Pest Management in Horticultural Ecosystems
Vol. 28, No.1 pp 93-99 (2022)
DOI number : 10.5958/0974-4541.2022.00007.8

Efficacy of certain biopesticides against whitefly, *Bemesia tabaci* (Gennadius) on okra and its correlation with abiotic factors

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ABSTRACT: A field experiment was carried out at the Assam Agricultural University, Jorhat, Assam, India during 2018-2019 to evaluate the efficacy of different biopesticides against whitefly, *Bemesia tabaci* (Gennadius) on okra. The treatments *viz.,* neem oil @ 5%, karanj oil @ 5%, *Melia azedarach* leaf extract @ 5%, garlic extract @5%, chilli fruit extract @5%, *Beauveria bassiana* @ 5%, *Lecanicillium lecanii* @ 5%, deltamethrin @ 10 g *a.i.*/ha were applied at 15 days interval starting from seedling stage when whitefly infestation started. Results revealed that overall best performance of insecticides against whitefly recorded in deltamethrin treated plots with lowest mean population followed by neem oil, *Verticillim lecanii*. And observations for whiteflies were recorded at a weekly interval from three leaves per plant, starting from 14th Standard Meteorological Week (SMW). The maximum population of whiteflies (14.91 whiteflies/3 leaves) was observed during the 18th SMW. While the minimum population of whiteflies (3.04 whiteflies/3 leaves) was observed during 31st SMW. Whitefly population was significantly and negatively correlated with maximum temperature and minimum temperature and positively correlated with the bright sunshine hours and the correlation of whiteflies with all other weather parameters was negative and non-significant.

Keywords: Whitefly, neem oil, *Lecanicillium lecanii*, abiotic factors, correlation, okra.

INTRODUCTION

Okra (*Abelmoschus esculentus*), also called Lady's finger/ bhendi, belongs to the family Malvaceae. It is a short duration crop and grown throughout the year. In India, okra is cultivated over an area of 509 (000'Ha) with production of 6095 (000' MT) and productivity of 12 MT/ha. Andhra Pradesh, Arunachal Pradesh, Bihar, Assam, Chhattisgarh, Gujarat, Haryana and Himachal Pradesh are major okra growing states. In Assam, it is cultivated in an area of 12,110 hectares with a production of 191.70 thousand tonnes (Anon., 2017). Throughout its growth period, okra is devastated by around 72 species of insect pests and mites (Rao and Rajendran, 2003). This is the major constraint for the low productivity of okra in India. The intensity of damage caused by pests also varied from one region to another. Among insect pests of okra, leafhopper, *Amrasca biguttula biguttula* (Ishida), whitefly, *Bemesia tabaci* (Gennadius) and shoot and fruit borer *Earias* spp. are the prominent insect pests (Singh *et al.*, 1993). The sucking pest complex comprising whiteflies, thrips, leafhoppers and mites are major pests and causing17.46 percent yield loss in okra (Sarkar *et al.,* 1996). Whitefly, *B. tabaci* has become a crucial pest on vegetables, field crops, ornamental plants and fruits all over the world and attacks 176 plant species with ample damage (Oliveira *et al.,* 2001). The pest also transmits serious disease like yellow vein mosaic, influencing the quality of the produce. At present, schedule based application of various insecticides is recommended for the management of different insect pests. But, the injudicious use of synthetic chemicals to manage these pests has resulted in resistance, resurgence, secondary pest outbreak, toxicity to beneficial organisms (Mandal *et al.* 2006). Botanical and biological agents have a vital role to control pest damage. Abiotic parameters play an essential role to accelerate the population of insect pests. To avoid the reduction in yield caused by the sucking pests, all efforts are needed to manage these pests by gathering the information of appearing of the pests and the influence of various abiotic factors on them. Moreover, correlation study helps in allocating either positive or negative association of pest population with abiotic factors. Thus, in this experiment, efforts have been made to examine the population fluctuation of the whitefly of okra and its correlation with abiotic parameters.

MATERIALS AND METHODS

Experimental site

Field experiment was carried out at the Experimental farm, Department of Horticulture, Assam Agricultural University, Jorhat, Assam. The experiment was conducted with okra (Arka Anamika) in Randomized Block Design with nine treatments including control and three replications. The net area for the experiment was 230sq.m. The area was divided into three blocks and each block was further divided into nine equal plots (2.7m×2.1m) each, respectively. Interspacing between blocks was 0.60m and plots were 0.45m.

Extraction of botanicals

Preparation of *Melia azedarach* L. leaf extract

The fresh leaves of naturally grown mature plants were collected and washed thoroughly and then were dried under shade. After, drying the plant material was grounded to a fine powder and sieved separately through an 80 mesh nylon cloth and soaked in distilled water at room temperature between 24 to 48 hours. The ratio of plant material to water was 1:20 (w:v), which was necessary to make a 5% solution. After soaking, the plant materials were squeezed manually. The solution was then filtered through a fine-mesh nylon cloth to obtain an extract, free of plant residue and detritus.

Preparation of garlic extract

The outer layers of matured garlic were peeled off, after that grounded to paste. 50 gm of paste was mixed with one litre of distilled water at room temperature for 24 to 48 hours to give a 5% solution. The solution was filtered through a fine-mesh nylon cloth to obtain an extract free of any residue and detritus.

Preparation of chilli fruit extract

The chilli fruits were collected and dried under shade and grounded to a fine powder. 50 gm of chilli powder was mixed with one litre of water to make a 5% concentration. After that soaked in distilled water at room temperature for 24 to 48 hours. After soaking the solution was filtered through a fine mesh nylon cloth to obtain an extract, free of residue and detritus.

Preparation of fungal bio-formulations

The fungal bio-agents *viz*., *Beauveria bassiana* and *Lecanicillium lecanii* were collected from the Department of Plant Pathology, Assam Agricultural University. 5 ml of the fungal formulation was mixed with 1000ml of water.

Recording observations

At the time of appearance of the pest, the crop was sprayed with these treatments as mentioned above. The treatments were imposed by using a knapsack sprayer @ 400-500 litres of spray solution/ha depending on the stage of the crop. The crop received a total of 3 sprays. The spray application was given at the time of incidence noticed and second, the spray was given at an interval of 15 days thereafter. For recording the number of whiteflies, five plants were selected randomly in each plot and were tagged. Observations were recorded on three leaves; each at the top, middle and bottom of five tagged plants in each plot. The first observation was recorded 1 day before treatment as a pre-treatment count and post-treatment observations were recorded at the 3, 7 and 10 days after each spraying. Data thus obtained were analysed statistically and presented.

To know the correlation of the whitefly population with the abiotic factors, observations were recorded on 10 tagged plants once in a standard week, which started from the first appearance of the pest and was continued till their availability or maturity of the crop, whichever was earlier. Simultaneously, a corresponding weekly record of meteorological data was recorded. Standard week average of all the data collected *viz.,* minimum and maximum temperature, morning and evening percent relative humidity, total rainfall per week and bright sunshine hours were maintained. These meteorological factors were calculated for statistical analysis. All the possible correlations and multiple regression were worked out. The influence of different weather parameters on whitefly population was studied.

RESULTS AND DISCUSSION

Results revealed that there was no significant difference in the whitefly population among the treatments before spraying. During the first spray (Table 1), the lowest mean population of whiteflies was observed in the deltamethrin treated plots (1.23 whiteflies/3 leaves), followed by neem oil (1.74 whiteflies/3 leaves) and the next best treatment was *Lecanicillium lecanii* (2.03 whiteflies/3 leaves). The other treatments recorded the pest count in the range of 2.63 to 3.82 whiteflies/3 leaves. The data showed that the treatment of deltamethrin @ 10 gm *a.i.*/ha recorded the highest percent reduction (70.78%) of whitefly population followed by neem oil @ 5% (62.74%), *L. lecanii* @ 5ml/l (57.62%), karanj oil @ 5% (50.10%), *B. bassiana* @ 5ml/l (44.75%) and *M. azedarach* leaf extract @ 5% (42.38%). After the second spray (Table 2), results revealed that the deltamethrin recorded the minimum population of 2.18 whiteflies/3 leaves. Followed by neem oil @ 5% (3.01 whiteflies/3 leaves), *L. lecanii* @ 5ml/l (3.15 whiteflies/ 3 leaves). Garlic extract and chilli fruit extract were found to be less effective in reducing the whitefly population but were superior over control. A similar trend was observed in the percent reduction of whitefly population over control as in the first spray. After the final spray (Table 3), the lowest mean population of whitefly was observed in deltamethrin treated plots with 2.58 whiteflies/3 leaves followed by neem oil @ 5% was found best with 3.21 whiteflies/3 leaves, *L. lecanii* @ 5ml/l (3.35 whiteflies/ 3 leaves). The data showed that the treatment of deltamethrin 10 gm *a.i.*/ha recorded the highest percent reduction (71.21%) of whitefly population followed by neem oil @ 5% (63.36%), *L. lecanii* @ 5ml/l (55.75%) and karanj oil @ 5% (44.16%). The minimum percent reduction in the whitefly population was observed in plots

Table 1. Efficacy of different treatments against whitefly, *Bemisia tabaci* population on okra during 1st spray

Treatment	Dose	Number of Whiteflies/3 leaves I spray					Per cent reduction in population
		1 DBS	3 DAS	7 DAS	10 DAS	Mean	
Neem oil	5%	4.67	1.85	1.42	1.96	1.74	62.74
Karanj oil	5%	4.87	2.43	1.65	3.21	2.43	50.10
Melia azedarach leaf extract	5%	5.12	2.92	1.98	3.96	2.95	42.38
Garlic extract	5%	5.23	3.26	3.33	3.35	3.31	26.96
Chilli fruit extract	5%	4.87	3.21	2.92	3.01	3.04	27.93
Beauveria bassiana	5ml/l	4.76	2.81	1.86	3.23	2.63	44.75
Lecanicillium lecanii	5ml/l	4.79	2.16	1.57	2.37	2.03	57.62
Deltamethrin	10g *a.i*/ha	4.21	1.54	0.98	1.18	1.23	70.78
Control	-	5.02	4.34	3.89	6.70	4.98	0.80
S.Ed±	-	0.39	0.43	0.28	0.33	-	-
CD(P=0.05)	-	NS	0.92	0.63	0.71	-	-

NS=Non significant DBS=Day before spray DAS=Days after spray Data are mean of 3 replications

Table 2. Efficacy of different treatments against whitefly, *Bemisia tabaci* population on okra during 2nd spray

Treatment	Dose	Number of Whiteflies/3 leaves					Per cent reduction in population
		1 DBS	3 DAS	7 DAS	10 DAS	Mean	
Neem oil	5%	6.23	3.86	2.33	2.83	3.01	51.68
Karanj oil	5%	5.65	3.55	2.87	3.34	3.25	42.48
Melia azedarach leaf extract	5%	5.52	3.86	3.70	5.99	4.52	18.12
Garlic extract	5%	6.12	5.19	4.87	4.96	5.01	18.14
Chilli fruit extract	5%	5.53	5.52	4.11	5.12	4.92	11.03
Beauveria bassiana	5ml/l	6.39	4.22	3.81	4.61	4.21	34.12
Lecanicillium lecanii	5ml/l	5.92	3.97	2.16	3.33	3.15	46.79
Deltamethrin	10g *a.i*/ha	6.53	2.56	2.15	1.82	2.18	66.62
Control	-	6.91	6.46	6.23	6.73	6.47	6.37
S.Ed±	-	0.40	0.41	0.29	0.39	-	-
CD(P=0.05)	-	0.85	0.88	0.62	0.82	-	-

DBS=Day before spray DAS=Days after spray Data are mean of 3 replications

Table 3. Efficacy of different treatments against whitefly, *Bemisia tabaci* population on okra during 3rd spray

Treatment	Dose	Number of Whiteflies/3 leaves					Per cent reduction in population
		III spray					
		1 DBS	3 DAS	7 DAS	10 DAS	Mean	
Neem oil	5%	8.76	3.45	2.98	3.21	3.21	63.36
Karanj oil	5%	7.54	4.43	3.65	4.54	4.21	44.16
Melia azedarach leaf extract	5%	8.12	4.98	4.55	6.12	5.22	35.71
Garlic extract	5%	7.92	5.76	4.98	6.61	5.78	27.02
Chilli fruit extract	5%	8.58	5.98	4.93	6.35	5.75	32.98
Beauveria bassiana	5ml/l	7.22	4.98	4.12	5.40	4.83	33.10
Lecanicillium lecanii	5ml/l	7.57	3.25	3.01	3.79	3.35	55.75
Deltamethrin	10g *a.i*/ha	8.96	2.65	2.45	2.65	2.58	71.21
Control	-	8.91	8.40	8.78	8.57	8.58	3.70
S.Ed±	-	0.51	0.53	0.43	0.36	-	-
CD(P=0.05)	-	1.08	1.12	0.92	0.77	-	-

DBS=Day before spray DAS=Days after spray Data are mean of 3 replications

Table 4. Correlation coefficient (r) of whitefly on okra with meteorological parameters

Insect Pests	Temperature (ºC)		Relative Humidity (%)		Rain fall (mm)	BSSH
	Max.	Min.	RH I	RH II		
Whitefly	-0.698**	-0.790**	-0.370^{NS}	-0.439^{NS}	-0.236^{NS}	0.224^{NS}

** Correlation is significant at P=0.01 level

treated with garlic extract @ 5% (27.02%). In control plots, there was 3.70 percent reduction in the population of whiteflies over the pre-treatment count.

The mean data of three sprays imposed in okra, targeting whiteflies indicated that among biopesticides, neem oil @ 5% was the most superior treatment (2.65 whiteflies/3 leaves) followed by *L. lecanii* @ 5ml/l (2.84 whiteflies/3 leaves), karanj oil @ 5% (3.30 whiteflies/3 leaves). The reduction of whitefly population in different treatments was in order of deltamethrin > neem oil > *L. lecanii* > karanj oil > *Beauveria bassiana* > *Melia azedarach* leaf extract > chilli fruit extract > garlic extract. The higher effect of neem oil against sucking pests may be due to feeding deterrence in addition to mortality. As back as 1962, the antifeedant property of neem has been discovered by Pradhan *et al.* the neem seeds contain azadirachtin which possesses antifeedant, repellents as well as insecticidal properties. The findings on the higher efficacy of neem oil against whitefly are in line with Rosaiah (2001) who reported that neem oil @ 0.5% was significantly superior in reducing the population of whitefly *B. tabaci* on okra. The effectiveness of *L. lecanii* is in agreement with Quinden (1984), Meade and Bruce (1991) and Nier *et al.* (1993) and according to them *L. lecanii* was found effective against whitefly, *B. tabaci*. According to Mallappanavar (2002) higher concentration of *L. lecanii* @ 1.33×10^7 spores/ml was found most effective against spiralling whitefly. According to Abdel-Raheem, M.A. and Lamya Ahmed Al-Keridis (2017), *L. lecanii* and *B. bassiana* isolates are promising agents for whitefly control in the field. The effectiveness of *M. azedarach* is in line with Abou – Fakhr *et al.* (2000) who reported that aqueous extracts of *M. azedarach* fruit were detrimental to first and second instars of *B. tabaci*, causing significant mortality of 30.3% compared with the control. During the present investigation, chilli fruit extract and garlic bulb extract were found effective against whitefly. Similar to the present finding Nayem and Rokib (2013) also reported garlic bulb extract to be effective against whitefly.

Correlation of whitefly population with abiotic factors

The results presented in (Table 4), revealed that the population of whitefly ranging from 3.04 to 14.91 whiteflies/3 leaves. The whitefly incidence was started from the 14th SMW (First week of April) at 31.5 ^{0}C maximum temperature, 18.4 ^{0}C minimum temperature, 92% and 56% morning and evening relative humidity, respectively. During the experiment, peak population whitefly (14.91 whiteflies/3 leaves) was observed at 18th SMW (First week of May) with 28.6 ^{0}C maximum temperature, 20.5 ^{0}C minimum temperature, 93% and 72% morning and evening relative humidity, 39.7mm rainfall. After the peak point, the population declined gradually during the successive weeks (Fig.1). The present observations are in corrobortion with the findings of Anitha (2007), who reported as a peak incidence of whitefly attack during the last week of April. Earlier, Hasan *et al.* (2008) reported peak whitefly population when the crop was 60 days old and these results are similar to the present observations. A study on the effect of weather parameters on the whitefly population on okra (Table 5), indicated that maximum temperature (r=-0.698) and minimum temperatures (r=-0.790) were negative and significant. While morning and evening relative humidity was found to have a non-significantly negative correlation with the whitefly population (r= -0.370 and -0.439 respectively). The correlation of whiteflies population with rainfall was also noted to be negative and non-significant (r=-0.236). While with bright sunshine hours it was positive and non-significant (r=0.224). The present findings are in line with Singh *et al.* (2013) who reported that the whitefly population responded negatively with maximum and minimum temperatures. Further, a non-significant negative correlation was obtained by Sharma and Rishi (2005) in relation to rainfall and the whitefly population incidence. Chandrakumar *et al.* (2008) found a negative correlation with maximum temperature and rainfall.

Yield

The yield of okra was significantly different among treatments. The highest fruit yield of okra was recorded in deltamethrin treated plots followed by neem oil, karanj oil. Whereas, the yield obtained from untreated control plots was 22.05q/ha.

CONCLUSION

The present study on evaluation of different biopesticides for eco-friendly management of whitefly population of okra revealed that among the biopesticides used, neem oil and *Lecanicillium lecanii* were found very effective against the target pest. Therefore, neem oil and *L. lecanii* can be an alternative eco-friendly management option for the whitefly of okra. And from the present study, we can conclude that maximum population of whitefly was observed at last week of April and first week may. During the study of whitefly population, significant negative correlation between whitefly population and the abiotic factors like maximum temperature, minimum temperature. However, parameters like morning and evening RH, rainfall and BSSH showed non-significant negative correlation during experimentation.

ACKNOWLEDGEMENT

The authors are grateful to the staff of Department of Entomology, Assam Agricultural University, Jorhat, Assam for their constant support and guidance throughout the course of work.

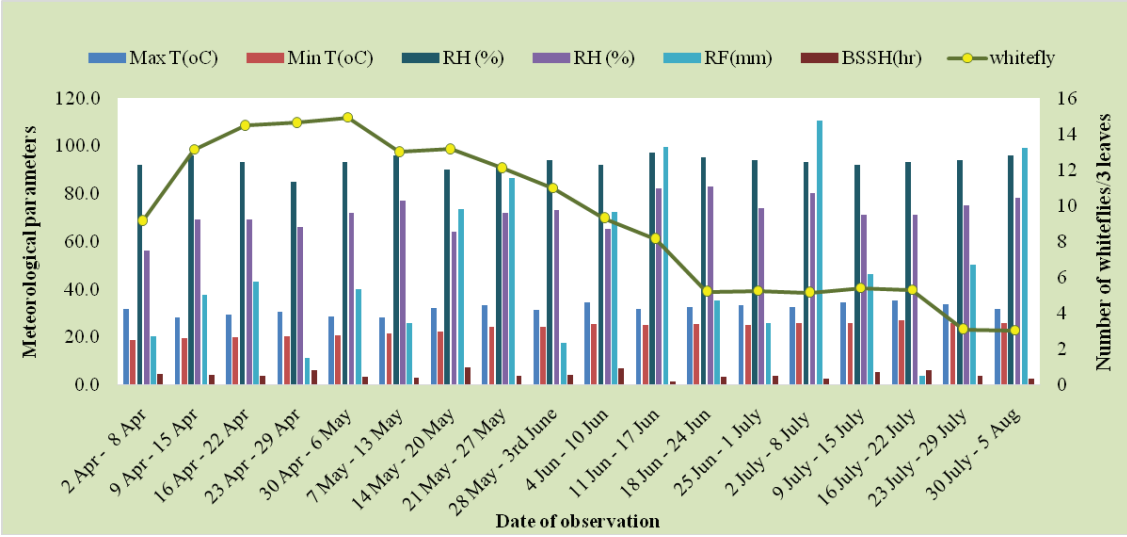

Fig. 1. Population build-up of whitefly, *Bemisia tabaci* in relation to meteorological parameters during April, 2018 to August, 2018

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MS Received: 10 March 2022
MS Accepted: 22 May 2022