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Thakoor Pavan
PhD Research scholar, Department of Agricultural Entomology Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal, India

Sunil Kumar Ghosh
AINP on Agricultural Acarology, Directorate of Research Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal, India

Nihal R
PhD Research scholar, Department of Agricultural Entomology Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal, India

Nagamandla Ramya Sri
PhD Research scholar, Department of Agricultural Entomology, Professor Jayashankar Telangana State Agricultural University, Hyderabad, Telangana, India

Correspondence
Thakoor Pavan
PhD Research scholar, Department of Agricultural Entomology Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal, India

Effect of abiotic factors on seasonal incidence and bio-efficacy of some newer insecticides against aphid (*Aphis gossypii*) in tomato

Thakoor Pavan, Sunil Kumar Ghosh, Nihal R and Nagamandla Ramya Sri

Abstract
An experiment was conducted at District seed farm, Bidhan Chandra Krishi Viswavidyalaya, Kalyani, Nadia, West Bengal to perceive the seasonal incidence and bio-efficacy of some newer insecticides against *Aphis gossypii* in tomato. Results from the population dynamics revealed that the aphid incidence started from 48^{th} standard week (2.50/3leaves) with peak population attained by 7^{th} standard week (12.19/3 leaves). Correlation studies revealed that the aphid population had a significant positive correlation with diurnal and maximum temperature, while significant negative correlation with maximum and minimum relative humidity. The Bio-efficacy results indicated that all the newer insecticide were significantly superior over control. Maximum population reduction were observed in the insecticidal treatment Imidacloprid 30.5 SC @ 160ml/ha (88.73%) and Flonicamid 50 WG @ 300g/ha (88.71%), followed by other insecticides like Clothianidin 50 WDG @ 500g/ha (83.39%), Dimethoate 30 EC @ 1000ml/ha (79.84%), Difenthiuron 50 WP @1000g/ha (79.51%), Dinotefuran 20 SG @500g/ha (76.14%) and Spinosad 45 SC @100ml/ha (63.04%) also gave significant population reduction over control.

Keywords: Tomato, aphid, bio-efficacy, population dynamics

1. Introduction

A member of the nightshade family (along with pepper and chillies), tomatoes are in fact a fruit, but their affinity for other savoury ingredients means that they are usually classed as a vegetable. Tomatoes originated in western South America, crossed Atlantic to Spain with the conquistadors in the 16th century, but only finally caught on in northern Europe in 19th century (Acquaah, 2002) [1]. Tomato is rich in minerals, fiber and vitamin A and B which are very essential for the human health. Tomato also contains carotene lycopene, the natural antioxidant. Lycopene is very essential which improves skins ability to protect against ultra-violate rays (Miller *et al*., 2002) [2].

China ranks number one in production with 59.6 million tonnes followed by India with 20.70 million tonnes (faostat, 2017) [3]. Share of West Bengal state in Vegetable production is 14.60 percent among India with 25.50 million tonnes. Area and Production of Tomato in West Bengal state is 57,17,000 Ha and 12,04,43,000 tonnes.(Horticultural Statistics, 2017)[4]

The aphid transmits yellowing virus reduces yield and quality of tomato. Early infection (2-3 week after transplanting) causes the greater plant stunting 8-15 per cent and reduction in yields 60-83 per cent (Zitter and Everett, 1982) [5]. Abiotic factors have the long-term effect and determines which insects are present and how many generations are possible in a single active season, while weather is the short term or day to day effect and plays primary role in influencing insect abundance and damage. These two probably are the most important factors that directly or indirectly limit the abundance the pests.

Aphid transmits Potato Virus Y (PVY) which is the most important viral pathogen in potato worldwide and can cause yield loss of 10-100 per cent and 39-75 per cent on tobacco. (Binyam, 2015) [6]. Flonicamid is very effective against aphids, regardless of differences in species, stages and morphs as this compound inhibited the feeding behaviour of aphids its antifeeding activity leads to starvation and death (Morita *et al.,* 2007) [7]. Keeping in view the importance of damage caused by aphid in tomato crop the present study was initiated with the aim to compare different insecticides for the control of aphid for increasing tomato production.

2. Materials and Methods

The field experiment was conducted to study the seasonal incidence and bio efficacy of newer insecticides against aphid an important sucking pest of tomato during Rabi 2017 at District seed farm, Bidhan Chandra Krishi Viswavidyalaya, Kalyani, Nadia, West Bengal.

The geographical details of the site are 23° N latitude, 89° E longitude and 9.75 meter above mean sea level (MSL). The experiment was conducted in Randomized Block Design with eight treatments and three replications and standard agronomic practices were carried out as usual.

The observations on *Aphis gossypii* were recorded at weekly interval. Observations on the number of nymph and adults of aphids was recorded from three leaves per plant selected from top, middle and bottom canopy from the selected plants at weekly interval starting from 15 days after germination till the removal of the crop. Plots were kept completely free from the insecticidal spray. Observation on aphid population was recorded from randomly selected plants. Data regarding weather parameters were collected from All India Co-ordinated Research Project on Agricultural Meteorology, Directorate of Research, Bidhan Chandra Krishi Viswavidyalaya, Kalyani, West Bengal. The relationship between weather factors and sucking pests was established by using simple correlation coefficient and regression analysis.

The observations on *Aphis gossypii* for bio efficacy were recorded at 1 day before spray and 1,5,10,14 days after spray. First spray was done at starting of pest incidence and the second spray was done 15 days after the first spray. All the insecticides were applied in the form of foliar spray with the help of knapsack spryer. For deciding the quantity of spray fluid required per plot, the control plot was sprayed with water and the required spray fluids were determined. Spray fluid was prepared by mixing measured quantity of water and insecticide. Care was also taken to rinse the sprayer thoroughly before and after each spray with soap water to avoid contamination from treatment to treatment. The details of treatments used for conducting experiment are given in (Table 1). Spraying of formulations was done in early morning hours to avoid the midday heat. The insecticidal concentration for different treatment was prepared and spraying was done using knapsack sprayer.

$$\text{Percent reduction in population} = \frac{a-b}{a} \times 100$$

a = population in control plots

b = population in treated plots

3 Results and Discussion

3.1 Population dynamics of Aphid, *Aphis gossypii* (Glover) in tomato during Rabi season, 2016-17

The seasonal fluctuation of aphid population, *Aphis gossypii* was monitored in tomato under field condition during 2017. In fact, aphid population dynamic is strongly influenced by climatic conditions and cool spring and fall of temperature as reported by (Hajek and Dahisten, 1988) [8]. The abundance of this pest population is dramatically affected by changes of weather factors. However, aphid population first appeared in the field during 48th standard metrological week (SMW) that is 2.50 per three leaves (Fig 1). After that the population progressively increased and reached its peak (12.19 aphids per 3 leaves) in the 7th meteorological week (Fig 1) when average temperature, relative humidity and Bright sunshine were 21.9^{0}C, 66.83% and 5.6 Hrs respectively. When the population first appeared in the field the crop was in early vegetative stage and this pest was highly active during winter period due to favourable environmental condition. Later the infestation of aphid population gradually declined from 8th to 10th standard metrological week (SMW) when the atmospheric temperature was quite high. Present findings are in similar with the results of (Ram and Parihar 2002) [9] who reported that aphid populations remained low on tomato during first fortnight of February which attained peak during second fortnight of February. Thereafter, the population declined in the first fortnight and consequently disappeared from second fortnight of March.

Correlation studies (Table 2) revealed that the aphid population had a significant positive correlation with temperature difference and maximum temperature while significant negative correlation with relative humidity (maximum, minimum, average). On the contrary it showed non- significant positive correlation with temperature (minimum, average) and bright sunshine Hrs. The findings are in close relation with those of Sharma *et al.* (2013) [10] who reported that the aphid population was positive but non-significantly correlated with the maximum, minimum temperature („r‟=0.576; 0.215) and sunshine („r‟=0.343) but exhibited negative but non-significant correlation with relative humidity (maximum and minimum) („r‟= –0.506; –0.381) and rainfall („r‟= –0.613).

3.2 Bio-efficacy of insecticides against sucking pest aphid *Aphis gossypii* (Glover) in tomato

A field experiment was conducted for the control of major sucking pest Aphid of tomato using chemical insecticides, microbial toxins. The results of the experiment are discussed as under.

3.3 First application

Before the imposition of the treatments the mean number of no. of aphids per 3 leaves ranged from 9.56 to 10.61 aphids per 3 leaves. After the imposition of treatments, the number of aphids decreased gradually till fourteen days and all the treatments were significantly superior to the untreated control. At fourteen days after the application the least infestation i.e. 1.27 and 1.56 was recorded in the treatments Flonicamid 50 WG @ 120 g/ha & Imidacloprid 30.5 SC @ 60 ml/ha. (88.98% and 86.46% reduction over control) and were on par with each other. These were followed by Dimethoate 30 EC @ 400ml/ha, Clothianidin 50 WDG @ 200g/ha, Difenthiuron 50 WP @ 400g/ha, Dinotefuran 20 SG @ 200g/ha & Spinosad 45 SC @ 80 ml /ha which recorded 1.98, 2.01, 2.03, 2.32 and 4.56 aphids per 3 leaves (82.81, 82.55, 82.38, 79.86 & 60.42% reduction over control). In untreated control the maximum number of aphids recorded was 11.52 per 3 leaves (Table 3).The above findings are in close relation with those of (Fonseca *et al.* 2011)[11] who carried out an experiment to evaluate the efficacy of flonicamid against *Aphis gossypii* on cotton crop and reported that foliar application was effective in control of the pest.

3.4 Second application

Similar trend was observed after the second application imposition. Before the imposition of treatments, the mean number of no. of aphids per 3 leaves ranged from 9.68 to 8.12 aphids per 3 leaves. After the imposition of treatments, the number of aphids decreased gradually till fourteen days and all the treatments were significantly superior to the untreated control. At fourteen days after the application the least infestation i.e. 0.77 and 0.99 was recorded in the treatments Imidacloprid 30.5 SC @ 60 ml /ha & Flonicamid 50 WG @ 120 g /ha. (91.00% and 88.43% reduction over control) and were on par with each other. These were followed by Dimethoate 30 EC @ 400ml /ha, Clothianidin 50 WDG @ 200g/ha, Difenthiuron 50 WP @ 400g/ha, Dinotefuran 20 SG @ 200g/ha & Spinosad 45 SC @ 80 ml /ha which recorded 1.27, 1.35, 2.00, 2.36 and 2.94 aphids per 3 leaves (85.16, 84.23, 76.64, 72.43 & 65.65% reduction over control). In untreated control the maximum number of aphids recorded was 8.56 per 3 leaves (Table 4). The findings are similar to (Nderitu *et al.* 2008) [12] who recorded lowest aphid population in plot treated with imidacloprid (350 g L^{-1}) causing more than 95 per cent aphid population reduction and slightly higher yields. The findings are in close relation with those of (Ghosal *et al.* 2013) [13] who reported that imidacloprid 17.8 SL @ 50 g a.i. ha^{-1} most effective against aphid showing least aphid infestation and 84.54 per cent reduction of population over control on okra crop. Whereas Konar *et al.* (2013) [14] reported that imidacloprid @ 30 g a.i. / ha was found most effective in reducing population of aphid on okra.

4. Conclusion

It is found that the aphid population reached its peak (12.19 aphids per 3 leaves) in the 7^{th} meteorological week when average temperature, relative humidity and bright sunshine hours were 21.9^0C, 66.83% and 5.6 Hrs respectively. Maximum population reduction were found in the insecticidal treatment Imidacloprid 30.5 SC @ 160ml/ha (88.73%) and Flonicamid 50 WG @ 300g/ha (88.71%).

Table 1: Treatment details of treatments of experiment on bio-efficacy of insecticides

S. No	Treatments	Concentration %	Dosage per hectare (ml/g)
1	Imidacloprid 30.5 SC	0.005%	160 ml
2	Spinosad 45 SC	0.009%	100 ml
3	Clothianidin 50 WDG	0.025%	500g
4	Dinotefuran 20 SG	0.001%	500g
5	Difenthiuron 50 WP	0.050%	1000g
6	Flonicamid 50 WG	0.015%	300g
7	Dimethoate 30 EC	0.030%	1000ml
8	Control		

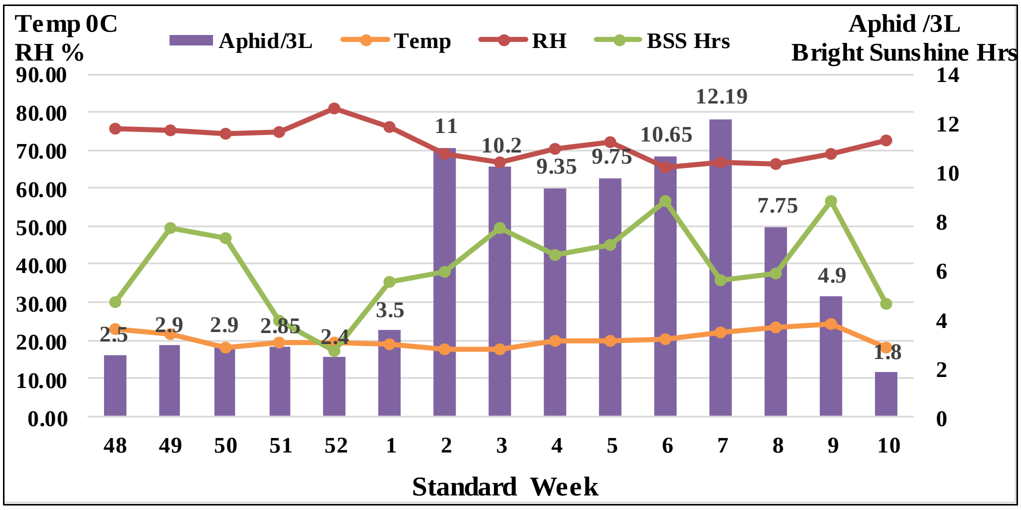

Fig 1: Population fluctuation of Aphid, *Aphis gossypii* (Glover) infesting tomato during *Rabi* season 2016- 17.

Table 2: Correlation and Regression Coefficient of Aphid, *Aphis gossypii* (Glover) in tomato with weather factors during 2016-17.

Environmental parameter		Correlation co-efficient (r)	Co-efficient of determination (R^2)	Regression equation
Temperature (^{0}C)	Maximum	0.511*	0.261	Y= 0.227X+25.489
	Minimum	0.161	0.026	Y= 0.084X+12.515
	Difference	0.506*	0.256	Y=0.145X+12.972
	Average	0.337	0.113	Y=0.156X+19.003
Relative Humidity (%)	Maximum	(-)0.814**	0.664	Y= -0.372X+94.622
	Minimum	(-)0.757**	0.574	Y= -1.171X+60.117
	Average	(-)0.791**	0.626	Y= -0.772X+77.376
Bright Sunshine (Hr)		0.417	0.174	Y= 0.191X+4.971

*Significant at 5% level of significance, ** Significant at 1% level of significance

Table 3: Bio-efficacy of insecticides against aphid (*Aphis gossypii*) (First application).

S. No	Treatments	Concentration (%)	Dosage per hectare (ml/g)	Mean No. of aphids per 3 leaves					% reduction at 14 days after application over control
				PT	1DAS	5DAS	10DAS	14DAS	
T1	Imidacloprid 30.5 SC	0.005%	160 ml	10.28 (3.27)	6.45 (2.62)	3.18 (1.91)	1.11 (1.27)	1.56 (1.43)	86.46
T2	Spinosad 45 SC	0.009%	100 ml	9.68 (3.18)	7.12 (2.75)	6.45 (2.63)	3.55 (2.01)	4.56 (2.24)	60.42
T3	Clothianidin 50 WDG	0.025%	500g	10.25 (3.28)	6.65 (2.67)	4.56 (2.25)	1.45 (1.39)	2.01 (1.58)	82.55
T4	Dinotefuran 20 SG	0.001%	500g	9.56 (3.17)	7.01 (2.74)	5.01 (2.35)	2.25 (1.66)	2.32 (1.68)	79.86
T5	Difenthiuron 50 WP	0.050%	1000g	9.98 (3.22)	6.84 (2.70)	4.75 (2.28)	2.00 (1.58)	2.03 (1.58)	82.38
T6	Flonicamid 50 WG	0.015%	300g	10.46 (3.31)	6.05 (2.56)	3.03 (1.88)	0.84 (1.16)	1.27 (1.33)	88.98
T7	Dimethoate 30 EC	0.030%	1000ml	10.61 (3.33)	6.56 (2.66)	4.00 (2.12)	1.25 (1.32)	1.98 (1.57)	82.81
T8	Control			9.88 (3.22)	10.89 (3.37)	11.12 (3.41)	10.49 (3.31)	11.52 (3.46)	
	Sem±			0.16	0.13	0.11	0.08	0.07	
	CD (p=0.05)			0.48	0.39	0.33	0.25	0.22	
	CV %			8.43	8.16	7.93	7.59	7.29	

*PT = Pre Treatment, Figures in the parenthesis are Arc Sine transformed values

Table 4: Bio-efficacy of insecticides against aphid (*Aphis gossypii*) (second spray).

S. No	Treatments	Concentration (%)	Dosage per hectare (ml/g)	Mean No. of aphids per 3 leaves					% reduction at 14 days after application over control
				PT	1DAS	5DAS	10DAS	14DAS	
T1	Imidacloprid 30.5 SC	0.005%	160 ml	8.45 (2.99)	5.06 (2.36)	2.17 (1.63)	0.57 (1.03)	0.77 (1.13)	91.00
T2	Spinosad 45 SC	0.009%	100 ml	9.68 (3.18)	6.37 (2.61)	5.00 (2.34)	2.76 (1.80)	2.94 (1.85)	65.65
T3	Clothianidin 50 WDG	0.025%	500g	8.78 (3.03)	5.18 (2.37)	3.55 (2.00)	1.11 (1.27)	1.35 (1.36)	84.23
T4	Dinotefuran 20 SG	0.001%	500g	8.19 (2.95)	5.79 (2.51)	4.18 (2.16)	2.71 (1.79)	2.36 (1.69)	72.43
T5	Difenthiuron 50 WP	0.050%	1000g	8.77 (3.03)	6.14 (2.56)	4.20 (2.16)	2.88 (1.83)	2.00 (1.58)	76.64
T6	Flonicamid 50 WG	0.015%	300g	8.54 (3.01)	4.03 (2.13)	2.45 (1.72)	0.25 (0.87)	0.99 (1.22)	88.43
T7	Dimethoate 30 EC	0.030%	1000ml	8.73 (3.04)	5.55 (2.46)	3.43 (1.98)	1.09 (1.26)	1.27 (1.33)	85.16
T8	Control			8.12 (2.93)	8.25 (2.96)	9.12 (3.10)	9.03 (3.09)	8.56 (3.01)	
	Sem±			0.15	0.12	0.10	0.07	0.07	
	CD (p=0.05)			0.45	0.36	0.30	0.22	0.21	
	CV %			8.54	8.27	8.08	7.67	7.24	

*PT = Pre Treatment, Figures in the parenthesis are Arc Sine transformed values

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