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Evaluation of botanicals and synthetic insecticides against major sucking pests of brinjal and its impacts on natural enemies

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Abstract
The present investigation entitled, "Evaluation of botanicals and synthetic insecticides against major pests of brinjal", was conducted during kharif 2017-18 on the field of Department of Entomology Dr. Panjabrao Deshmukh Krishi Vidhyapeeth, Akola. The effects of botanicals along with synthetic insecticides were assessed against pests of brinjal to find out the cost effective treatment. The experiment was laid out in randomized block design (RBD) with twelve treatments replicated thrice. Total five sprays of the above treatments were done at an interval of 15 days commencing first application at 30 days after transplanting. The treatment Thiamethoxam 25 WG@ 0.4 g/L followed by Imidacloprid 17.8 SL @ 0.25 ml/L, Triazophos 40 EC @ 2 ml/Land NSE (Neem Seed Extract) @7% were found significantly effective in recording lower population of sucking pests i.e. leafhopper, whitefly and mites. Deleterious effect of treatments either botanical or synthetic insecticides were not observed on predator's *viz*., ladybird beetle, Chrysopids and spider on brinjal throughout the season.

Keywords: evaluation, botanicals, insecticides, natural enemies

Introduction
Brinjal (*Solanum melongena* Linn.) is an important vegetable crop, in almost all parts of our country. It is a versatile crop adapted to different agro-climatic regions and can be grown throughout the year. It is a perennial but grown commercially as an annual crop. A number of cultivars are grown in India and the consumer's preference being dependent upon fruit colour, size and shape. Brinjal is known as eggplant, which is very important common man's vegetable in India. It is often described as a poor man's vegetable because it is popular amongst small-scale farmers and low income consumers. Brinjal is also called by some as the 'King of Vegetables'. It contains high percentage of nutrition, high water content and is a very good source of fiber, calcium, phosphorus, folate, low in calories, fats, vitamins B and C, some protein, fibre and carbohydrates. It is a good source of minerals and vitamins and is rich in total water soluble sugars, free reducing sugars, amide proteins among other nutrients. Therefore, used in ayurvedic medicine for curing diabetes, hypertension and obesity.

In India productivity of brinjal is very low because of attack by number of sucking insect pest's right from nursery stage to till harvesting (Ragupathy *et al*., 1997) [10]. Sucking insects pests are the serious pest of brinjal. The losses caused by various pests were estimated to be ranging from 28-85% (Ahmed, 1974) [1]. Singh *et al.*, (1984) [14] have listed about 25 insect pests of brinjal, of which some major insect pests are brinjal includes shoot and fruit borer (*Leucinodes orbonalis* Gu.), Epilachna beetle (*Epilachna vigintioctopunctata* F.), aphids *(Aphis gossypi* Glower), stem borer (*Euzophera perticella* Rag.) and jassid (*Amrasca biguttula*). Among them sucking pests hamper the growth of brinjal by sucking the cell sap constantly from brinjal leaves. The leafhopper nymphs and adults suck the sap from underside of leaves and inject their toxic saliva into the tissue causing toxaemia. As a result the spots attacked turn yellowish and start curling from margins inwardly; gradually the entire leaf shows yellow patches which become red, dark brick red and ultimately crumples. Leafhoppers also transmit virus disease known as 'little leaf'. The whitefly nymphs and adults suck the cell sap from leaves and tender apical shoots. In addition, these insects also secrete the 'honeydew' on which fungus (Capnodium species) or black sooty mould develops, which in turn interferes with the photosynthesis activity of the plant, which retard the growth of plant, reduced fruit size & yield reduced considerably.

As Brinjal is a consumable commodity, the effect of residue of pesticide in Brinjal is harmful to human health therefore several non-chemical means of pest management have been proposed for brinjal like the manipulation of cultural practices, nutrient management, use of biological agents, etc. Suitable use of insecticides necessary for the control of brinjal pests because its causes problems of resistance and resurgence of sucking pests in brinjal (Mehrotra, 1990) [6]. These toxic insecticides pollute environment and also adversely affect the natural enemies of pests.

To reduce pesticide hazards, one of the resorts is the application of insecticides of plant origin. In this context, botanicals are being considered as environmentally safe, selective, biodegradable, economical and renewable alternative for use in IPM programmers. Botanicals are natural plants products and may be grown by the planters with minimum cost and extracted by indigenous methods. Biopesticides are secondary metabolites, which includes alkaloids, terpenoids, phenolics, and minor secondary chemicals. It is estimated that as many as 2121 plants species have been reported to posses' pest control properties. Botanicals like neem, Ghaneri, Karanj, Kanheri, Castor, Gulvel, Custard apple, Rui, Papaya, Nirgudi many others may be grown by planter with minimum expense.

The present investigation entitled "Evaluation of botanicals and synthetic insecticides against major pests of brinjal" was conducted with a view to suggest the safer and compatible alternative method of pest control in order to save the crop from the disastrous pests and at the same time to ensure eco-safety to the environment to reduce the application of chemical insecticides to delay the insecticides resistance and to safeguard the consumers by an integrated approach utilizing the botanical insecticide such as Azadirachtin, Dashparni, Neem Seed Extract, fresh neem leaf extract, fermented neem leaf extract, entomopathogenic fungi like *Lecanicillium lecanii* and some synthetic insecticides.

Materials and Methods

i. Study areas: The present investigation entitled "Evaluation of botanicals and synthetic insecticides against major pests of brinjal" were carried out with a view to evaluate the management of major pests of brinjal using botanicals, microbial, newer and conventional insecticides for the control of sucking pests like leaf hopper, whitefly, as well as mite in field trial. The experiment was conducted at the experimental farm of Department of Agricultural Entomology, Dr.Panjabrao Deshmukh Krishi Vidyapeeth, Akola (M.S.) during the kharif season of 2017-18.

ii. Layout: The field experiments were laid out in randomized block design (RBD) consisting of twelve treatments including control during kharif season 2017. Brinjal (Cultivar: AKLB-9) was raised in the plots size of Gross plot size 4.8 m x 3.6m and Net plot size: 3.6 m × 2.4 m with the spacing of 60 x 10 cm. Cultural practices like preparatory tillage, hoeing, weeding, thinning, gap filling, fertilizer applications, etc. were done as per the university recommendations.

iii. Treatment details: The field experiment was conducted with twelve treatments including an untreated control. The various treatment evaluated in the present study were composed of five sprays in management of sucking pests in brinjal. The details of the composition of insecticides used in management modules given in (Table 1).

Table 1: Details of treatments used for pest's management in Brinjal

Treatments details (Doses (g or ml / L)	Chemical Name	Trade Name	Group Of Insecticides
T-1, Dashparni Extract 15% (12.5 ml)	-	Botanicals	Botanicals
T-2, Dashparni Extract 15% (25.0 ml)	-	Botanicals	Botanicals
T-3, Fresh Neem Leaf Extract (NLE) 10%	-	Botanicals	Botanicals
T-4, Fermented Neem Leaf Extract (NLE) 10%	-	Botanicals	Botanicals
T-5, NSE (Neem Seed Extract) 5%	-	Botanicals	Botanicals
T-6, NSE (Neem Seed Extract) 7%	-	Botanicals	Botanicals
T-7, Azadirachtin 10000 ppm (1% w/w) (2 ml)	Surya gold	Botanicals	Agrochemicals
T-8, *Lecanicillium lecanii* (1 x 108 cfu/g) (4 g)	*Lecanicillium* lecanii	Active	Entomopathogenic Fungi
T-9, Imidacloprid 17.8 SL (0.0045) (0.25 ml)	N-(1-(6-Chloro-3- pyridyl)methyl)-4,5-dihydroimidazol-2-yl)nitramide	Confidor	Neonicotinoid
T-10, Thiamethoxam 25 WG (0.01%) (0.4 g)	3-(2-Chloro-1,3-thiaol-5-yl)methyl)-5-methyl-N-Nitro-1,3,5-oxadiazinan-4-imine	Actara	Neonicotinoid
T-11, Triazophos 40 EC (0.08%) (2 ml)	O,O-DiethylO-(1-phenyl-1H-1,2,4-triazol-3-yl)phosphorothioate	Triazocel	Organophosphorus
T-12, Untreated control	-	-	-

iv. Method of application: The first spraying of each treatment was commenced from 30 days after transplanting and further it was repeated at 15 days of interval. As per treatments; overall five sprays were undertaken for management of major pests of Brinjal. Pre-treatment observations were taken 24 hours before first spray. Sprayings were done using knapsack sprayer with solid cone nozzle early in morning hours to avoid the mid-day heat.

a. Preparation of Dashparni extract: As per Raskar *et al*. (2014) [11] For Preparation of 15% stock solution of Dashparni extract following contents were required. Leaves of Neem (*Azadirachta indica*) 5 kg + Leaves of Ghaneri +(*Lantena camera*) 2 kg+ Leaves of Karanj (*Pongamia pinnata*) 2 kg + Leaves of Kanheri (*Nerium indicum*) 2 kg+ Leaves of Castor (*Ricinus communis*) 2 kg + Leaves of Gulvel (*Tinospora cordifolia*) 2 kg+ Leaves of Custard apple *(Annona squamosa*) 2 kg + Leaves of Rui (*Calotropis procera*) 2 kg + Leaves of Papaya (*Carica Papaya*) 2 kg + Leaves of Nirgudi (*Vitex negundo*) 2 kg + Cow Urine 5 L + Cow Dung 2 kg+ Water 170 L of water in 200 L. plastic barrels. Then it was kept for 5 days as such. Than 5-7 L. of water was added in it and mixed again all the contents. Then the barrel was kept for one month. Shake this barrel regularly three times a day and placed it in shade. After one month the extract was separated or extracted through sieve. This ark or extract was used for spraying in the field and as per the dose mentioned by Raskar *et al*. (2014) [11] i.e. 125 ml/10L of water and double dose i.e.

250ml/10L was used for spraying.

b. Preparation of 5% Neem Seed Extract: 5 kg Neem seeds were crushed to powder and was soaked in 9 L. of water overnight and in 1 L. water separately 200 gm of washing powder was soaked and next day morning the above solution was mixed and filter from muslin cloth and this solution was sprayed in field adding 90 L. of water. Accordingly as above procedure Neem seed extract 7% and Neem leaf extract 5% was prepared one day before spraying.

c. Preparation of 10% Fermented Neem leaf extract: 5 kg fresh Neem leaves was crushed, then added 2 kg cow dung and 3 Liter cow urine. These Neem leaves, cow urine and cow dung were mixed in 10 L of water and it was allowed to ferment for one month. Shake regularly three times a day then this solution was filtered through muslin cloth and this solution was sprayed in field by adding 100 L. of water.

v. Observation: The observations were recorded on various major sucking pests of Brinjal *viz*., leafhopper, whitefly, and mites. Pretreatment observations were recorded 24 hours before first spray and post treatment observations were recorded at 3, 7 and 14 days after each treatment spray on randomly selected five plants from each net plot and from three leaves (top, middle and bottom) on randomly selected plants. Average population of natural enemies was recorded on 5 randomly selected plants from each plot, 3rd, 7th, 14th days after application of treatment.

vi. Data analysis: The data obtained in number in different treatments was transformed into corresponding square root or arc sine value as per Gomez and Gomez (1984) [5] and subjected to statistical analysis for testing the level of significance.

Results

a. Effect of various treatments against leafhopper population on brinjal crop: a. 1. At 3DAT: The cumulative average population of leafhoppers/leaf in all treated plots were significantly lower (1.28 to 2.79) than the untreated control plot (4.77). All the treatments were significantly superior over control treatment. The lowest population of leafhopper was recorded in treatment (T10) Thiamethoxam 25 WG (1.28 leafhoppers/leaf) which was found statistically at par with (T9) Imidacloprid (1.52 leafhoppers/leaf), (T11) Triazophos 40 EC (1.56 leafhoppers/leaf). The next best effective treatment (T6) NSE (Neem Seed Extract) @7% (1.85 leafhoppers/leaf) which was statistically at par with (T5) NSE (Neem Seed Extract) @5% (2.01 leafhoppers/leaf), (T2) Dashparni extract 15% @ 25.0 ml/L (2.05 leafhoppers/leaf), (T1) Dashparni extract 15% @ 12.5 ml/L (2.15 leafhoppers/leaf), (T7) Azadirachtin 10000 ppm @ 2 ml/L (2.37 leafhoppers/leaf), (T4) Fermented neem leaf extract @10% (2.42 leafhoppers/leaf). The next effective treatment (T3) Fresh neem leaf extract @10% (2.75 leafhoppers/leaf) which was at par with (T8) Lecanicillium lecanii 1 x 108 cfu/g @ 4 g/L (2.79 leafhoppers/leaf) (Table 2). Effectiveness of remaining treatments against brinjal leafhopper as given in descending order as T6>T5>T2>T1>T7>T4>T3>T8(Table 2).

2. At 7 DAT: Similarly, the lowest population of leafhopper was recorded in (T10) Thiamethoxam (1.41 leafhoppers/leaf) which was found statistically at par with (T9) Imidacloprid (1.75 leafhoppers/leaf), (T11) Triazophos (1.84 leafhoppers/leaf). The next effective treatment (T6) NSE (Neem Seed Extract) @7% (1.85 leafhoppers/leaf) which was found at par with (T5) NSE (Neem Seed Extract) @5% (2.25 leafhoppers/leaf), (T2) Dashparni extract 15% @ 25.0 ml/L (2.29 leafhoppers/leaf), (T1) Dashparni extract 15% @ 12.5 ml/L (2.44 leafhoppers/leaf), (T7) Azadirachtin 10000 ppm @ 2 ml/L (2.63 leafhoppers/leaf). Remaining treatments leafhopper population found in the range between 2.90-3.54 leafhopper/leaf (Table 1).

3. At 14 DAT: The data at 14 DAT of cumulative average population of leafhopper revealed that population of leafhoppers/leaf in all treated plots were significantly lower (1.80 to 3.87) than the untreated control plot (6.18). Similar trends of effectiveness of treatments seen after 14 days. Thiamethoxam insecticides found to be effective against leafhopper recorded (1.80 leafhopper/leaf) and was found statistically at par with (T9) Imidacloprid (2.21leafhoppers/leaf), followed by Triazophos (2.22 leafhoppers/leaf). The effectiveness of remaining treatments in descending order against leafhopper in brinjal as T6 > T5> T2> T1> T7 (Table 2).

b. Effect of various treatments against whitefly population on brinjal crop: 1. At 3DAT: The cumulative average population of whiteflies/leaf in all treated plots were significantly lower (2.04 to 4.19) than the untreated control plot (6.44). The lowest population (2.04) was recorded due to treatment (T10) Thiamethoxam 25 WG @ 0.4 g/L which recorded minimum population of whitefly/leaf i.e. (2.04 whiteflies/leaf) and it was statistically at par with treatments (T9) Imidacloprid 17.8 SL @ 0.25 ml/L (2.47 whiteflies/leaf), (T11) Triazophos 40 EC @ 2 ml/L (2.49 whiteflies/leaf). The next best treatment (T6) NSE (Neem Seed Extract) @7% (2.80 whiteflies/leaf) which was at par with (T5) NSE (Neem Seed Extract) @5% (2.99 whiteflies/leaf), (T2) Dashparni extract 15% @ 25.0 ml/L (3.13 whiteflies/leaf), (T1) Dashparni extract 15% @ 12.5 ml/L (3.34 whiteflies/leaf). The next effective treatment was (T7) Azadirachtin 10000 ppm @ 2 ml/L (3.66 whiteflies/leaf) which was at par with (T4) Fermented neem leaf extract @10% (3.76 whiteflies/leaf), (T3) Fresh neem leaf extract @10% (3.96 whiteflies/leaf), (T8) *Lecanicillium lecanii* 1 x 108 cfu/g @ 4 g/L (4.19 whiteflies/leaf) (Table 2).

2. At 7 DAT: Among the selected treatment (T10) Thiamethoxam 25 WG @ 0.4 g/L which recorded minimum population of whitefly/leaf i.e. (2.66 whiteflies/leaf) and found stastically effective against whitefly and it was statistically at par with treatment(T9) Imidacloprid 17.8 SL @ 0.25 ml/L (3.16 whiteflies/leaf). Remaining treatments *viz*., (T11, T6, T5, T2, T1 and T7) whiteflies population recorded within 3-4 whiteflies/ leaf. Maximum population of whiteflies were recorded in T3, T8 which recorded 4.58, 4.81 whiteflies/leaf, respectively (Table 2).

3. At 14 DAT: The treatment (T10) Thiamethoxam 25 WG @ 0.4 g/L which recorded minimum population of whitefly/leaf i.e. (2.81 whiteflies/leaf) and it was statistically at par with treatments (T9) Imidacloprid 17.8 SL @ 0.25 ml/L (3.28 whiteflies/leaf) and (T11) Triazophos 40 EC @ 2 ml/L (3.46 whiteflies/leaf). The next best treatment was (T6) NSE (Neem Seed Extract) @7% (3.90 whiteflies/leaf) at par with (T5) NSE (Neem Seed Extract) @5% (4.18 whiteflies/leaf) (T2)

Dashparni extract 15% @ 25.0 ml/L (4.45 whiteflies/leaf), (T1) Dashparni extract 15% @ 12.5 ml/L (4.48 whiteflies/leaf).The next effective treatment (T7) Azadirachtin 10000 ppm @ 2 ml/L(5.44 whiteflies/leaf) which was at par with (T4) Fermented neem leaf extract @10% (5.08 whiteflies/leaf), (T3) Fresh neem leaf extract @10% (5.19 whiteflies/leaf), (T8) *Lecanicillium lecanii* 1 x 108 cfu/g @ 4 g/L (5.44 whiteflies/leaf) Maximum population of whiteflies were recorded in (T12) untreated control (8.30 whiteflies/leaf) (Table 2).

c. Effect of various treatments against mite population on brinjal crop: a. 1. At 3DAT: The effects of various treatments under investigation on the survival of mites stated that among the selected treatments Thiamethoxam 25 WG was most effective against the mite population which recorded minimum population of mite /leaf i.e. (1.47 mites /leaf) and it was statistically at par with treatments (T9) Imidacloprid 17.8 SL (1.76 mites /leaf), (T11) Triazophos 40 EC (1.99 mites /leaf), (T6) NSE (Neem Seed Extract) (2.18 mites /leaf), (T5) NSE (Neem Seed Extract) @5% (2.45 mites /leaf). The next best treatment was (T2) Dashparni extract15% (2.79 mites /leaf) was found at par with (T1) Dashparni extract 15% @ 12.5 ml/L (3.05 mites /leaf), (T4) Fermented neem leaf extract @10% (3.38 mites /leaf) (Table 2).

2. At 7 DAT: Data recorded on population of mites/leaf at 7 DAT (Table 2) revealed that the least population of mites recorded in treatment (T10) Thiamethoxam 25 WG which recorded minimum population of mites /leaf i.e. (1.75 mites /leaf) and it was statistically at par with treatments (T9) Imidacloprid 17.8 SL @ 0.25 ml/L (2.12 mites /leaf), (T11) Triazophos 40 EC @ 2 ml/L (2.32 mites /leaf), (T6) NSE (Neem Seed Extract) @7% (2.48 mites /leaf), (T5) NSE (Neem Seed Extract) @5% (2.78 mites /leaf) (T2) Dashparni extract 15% @ 25.0 ml/L(3.00 mites /leaf), (T1) Dashparni extract 15% @ 12.5 ml/L (3.22 mites /leaf), (T7) Azadirachtin 10000 ppm @ 2 ml/L (2.67 mites /leaf) and (T4) Fermented neem leaf extract @10%(3.00 mites /leaf). The next best treatment (T7) Azadirachtin 10000ppm (3.35 mites/leaf) which was at par with (T4) Fermented neem leaf extracts @10% (3.65 mites /leaf).

3. At 14 DAT: Among the selected treatments lowest mite population counts was recorded in (T10) Thiamethoxam 25 WG (2.12 mites/leaf) and it was statistically at par with treatments (T9) Imidacloprid 17.8 SL which recorded 2.45 mites /leaf. The next best treatment against the mites was (T11) Triazophos 40 EC which recorded (2.83 mites /leaf), followed by (T6) NSE (Neem Seed Extract) @ 7% (2.93 mites/leaf). Remaining treatments mite's counts recorded more than 3 mites /leaf (Table 2).

d. Cumulative effect of various treatments of natural enemies of brinjal crop

i. Lady bird beetle: Cumulative data on ladybird beetle Grub and Adult /plant recorded from treatment plots at 3, 7 and 14 days after each sprays revealed non-significant differences. The cumulative population of ladybird beetle (grub and adult) after five sprays at 3 DAT was 0.11 to 0.98 /plant, though the treatment differences were non significant but numerically the maximum ladybird beetle/plant population was recorded in (T12) untreated control plot (1.05 ladybird beetle/plant) followed by the treatments (T8) Lecanicillium lecanii 1 x 108 cfu/g @ 4 g/L (0.63 ladybird beetle/plant). As per the LBB population recorded in various treatments was arranged in descending order as T7>T3>T4>T1>T2>T5>T6>T9 (Table 3).

ii. Chrysopa: The data recorded after five sprays on population of chrysopa/plant was analyzed statistically and is presented in Table 3. Cumulative data on chrysopa/plants recorded from treatment plots at 3, 7 and 14 days after each sprays revealed non-significant differences. The population from 3 DAT to 14 DAT of chrysopa/plants in treated and untreated control plots range from 0.09 to 0.90. The cumulative population of chrysopa after five sprays at 3 DAT was 0.09 to 0.83/plant revealed non-significant differences among all the treatments, indicating that the treatments had no adverse effect on the population of chrysopa. But, numerically the maximum chrysopa/plant population was recorded in(T12) untreated control plot (0.83) followed by the treatments *viz*. T8 >T7> T3> T4> T1>T5> T6> T9> T10 in descending order (Table 3).

c. Spider: The cumulative data the population of spider after five sprays of insecticidal treatments revealed no significant differences amongst all the treatments, indicating that the treatments had neither favorable nor adverse effects on the population of spiders. But, still numerically the maximum spider/plants population was recorded in (T12) untreated control plot (0.63) followed by the treatments *viz*. (T8) *Lecanicillium lecanii* 1 x 108 cfu/g @ 4 g/L (0.5 spider/plant), (T7) Azadirachtin 10000 ppm @ 2 ml/L (0.43 spider/plant) (Table 3).

Discussion

A. Effect of various treatments against leafhopper population on brinjal crop: Our findings showed that treatment (T10) Thiamethoxam 25 WG was significantly superior over untreated control but at par with (T9) Imidacloprid 17.8 SL, (T11) Triazophos 40 EC, (T6) NSE (Neem Seed Extract) @7%,(T5) NSE (Neem Seed Extract) @5%, (T2) Dashparni extract 15% @ 25.0 ml/L, (T1) Dashparni extract 15% @ 12.5 ml/L, (T7) Azadirachtin 10000 ppm @ 2 ml/L, (T4) Fermented neem leaf extract @10%, (T3) Fresh neem leaf extract @10% (T8) Lecanicillium lecanii1 x 108 cfu/g @ 4 g/L. Similar observation was recorded by Sharma and Lal (2002) [13], who reported that efficacy of thiamethoxam @ 25 g a.i./ha against leafhopper of brinjal which was superior over synthetic pyrethroid i.e deltamethrin and profenophos. Similar observation was reported by Mhaske and Mote (2005) [7], Shaikh and Patel (2012) [12] and Omprakash and Raj (2013) [8] which stated that thiomethan and Imidacloprid was found to be effective against the leafhopper population in brinjal. Regarding the efficacy of Triazophos the above results are in close confirmation with Prasad kumar (2010) [9] who reported that Triazophos @ 1250 ml/ha was found more effective against leaf hoppers.

B. Effect of various treatments against whitefly population on brinjal crop: The above findings showed that the treatment (T10) Thiamethoxam 25 WG @ 0.4 g/L was significantly superior over untreated control but at par with (T9) Imidacloprid 17.8 SL @ 0.25 ml/L, (T11) Triazophos 40 EC @ 2 ml/L, (T6) NSE 7% (Neem Seed Extract), (T5) NSE

5% (Neem Seed Extract),(T2) Dashparni extract 15% @ 25.0 ml/L, (T1) Dashparni extract 15% @ 12.5 ml/L, (T7) Azadirachtin 10000 ppm @ 2 ml/L, (T4) Fermented neem leaf extract @10%, (T3) Fresh neem leaf extract @10%, (T8) *Lecanicillium lecanii*1 x 108 cfu/g @ 4 g/L More or less similar trend was found on 7 DAT and 14 DAT. These results are in confirmation with the findings of the authors *viz*. Sharma and Lal (2002) [13] who reported the efficacy of thiamethoxam @ 25 g a.i./ha against whiteflies of brinjal was superior over synthetic pyrethroid i.e deltamethrin and profenophos. Also Mhaske and Mote (2005) [7] reported efficacy of Imidacloprid and thiamethoxam were effective against whiteflies of brinjal. Regarding the efficacy of Triazophos the above results are in close confirmation with Prasad kumar (2010) [9] who reported that Triazophos @1250 ml/ha was found more effective against whiteflies.

C. Effect of various treatments against mites population on brinjal crop: Over all it is seen from above investigation that the treatment(T10) Thiamethoxam 25 WG @ 0.4 g/L was significantly superior over untreated control but at par with (T9) Imidacloprid 17.8 SL @ 0.25 ml/L, (T11) Triazophos 40 EC @ 2 ml/L, (T6) NSE (Neem Seed Extract) @7%, (T5) NSE (Neem Seed Extract) @5%, (T2) Dashparni extract 15% @ 25.0 ml/L, (T1) Dashparni extract 15% @ 12.5 ml/L, (T7) Azadirachtin 10000 ppm @ 2 ml/L, (T4) Fermented neem leaf extract @10%, (T3) Freshneem leaf extract 10%), (T8) *Lecanicillium lecanii* 1 x 108 cfu/g @ 4 g/L. More or less similar trend was found on 7 DAT and 14 DAT. Similar, results of Varghese and Mathew (2013) [16] who reported that spraying of Thiamethoxam 40 g a.i.ha-1 and Imidacloprid 20 g a.i.ha-1 recorded minimum mite population on chilli. Regarding the efficacy of the (T3) Fresh Neem leaf extract and (T4) and fermented neem leaf extract above results are in close confirmation with Ursani *et al*. (2014) [14] who reported that the neem extract showed 2nd rank in reducing mites infestation from 4.85/plant to 1.33/plant showing efficacy of 72.80% after the chemical control (Nissuran) which showed highest efficacy of 80.57%. Regarding the efficacy of the (T9) Imidacloprid and (T3) Fresh Neem leaf extract above results are in close confirmation with Ali *et al*.(2016) [2] who reported that the Imidacloprid (Confidor) was found to be most effective in mites reduction/leaf in brinjal and ranked 1st *viz*.,45.86/ plant to 0.83/plant showing the highest effect of reduction per cent i.e.98.19% followed by neem extract which was ranked 2nd in reducing the jassid infestation *viz*., 41.78/plant to 1.59/plant showing efficacy of 96.19%.

D. Natural enemies: The result of the present investigation are similar with the findings Chakraborti (2001) [4] reported that neem based treatments like spraying of neem oil and NSKE were found safer to natural enemies and were on par with untreated check in brinjal ecosystem.

The result of the present investigation are similar with the findings Anamika Kar (2017) [3], reported that the treatment Imidacloprid 17.8 SL @125 ml/ha and treatment Thiamethoxam 25% WG @200 ml/ha both these insecticides showed no or minimum suppression of natural enemies population even at higher dose of spray in tomato ecosystem.

Table 2: Cumulative effect of various treatments against sucking pest's population on brinjal crop after five sprays

Tr. No.	Cumulative effect of treatments after five sprays								
	Number of leafhopper/leaf			Number of whitefly/leaf			Number of mite/leaf		
	3DAT	7 DAT	14DAT	3DAT	7DAT	14DAT	3DAT	7DAT	14DAT
T1	2.15 (1.45)	2.44 (1.56)	3.04 (1.74)	3.34 (1.74)	3.91 (1.97)	4.48 (2.11)	3.05 (1.72)	3.22 (1.78)	3.59 (1.88)
T2	2.05 (1.43)	2.29 (1.51)	2.86 (1.69)	3.13 (1.77)	3.73 (1.92)	4.45 (2.10)	2.79 (1.67)	3.00 (1.72)	3.30 (1.80)
T3	2.75 (1.64)	2.90 (1.70)	3.65 (1.91)	3.96 (1.99)	4.58 (2.14)	5.19 (2.26)	3.57 (1.88)	3.91 (1.97)	4.10 (2.02)
T4	2.42 (1.55)	2.82 (1.68)	3.40 (1.84)	3.76 (1.93)	4.44 (2.10)	5.08 (2.25)	3.38 (1.83)	3.65 (1.90)	3.94 (1.97)
T5	2.01 (1.41)	2.25 (1.50)	2.64 (1.62)	2.99 (1.72)	3.72 (1.92)	4.16 (2.03)	2.45 (1.56)	2.78 (1.66)	3.17 (1.78)
T6	1.85 (1.35)	2.03 (1.42)	2.48 (1.57)	2.80 (1.67)	3.56 (1.88)	3.90 (1.97)	2.18 (1.46)	2.48 (1.57)	2.93 (1.71)
T7	2.37 (1.53)	2.68 (1.63)	3.20 (1.78)	3.66 (1.91)	4.17 (2.04)	5.03 (2.24)	3.15 (1.76)	3.35 (1.83)	3.78 (1.93)
T8	2.79 (1.67)	3.54 (1.87)	3.87 (1.96)	4.19 (2.03)	4.81 (2.20)	5.44 (2.31)	3.81 (1.95)	4.13 (2.00)	4.43 (2.10)
T9	1.52 (1.23)	1.75 (1.32)	2.21 (1.49)	2.47 (1.57)	3.16 (1.77)	3.28 (1.80)	1.76 (1.32)	2.12 (1.45)	2.45 (1.56)
T10	1.28 (1.12)	1.41 (1.19)	1.80 (1.34)	2.04 (1.43)	2.66 (1.62)	2.81 (1.68)	1.47 (1.21)	1.75 (1.32)	2.12 (1.45)
T11	1.56 (1.25)	1.84 (1.35)	2.22 (1.49)	2.49 (1.58)	3.41 (1.85)	3.46 (1.84)	1.99 (1.40)	2.32 (1.52)	2.83 (1.68)
T12	4.77(2.18)	5.74 (2.40)	6.18 (2.49)	6.44 (2.54)	7.16 (2.67)	8.30 (2.88)	6.52 (2.55)	6.97 (2.64)	7.28 (2.70)
F test	Sig	Sig	Sig	Sig.	Sig.	Sig	Sig.	Sig.	Sig.
SE(M)±	0.07	0.07	0.07	0.06	0.06	0.09	0.11	0.10	0.08
CD at 5%	0.20	0.21	0.22	0.17	0.17	0.25	0.32	0.29	0.24
CV %	8.04	7.83	7.36	5.44	4.91	6.97	11.29	9.68	7.50

Table 3: Cumulative mean of natural enemy's population of five sprays on brinjal crop

Tr. No	Cumulative mean of five sprays								
	LBB/ plant			Chrysopa/plant			Spider/plant		
	3DAT	7DAT	14DAT	3DAT	7 DAT	14 DAT	3DAT	7 DAT	14DAT
T1	0.22 (0.85)	0.47 (0.98)	0.52 (1.0)	0.25 (0.86)	0.27 (0.88)	0.47 (0.98)	0.22 (0.85)	0.32 (0.90)	0.38 (0.94)
T2	0.20 (0.83)	0.43 (0.96)	0.48 (0.98)	0.23 (0.85)	0.25 (0.85)	0.43 (0.96)	0.21 (0.84)	0.30 (0.89)	0.34 (0.91)
T3	0.30 (0.89)	0.56 (1.03)	0.60 (1.05)	0.38 (0.93)	0.32 (0.90)	0.56 (1.03)	0.31 (0.90)	0.39 (0.94)	0.45 (0.97)
T4	0.24 (0.85)	0.53 (1.01)	0.57 (1.03)	0.30 (0.89)	0.30 (0.89)	0.53 (1.01)	0.27 (0.87)	0.37 (0.93)	0.42(0.95)
T5	0.19 (0.82)	0.40 (0.95)	0.47 (0.98)	0.22 (0.85)	0.25 (0.85)	0.43 (0.96)	0.17 (0.82)	0.28 (0.88)	0.32 (0.90)
T6	0.18 (0.82)	0.39 (0.94)	0.42 (0.96)	0.19 (0.83)	0.23 (0.83)	0.42 (0.96)	0.16 (0.81)	0.26 (0.87)	0.30 (0.89)
T7	0.34 (0.91)	0.63 (1.05)	0.70 (1.07)	0.42 (0.95)	0.35 (0.95)	0.66(1.06)	0.38 (0.93)	0.43 (0.96)	0.49 (0.99)
T8	0.45 (0.97)	0.70 (1.09)	0.75 (1.12)	0.45 (0.97)	0.37 (0.93)	0.72(1.10)	0.42 (0.96)	0.45 (0.97)	0.52 (1.00)
T9	0.14 (0.80)	0.29 (0.89)	0.37 (0.92)	0.15 (0.81)	0.23 (0.81)	0.31 (0.89)	0.15 (0.81)	0.21 (0.84)	0.26 (0.87)

T10	0.12 (0.78)	0.27 (0.87)	0.33 (0.91)	0.14 (0.80)	0.17 (0.82)	0.28 (0.88)	0.13 (0.79)	0.18 (0.82)	0.23 (0.85)
T11	0.11 (0.78)	0.25 (0.86)	0.27 (0.88)	0.09 (0.77)	0.12 (0.79)	0.26 (0.86)	0.10 (0.77)	0.15 (0.80)	0.20 (0.83)
T12	0.65 (1.07)	1.05 (1.21)	0.98 (1.18)	0.83 (1.13)	0.90 (1.14)	0.90 (1.14)	0.45 (0.97)	0.73 (1.08)	0.73 (1.08)
F test	N.S	N.S.	N.S.	N.S	N.S.	N.S.	N.S	N.S.	N.S.
SE(M)±	0.06	0.09	0.10	0.07	0.08	0.07	0.05	0.07	0.08
CD at 5%	-	-	-	-	-	-	-	-	-
CV %	11.55	16.29	17.21	14.29	15.94	12.86	9.50	14.47	15.26

Conclusion

The treatment Thiamethoxam 25 WG @ 0.4 g/L, Imidacloprid 17.8 SL @ 0.25 ml/L, Triazophos 40 EC @ 2 ml/L, NSE (Neem Seed Extract) @7% and NSE (Neem Seed Extract) @5% were significantly effective in recording lower population of sucking pests i.e. leafhopper, whitefly and mites. Deleterious effects of treatments were not observed on predator on brinja**l** throughout the season *viz.*, ladybird beetle, chrysopa and spider. The treatment of Triazophos 40 EC @ 2ml/L, Imidacloprid 17.8 SL @ 0.25ml/L, Neem seed extract 7%, Neem seed extract 5%recorded 1:6.99, 1:6.34, 1:5.48 and 1:5.06 ICBR, respectively, whereas, lowest ICBR of 1:1.43 was recorded in Azadirachtin 1000 ppm @ 2 ml/L.

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