I.J.A.B.R., VOL. 2(3) 2012: 500-505 ISSN 2250 - 3579

INTERNATIONAL JOURNAL OF ADVANCED BIOLOGICAL RESEARCH

www.scienceandnature.org

POPULATION DYNAMICS OF MAJOR INSECT PESTS OF COTTON IN RELATION TO ABIOTIC FACTORS

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ABSTRACT
Population dynamics play a significant role for a sound and sustainable integrated pest management module for the insect pest control. Field trial was conducted at Aligarh district, Uttar Pradesh during 2009-10 and 2010-11, to ascertain the population dynamics of *B. tabaci, A. biguttula biguttula* and *H. armigera* on cotton crop. Nymphs count of the *B. tabaci* and *A. biguttula biguttula* were made at biweekly interval from 20 random plants in the field taking three fully formed leaves in the upper canopy of each plant. The population of *B. tabaci* was counted nymph/adult/leaf. The mean population of *B. tabaci, A. biguttula biguttula* and *H. armigera* was recorded maximum ranged from 2.10 to 3.64, 2.10 to 2.92 nymphs/adult/leaves and 26.0 to 38.0 larvae/plant at 150 DAS (35th week) and the minimum population was recorded at 60 and 90 DAS (23rd and 27th week) ranged from 0.15 to 0.30, 0.10 to 0.20 nymphs/adult/leaves and 0.00 to 2.50 larvae/plant while, at 60 DAS was not found (0.00) population of *H. armigera* on three varieties (R.S.-875, F-1378 and H-1098) of cotton during both cropping years.
The correlation coefficient of *B. tabaci, A. biguttula biguttula* and *H. armigera* was calculated negative with maximum and minimum temperatures during 2009-10 and 2010-11, respectively. Whereas, with maximum and minimum relative humidity was calculated positive against *B. tabaci, A. biguttula biguttula* and *H. armigera* during both cropping seasons. The values of coefficient of determination (R^2) were high (0.89 to 0.94), indicated that the population of *B. tabaci, A. biguttula biguttula* and *H. armigera* governed significantly with the weather parameters. It concluded that the population of *L. erysimi* exhibited negative correlation with maximum and minimum temperature, wind velocity and positive with afternoon and morning relative humidity.

KEY WORDS: Population dynamics, *B. tabaci, A. biguttula biguttula* and *H. armigera.*

INTRODUCTION

Cotton (*Gossypium hirsutum*) being a friendly fibre grown in 111 countries all along the world. In India it is cultivated in 9 million hectare with a production of 21.3 bales of seed cotton (Anonymous, 2005). Insect pests are well known as the major constraint to crop production. One of the problems in addressing pest management is inadequate knowledge about the factors influencing pest population dynamics. To understand pest dynamics, scientists collect pest surveillance data and related agricultural operations regarding crops, farming practices and other weather parameters.

Cotton whitefly (*Bemisia tabaci* Gen.) was described over 100 years ago as a pest of tobacco in Greece (Anonymous, 1989). Since then, it has become one of the most important sucking pests of world's industrial and food crops like cotton, sunflower, melon, tomato, brinjal etc. Over 500 plant species from Asia, Africa, America, Europe, Russia, Australia and the Pacific Islands confirms its polyphagous nature (Anonymous, 1986; Greathead, 1986). From cotton growing areas of central Punjab, Pakistan, it has been reported from 164 plant species (Attique *et al*., 2003). In 16 out of 27 cotton producing countries, whitefly has been reported as a major pest during mid to late cotton growing season (Anonymous, 1989). In the subcontinent region of Punjab, American cotton varieties failed completely during 1919 and 1926 and partially in 1921, 1923 and 1927, because of whitefly attacks (Hussain & Trehan, 1933). It acts as a sole vector of more than 100 plant viruses, which cause diseases to many commercial crops in different parts of the world (Jones, 2003). Role of different crops in the winter survival, population build up and carry-over of whitefly to cotton has been recognized by various workers like Hussain and Trehan (1933) and Hussain *et al*. (1936) from India and Mohyuddin *et al*. (1989) from Pakistan. Similar role of crops and vegetables in the carry-over and population build up of whitefly has also been signified by Butler *et al.* (1986) and Johnson *et al*. (1982) from Southern California, Melamed-Madjar *et al*. (1979) and Gerling (1984) from Israel, Mabbit (1978) and Nachapong and Mabbit (1979) from Thailand. *B. tabaci responsible for transmission of yellow mosaic virus (YMV), which is a major constraint for cultivation of the crop. A single female lives about 25 to 30 days depending on environmental conditions.* The leaf hopper, *Amrasca biguttula biguttula* (Ishida) (Homoptera: Cicadellidae) is a major sucking insect pest (Kumar and Singh, 2002) and its incidence not only results in the loss of plant vigour, but also spreads the mosaic virus diseases affecting fruit yield perceptibility (Samal and Patnaik, 2008). The nymphs and adults suck the sap from leaves and cause phytotoxic symptoms known as hopper burn which results in complete desiccation of plants and has become one of the limiting factors in economic productivity of the crop (Shivanna *et al.,* 2009). Adults and nymphs suck the sap from the leaves and also injecting toxic saliva in to the tissue which causes toxemia .The hopper generally feeds from the lower side of the leaves. The attacked leaves become crinkle and show the characteristic of browning and the other symptom of hopper burn. The attacked plants become stunted and fail to grow and bear no fruits.

A. biguttula biguttula appear with the onset of cloudy weather and their population is adversely affected by heavy rain. Eggs are laid singly within leaf veins in the parenchymatous layer between the vascular bundles and the epidermis on the upper leaf surface. Eggs are pear–shaped, elongated and yellowish–white in colour. Nymphs are whitish–pale–green, wingless and move in a peculiar fashion, diagonally. Adults are wedge-shaped, 2 to 3 mm long, pale green in colour with a black dot on posterior portion of each forewing. Adults of winter generation are slightly reddish in colour. Averages of 15 eggs (with a maximum of 29) are laid /female. Mature leaves (35 to 45 days old) are preferred for egg deposition. Incubation and nymphal periods last for 4 to 11 and 7 to 21 days respectively. Longevity of the adults varies from 5 to 8 weeks and there are 10 to 12 overlapping generations in a year. Nangpal (1948) has reported that mating takes place 2 to 16 days after emergence and oviposition begins 2 to 7 days after copulation. Life cycle is completed in 15 to 46 days in the different seasons.

Helicoverpa armigera (Hubner) is one of the most destructive pests and one of the major constraints for low yield of the crops right from vegetative to podding stage (Devi *et al*., 2002; Dhingra *et al*., 2003) and found on a large number of cultivated and wild plants throughout India (Pandey and Kanujia, 2004). The pest has been reported resistant to many commonly used insecticides (Jaysawal, 1990; Phokela *et al.*, 1990 and Lande, 1992). Ecological and physiological features like high fecundity, multi-voltinism, and ability to migrate long distances and diapauses during unfavorable conditions contribute for its severity in different situations. The *H. armigera* incidences, on other hand show a certain pattern in term of population dynamics. In this an effort has been made to understand the *H. armigera* population dynamics on cotton crop.

MATERIALS AND METHODS

This experiment was carried out in a field of loamy and black soil at Aligarh during 2009-10 and 2010-2011, to ascertain the population dynamics of *B. tabaci*, *A. biguttula biguttula* and *H. armigera* on cotton varieties i.e. R.S.-875, F-1378 and H-1098. Recommended agronomic practices were followed for raising the crops. Manure and fertilizers were applied: compost @200 Q/ha and half quantity of N_2 (45 kg/ha), P_2O_5 (50 kg/ha) and K_2O 60 kg/ha was given as basal dose at the time of sowing and half of the N_2 (45 kg/ha) was given 20 and 40 days after sowing. Nymphal counts of the *B. tabaci* and *A. biguttula biguttula* were made at biweekly interval from 20 random plants in the field taking three fully formed leaves in the upper canopy of each plant. Data on pest population as well as weather variables were averaged for different standard meteorological weeks. Mean temperature of around 30^0 C and mean relative humidity above 70% were found to be highly conducive for population build-up of these pests. The obtained data was analyzed by ANOVA and the critical difference (CD) was calculated at a probability level of 1 and 5%.

RESULTS AND DISCUSSION

The average population density of *B. tabaci* (Table-1) ranged from 0.15-0.30, 0.40-0.70, 0.48-1.25, upto 2.5, 1.45-2.0, 2.80-3.10 and 2.10-3.64 nymphs/adult/leaf where as the mean population of *A. biguttula bigutulla* (Table-1) was observed ranged from 0.10-0.20, 0.50-0.80, upto 0.95, 1.20-1.35, 1.40-1.85, 2.44-2.50 and 2.10-2.92 nymphs/adult/leaf while, the mean population density of *H. armigera* (Table-1) ranged from 0.15, 0.50-0.80, upto 0.95, upto 1.35, 2.50-2.85, 3.2-3.85 and 3.5 larvae/plant was recorded at 60 (23^{rd} week), 75 (25^{th} week), 90 (27^{th} week), 105 (29^{th} week), 120 (31^{st} week), 135 (33^{rd} week), and 150 (35^{th} week) DAS (days after sowing) on three varieties of cotton crop during 2009-10 and 2010-2011.

Sharma (2001) observed the similar findings on the pest followed the regular distribution in the beginning of the infestation each year and contagious distribution during rest of the period of crop infestation. Pereira *et al.* (2004) found a positive distribution of adult of *B. tabaci* in common bean, *Phaseolus vulgaris*. The results of Rathore and Tiwari (1998) showed an aggregated distribution of *B. tabaci* on mung bean (*Vigna radiata*), urd bean (*V. mungo*) and cow pea (*V. unguiculata*) during the summer and kharif seasons. Shen *et al.* (2005) found that the number of *B. tabaci* adults was highest on the upper, tender and fully open leaves on water melon and musk melon and the pest was aggregated on these plants as well as on cucumber.

In the present study was observed the mean population of *H. armigera* the similar findings who reported in agreement with Nath and Bhusan (2006) and peak population during month of April that synchronized with podding stage of the crop. Kant *et al.* (2007) the larger pest population in the high density crop could mainly be attribute to micro environment caused by crop conducive to pest and unfavorable to natural enemies.

The population of *B. tabaci* was counted nymph/adult per leaf. Correlation coefficient (Table-2) of *B. tabaci* population with temperature and wind velocity was negative. In case of minimum temperature it was insignificant in variety R.S.-875 (-0.398) and significant in other two varieties i.e. F-1378 (-0.382) and H-1098 (-0.398). Whereas, maximum temperature was significantly and ranges from (-0.698 to -0.809) during 2009-10 and 2010-2011, respectively. The correlation coefficient with humidity was significant and positive in R.S.-875 (0.742) and in H-1098 (0.723) where as it was positive and insignificant on F-1378 (0.641). In case of maximum relative humidity it was highly significant in variety F-1378 (0.845) and significant in H-1098 (0.835) however it was insignificant in R.S.-875 (0.846). Wind velocity exhibited negative correlation and non significant in two varieties i.e. R.S.-875 (-0.598) and F-1378 (-0.543) where as significant in H-1098(-0.594) during 2009-10 and 2010-2011, respectively.

TABLE: 1. Average population buildup of *B. tabaci, A. biguttula biguttula, H. armigera* on cotton under field conditions, 2009-10 and 2010-2011

Varieties	23 week (60DAS)	25 week (75 DAS)	27 week (90 DAS)	29 week (105 DAS)	31 week (120 DAS)	33 week (135 DAS)	35 week (150 DAS)	Control C.D. at 5%	Control C.D. at 1%
	B. tabaci — Average number of nymph/adult per leaf during standard weeks								
R.S.-875	0.15 (1.07)	0.70 (1.30)	1.25 (1.50)	2.50 (1.87)	2.60 (1.90)	3.10 (2.02)	2.60 (1.90)	0.501	0.405
F-1378	0.15 (1.07)	0.64 (1.28)	0.90 (1.38)	1.50 (1.58)	2.10 (1.76)	3.10 (2.02)	4.85 (2.42)	0.632	0.451
H-1098	0.15 (1.07)	0.40 (1.18)	0.48 (1.22)	0.90 (1.38)	2.00 (1.73)	2.80 (1.95)	3.95 (2.22)	0.584	0.425
	A. biguttula biguttula								
R.S.-875	0.15 (1.07)	0.75 (1.32)	0.95 (1.40)	1.20 (1.48)	2.80 (1.95)	3.20 (2.05)	3.40 (2.10)	0.482	0.421
F-1378	0.15 (1.07)	0.80 (1.34)	0.95 (1.40)	1.35 (1.53)	2.50 (1.87)	3.40 (2.10)	3.50 (2.12)	0.342	0.228
H-1098	0.15 (1.07)	0.50 (1.22)	0.62 (1.27)	1.35 (1.53)	2.85 (1.96)	3.85 (2.20)	2.85 (1.96)	0.431	0.321
	H. armigera								
R.S.-875	0.30 (1.14)	0.80 (1.34)	1.90 (1.70)	3.50 (2.12)	4.10 (2.26)	4.00 (2.24)	3.80 (2.19)	0.489	0.355
F-1378	0.50 (1.22)	0.90 (1.38)	2.20 (1.79)	3.40 (2.10)	4.10 (2.26)	4.60 (2.37)	3.40 (2.10)	0.601	0.436
H-1098	0.30 (1.14)	0.80 (1.34)	1.90 (1.70)	3.50 (2.12)	4.10 (2.26)	4.00 (2.24)	3.80 (2.14)	0.594	0.431

Figures in parentheses are $\sqrt{(n+1)}$ transform value

TABLE: 2 Correlation co-efficient between the populations of *B. tabaci, A. biguttula biguttula, H. armigera* and weather parameters on cotton during 2009-10 and 2010-2011

Varieties	Temperature (^{0}C) Maximum	Temperature (^{0}C) Minimum	Relative Humidity 0712 A.M.	Relative Humidity 1412 P.M.	Wind Velocity (Km/h) Control
	Control	Control	Control	Control	-0.598 ^{NS}
	B. tabaci				
R.S.-875	-0.788*	-0.398 ^{NS}	0.742*	0.846^{NS}	- 0.543^{NS}
F-1378	-0.698*	-0.382*	0.641^{NS}	0.845**	-0.594*
H-1098	-0.809*	-0.398*	0.723*	0.835*	
	A. biguttula biguttula				
R.S.-875	-0.690*	-0.598*	0.715*	0.826*	-0.812**
F-1378	-0.681*	-0.582^{NS}	0.638*	0.815**	-0.671*
H-1098	-0.812*	-0.539^{NS}	0.715*	0.814**	-0.703*
	H. armigera				
R.S.-875	-0.521^{NS}	-0.652^{NS}	0.710*	0.451*	-0.845*
F-1378	-0.654*	-0.764^{NS}	0.782^{NS}	0.541^{NS}	-0.875^{NS}
H-1098	-0.415**	-0.682*	0.715*	0.421*	-0.812*

TABLE: 3. Regression relationship between the population of *B. tabaci, A. biguttula biguttula, H. armigera* and weather parameters on cotton in 2009-10 and 2010-2011

Varieties		Regression equation	R^2
		B. tabaci	
R.S.-875	Control	$Y=1.098+0.421 X_1 +0.314X_2 +0.312X_3 -0.351X_4 +0.828X_5$	0.912
F-1378	Control	$Y=2.104+0.214X_1 +0.105X_2 +0.124X_3 -0.231X_4 +0.111X_5$	0.915
H-1098	Control	$Y=2.012+0.864 X_1 +0.524X_2 +0.454X_3 -0.544X_4 +0.097X_5$	0.925
		A. biguttula biguttula	
Varieties		Regression equation	R^2
R.S.-875	Control	$Y=2.025-0.625 X_1 +0.291X_2 +0.548X_3 -0.123X_4 +0.205X_5$	0.901
F-1378	Control	$Y=2.141-0.185 X_1 +0.398X_2 +0.589X_3 -0.209X_4 +0.114X_5$	0.903
H-1098	Control	$Y=2.2431-0.345 X_1 +0.204X_2 +0.542X_3 -0.241X_4 +0.181X_5$	0.934
		H. armigera	
Varieties		Regression equation	R^2
R.S.-875	Control	$Y=2.056-0.245X_1 +0.561X_2 -0.435X_3 -0.145X_4 -0.234X_5$	0.915
F-1378	Control	$Y=1.415-0.241X_1 +0.541X_2 -0.210X_3 +0.215X_4 -0.120X_5$	0.935
H-1098	Control	$Y=1.264-0.245X_1 +0.542X_2 -0.245X_3 +0.235X_4 -0.456X_5$	0.901

TABLE 4: Yield of cotton in different varieties (Q./acare) in 2009-10 and 2010-2011

Varieties	R.S.-875	F-1378	H-1098	Mean	C.D. at 5%	C.D. at 1%
Control	3.01 (2.00)	2.85 (1.96)	2.15 (1.77)	2.67 (1.92)	0.592	0.561
Mean	4.06 (2.25)	3.08 (2.02)	3.05 (2.01)	3.39 (2.10)	0.976	0.765

A. biguttula bigutulla with different weather variables exhibited negative correlation with respect to the temperature, wind velocity and positive correlation with the humidity. The correlation coefficient between leafhopper population and temperature was negative as well as significant in case of maximum it ranges from (0.681 to -0.812 max.) and in case of minimum it was non significant in varieties F-1378 (-0582) and in H-1098 (-0.539) although it was significant in R.S.-875 (-0.598). The correlation coefficient of pest population with relative humidity was positive and significant, its ranges from (0.638 to 0.715 min.) and (0.814to 0.826 max.). Wind velocity showed negative correlation coefficient as well as significant it ranges from -0.671 to -0.812 (Table-2) during 2009-10 and 2010-2011, respectively.

The correlation coefficient of *H. armigera* mean population (Table-2) with different parameter showed negative in maximum and minimum temperature and wind velocity whereas it was positive in case of humidity. The correlation with mean population of *H. armigera* and maximum temperature recorded as negative and non significant in R.S.-875 (-0.521) where as in F-1378 it was significant and in case of H-1098 it was highly significant. Whereas minimum temperature it was significant in H-1098(-0.682) and insignificant in varieties R.S.-875 (-0.675) and F-1378 (-0.764) during 2009-10 and 2010-2011, respectively. The minimum relative humidity showed positive and significant correlation in R.S.-875 (0.710) and H-1098 (0.715) but variety F-1378 (0.782) showed positive and insignificant result. Whereas maximum relative humidity showed positive and non significant in variety F-1378 (0.541) where as R.S.-875 and H-1098 gave positive and significant results. Wind velocity showed negative and significant correlation coefficient in varieties R.S.-875 and H-1098 however variety F-1378 showed insignificant result.

The values (Table-3) of correlation coefficient of determination (R^2) were high (0.89 to 0.94), indicated that the population of *B. tabaci, A. biguttula biguttula* and *H. armigera* governed significantly with the weather parameters. It concluded that the population ofmustard aphid, *L. erysimi* exhibited negative correlation with maximum and minimum temperature, wind velocity and positive with afternoon and morning relative humidity.

The average production was observed on cotton varieties such as 3.01 Q/acre in R.S.-875, 2.85 Q/acre in F-1378 and 2.15 Q/acre in H-1098 during 2009-10 and 2010-2011, respectively (Table-4). The attack of *H. armigera* was more in the three varieties and its population went up to 51.0 larvae/plant.

Acknowledgments

This research work was supported by the University Grants Commission, New Delhi under the Dr. D. S. Kothari Postdoctoral Fellowship Scheme Ref. no. F. 4-2/2006(BSR)/13-79/2008(BSR) which is greatly appreciated.

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