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Population dynamics and management of whitefly, *Bemisia tabaci* in tomato ecosystem, *Solanum lycopersicum* L.

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Abstract

Field experiment on population dynamics and management of whitefly, *Bemisia tabaci* was carried out at the experimental farm, Department of Horticulture, Assam Agricultural University, Jorhat, during 2015-16 and 2016-17, respectively. The peak activity of whitefly (6.74/leaf) was observed during the last week of February, 2016 and (6.30/leaf) was observed during the first fortnight of March, 2017. Population of whitefly showed a significant negative correlation with average relative humidity and positive correlation with maximum temperature, total rainfall during both the seasons. The result indicated that all the treatments tested against *B. tabaci* gave effective control. Spinosad @ 0.3 ml/litre was graded as the most effective treatment followed by azadirachtin @ 5 ml/litre and *Beauveria bassiana* @ 5 ml/lit in reducing whitefly population.

Keywords: *Bemisia tabaci*, population dynamics, Spinosad, Azadirachtin, *Beauveria bassiana*, tomato

1. Introduction

Tomato, *Solanum lycopersicon* L. is an herb belonging to family Solanaceae grown throughout India for fresh fruits and processing. It ranks second to potato in importance, but it is first in the list of canned vegetables in the world (Singh, 2005) [1]. Tomato is believed to have been originated in peruvianum and Mexican region, introduced into India by Portuguese. Number of insect pests attack tomato crop from seedling stage to harvest which cause damage to different parts of the plant. Among those, whitefly, *Bemisia tabaci* is one of the important sucking pest. Now farmers mostly rely on chemical insecticides to reduce the population of whitefly, which are not safer to environment. In order to develop ecofriendly management practices, understanding the seasonal incidence of whitefly is very essential and it helps to take management practices at the right time. Hence the present study on seasonal incidence and management of whitefly was conducted.

2. Material and Methods

The present experiment was conducted to study the population dynamics of whitefly, *B. tabaci* of tomato var. Pusa Ruby as well as to evaluate the efficacy of some biopesticides against whitefly during 2015-16 and 2016-17. Observations on whitefly activity were recorded in weekly intervals by taking five randomly selected plants per plot and counting the population from the top, middle and lower parts of the tomato plant. Meteorological factors such as maximum and minimum temperature, relative humidity, rainfall and bright sunshine hours that prevailed during the field experiment were recorded from the meteorological observatory of Assam Agricultural University, Jorhat. To study the influence of meteorological factors on the population build up, correlation studies were carried out. There were all together seven treatments including, Azadirachtin, *Beauveria bassiana*, Spinosad, *Bacillus thuringiensis var krustaki*, *Trichogramma pretiosum*, HaNPV (250 LE) and untreated control were applied in the experimental plot. The observations were recorded on 7, 10 and 15 days after imposing each treatment at 15 days interval and pre count treatment was taken only before first spray. Data obtained from the field experiment on the management of the pest was statistically analysed by Fisher's method of "Analysis of Varience". The source of variation due to replication, treatment and error were separated out from total variation. The significance and non- significance of a given variation was then ascertained by Duncan's Multiple Range Test (DMRT).

3. Results and Discussion

3.1 Influence of weather parameters on population buildup of *Bemisia tabaci* during 2015-16 and 2016-17

The data pertaining to seasonal incidence is given in table 1 and table 2. The pest started appearing during third week of November in 2015-16 and it was second week of November during 2016-17 of investigation and remained active throughout the cropping season with a fluctuating population ranged from 0.16 to 6.74 whitefly per leaf during the first year and from 0.66 to 6.30 whitefly per leaf during the second year. *Arnal et al.* (1998) [2] also observed that the adult white flies were present through the growing period in the course of his study in the tomato field. High infestation levels were observed from mid-February to mid- March during the both years of study. During the peak period of activity, the maximum temperature, minimum temperature, average humidity, rainfall and sunshine hours per week were 28.3^0 C, 13.1^{0}C, 74 %, 3.8 mm and 49.5, respectively in first year and 26.3^{0}C, 14.6^{0}C, 76.5%, 0 mm and 49.5, respectively during second year. The present investigation on population build up of white fly was in conformity with the findings of Chaudhuri *et al*. (2001) [3]. They reported that high infestation levels were maintained from mid-February to mid-March when temperature, relative humidity, sunshine and rainfall were 17.07-22.13^{0}C, 65.29-72.78%, 35.2 hours and 19.2 mm, respectively.

3.2 Correlation studies on population buildup of *Bemisia tabaci* during 2015-16 and 2016-17

As regards to meteorological parameters, it was observed that maximum temperature(r=0.048, r=0.009) and total rainfall (r=0.182, r=0.015) exhibited a non-significant positive correlation during both the year of study. However, a negative correlation of whitefly population was observed with bright sunshine hours (r= -0.090, r= -0.097). Moreover, a significant impact of average relative humidity(r=-0.436, r=-0.763) were observed with whitefly population during both the years of investigation. The findings were not in conformity with Abdel *et al*. (1998) [4] who reported that relative humidity had no significant effect. However, a significant impact of whitefly population with average relative humidity was observed during both seasons of investigation and this indicated that an increase in rainfall and average relative humidity would lead to suppression of pest population whereas increased temperature would favour growth and development of pest population. Rishikesh *et al*. (2015) [5] observed a positive correlation with rainy days and temperature (maximum and minimum) was found to be negatively associated (Table 3).

Table 1: Population buildup of *Bemisia tabaci* relation to meteorological parameters during 2015-16

Dates of observation	Temperature (^{0}C)		Average RH (%)	Rainfall (mm)	BSSH (hr.)	No. of whitefly /leaf (nymphs & adults)
	Max.	Min.				
29 Oct - 4 Nov	29.5	19.0	83	6.9	37.4	0
5 Nov - 11 Nov	27.1	15.7	79.5	0.0	43.4	0
12 Nov-18 Nov	27.9	15.4	80.5	3.3	40.8	0.16
19Nov -25 Nov	26.8	13.3	84.5	0.0	45.6	0.33
26 Nov - 2 Dec	27.0	12.9	81	0.0	55.2	1.1
3 Dec - 9 Dec	23.7	12.7	87.5	14.1	24.2	1.45
10Dec -16 Dec	21.9	13.8	90	21.1	2.7	1.98
17Dec -23 Dec	21.9	8.6	81	0.5	40.6	2.34
24Dec- 31 Dec	23.1	8.2	81.5	0.0	47.1	2.68
1 Jan - 7 Jan	25.3	9.1	81.5	0.0	48.1	3.1
8 Jan - 14 Jan	23.1	9.9	85.5	29.4	22.7	3.3
15 Jan -21 Jan	20.2	10.8	89.5	5.8	12.5	2.08
22 Jan - 28 Jan	21.1	10.2	84	0.0	23.2	1.86
29 Jan - 4 Feb	20.7	10.7	88	0.0	8.3	1.42
5 Feb - 11 Feb	22.8	12.6	83	1.4	11.7	2.2
12Feb - 18 Feb	24.5	13.2	79	0.0	11.2	2.72
19Feb - 25 Feb	26.1	15.9	82.5	5.2	20.6	4.82
26 Feb - 4 Mar	28.3	13.1	74	3.8	49.5	6.74
5 Mar - 11 Mar	25.7	15.9	80	19.5	26.5	5.1
12Mar -18 Mar	28.2	16.9	73.5	0.8	26.4	4.62
19Mar -25 Mar	26.6	16.0	76.5	30.6	28.4	2.4

BSSH- Bright Sunshine Hours

Table 2: Population buildup of *Bemisia tabaci* relation to meteorological parameters during 2016-17

Date of observation	Temperature (^{0}C)		Average RH (%)	Rainfall (mm)	BSSH (hr.)	No. of whitefly/leaf (nymphs & adults)
	Max.	Min.				
5Nov-11 Nov	27.9	19.8	88.5	16.5	17.3	0
12Nov-18 Nov	30.2	18.0	81	0.0	23.4	0
19Nov -25 Nov	27.5	12.3	80.5	0.0	61.6	0.66
26 Nov - 2 Dec	27.7	13.8	78.5	0.0	57.4	0.33
3 Dec - 9 Dec	27.6	11.8	80	0.0	56.3	1.1
10Dec -16 Dec	26.5	9.7	79	0.0	61.7	1.45
17Dec -23 Dec	26.0	12.6	80.5	0.0	37.4	1.98
24 Dec-31 Dec	25.0	12.6	82.5	43.5	46.3	2.34
1 Jan - 7 Jan	25.9	10.7	77.5	0.1	57.6	2.68
8 Jan - 14 Jan	24.0	9.3	79.5	0.0	46.0	3.1
15 Jan -21 Jan	24.3	8.0	78	0.0	57.0	3.3
22 Jan - 28 Jan	26.8	9.1	73.5	0.0	53.3	2.08

29 Jan - 4 Feb	25.5	11.3	78	2.0	51.1	1.86
5 Feb - 11 Feb	27.4	12.6	74	0.0	30.1	1.42
12Feb - 18 Feb	27.9	11.0	69	0.0	49.8	2.2
19Feb - 25 Feb	25.6	15.0	81	37.4	31.3	2.72
26 Feb - 4 Mar	25.9	15.0	77	0.0	22.3	4.82
5 Mar - 11 Mar	26.3	14.6	76.5	19.2	35.2	6.30
12Mar -18 Mar	26.8	14.3	72	10.6	46.7	5.1
19Mar -25 Mar	26.3	12.6	82.5	26	34.4	4.62

BSSH- Bright Sunshine Hours

Table 3: Correlation coefficient (r) and regression equation of whitefly with meteorological parameters during 2015-16 and 2016-17

Insect	Year	Temperature		Average Relative humidity (%)	Total rainfall (mm)	BSSH (hr.)
		Maximum	Minimum			
Bemisia tabaci	2015-16	0.048^{NS}	0.317^{NS}	-0.436* Y=31.649-0.403x	0.182^{NS}	-0.090^{NS}
	2016-17	0.009^{NS}	0.118^{NS}	-0.763* Y=5.94-0.090x	0.015^{NS}	-0.097^{NS}

3.3 Effect of different treatments on whitefly, *Bemisia tabaci* during 2016-17

In the present study, all the treatments were found to be superior in reducing the white fly population over untreated control (Table 4). Almost a similar trend in the efficacies of different treatments was observed after all three sprays. The lowest whitefly population was recorded in the plot treated with spinosad @ 0.3 ml per litre 4.93, 4.89 and 5.35 whitefly per leaf after seven, ten and fifteen days of first treatment, respectively. The next best treatment was found to be Azadirachtin @ 5 ml per litre resulted in lowest population of whitefly population with 5.87, 5.6 and 5.98 whitefly per leaf after the seven, ten and fifteen days, respectively. Same trend was also observed after the second application. The lowest population of 3.54, 3.10 and 3.36 whitefly per plant was recorded in the plots treated with spinosad @ 2 ml per litre and it was followed by azadirachtin @ 5 ml per litre which recorded 4.98, 4.44 and 4.64 whitefly per leaf. It is evident from the data of the third treatment that spinosad @ 2 ml per litre was still found to be effective giving the lowest population of 2.62, 2.51 and 2.90 whitefly per leaf at seven, ten and fifteen days after treatment, respectively. The next best treatment was azadirachtin @ 5 ml per litre followed by *B. bassiana* @ 5 ml per litre These findings, however was found to be same with Kalyan *et al*. (2012) [6], who also reported that treatment with spinosad was the best treatment in reducing whitefly population.

Table 4: Efficacy of different treatments on *Bemisia tabaci* population after first, second and third sprays during 2016-17

Treatments	Dose	Pre-treatment count	After 1st Spray			After 2nd Spray			After 3rd Spray		
			7 DAT	10 DAT	15 DAT	7 DAT	10 DAT	15 DAT	7 DAT	10 DAT	15 DAT
Spinosad 45% EC	0.3 ml/lit	7.16	4.93^{e}	4.89^{d}	5.35^{e}	3.45^{e}	3.10^{e}	3.36^{f}	2.62^{d}	2.51^{f}	2.90^{e}
Azadirachtin 1500 ppm	5 ml/lit	7.26	5.87^{d}	5.60^{c}	5.98^{d}	4.98^{d}	4.44^{d}	4.64^{e}	3.97^{c}	3.68^{e}	3.95^{d}
Trichogramma pretiosum	1,00,000/ha	6.86	6.73^{b}	6.76^{b}	7.10^{b}	6.44^{b}	6.53^{b}	6.76^{b}	6.29^{b}	6.40^{bc}	6.77^{b}
Beauveria bassiana	5 ml/lit	6.93	6.12^{cd}	6.18^{bc}	6.48^{cd}	5.72^{c}	5.22^{c}	5.62^{d}	4.68^{c}	4.89^{d}	5.17^{c}
Bacillus thuringiensis var. krustaki	2 ml/lit	6.93	6.66^{bc}	6.50^{b}	6.74^{bc}	5.94^{bc}	6.10^{b}	6.22^{c}	5.68^{b}	5.82^{c}	6.06^{b}
HaNPV 250 LE	5 ml/lit	7.13	6.83^{b}	6.66^{b}	6.97^{b}	6.28^{bc}	6.68^{b}	7.26^{b}	6.41^{bc}	6.63^{b}	6.80^{b}
Untreated control	-	7.10	7.43^{a}	7.4^{a}	7.83^{a}	8.2^{a}	7.94^{a}	8.35^{a}	8.82^{a}	8.70^{a}	8.87^{a}
S.Ed. (±)		0.17	0.25	0.30	0.28	0.30	0.32	0.26	0.29	0.36	0.38
CD (P=0.05)		NS	0.55	0.66	0.61	0.65	0.71	0.54	0.46	0.79	0.83

DAT: Days after treatment

Data based on mean of 3 replication (5 plants /plot and 3 leaves / plant)

NS: Non- significant

Treatment means followed by a common letter do not differ significantly at 5 % of probability by DMRT.

4. Summary and Conclusion

From the present investigation, it can be concluded that out of the seven treatments, spinosad @ 0.3 ml per litre was found to be superior in reducing the population of *B. tabaci* followed by Azadirachtin @ 5 ml/lit. Whitefly, *B. tabaci* become a major threat for tomato cultivation in Assam because of their severity of attack. Various efforts have been made to manage these serious pests by applying many conventional insecticides which in turn results in various problems like development of pest resistance against insecticides, pest outbreak, environmental pollution and the unacceptable higher level of pesticide residue on fruits. Therefore, a proper eco friendly management practices preferably the use of plant products, microbial origin insecticides and release of natural enemies are necessary in future to combat these problems. However, a detailed study on different aspects of pests with different potential bio pesticides and bio control agents are very much essential in near future.

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