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Research Article

SEASONAL ABUNDANCE OF WHITEFLY, *BEMISIA TABACI* GAENNADIUS AND THEIR RELATION TO WEATHER PARAMETERS IN COTTON

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ABSTRACT
In this study, field trial was conducted to determine the effect of ecological factors on the incidence and development of whitefly, *Bemisia tabaci* at five different date of sowing on three varieties of cotton. The pest population was started from first week of March on five weeks old crop and acquired its peak in fourth week of July on thirteen weeks old crop. Maximum pest population (7.99/3 leaves) was build up at temperature ranged from 26^0 C to 35^0 C, relative humidity ranges from 84 and 67 per cent, zero rainfall, wind velocity 6.30 km/hr, total sunshine hours (9.4 hrs/week), evaporation (52.20 mm) and dewfall (0.708 mm). The highest incidence of whitefly population was recorded in SPCH 22 followed by SVPR 3 and MCU 7. Whitefly population was build up showed a significant and positive correlation with maximum and minimum temperature whereas, it was significant and negative association with evening relative humidity. The determination of effects of different weather factors on population of whiteflies in cotton was essential for effective pest management.

Key Words: *Cotton, Bemisia Tabaci, Weather Factors, Correlation, Date of Sowing and Pest Management*

INTRODUCTION
Cotton (*Gossypium* Spp.) being the king of natural fiber is grown in 111 countries all along the world. In India it is cultivated in 8.97 million ha with a production of 21.3 million bales of seed cotton (Anonymous, 2005). Moreover, due to the top most position in Indian agriculture and it is also popularly known as white gold. Cotton fiber is an important raw material to the textile industries and plays a key role in national economy in terms of employment generation and foreign exchange up to 62.3- 68.3 per cent (Khan et al., 2003). The cotton is not only principal cash crop but also each and every parts of the cotton plant are useful to farmer in one way or the other (Shivanna et al., 2009). Unfortunately, cotton is highly vulnerable to insect pests. During growth period, 148 insect pests have been recorded on cotton crop, out of which only 17 species have been recorded as major insect pests of cotton crop (Abbas, 2001). Cotton pests can be primarily divided in to sucking pests and bollworms. Among the sucking pests, whitefly, *Bemisia tabaci* Gaennadius is a major importance. Whiteflies occur at all the stages of the crop growth and responsible for indirect yield losses. Since, these pests suck the sap from the plants which leads to reduction in growth and vigour of the plants. In severe case of infestation, the plants get dried up and eventually die. Climatic conditions largely influence the pest numbers and activity as well as several predators and parasites either directly or indirectly (Arif et al., 2006; Chaudhari et al., 1999). For developing a weather based pest forewarning system, information regarding population dynamics in relation to prevalent meteorological parameters (temperature, relative humidity, sun shine hours etc.) is needed. Moreover, the same meteorological parameters also influence the growth and development of crop. Therefore, a thorough understanding of interaction between the crop growth stageand meteorological parameters/pest dynamics is a pre requisite for weather based pest forecasting model. Hence, the present studies were focused on location specific seasonal occurrence of whiteflies at different

crop growth stages and its relation with weather factors which is of great significance in formulating efficient pest management tactics.

MATERIALS AND METHODS

The field experiment was laid out at Pandit Jawaharlal Nehru College of Agriculture and Research Institute (PAJANCOA & RI) Karaikal between February and July in 2007 (Rice fallow cotton). The experiment was laid out in Factorial concept of Randomized Block Design (FRBD) with three replications and three treatments (varieties/hybrid - MCU 7, SVPR 3 and SPCH 22) having five sub treatments (Date of sowing - 1^{st}, 8^{th}, 15^{th}, 22^{nd} February and 1^{st} March). The plot size for each treatment was 5 x 4 m (20 m^2) plots. The seeds of varieties MCU 7, SVPR 3 and SPCH 22 were sown at two per hole with a spacing 60 x 30 cm, 60 x 30 cm and 120 x 60 cm respectively. The interval between each sowing was seven days. The data on abiotic factors i.e., temperatures, relative humidity, wind speed, rainfall, sunshine hours, evaporation and dewfall were taken from department of Agronomy, PAJANCOA & RI, Karaikal. The data on whiteflies population were recorded from 16^{th} February to 7^{th} August at weekly interval from ten randomly selected plants from each plot. Whiteflies were counted from three leaves each from top, middle and bottom canopies of the plant (Prasad et al., 2008).

Statistical Analysis

At the end of season, the data obtained were subjected to proper statistical analysis. The correlations as well as regression between cotton whitefly population and weather factors were estimated. Whitefly population was collected every week from the field. Weather factors were collected from Department of Agronomy (PAJANCOA & RI). Data was analyzed statistically by SPSS simple correlation worked out between population of whitefly and weather factors (maximum and minimum temperature, morning and evening relative humidity, sunshine hours, rainfall, evaporation and dewfall). The impact of weather factors on whitefly population fluctuation was determined through multiple linear regression models.

RESULTS AND DISCUSSION

Seasonal abundance of whitefly population

The incidence of whiteflies was observed during first week of March on five weeks old crop and acquired its peak incidence of whitefly (7.99/3 leaves) was observed in fourth week of July on thirteen one weeks old crop. The population of whiteflies was high during later stages of crop growth with peak population during 17^{th} Standard weeks (7.99 /3 leaves) (Table 1). On the whole crop season, the population of whiteflies was very low during initial periods of crop growth with gradual increase as crop stage advanced. The population of whitefly was maximum (7.99/3 leaves) during later stages of crop growth with maximum temperature ranged from 32°C to 35°C and minimum temperature ranged from 23°C to 26°C, morning relative humidity 84 to 93 per cent and evening relative humidity 58 to 67 per cent, wind velocity 4.7 to 6.3 kmph, sunshine hours 6.5 to 8.9 hrs and zero rainfall was favourable for multiplication of whiteflies (Table 1). The present findings are in corroboration with those of Kaur et al. (2009) who reported the peak population of whiteflies was observed when the maximum temperature and minimum temperature range of less than 36°C and more than 26°C respectively and the number of sunshine hours variably more than 8 hrs. Similarly, Prasad et al. (2008); Reddy and Rao (1989) who reported that a maximum and minimum temperature range of 29°C to 32°C and 18°C to 22°C respectively, was highly favourable for the population build up of whiteflies.

Correlation and regression between meteorological parameters and whitefly population

The population of whitefly showed significant positive correlation with maximum temperature ($r = 0.647$) and minimum temperature ($r = 0.591$). The correlation was negative and significant with evening relative humidity ($r = -0.163$), while association was positive and non significant with other parameters (Table 1). The present findings are in corroboration with those of Selvaraj et al. (2010); Dhaka and Pareek (2008); Arif et al. (2006); Gupta et al. (1998); Rao and Chari (1993), Rote and Puri et al. (1991); Singh and Butter (1985) who reported significant positive association between maximum temperature and the population of

Table 1: Weekly Mean Weather and Incidence of Whitefly, *B. Tabaci* in Cotton

MSW	Weather factors									Population of Whitefly/ 3 leaves
	Temperature (^{o}C)		Relative Humidity (%)		Wind speed (km/hr)	Bright sunshine (hrs)	Rainfall (mm)	Evaporation (mm)	Dewfall (mm)	
	Max.	Min.	Morning	Evening						
7	31.70	22.50	95.00	67.00	4.70	7.29	1.25	35.10	1.409	0.00
8	30.20	21.80	85.00	59.00	6.40	6.71	5.00	45.60	0.282	0.00
9	31.70	22.30	95.00	63.00	4.70	5.76	0.00	42.60	1.400	0.52
10	31.00	21.10	94.00	55.00	4.00	9.53	0.00	56.10	1.491	0.64
11	31.30	22.40	94.00	63.00	4.60	10.16	0.00	50.70	1.229	0.44
12	30.20	21.70	95.00	60.00	4.60	9.59	0.00	46.70	1.908	2.92
13	31.90	22.90	86.00	58.00	4.70	9.26	0.00	49.80	1.431	4.31
14	33.10	24.60	94.00	66.00	4.40	8.76	0.00	46.00	1.067	4.62
15	33.30	25.50	92.00	70.00	5.60	6.03	1.50	45.30	0.198	7.48
16	33.70	25.10	92.00	66.00	5.30	7.94	16.25	40.50	0.633	7.56
17	35.20	26.10	93.00	67.00	6.30	9.46	0.00	52.20	0.708	7.99
18	35.10	26.00	89.00	62.00	6.20	9.23	0.00	53.20	0.16	7.22
19	38.80	27.50	83.00	44.00	11.20	8.47	2.50	56.90	0.000	5.50
20	38.80	28.20	77.00	41.00	12.80	8.87	0.00	65.70	0.000	3.15
21	37.70	27.50	85.00	54.00	9.50	8.60	0.00	55.70	0.000	2.00
22	37.00	27.20	81.00	62.00	9.20	8.93	0.00	65.60	0.000	1.78
23	36.90	26.30	91.00	63.00	8.20	9.01	42.75	45.70	0.033	1.97
24	36.00	27.10	80.00	60.00	8.00	7.53	3.00	55.00	0.000	2.50
25	33.70	25.90	80.00	58.00	10.80	8.89	2.00	42.10	0.000	4.24
26	35.70	26.60	75.00	55.00	11.00	8.50	5.00	56.80	0.000	5.78
27	37.10	27.50	72.00	47.00	14.80	7.06	0.00	85.00	0.000	2.54
28	37.30	27.10	78.00	50.00	11.70	8.26	0.00	83.70	0.000	2.06
29	36.20	26.30	76.00	50.00	8.50	7.34	0.00	67.00	0.000	1.78
30	34.10	26.10	85.00	56.00	6.60	8.49	10.00	52.20	0.203	2.51
Correlation										
Whitefly	0.647**	0.591**	-0.054	-0.163*	0.250	0.343	0.042	0.053	0.371	

MSW - Meteorological Standard Week Max - Maximum temperature Min - Minimum temperature
*Significant at * P = 0.05 and **P = 0.01 level*

Effect of date of sowing on the incidence of whitefly

The incidence of whitefly population was compared with different dates of sowing. The overall mean incidence of whitefly population was 1.00 number for 1st February sowing, 2.01 number for 8th February sowing, 2.62 number for 15th February sowing, 3.10 number for 22nd February sowing and 3.76 number for 1st March sowing (Table 2). The incidence of whitefly was highest (3.76/3 leaves) in the last sowing (1st March) while the incidence was least (1.00/3 leaves) in first sowing (1st February) in irrespective of varieties (Table 2). A gradual increase of whitefly population was observed when the sowing dates were progressed whiteflies.

Table 2: Effect of Date of Sowing on the Incidence of Whitefly, *B. Tabaci* in Cotton Varieties

Crop stages	Date of sowing				
	First sowing	**Second sowing**	**Third sowing**	**Fourth sowing**	**Fifth sowing**
16 DAS	0.00	0.00	0.11	0.22	0.11
23 DAS	0.00	0.44	0.56	0.68	1.22
30 DAS	1.00	1.00	0.89	1.33	0.44
37 DAS	0.78	0.67	2.54	1.44	1.31
44 DAS	0.33	1.54	2.67	1.22	1.11
51 DAS	2.00	0.78	3.15	1.11	3.24
58 DAS	2.22	2.64	3.57	1.97	3.26
65 DAS	2.11	2.64	2.94	2.99	4.68
72 DAS	1.00	1.97	1.97	5.59	5.68
79 DAS	0.89	3.15	4.67	4.67	6.25
86 DAS	0.89	3.50	3.46	4.59	6.48
93 DAS	0.89	3.46	1.01	5.02	5.46
100 DAS	1.33	1.78	3.45	5.67	6.78
107 DAS	1.22	3.44	3.67	5.26	6.57
114 DAS	1.22	2.99	3.99	5.12	6.18
121 DAS	0.22	3.46	2.57	4.67	4.99
128 DAS	0.44	2.47	3.22	3.57	3.16
135 DAS	1.11	1.59	3.14	2.91	2.11
142 DAS	0.78	1.22	2.45	2.54	3.22
149 DAS	1.56	1.44	2.30	1.44	3.00
Mean	1.00	2.01	2.62	3.10	3.76

DAS – Days after Sowing

The present findings are in close conformity with those of Purohit et al. (2006); Umar et al. (2003) who reported the positive correlation with all the abiotic factors except wind velocity. The present findings are in not agreement with those of Prasad et al. (2008); Nandihalli et al. (1993); Singh et al. (2004) who reported that maximum temperature, minimum temperature and rainfall were found to exhibit significant negative association with the population of whiteflies. Shitole and Patel (2009) also reported the correlation of whitefly population was no significant negative association with rainfall, rainy days and wind velocity. This difference may be due to different ecological condition and difference crop on which the experiment was conducted. The regression revealed that among the various abiotic factors maximum temperature (X_1) and minimum temperature (X_2) was found to be most influencing factor, which contributed (R^2 = 0.8832) 88 per cent variation in whitefly population. The prediction equation obtained was $Y_1 = - 66.471 + 0.378 (X_1) + 1.368 (X_2)$

Where, Y_1 = Whitefly population

X_1 = Maximum temperature X_2 = Minimum temperature

The regression equation further indicated that maximum temperature and minimum temperature had a significant positive impact on the population of whiteflies i.e. for one unit increase in maximum temperature and minimum temperature there will be 0.37 and 1.36 unit increase in the population of whiteflies respectively.

Effect of varieties on the incidence of whitefly

The overall mean incidence of whitefly population was recorded in respect of three different varieties was maximum in 93rd Days after Sowing (DAS). The highest incidence was recorded in SPCH 22 (4.21/3 leaves) followed by MCU 7 (2.68/3 leaves) and SVPR 3 (3.15/3 leaves) on 93rd DAS. The mean incidence of whitefly was least in MCU 7 and maximum in SPCH 22 (Figure 1). The correlation analysis of mean data (Table 3) for all varieties revealed that maximum temperature, minimum temperature and wind velocity showed highly significant positive influence on whitefly population except MCU 7.

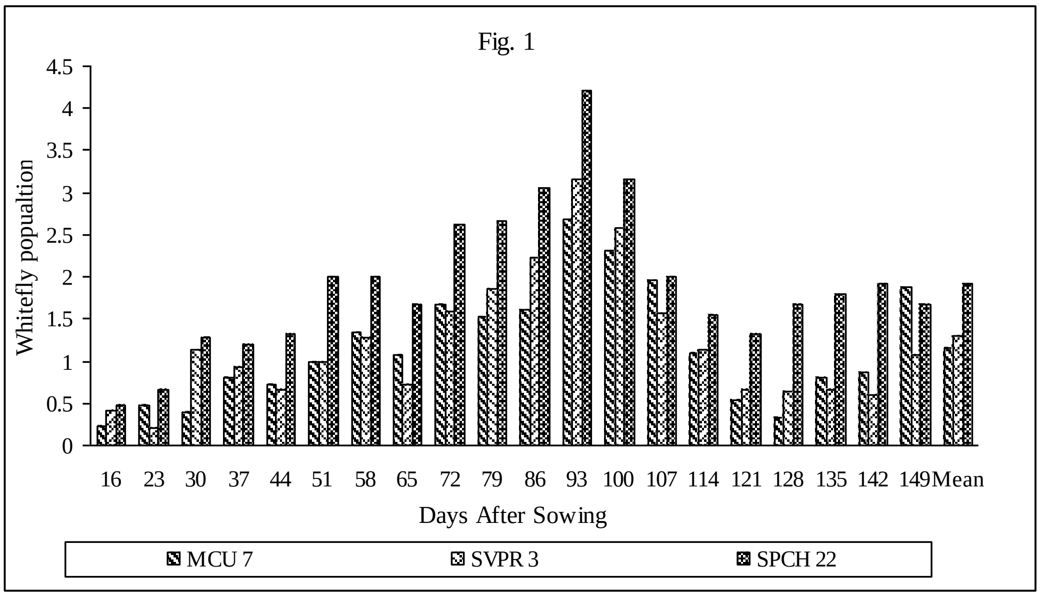

Figure 1: Effect of Different Varieties on the Incidence of Whitefly, *B. Tabaci* in Cotton

Table 3: Correlations Coefficient between the Incidences of Whitefly, *B. Tabaci* in Varieties and Various Weather Factors

Weather factors									
Variety	**Temperature (°C)**		**RH (%)**		**Wind speed (kmph)**	**Bright sunshine (hrs)**	**Rainfall (mm)**	**Evaporation (mm)**	**Dewfall (mm)**
	Max.	**Min.**	**Morning**	**Evening**					
MCU 7	0.094	0.097	-0.301	-0.415*	-0.295	0.389	-0.171	0.118	-0.254
SVPR 3	0.609 **	0.463*	-0.219	-0.636**	0.441*	0.305	-0.080	0.484*	-0.361
SPCH 22	0.573 **	0.393*	-0.236	-0.676**	0.480*	0.334	-0.063	0.416	-0.279

** Significant at 0.05 level* *** Significant at 0.01 level*
Max - Maximum temperature *Min - Minimum temperature* *RH - Relative humidity*

Evening relative humidity showed highly significant negative influence on the whitefly population for all varieties, while, the association was no significant with other parameters. The multiple linear regression analysis indicated that the influence of all the weather parameters was high and significant. It was up to 35.10 (R^2 = 0.3510) in MCU 7, up to 40.42 per cent (R^2 = 0.4042) in SVPR 3 and up to 57.83 per cent (R^2

= 57.83) in SPCH 22 on incidence of whitefly population (Table 4).

Table 4: Multiple Linear Regression Analysis between Weather Parameters and Whiteflies of Cotton in Different Varieties

Varieties/hybrid	Regression equation	R^2 value
MCU 7	= -120.410 -0.096 (X_1)	0.3510
SVPR 3	= 15.447 -0.211 (X_1)	0.4042
SPCH 22	= 15.386 -0.535 (X_1) +0.234 (X_2)	0.5783

X_1 = Evening relative humidity, *X_2 = Sunshine hours*

The regression equation further indicated that evening relative humidity had individual significant positive impact on the population of whiteflies i.e. for one unit increase in evening relative humidity there will be 0.09, 0.21 and 0.53 units decrease whitefly population in MCU 7, SVPR 3 and SPCH 22 respectively. It may be concluded that climatic factors determine seasonal activity and seasonal abundance of whitefly in cotton. This information generated in present study would be helpful in developing efficient pest management strategies against insect pests of cotton crop for increased production efficiency, profit, besides safety to the environment.

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