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Population dynamics of whitefly, *Bemisia tabaci* Gennadius in tomato and its management using novel insecticides under polyhouse condition

VYSHNAVI SUNIL[1]*, P. DINESH KUMAR[2] and MANOJ KUMAR[1]

[1]Department of Entomology, Dr. Rajendra Prasad Central Agricultural University, Pusa- 848125, Bihar, India

[2]Department of Agricultural Statistics, Bidhan Chandra Krishi Viswavidyalya, Mohanpur-741252, West Bengal, India

***E-mail**: vyshnavinair12@gmail.com

ABSTRACT: The present study was conducted to assess the effect of environmental factors on population build up of whitefly, *Bemisia tabaci* and management using novel insecticides under polyhouse conditions.The investigation was carried out at Hi-Tech Horticulture of Dr. Rajendra Prasad Central Agricultural University, Pusa (Samastipur), Bihar during *rabi* season of 2019-20. The whitefly population was highest in 46th SMW and was positively correlated with maximum temperature and the coefficient of determination (R^2) was worked out as 40%. Among insecticides, chlorantraniliprole + thiamethoxam @ 150 g a.i. ha^{-1}gave the maximum per cent reduction over control in all the three sprays.

Keywords: Whitefly, temperature, population dynamics, polyhouse, bioefficacy, insecticides

INTRODUCTION

Tomato, *Solanum lycopersicum* L. (Solanaceae) is one among the most popular vegetable crops grown in India. The protected cultivation is the most intensive method of crop production to provide protection to the plants from adverse environmental conditions while, it provides favourable microclimatic condition for growth and development of insect pests which hampers successful propagation of crops under polyhouse condition. In tropical and sub-tropical regions, whitefly causes a huge economic damage (Block, 1982). In tomato it affects the seedling, vegetative and flowering stage. The damage caused by whitefly can cause qualitative and quantitative losses to the tomato production. Different methodologies are recommended for the management of these pests. Among them the most popular one is the chemical management due to their quick results and high efficiency. Several chemicals belonging to organochlorines, carbamates and organophosphates have been used to manage the insect pests in tomato but they leave toxic residues on the fruit and also continuous application of these chemicals leads eventually the development of resistance and resurgence of insect pests. Hence, presently farmers have switched on to the use of novel insecticides with lesser doses of few grams per hectare for the effective management of the pests. The present study has been conducted because of the scarcity of data on the population dynamics of whitefly and its management using newer insecticides under poyhouse in Bihar conditions.

MATERIALS AND METHODS

The investigation was carried out at Hi-Tech Horticulture of Dr. Rajendra Prasad Central Agricultural University, Pusa (Samastipur), Bihar during *rabi* season of 2019-20. Randomized Block Design (RBD) was employed for the purpose of the experiment. There were eight treatments, each having three replications. Tomato variety, Hem shikhar was used and was sown on with a spacing of 100 x 50 cm by adopting standard agronomic practices without plant protection measures.

For the population dynamics experiment, five plants of tomato were chosen randomly and kept free from insecticidal application. The population of whiteflies (nymphs and adults) was recorded from 3 leaves i.e., one each from the upper, middle and lower position. The population was recorded during morning hours 6.30AM to 8.30AM in each plot using a hand lens of 10x magnification. Major abiotic factors, *viz.*, maximum and minimum temperature (ºC) and relative humidity (%) were also recorded during the crop period. The data was utilized to work out simple correlation co-efficient between insect pest population and various abiotic factors and was statistically analysed. Simultaneously, weather parameters were also recorded during the entire experimental period.

In the management study, seven novel insecticides *viz.,* chlorantraniliprole + thiamethoxam (T_1)@ 150 g a.i. ha^{-1}novaluron + indoxacarb (T_2)@ 80 g a.i. ha^{-1}, chlorantraniliprole (T_3) @30 g a.i. ha^{-1}, spinosad (T_4)@ 80 g a.i. ha^{-1}, novaluron (T_5) @ 75 g a.i ha^{-1}, thiamethoxam(T_6) @ 50 g a.i. ha^{-1}, indoxacarb (T_7) @ 75 g a.i. ha^{-1} were evaluated for their field efficacy against the whitefly. There was also an untreated control. These eight treatments were replicated thrice. All the treatments were applied thrice at 15 days interval.

Table 1. Population dynamics of whitefly on tomato during crop season in relation to abiotic factors

Months	Standard weeks	Temperature		Relative humidity (%)		No. / 3 leaves
		Max.	Min.	07 00 h	14 00 h	
September (2019)	36	35.0	29.0	82	70	2.31
	37	35.5	27.0	88	80	6.15
	38	36.5	27.1	87	73	10.5
	39	33.2	27.0	92	86	11.2
October (2019)	40	31.8	25.5	90	79	12.45
	41	32.0	25.3	88	80	15.12
	42	33.0	23.2	87	79	17.99
	43	30.1	22.0	84	73	13.67
	44	32.2	24.7	91	76	17.53
November (2019)	45	32.5	22.3	89	60	21.5
	46	31.6	19.5	90	62	24.49
	47	29.5	16.5	87	60	19.49
	48	30.2	16.9	90	66	15.13
December (2019)	49	28	14.5	75	67	12.11
	50	26.0	13.0	90	75	9.12
	51	20.5	12	88	81	6.72
	52	18.1	8.9	95	77	5.22
January (2020)	1	20	9.0	94	65	5.15
	2	20.0	6.0	85	55	4.54
	3	23.0	12.0	93	74	3.21

Table 2. Correlation coefficient and regression equation between weather parameters (X) and mean number of whitefly per three leaves per plant (Y)

Weather parameters	Correlation coefficient(r)	Regression coefficient(b)
X1- Maximum Temperature (ºC)	0.468*	1.52
X2- Minimum temperature (ºC)	0.324	-0.733
X3- Relative Humidity 07 00 hrs (%)	-0.039	0.362
X4- Relative Humidity 14 00 hrs (%)	-0.222	-0.157

Benefit cost ratio was calculated to understand the economics of insecticidal management of whitefly. After picking plot wise total weight of fruits was noted. Gross benefit was computed for every treatment after removing cost of insecticides and cost of labour. Extra profit by use of insecticides for each treatment was computed by subtracting value realized in control treatment from gross benefit. The per cent increase over control was also computed based on extra profit divided by value realized in control and multiplied in hundred. The additional income obtained over control plot was divided with the additional cost made for controlling the pest to obtain the benefit-cost ratio.

RESULTS AND DISCUSSION

The data on whitefly population were recorded on tomato in *rabi* season 2019-20 at 7 days interval from 30 days after transplanting up to the crop was harvested. The data represented in Table 1. shows that all around the vegetative stage the whitefly population was seen. Results revealed that the whitefly population appeared 30 days after crop transplantation and was present throughout the vegetative stage of the crop initially recording a population density of 2.31 per three leaves reaching 17.99 on 42nd SMW. The population showed an increase with the advancement of crop growth and peak population of 24.49 per three leaves on 46th SMW. When the vegetative stage was ending the population decreased and reached up to 3.21 per three leaves. The decline in whitefly population after 48th SMW might be due to the crop reaching its maturity. The lowest population was marked at third SMW.

An attempt was made to study influence of weather parameters on whitefly. The data represented that maximum temperature influenced the whitefly population. The results revealed maximum temperature was positively correlated and statistically significant. Minimum temperature was negatively correlated

Table 3. Effect of insecticides on whitefly (*Bemisia tabaci*) population in tomato after first, second and third spray

Treatment	Dose (g a.i. ha^{-1})	1day before spray	First spray				Second spray				Third spray			
			3rd DAS	7th DAS	14th DAS	Reduction over control (%)	3rd DAS	7th DAS	14th DAS	Reduction over control (%)	3rd DAS	7th DAS	14th DAS	Reduction over control (%)
T_1	150	18.2 (4.25)	8.22 $(2.86)^{d}$	7.3 $(2.69)^{d}$	6.46 $(2.53)^{d}$	61.18	4.58 $(2.13)^{e}$	4.13 $(2.03)^{d}$	3.88 $(1.97)^{d}$	79.3	2.26 $(1.50)^{e}$	2.31 $(1.52)^{e}$	2.17 $(1.47)^{d}$	90.2
T_2	80	19.12 (4.36)	10.23 $(3.19)^{bcd}$	10.69 $(3.26)^{bcd}$	11.12 $(3.32)^{bc}$	43.37	10.21 $(3.18)^{bcd}$	10.32 $(3.20)^{bc}$	10.85 $(3.28)^{bc}$	48.52	7.21 $(2.67)^{cd}$	8.13 $(2.83)^{cd}$	8.26 $(2.86)^{c}$	65.76
T_3	30	18.67 (4.29)	13.43 $(3.65)^{b}$	13.21 $(3.62)^{b}$	14.97 $(3.86)^{ab}$	26.45	12.97 $(3.59)^{b}$	12.23 $(3.49)^{b}$	12.68 $(3.56)^{b}$	37.84	11.92 $(3.44)^{b}$	11.5 $(3.38)^{b}$	11.78 $(3.42)^{b}$	50.21
T_4	80	18.43 (4.27)	10.34 $(3.20)^{bcd}$	9.23 $(3.02)^{cd}$	10.56 $(3.24)^{bc}$	46.76	9.23 $(3.02)^{cd}$	10.54 $(3.23)^{bc}$	10.39 $(3.21)^{bc}$	50.54	6.58 $(2.55)^{d}$	7.12 $(2.66)^{d}$	7.36 $(2.70)^{c}$	69.94
T_5	75	19.32 (4.39)	11.23 $(3.34)^{bcd}$	11.45 $(3.38)^{bc}$	11.95 $(3.45)^{bc}$	38.81	10.57 $(3.24)^{bcd}$	10.63 $(3.25)^{bc}$	11.32 $(3.35)^{bc}$	46.65	9.13 $(3.02)^{bcd}$	9.23 $(3.03)^{bcd}$	9.26 $(3.04)^{bc}$	59.93
T_6	50	18.28 (4.27)	9.23 $(3.04)^{cd}$	8.29 $(2.88)^{cd}$	8.45 $(2.90)^{cd}$	54.13	8.25 $(2.87)^{d}$	7.92 $(2.81)^{c}$	8.01 $(2.83)^{c}$	60.33	6.14 $(2.47)^{d}$	6.47 $(2.54)^{d}$	7.13 $(2.66)^{c}$	71.34
T_7	75	18.23 (4.27)	11.97 $(3.45)^{bc}$	11.81 $(3.42)^{bc}$	12.34 $(3.50)^{bc}$	36.16	12.32 $(3.50)^{bc}$	11.75 $(3.42)^{b}$	12.49 $(3.52)^{b}$	40.05	10.07 $(3.15)^{bc}$	11.24 $(3.33)^{bc}$	11.85 $(3.42)^{b}$	51.87
T_8		18.4 (4.29)	18.45 $(4.29)^{a}$	18.59 $(4.30)^{a}$	19.56 $(4.39)^{a}$		19.56 $(4.42)^{a}$	20.28 $(4.49)^{a}$	21.12 $(4.58)^{a}$		22.21 $(4.70)^{a}$	22.91 $(4.78)^{a}$	23.76 $(4.87)^{a}$	
SEm (±)			0.18	0.19	0.22		0.17	0.18	0.20		0.18	0.18	0.17	
CD (p=0.05)		NS	0.54	0.58	0.67		0.52	0.56	0.61		0.55	0.55	0.53	
CV (%)			9.09	9.95	11.23		9.20	9.84	10.62		10.63	10.38	9.85	

T1- Chlorantraniliprole + Thiamethoxam; T2- Novaluron + Indoxacarb; T3- Chlorantraniliprole; T4- Spinosad; T5- Novaluron; T6- Thiamethoxam; T7- Indoxacarb; T8- Control.

Values in the parenthesis are the square root transformed values of mean; DAS- Days after spraying.

and statistically non-significant while morning and evening relative humidity was non-significant and negatively correlated. The correlation coefficient (r) was worked out as 0.324, 0.468, -0.222 and -0.39 for minimum temperature, maximum temperature, evening and morning relative humidity, respectively. The coefficient value of determination (R^2) computed as 40 %indicating 40% variation in whitefly attributed by weather parameters ($R^2 = 0.40$). This is in partial conformity with the results of Sharma *et al.* (2017) who found a positive correlation of whitefly population with maximum and minimum temperature and negative correlation with relative humidity, results of Subba *et al.* (2017) whose correlation studies between whitefly population and environmental parameter revealed that whitefly population had a significant positive correlation with temperature difference while significant negative correlation with relative humidity (maximum, minimum and average) and Nissar *et al.* (2019) who found a positive significant correlation between whitefly population (nymph and adult) and weather parameters viz. temperature (maximum and minimum) whereas relative humidity (maximum) exhibited positive non-significant whereas relative humidity (minimum) showed a negative non significant correlation with population.

The mean per cent reduction in whitefly population over control after third, seventh and fourteenth day of 1st spray was maximum in chlorantraniliprole + thiamethoxam @150 gm a.i. ha^{-1} (61.18%) after third, seventh and fourteenth day of spray and was efficient than all other insecticidal treatments i.e., novaluron + indoxacarb @ 150 gm a.i. ha^{-1} (43.37%), chlorantraniliprole @ 30 gm a.i. ha^{-1} (26.45%), spinosad @ 80 gm a.i. ha^{-1} (46.76 %), novaluron 75 g a.i. ha^{-1} (38.81%), thiamethoxam @ 50 gm a.i. ha^{-1} (54.13 %), indoxacarb 75 gm a.i. ha^{-1} (36.16%) whereas chlorantraniliprole @30 gm a.i. ha^{-1}(26.45%) was least effective.The mean per cent reduction in whitefly populationovercontrol after third, seventh and fourteenth day of 2nd spray was maximum in chlorantraniliprole + thiamethoxam @ 150 gma.i.ha^{-1} (79.30%). Chlorantraniliprole @ 30 gm a.i.ha^{-1} (37.84%) was least effective among all insecticidal treatments. The mean per cent reduction in whitefly population over control after third, seventh and fourteenth day of 3rd spray was maximum in chlorantraniliprole + thiamethoxam @ 150 gma.i.ha^{-1}(90.20%), whereas chlorantraniliprole@ 30 gma.i.ha^{-1} (50.21%) was least effective. These results are in accordance with literature reports of Patra et al. (2016), Kalyan *et al.* (2012), Patil *et al.* (2014), Gopalaswamy *et al.* (2012), Wagh et al. (2017) and Rajawat *et al.* (2017). Patra *et al.* also reported an excellent control of whitefly population by usingchlorantraniliprole + thiamethoxam @ 150 gma.i.ha^{-1} which completely agree to our present observation.

The maximum percent reduction over control was shown by chlorantraniliprole + thiamethoxam which is a broadspectrum insecticide with trans laminar as well as ovicidal and larvicidal activity and a greater persistence and higher dose. It was followed by thiamethoxam which is systemic and very effective against sucking pest complex. The least per cent reduction over control was shown by chlorantraniliprole which is effective for borer pest complex and didn't produce any significant reduction in whitefly population. Rest all insecticides were ranked in the middle based on their efficacies.

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