence the results of the present findings are analogues to the results of above scientist and gave support to the data. While the other treatments could not compare due to want of literature.

4.3 Effect of different treatments on yield of soybean

The yield recorded from the different treatments is given in Table 17 and depicted in Fig. 17 indicated that significant differences among the various treatments in respect to yield of soybean.

Table 17. Effect of different treatments on yield

Tr. No.	Treatment	Dosage	Yield per plot (kg)	Increased yield per plot (kg)	Yield per ha (kg)	Increased yield per ha (kg)
1	*Pongamia pinnata* (Karanj) leaves extract	5%	0.985	0.235	1368	326
2	*Azadirachta indica* (Neem) leaves extract	5%	1.050	0.300	1458	416
3	*Calotropis procera* (Rui) leaves extract	5%	0.960	0.210	1333	291
4	*Lantana camera* (Ghaneri) leave extract	5%	0.940	0.190	1305	263
5	Karanj seed extract	5%	1.000	0.250	1388	347
6	Neem seed extract	5%	1.200	0.450	1666	625
7	Quinalphos 25 EC	0.05%	1.450	0.700	2013	972
8	Untreated control		0.750	-	1041	-
	'F' test		Sig.	-	Sig.	-
	SE(m)±		0.082	-	1.175	-
	CD at 5%		0.249	-	3.564	-
	CV %		13.66	-	14.07	-

The significantly highest yield (2013 kg/ha) was obtained due to application of Quinalphos 25 EC at 0.05% and it followed by Neem seed extract 5% and Neem leaves extract 5% in which 1666 and 1458 kg/ha yield of soybean was recorded and these treatments were found

significantly superior to Karanj seed extract 5%, Karanj leaves extract 5%, Rui leaves extract 5% and Ghaneri leaves extract 5% in which 1388, 1368, 1333 and 1305 kg/ha yield of soybean were recorded respectively. Amongst these treatments Karanj seed extract and Karanj leaves extract were at par with each other. Significantly the lowest (1061kg/ha) yield was recorded in untreated control and it was least significant over all the treatments.

Singh and Singh (1988) studied the field efficacy of 11 insecticides against grey semilooper and found that Fenvalerate and Quinalphos were highly toxic against grey semilooper and the crop was remained free from larval population of grey semilooper and also yielded highest quantity of grain yield (1700 kg/ha). Hence these findings are analogous to the present investigation and gave support to the data.

4.4 Incremental cost benefit ratio of different treatments

Considering the costs of inputs for different treatments and corresponding yield obtained from the different plots treatment, the incremental cost benefit ratio (ICBR) of all treatments were worked out at prevailing market rates and presenting the data in Table 18 and depicted in Fig.18 revealed that the Quinalphos 25 EC 0.05% was the most economic and recording highest ICBR of 1:7.69 and it followed by Neem seed extract 5% and Neem leaves extract 5% recording 1: 5.41 and 1:3.63 ICBR respectively. The next better economic treatments were Karanj leaves extract 5% and Rui leaves extract 5% recording ICBR 1:2.00 and 1:1.68 respectively.

The remaining treatments viz., Ghaneri leaves extract 5% and Karanj seed extract 5% recording of 1:1.42 and 1:0.34 ICBR respectively. However the lowest ICBR (1:0.34) was recorded in Karanj seed extract 5%. The treatment due to Quinalphos 25 EC (Rs.17205/ha), Neem leaves extract 5% (Rs. 10550/ha) were found most efficient in terms of getting maximum increment benefit (Rs/ha).

In present study the various treatments Quinalphos 25 EC 0.05 was found to be most economic recording highest ICBR 1:7.69 and it followed by Neem seed extract 5% and Neem leaves extract 5% recording ICBR of 1:5.41 and 1:3.63 respectively. Economically least effective

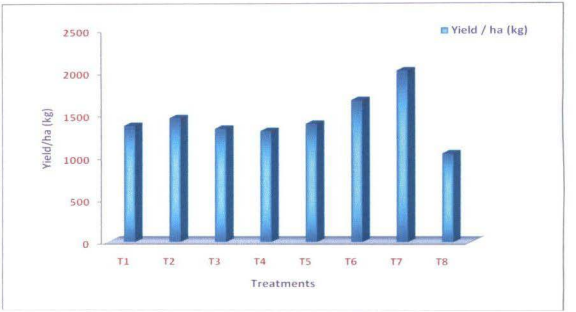


Fig. 17: Effect of different treatments on yield of soybean

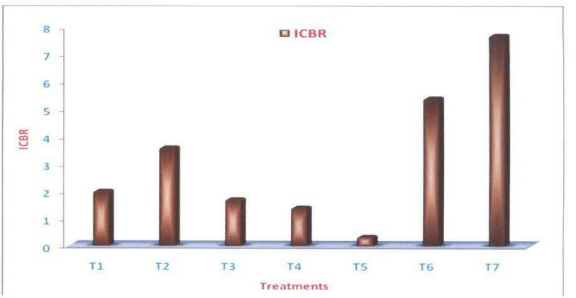


Fig. 18: Incremental cost benefit ratio for different treatments

T_1 Karanj leaves extract 5%

T_2 Neem leaves extract 5%

T_3 Rui leaves extract 5%

T_4 Ghaneri leaves extract 5%

T_5 Karanj seed extract 5%

T_6 Neem seed extract 5%

T_7 Quinolphos 25 EC 0.05

treatment was Karanj seed extract 5% recording least ICBR 1:0.34 because its cost and moderate efficacy. Therefore these findings are in conformity with the findings of Das et al. (1998) they evaluated Neem derivatives on soybean and found that ICBR was higher for chemical insecticides followed by Neem seed kernel extract 5%.

Table 18. Yield and incremental cost benefit ratio for different treatments

Sr. No.	Treatments	Qty. of insecticide required /ha for 3 spray	Cost of treatment (Rs./ha)		Total cost (A)	Yield (kg/ha)	Increase yield over control (kg/ha)	Value of increased yield (Rs./ha) (B)	Increment benefit (C) (B-A)	ICBR (C/A)	Rank
			Cost of insecticide	Labour + sprayer charges							
1	*Pongamia pinnata* (Karanj) leaves extract	75 kg	750	1425	2175	1368	327	6540	4365	1:2.00	IV
2	*Azadirachta indica* (Neem) leaves extract	75 kg	375	1425	1800	1458	417	8340	6540	1:3.63	III
3	*Calotropis procera* (Rui) leaves extract	75 kg	750	1425	2175	1333	292	5840	3665	1:1.68	V
4	*Lantana camera* (Ghaneri) leaves extract	75 kg	750	1425	2175	1305	264	5280	3105	1:1.42	VI
5	Karanj seed extract	75 kg	3750	1425	5175	1388	347	6940	1765	1:0.34	VII
6	Neem seed extract	75 kg	525	1425	1950	1666	625	12500	10550	1:5.41	II
7	Quinalphos 25 EC	3 lit.	810	1425	2235	2013	972	19440	17205	1:7.69	I
8	Untreated control	-	-	-	-	1041	-	-	-	-	-

1. Cost of botanicals and insecticides

i. *Pongamia pinnata* leaves extract = Rs 10/kg
ii. *Azadirachta indica* leaves extract = Rs. 5/kg
iii. *Calotropis procera* leaves extract = Rs. 10/kg
iv. *Lantana camera* leaves extract = Rs. 10/kg
v. Karanj seed extract = Rs. 7/kg
vi. Neem seed extract = Rs. 50/kg
vii. Quinalphos 25 EC = Rs. 270/lit.

2. Labour charges = Rs. 70/day (for one spray) 5 labour/ha
3. Spray pump = Rs. 25/day
4. Market value of soybean = Rs. 2000/qtl.

CHAPTER V

SUMMARY AND CONCLUSIONS

An experiment was carried out at field of Department of Agricultural Entomology, Post Graduate Institute, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola in *kharif* 2009 for evaluation of some plant extracts against major pests of soybean.

The eight treatments were used in present study consisting of botanicals and insecticide namely Karanj leaves extract 5%, Neem leaves extract 5%, Rui leaves extract 5%, Ghaneri leaves extract 5%, Karanj seed extract 5%, Neem seed extract 5% and Quinalphos 25 EC 0.05% and untreated control.

The experiment was planned in Randomized Block Design with three replications in eight treatments. The soybean variety JS-335 was used with gross plot size of 3 m x 2.4 m and net plot size of 2.40 m x 2.24 m. The efficacy of various treatments was judged on per cent reduction of tobacco leaf eating caterpillar, green semilooper and hairy caterpillar, average population of lady bird beetle and chrysopa, grain yield and incremental cost benefit ratio.

The observations on tobacco leaf eating caterpillar, green semilooper and hairy caterpillar were recorded on randomly selected one meter row length at five places from each plot, before 24 hrs and after 3^{rd}, 7^{th} and 14^{th} days after application of treatment. The population of natural enemies recorded on 5 randomly selected plants from each plot before 24 hours and after 3^{rd}, 7^{th} and 14^{th} days after application of treatment. The first spray was conducted after 20 days after emergence then next 2 sprays were conducted at 15 days interval. Overall three sprays were conducted. Per cent reduction of tobacco leaf eating caterpillar, green semilooper and hairy caterpillar were calculated and average population of natural enemies viz., lady bird beetle, and chrysopa were recorded. Post harvest observations i.e. the grain yield of each plot were recorded to work out the efficacy of various treatments on yield basis and for calculation of ICBR.

The obtained data were statistically analyzed after transformation in arc sin and square root values wherever applicable. The

results obtained during the course of study are summarized as below along with the conclusions.

5.1 Efficacy of some botanicals and insecticide against major pest of soybean

5.1.1 Tobacco leaf eating caterpillar

Application of Quinalphos 25 EC 0.05% was most effective treatment followed by Neem seed extract 5%, Neem leaves extract 5% and Karanj seed extract 5% were found most effective in control of tobacco leaf eating caterpillar.

5.1.2 Green semilooper

Application of Quinalphos 25 EC 0.05% was most effective treatment followed by Neem seed extract 5%, Neem leaves extract 5% and Karanj seed extract 5% were found most effective in control of green semilooper.

5.1.3 Hairy caterpillar

Application of Quinalphos 25 EC 0.05% was most effective treatment followed by Neem seed extract 5%, Neem leaves extract 5% and Karanj seed extract 5% were found most effective in control of hairy caterpillar.

5.2 Effect of various treatments on population of natural enemies

5.2.1 Effects of various treatments on average population of lady bird beetle

Among the various treatments maximum population of lady bird beetle other than control was found in Ghaneri leaves extract 5% followed by Rui leaves extract 5% and Karanj leaves extract 5%.

5.2.2 Effect of various treatments on average population of Chrysopa

Among the various treatments maximum population of chrysopa, other than control was found in Ghaneri leaves extract 5% followed by Rui leaves extract 5% and Karanj leaves extract 5%.

5.3 Effect of various treatments on yield of soybean

The plots treated with Quinalphos 25 EC 0.05% recorded maximum yield of soybean i.e. (2013 kg/ha) followed by Neem seed extract 5% and Neem leaves extract 5% recording 1666 kg/ha and 1458 kg/ha. Yield of Quinalphos 25 EC 0.05% was at par with Neem seed extract 5% and significantly superior over rest of the treatments.

The treatment Neem seed extract 5% followed by Neem leaves extract 5%, Karanj seed extract 5%, Karanj leaves extract 5%, Rui leaves extract 5% and Ghaneri leaves extract 5% were found statistically at par with each other and significantly superior over control.

5.4 Incremental cost benefit ratio

Amongst the various treatments Quinalphos 25 EC at 0.05% most economically viable treatment, recording highest incremental cost benefit ratio i.e. ICBR (1:7.69). The next economical treatment was Neem seed extract 5% and Neem leaves extract 5% recorded 1:5.41 and 1:3.63 ICBR respectively. However, the remaining treatments comparatively less economic when compared with above treatments.

The lowest ICBR (1:0.34) was recorded in Karanj seed extract 5%. Overall study indicated that chemical insecticides followed by Neem seed extract are most effective to manage the pests of soybean with great net profit over control by application of 3 sprayings.

From the present study following conclusions could be drawn.

5.5 Conclusions

From the findings of the present investigations, it is concluded that maximum reduction of tobacco leaf eating caterpillar, green semilooper and hairy caterpillar was observed in Quinalphos 25 EC 0.05% followed by Neem seed extract 5% and Neem leaves extract 5% at 3 ,7 and 14 days after spray. Neem products ranked in second order in case of efficacy and economics.

The treatment Quinalphos 25 EC was ranked top in recording maximum yield. While the treatments Quinalphos 25 EC 0.05% were most effective in recording highest ICBR. While Neem products like Neem seed extract and Neem leaves extract were also good in recording yield and ICBR. In term of monitory return obtained, the treatment Quinalphos 25 EC, Neem seed extract and Neem leaves extract were most efficient in that order.

CHAPTER VI

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Appendix

Weekly weather data for the year 2009-10 recorded at Meteorological Observatory of Agronomy, Dr. PDKV, Akola

Normal : 1971-2000
Actual : 2009-10

M W	Dates	T MAX (°C)		T MIN (°C)		BSH (hrs)		WS (km/hr)		RH I (%)		RH II (%)		Evap (mm)		RF (mm)		CRF (mm)	Rainy Days	
		N	A	N	A	N	A	N	A	N	A	N	A	N	A	N	A		N	A
	2009																			
26	25-1Jul	34.1	33.6	24.2	24.5	5.3	3.6	13.4	9.2	80	82	55	59	7.3	7.8	38.2	143.2	190.0	2.3	4.0
27	2-8	33.5	32.8	24.4	24.5	5.2	3.7	12.9	4.1	81	90	58	65	6.8	4.7	34.7	77.1	267.1	2.4	5.0
28	9-15	32.3	30.2	23.7	24.1	3.8	1.4	12.0	7.5	84	89	62	71	5.5	3.4	52.2	48.0	315.1	2.8	4.0
29	16-22	32.0	28.6	23.9	23.6	3.3	1.2	11.2	4.9	84	86	65	78	5.6	3.1	58.6	57.2	372.3	2.6	3.0
30	23-29	31.7	30.3	23.3	23.6	4.3	3.1	11.9	4.3	85	85	64	60	5.3	4.0	44.2	30.0	402.3	2.6	4.0
31	30-5 Aug	31.1	32.2	23.1	24.0	3.6	3.4	11.7	7.5	88	81	66	52	4.6	5.9	49.3	0.0	402.3	2.5	0.0
32	6-12	30.2	32.1	22.9	24.0	3.5	2.3	11.6	7.2	87	84	69	56	4.2	4.8	59.9	4.2	406.5	2.9	0.0
33	13-19	30.5	32.8	22.8	24.9	4.4	3.7	11.7	7.7	86	77	66	49	4.5	6.3	40.6	0.0	406.5	2.2	0.0
34	20-26	30.5	31.1	22.6	22.8	4.3	2.5	11.0	4.2	88	94	66	73	4.3	3.8	46.7	65.7	472.2	2.0	3.0
35	27-2 Sep	30.4	30.2	22.7	23.5	4.4	2.8	10.6	6.5	86	91	64	68	4.2	3.5	47.1	2.9	475.1	2.4	0.0
36	3-9	31.1	30.3	22.5	23.3	5.7	3.2	9.1	10.1	85	93	61	67	4.7	4.0	28.5	30.2	505.3	1.6	1.0
37	10-16	32.2	33.2	22.4	22.9	7.1	5.4	9.0	6.0	85	85	56	43	5.1	5.2	18.9	0.0	505.3	1.1	0.0
38	17-23	33.4	35.2	22.3	22.8	7.2	7.1	8.5	2.7	83	81	53	34	5.3	5.7	24.6	2.1	507.4	1.4	0.0
39	24-30	33.7	34.3	21.9	24.5	7.6	5.6	5.4	5.5	83	83	50	49	4.9	6.5	24.4	6.8	514.2	1.5	2.0
40	1-7 Oct	33.9	32.2	20.2	23.7	8.1	4.1	7.5	4.3	81	90	45	60	5.5	4.3	21.8	67.8	582.0	1.1	4.0
41	8-14	34.1	32.9	18.7	19.8	4.2	8.1	4.1	4.4	76	90	40	33	5.3	5.1	16.0	0.0	582.0	0.9	0.0
42	15-21	33.9	34.9	18.1	17.8	8.4	7.8	4.4	1.5	74	81	36	23	5.5	5.7	3.1	0.0	582.0	0.4	0.0
43	22-28	33.1	33.8	18.5	14.7	8.4	6.7	4.1	1.6	73	74	36	19	5.3	5.6	10.0	0.0	582.0	0.6	0.0
44	29-4 Nov	33.0	34.4	16.8	14.3	8.7	6.8	4.7	1.6	72	70	31	17	5.3	6.4	2.3	0.0	582.0	0.3	0.0
45	5-11	32.4	31.0	14.8	19.1	8.6	4.1	4.5	2.1	70	81	30	50	5.2	4.9	3.7	5.0	587.0	0.3	1.0
46	12-18	31.7	29.3	13.7	21.7	8.6	3.6	4.6	1.6	70	92	30	58	4.9	3.6	1.1	97.8	684.8	0.2	3.0
47	19-25	31.0	27.5	13.1	13.1	8.6	7.9	4.4	1.1	71	89	30	35	4.6	3.8	10.1	0.0	684.8	0.3	0.0
48	26-2 Dec	30.3	28.8	12.4	12.2	8.8	7.2	4.6	1.3	71	82	31	29	4.3	4.0	6.8	0.0	684.8	0.3	0.0
49	3-9	29.8	29.6	11.2	13.5	8.7	5.4	4.7	1.0	70	85	29	33	4.3	3.5	1.3	0.0	684.8	0.2	0.0
50	10-16	29.4	30.5	10.3	15.1	8.8	4.9	4.5	0.8	70	88	27	34	4.2	3.4	1.3	0.0	684.8	0.2	0.0
51	17-23	29.5	29.0	10.6	14.7	8.7	5.1	4.7	2.1	69	86	29	36	4.3	3.3	0.9	0.7	685.5	0.1	0.0
52	24-31	29.2	27.4	10.7	12.2	8.6	4.8	4.8	1.7	70	76	31	33	4.3	3.8	2.6	14.0	699.5	0.2	1.0
	2010																			
1	1-7 Jan	29.0	27.2	10.3	10.8	8.7	6.8	4.9	1.2	78	81	30	25	4.2	4.0	1.7	0.0	0.0	0.2	0.0
2	8-14	29.2	28.2	11.3	13.5	8.6	5.1	6.3	2.4	71	86	30	37	4.5	3.3	3.4	30.9	30.9	0.2	2.0
3	15-21	29.9	27.5	11.6	10.8	8.9	7.3	5.4	1.0	69	85	28	30	4.8	3.5	0.9	0.0	30.9	0.1	0.0