P-ISSN: 2618-0723
E-ISSN: 2618-0731

NAAS Rating: 5.04
www.extensionjournal.com

International Journal of Agriculture Extension and Social Development

Volume 8; SP-Issue 5; May 2025; Page No. 35-40

Received: 05-02-2025
Accepted: 07-03-2025

Indexed Journal
Peer Reviewed Journal

Evaluation of the efficacy of different eco-friendly insecticides against Whitefly on tomato under polyhouse conditions

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DOI: https://doi.org/10.33545/26180723.2025.v8.i5Sa.1891

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Abstract

The present studies entitled "Eco-friendly management of whitefly on tomato under polyhouse conditions" were carried during the years 2019 and 2020 at farmers' field, Village Surajgarh, Block Matanhail, Distt. Jhajjar (Haryana). Under polyhouse conditions, out of 6 eco-friendly insecticides, Spinosad 45% SC @ 188 ml/ha proved to be most effective treatment in keeping the population of whitefly at significantly lowest level. Neem oil @ 0.3% was found to be the next most effective treatment against whitefly. The cow urine based formulations *viz*. Brahmastra, Neemastra and Dashparniark were found least effective among all the treatments but significantly better than untreated control.

Keywords: Brahmastra, dashparniark, ecofriendly, neemastra, spinosad, whitefly

1. Introduction

Tomato (*Solanum lycopersicum* L.), a member of the Solanaceae family, is one of the most important vegetable crops cultivated globally. In India, tomato ranks as the second most important vegetable crop after potato (Solieman *et al*., 2013) [8]. Tomato fruits are known to stimulate gastric secretions and act as a natural blood purifier. Nutritionally, tomatoes are rich in essential minerals, vitamins, amino acids, sugars, and dietary fiber. (Kachave *et al*., 2020) [4]. A key compound in tomatoes is lycopene, a powerful antioxidant linked to a reduced risk of certain cancers and neurodegenerative diseases.

Among the various factors contributing to low tomato yields, insect pests play a major role. Key pests causing significant damage include the fruit borer (*Helicoverpa armigera* Hub.), along with several sucking pests such as the whitefly (*Bemisia tabaci* Genn.), leafhopper (*Amrasca devastans* Ishida), thrips (*Scirtothrips dorsalis* Lind.), and the serpentine leaf miner (*Liriomyza trifolii* Burgess) (Lal *et al*., 2008) [5]. To mitigate pest damage and adverse climatic effects, cultivation under protected structures such as polyhouses has become increasingly popular. These structures not only offer protection against insect pests and diseases but also enhance fruit quality and improve yield and productivity per unit area and time. However, there is limited literature available on the occurrence and behavior of insect pests under polyhouse conditions (Sri *et al*., 2017) [9].

Currently, farmers rely heavily on chemical pesticides for pest control which led to several issues, including toxicity to non-target organisms, pesticide residues in food products, environmental pollution, and the development of resistance in pest populations. These challenges highlight the urgent need for the development of safer, biodegradable, and environmentally friendly alternatives to conventional insecticides. Keeping in view the above aspects present studies were carried out to evaluate efficacy of eco-friendly insecticides against whitefly (*B. tabaci*) under polyhouse conditions for devising effective pest management strategies.

2. Materials and Methods

The present studies on "evaluation of the efficacy of different eco-friendly insecticides against whitefly of tomato under polyhouse conditions" were carried out at farmers' field, Village Surajgarh, Block Matanhail, Distt. Jhajjar (Haryana) during the year 2019 and 2020.

Details of treatments used against whitefly on tomato under polyhouse conditions

- T1: *Beauveria bassiana* @ 4 g/l of water
- T2: Neem oil @ 0.3 ml/l of water
- T3: Brahmastra @ 40 ml/l of water
- T4: Neemastra @ 278 l/ha
- T5: Dashparniark @ 40 ml/l of water
- T6: Spinosad 45% SC @ 0.375 ml/l of water
- T7: Malathion 50% EC @ 2 ml/l of water
- T8: Untreated control

Preparation of cow-urine based formulation (eco-friendly insecticides) *viz.*, Agniastra, Brahmastra, Neemastra and Dashparni ark: The method of preparation of cow urine based formulations *viz.* Agniastra, Brahmastra, Neemastra

and Dashparniark was adopted as suggested by Bishnoi and Bhati (2017) [2]:

Neemastra: Crush 12.5 kg neem leaves in water, add 12.5 litre cow urine and 5 kg cow dung, ferment for 24 hours with intermittent stirring, filter squeeze the extract and dilute to 250 litre, use as foliar spray over one hectare.

Brahmastra

- Crush 7.5 kg neem leaves in 25 litre cow urine.
- Crush 5 kg custard apple leaves, 5 kg papaya leaves, 5 kg pomegranate leaves, 5 kg guava leaves.
- Mix the two and boil slowly till it becomes half.
- Keep for 24 hours, then filter squeeze the extract. This can be stored in bottles for six months.
- Dilute 5-6.25 litres of this extract with water to make the volume 250 litres for one hectare.

Agniastra

Ingredient Agniastra

- Tobacco - 50 gm
- Green chillies - 50 gm
- Garlic - 50 gm
- Neem leaves - 500 gm
- Cow urine - 1500 ml

Grind all the ingredients into fine paste and mix with cow urine. Boil this for four times. Leave it for 48 hours, filter it, mix with water and spray on the plants. Use Agniastra against the pests like leaf roller, stem borer, fruit borer, pod borer.

Dashparniark

Ingredients for Dashparniark

1. **Extracts:** Nirguna, Gudhal, Kaner, Neem, Green Chilli, Ghanari, Sitafal, Arand, Aak and Papaya leaves - 2 kg
2. **Cow dung:** 3-4 kg
3. **Cow urine:** 2-3 litres
4. **Water:** 200 litres

Preparation Method

Step-I: Take 200 litres of water in a tank and then put 2 kg leaves of ten types of plants in equal amounts. After this, add 5 litres cow urine and 5 kg cow dung to the submerged leaves and mix this mixture well.

Step-2: Leave the prepared mixture for 5 days. Put 5-7 litres water in this mixture on 6th day and mix all the ingredients in the tank well.

Step-3: Leave this mixture for one month. When the time is over, filter out this mixture and use it.

Preparation Time:1 month
Storage:4 month
Preparation of Spraying Solution:
The required amount of toxicant was calculated with the help of following formula:

$$\text{Amount of Formulation} = \frac{\text{Concentration required (Percentage) x Volume (Litre)}}{\text{Concentration of toxicant in insecticide}}$$

The required amount of solution was sprayed separately in each plot of experiment except control plots.
The first spray was applied at ETL of whitefly *B. tabaci i.e.* 4 adults/three leaves.

The following observations were recorded

1. The observation on nymphs and adults of whitefly, *Bemisia tabaci* were recorded on three leaves of all the five plants in each treatment one day before spray, then at three and seven days after each spray till end of the crop.
2. Total yield, marketable yield and incremental benefit cost ratio of all the treatments were calculated.

Statistical analysis of data

The data collected were statistically analyzed using SPSS (Statistical Package for the Social Science).

3. Results

The efficacy of different eco-friendly insecticides had been evaluated against, whitefly, *Bemisia tabaci* (Genn.) on tomato under polyhouse conditions and results are presented as under:

Population of whitefly, *Bemisia tabaci* after 1st spray on tomato under polyhouse conditions

It is evident from the Table 1 that non-significant differences among different treatments including untreated control were observed in the population of whitefly (*Bemisia tabaci)*, one day before first insecticidal spray (4.86 to 5.20 nymphs and adults/three leaves). Three days after first insecticidal spray, significantly lower population of the pest was recorded in all the treatments as compared to untreated control (T_8), where it varied from 4.06 to 5.26 nymph & adults/three leaves, in T_6 (Spinosad 45% SC @ 188 ml/ha) and in T_5 (cow urine based formulations i.e. Dashparniark @ 20 l/ha), respectively. After seven days of insecticidal spray, significantly lowest population of *B. tabaci* (3.19 nymph and adults/three leaves) was recorded in T_6 and highest population of the pest i.e. 6.26 nymph and adults/three leaves in T_4 (Neemastra @ 278 ml/ha) which was at par with T_5. Among the different treatments, the highest (58.40%) and lowest (18.38%) population reduction over untreated control was observed in T_6 and T_4, respectively.

Table 1: Effect of eco-friendly insecticides after 1st spray on the population of whitefly, *Bemisia tabaci* on tomato under polyhouse conditions

Sr. No.	Treatment (T)	Dose	Nymphs and adults/three leaves (No.)			Reduction over untreated control (%)
			1 Day Before Spray	3 Days after Spray	7 Days after Spray	
1	*Beauveria bassiana* 1% WP (1x10^8 cfu/g)	2.0 kg/ha	4.80	4.53^{d}	4.47^{d}	41.72
2	Neem oil	0.3%	4.86	4.14^{e}	4.03^{d}	47.45
3	Brahmastra	20 lt/ha	4.93	4.86^{c}	5.73^{c}	25.29
4	Neemastra	20 lt/ha	5.06	5.13^{bc}	6.26^{b}	18.38
5	Dashparniark	20 lt/ha	5.00	5.26^{b}	5.80^{b}	24.38
6	Spinosad 45% SC	188 ml/ha	4.90	4.06^{e}	3.19^{e}	58.40
7	Malathion 50% EC (Treated check)	1000 ml/ha	5.20	4.93^{b}	4.47^{d}	41.72
8	Untreated control		5.13	6.64^{a}	7.67^{a}	
	SE (m)		0.11	0.10	0.15	
	CD (p = 0.05)		NS	0.31	0.47	

Means with the same letter are not significantly different

Population of whitefly, *Bemisia tabaci* after 2nd spray on tomato under polyhouse conditions

The data presented in Table 2 revealed that before second insecticidal spray under polyhouse conditions, the population of whitefly varied from 3.19 to 6.26 nymphs and adults per three leaves in all treatments as against significantly highest (7.67 nymphs and adults/three leaves) in untreated control. After three days of insecticidal spray, all the treatments proved significantly better than untreated control, where the population of the pest varied between 2.73 and 6.06 nymphs and adults in T_6 and T_4, respectively. However, 2.00 to 5.83 nymphs and adults/ three leaves 7 days of 2nd treatment were recorded respectively. The significantly lowest population of the pest 2.73 and 2.00 nymphs and adults/three leaves was observed in treatment T_6 after 3 and 7 days of 2nd insecticidal sprays, respectively. It was followed by T_1 (Neem oil) and T_7 (treated check) which were statistically similar after 3 and 7 days of 2nd insecticidal spray.

Table 2: Effect of eco-friendly insecticides after 2nd spray on the population of whitefly, *Bemisia tabaci* on tomato under polyhouse conditions

Sr. No.	Treatment (T)	Dose	Nymphs and adults/three leaves (No.)			Reduction over untreated control (%)
			1 Day Before Spray	3 Days after Spray	7 Days after Spray	
1	*Beauveria bassiana* 1% WP (1x10^8 cfu/g)	2.0 kg/ha	4.47^{d}	4.26^{d}	4.07^{d}	58.72
2	Neem oil	0.3%	4.03^{d}	3.87^{e}	3.53^{e}	63.72
3	Brahmastra	20 lt/ha	5.73^{c}	5.33^{c}	5.20^{c}	46.56
4	Neemastra	20 lt/ha	6.26^{b}	6.06^{b}	5.83^{b}	40.08
5	Dashparniark	20 lt/ha	5.80^{b}	5.33^{c}	5.13^{c}	47.27
6	Spinosad 45% SC	188 ml/ha	3.19^{e}	2.73^{f}	2.00^{f}	79.44
7	Malathion 50% EC (Treated check)	1000 ml/ha	4.47^{d}	4.07^{de}	3.46^{e}	64.44
8	Untreated control		7.67^{a}	8.86^{a}	9.73^{a}	
	SE (m)		0.15	0.09	0.12	
	CD (p = 0.05)		0.47	0.29	0.35	

Means with the same letter are not significantly different

At this stage, the highest pest population reduction (79.44%) over untreated control was recorded in T_6 (Spinosad 45% SC) followed by T_7 (Malathion 50% EC) and T_2 (Neem oil 0.03%). The lowest pest population reduction (40.08%) over untreated control was observed in T_4 (Neemastra @ 278 l/ha).

Population of whitefly, *Bemisia tabaci* on tomato after 3rd spray under polyhouse conditions

The data recorded for the incidence of whitefly in different treatments before and after third insecticidal sprays are mentioned in Table 3. The recorded data indicated that the population of whitefly before 3rd insecticidal spray varied from 2.00 to 5.83 as against 9.73 nymphs and adults/three leaves in untreated control (T_8). After 3 and 7 days of spray, the recorded pest population data revealed that all the treatments were significantly better than untreated control. Among all the treatments including treated check, T_6 showing 1.46 and 1.27 nymphs and adults/three leaves after 3 and 7 days of spray, respectively proved to be statistically most effective followed by T_7 (Treated check) which was significantly better than the rest of the treatments. The treatments T_3 and T_4 were statistically at par and found least effective among all the treatments.

Table 3: Effect of eco-friendly insecticides after 3rd spray on the population of whitefly, *Bemisia tabaci* on tomato under polyhouse conditions

Sr. No.	Treatment (T)	Dose	Nymphs and adults/three leaves (No.)			Reduction over untreated control (%)
			1 Day Before Spray	3 Days after Spray	7 Days after Spray	
1	*Beauveria bassiana* 1% WP ($1x10^8$ cfu/g)	2.0 kg/ha	4.07^{d}	3.80^{c}	3.27^{d}	70.80
2	Neem oil	0.3%	3.53^{e}	3.33^{d}	3.14^{d}	71.96
3	Brahmastra	20 lt/ha	5.20^{c}	5.07^{b}	4.47^{b}	60.09
4	Neemastra	20 lt/ha	5.83^{b}	5.14^{b}	4.53^{b}	59.64
5	Dashparniark	20 lt/ha	5.13^{c}	4.86^{b}	3.74^{c}	66.60
6	Spinosad 45% SC	188 ml/ha	2.00^{f}	1.46^{f}	1.27^{f}	88.66
7	Malathion 50% EC (Treated check)	1000 ml/ha	3.46^{e}	2.93^{e}	2.60^{e}	76.78
8	Untreated control		9.73^{a}	10.80^{a}	11.20^{a}	
	SE (m)		0.12	0.13	0.16	
	CD (p = 0.05)		0.35	0.41	0.44	

Means with the same letter are not significantly different

The highest reduction in pest population over untreated control was recorded (88.66%) in T_6 (Spinosad 45% SC) followed by T_7 while the lowest population reduction was observed in T_4 (59.64%).

Population of whitefly, *Bemisia tabaci* on tomato after 4th spray under polyhouse conditions

The data pertaining to the incidence of whitefly in different treatments before and after 4th insecticidal spray is mentioned in Table 4. The perusal of the data indicated that the population of whitefly, *B. tabaci*, before 4th spray varied from 1.27 to 4.53 nymph and adult per three leaves against significantly highest i.e. 11.20 nymphs and adults per three leaves in untreated control. All the treatments proved significantly better than T_8 (untreated control) where whitefly population was 10.60 and 9.13 per three leaves at 3 and 7 days after 4th spray, respectively. The significantly lowest population of whitefly i.e.1.06 and 0.86 nymphs and adults per three leaves in T_6 (Spinosad 45% SC) was recorded, respectively as compared to the remaining treatments. Among various treatments, the highest pest population was recorded in T_4 (Neemastra @ 278 l/ha) and T_3 (Brahmastra @ 20 l/ha) which were statistically at par, both at 3 and 7 days after 4th spray. The rest of the treatments were statistically at par with each other and found place between two extremes. Among different treatments, the highest pest population reduction (90.58%) over untreated control was recorded in T_6 (Spinosad 45% SC @ 188 ml/ha) followed by T_2 (79.62%) while lowest in T_3 (58.30%).

Table 4: Effect of eco-friendly insecticides after 4th spray on the population of whitefly, *Bemisia tabaci* on tomato under polyhouse conditions

Sr. No.	Treatment (T)	Dose	Nymphs and adults/three leaves (No.)			Reduction over untreated control (%)
			1 Day Before Spray	3 Days after Spray	7 Days after Spray	
1	*Beauveria bassiana* 1% WP ($1x10^8$ cfu/g)	2.0 kg/ha	3.27^{d}	3.07^{c}	2.67^{c}	70.75
2	Neem oil	0.3%	3.14^{d}	2.40^{d}	1.86^{d}	79.62
3	Brahmastra	20 lt/ha	4.47^{b}	3.93^{b}	3.80^{b}	58.38
4	Neemastra	20 lt/ha	4.53^{b}	4.13^{b}	3.73^{b}	59.14
5	Dashparniark	20 lt/ha	3.74^{c}	3.20^{c}	2.73^{c}	70.09
6	Spinosad 45% SC	188 ml/ha	1.27^{f}	1.06^{e}	0.86^{e}	90.58
7	Malathion 50% EC (Treated Check)	1000 ml/ha	2.60^{e}	2.80^{cd}	2.47^{cd}	72.94
8	Untreated control		11.20^{a}	10.60^{a}	9.13^{a}	
	SE (m)		0.16	0.14	0.25	
	CD (p = 0.05)		0.44	0.43	0.74	

Means with the same letter are not significantly different

Population of whitefly, *Bemisia tabaci* on tomato after 5th insecticidal spray under polyhouse conditions

The data presented in Table 5 revealed that the population of whitefly one day before 5th spray varied from 0.86 to 3.80 nymphs and adults per three leaves in various treatments against 9.13 in untreated control. Three and seven days after 5th insecticidal spray, significantly lowest population i.e. 0.73 and 0.67 (nymphs and adults per three leaves), respectively was recorded in T_6 (Spinosad 45% SC @ 188 ml/ha). The highest population of whitefly i.e. 3.47 and 3.13 nymphs and adults per three leaves was recorded in T_3 (Brahmastra @ 20 l/ha) at 3 and 7 days after 5th spray, respectively which was statistically at par with T_4. However, all the treatments were proved significantly better than untreated control (T_8) where population of whitefly was 7.47 nymphs and adults three leaves.

Table 5: Effect of eco-friendly insecticides after 5th spray on the population of whitefly, *Bemisia tabaci* on tomato under polyhouse conditions

Sr. No.	Treatment (T)	Dose	No. of nymphs and adults per three leaves			Reduction over untreated control (%)
			1 Day Before Spray	3 Days after Spray	7 Days after Spray	
1	*Beauveria bassiana* 1% WP (1x10^8 cfu/g)	2.0 kg/ha	2.67^c	2.33^c	2.07^c	72.29
2	Neem oil	0.3%	1.86^d	1.60^d	1.33^d	82.19
3	Brahmastra	20 lt/ha	3.80^b	3.47^b	3.13^b	58.09
4	Neemastra	20 lt/ha	3.73^b	3.33^b	2.80^b	62.52
5	Dashparniark	20 lt/ha	2.73^c	2.40^c	1.94^c	74.03
6	Spinosad 45% SC	188 ml/ha	0.86^e	0.73^e	0.67^e	91.03
7	Malathion 50% EC (Treated check)	1000 ml/ha	2.47^{cd}	2.07^{cd}	1.86^c	75.10
8	Untreated control		9.13^a	8.73^a	7.47^a	
	SE (m)		0.25	0.17	0.12	
	CD (p = 0.05)		0.74	0.55	0.36	

Means with the same letter are not significantly different

At this stage, the highest pest population reduction (91.03%) was observed in T_6 (Spinosad 45% SC @ 188 ml/ha) followed by T_2 treatment (Neem oil 0.03%) where 82.19 per cent whitefly population reduction over untreated control was recorded.

Economics of different treatments against whitefly, *Bemisia tabaci* on tomato under polyhouse conditions

The data presented in Table 6 indicated that highest incremental benefit cost ratio (18.20) was recorded in T_5 (Dashparniark) over control. The treatment T_7 (Malathion 50% EC @ 1000 ml/ha) was next to T_5 in terms of incremental benefit cost ratio (17.07) and increased yield of about 64 q/ha over control with net profit of Rs.72,550/ha. Despite the highest increased yield (87 q/ha) over control and highest net return (Rs. 78,400/ha), in treatment T_6 (Spinosad 45% SC @ 188 ml/ha), there was lowest incremental benefit cost ratio i.e. 3.01 due to higher cost of plant protection (Rs. 26,000/ha) among all the treatments. The incremental benefit cost ratio in different treatments in terms of higher to lower are as T_5> T_7> T_4> T_3> T_1> T_2> T_6.

Table 6: Economics of different eco-friendly insecticidal sprays against whitefly, *Bemisia tabaci* on tomato under polyhouse conditions

Treatment (T)	No. of sprays	Cost of Insecticides (Rs./ha)	Labour Cost (Rs./ha)	Total cost of Plant Protection (Rs./ha)	Yield (q/ha)	Increased yield over Control (q/ha)	Value of Increased Yield (Rs.)	Net Profit (Rs./ha)	Incre-mental BCR
T_1	5	3000	2500	5500	327	55	66000	60500	11.00
T_2	5	6000	2500	8500	330	58	69600	65850	7.74
T_3	5	500	2500	3000	306	34	40800	37800	12.60
T_4	5	500	2500	3000	311	39	43800	43800	14.60
T_5	5	500	2500	3000	320	48	57600	54600	18.20
T_6	5	23500	2500	26000	359	87	104400	78400	3.01
T_7	5	1750	2500	4250	336	64	76800	72550	17.07
T_8	-	-	-	-	272	-	-	-	-

Cost of Insecticides

1. *Beauveria bassiana* @ Rs. 300/kg; 2. Neem oil 1500ppm (0.03%) @ Rs. 600/l; 3.c.u.b.f. (Brahmastra) @ Rs. 20/20l; 4. c.u.b.f. (Neemastra) @ Rs. 20/20l; 6.c.u.b.f. (Dashparniark) @ Rs. 20/20l; 6. Spinosad 45% @ Rs. 1875/75ml; 7.Malathion50% EC @ Rs. 350/l

4. Discussion

The efficacy of different eco-friendly insecticides had been evaluated against whitefly *Bemisia tabaci* on tomato under polyhouse conditions during 2019-20. On the basis of results, it is clear that out of 6 eco-friendly insecticides, Spinosad 45% SC @ 188 ml/ha proved to be most effective treatment in keeping the population of whitefly at significantly lowest level in all the treatments right from 1st to 5th spray at weekly interval under polyhouse conditions. Neem oil 0.3% was found to be the next most effective treatment which was at par with *Beauveria bassiana* 1% WP (1 x 10^8 cfu/g) during initial sprays but was significantly better after 5th spray. The cow urine based formulations *viz.* Brahmastra, Neemastra and Dashparniark were found least effective among all the treatments but significantly better than untreated control. However, Dashparniark was found significantly better than other cow urine based formulations against whitefly under polyhouse conditions. After completion of 5 sprays, maximum of 91.03 per cent reduction in the population of whitefly over control, was recorded in Spinosad 45% SC @ 188 ml/ha as against 58.09 per cent in Brahmastra, the least effective treatment.

The economics of different insecticidal treatments has also been calculated. The highest incremental benefit cost ratio (18.20) was recorded in T_5 (Dashparniark) closely followed by T_7 (treated check) while the lowest (3.01) incremental benefit cost ratio was reported in T_6 despite maximum net profit (Rs. 78,400/ha) among all the treatments. The low IBCR in T_6 is simply because of highest cost of plant protection. In cow urine based formulations, the IBCR ranged from 12.80 to 18.20 because total cost of plant protection was very low i.e. Rs. 3,000/ha but the net profit ranged from Rs. 37,800/- to Rs. 54,600/-, which was also lowest among all the treatments. The results of present study are in full conformity to the findings of Abdel-Razek *et al.* (2017) [1] who also reported high efficacy of Spinosad on

Bemisia tabaci population and different eco-friendly treatment reduced the whitefly population from 52.0 to 94.61 per cent. The results are also in concurrence with the findings of Senguttuvan *et al.* (2005) [7] and Leeuwen *et al.* (2005) [6] also found NSKE and Spinosad as very effective against the tomato whitefly, respectively. The study on the efficacy of eco-friendly insecticides against leaf miner get full support from the observations of Chavan *et al.* (2013) [3] who also recorded that Spinosad reduced the leaf infestation by *Liriomyza trifolii*.

5. Summary and Conclusion

The efficacy of different eco-friendly insecticides had been evaluated against whitefly, *Bemisia tabaci* (Genn.) on tomato under polyhouse conditions during 2019-20. Three and seven days after 5th insecticidal spray, significantly lowest population i.e. 0.73 and 0.67 (nymph and adults per three leaves), respectively of whitefly was recorded in T_6 (Spinosad 45% SC @ 188 ml/ha). The highest population of whitefly i.e. 3.47 and 3.13 nymph and adults per three leaves was recorded in T_3 (Brahmastra @ 20 l/ha) at 3 and 7 days after 5th spray, respectively which was statistically at par with T_4. However, all the treatments were proved significantly better than untreated control (T_8) where population of whitefly was 7.47 nymph and adults three leaves.

6. References

1. Abdel-Razek AS, El-Ghany NMA, Djelouah K, Mousa. An evaluation of some eco-friendly biopesticides against *Bemisia tabaci* on two greenhouse tomato varieties in Egypt. J Plant Prot Res. 2017;57(1):9-17.
2. Bishnoi R, Bhati A. An overview: Zero Budget Natural Farming. Trends Biosci. 2017;10(46):9314-6.
3. Chavan SM, Kumar S, Arve SS. Population dynamics and development of suitable pest management module against major insect-pests of tomato (*Solanum lycopersicum*). J Appl Hortic. 2013;15(2):150-5.
4. Kachave DR, Sonkamble MM, Patil SK. Population dynamics of major insect pests infesting tomato (*Lycopersicon esculentum*). J Pharmacogn Phytochem. 2020;9(3):344-8.
5. Lal KM, Singh SP, Kumari K, Singh SN. Bio-efficacy of beta-cyfluthrin, lambda-cyhalothrin and imidacloprid against *Earias vitella* Fab. in okra. Ann Plant Prot Sci. 2008;16(1):21-4.
6. Leeuwen TV, Veire MVD, Dermauw W, Tirry L. Systemic toxicity of Spinosad to greenhouse whitefly and *Spodoptera littoralis*. Phytoparasitica. 2005;34(1):102-8.
7. Senguttuvan K, Kuttalam S, Manoharan T, Srinivasan T. Bio-efficacy of *Melia dubia* Cav and neem products against major insect-pests of tomato. Pestology. 2005;29(1):47-50.
8. Solieman THI, El-Gabry MAH, Abido AI. Heterosis, potence ratio and correlation of some important characters in tomato (*Solanum lycopersicum* L.). Sci Hortic. 2013;150:25-30.
9. Sri NR, Jha S, Latha NS. Insect pests of tomato and their weather relations under open and cover cultivation. Int J Curr Microbiol Appl Sci. 2017;6(9):368-75.