Journal of Entomology and Zoology Studies

Available online at www.entomoljournal.com

E-ISSN: 2320-7078
P-ISSN: 2349-6800
www.entomoljournal.com
JEZS 2021; 9(2): 660-662

Received: 03-01-2021
Accepted: 07-02-2021

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Effect of plant spacing on incidence of whitefly, *Bemisia tabaci* on Bt cotton

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Abstract
The incidence of whitefly, *Bemisia tabaci* on different plant spacing's i.e. 67.5 cm ×105 cm, 67.5 cm × 90 cm, 67.5 cm × 67.5 cm, 67.5 cm × 45 cm and 67.5 cm × 30 cm was studied. The maximum populations of whitefly, *Bemisia tabaci* was noticed in the plant spacing of 67.5 cm × 30 cm followed by 67.5 cm × 45 cm. Whereas, minimum population was noticed in plant spacing 67.5 cm × 105 cm followed by 67.5 cm × 90 cm. The maximum seed cotton yield was reported from the plots having spacing of 67.5 cm × 67.5 cm.

Keywords: Plant spacing, whitefly, *Bemisia tabaci* and Bt cotton

Introduction
Cotton is one of the world oldest crop and has been in cultivation in India for more than five thousand years. India has the unique distinction of being the only country in the world to cultivate all four cultivable *Gossypium* species. Cotton in India has registered impressive growth both in productivity and production through advent of hybrid technology and transgenic contributing 36 per cent of world's cotton area and 26 per cent of world's cotton production. But the average national productivity is one of the lowest (560kg lint /ha) against the world's average of 788kg lint /ha and is much below other countries viz., Australia (1781kg lint/ha), China (1719 lint/ha) and Brazil (1522kg lint/ha) [3]. In the current scenario, with Indian exports gaining importance, there is a need to reorient research efforts to enhance the production from the current 340.5-lakh bales to 1000 lakh bales by 2030 in a sustainable manner through precision strategic planning in order to meet the market demand [3]. In India, majority of the cotton production comes from nine major cotton-growing states. Insect pest are one of the major limiting factors in the cotton production. About, 1300 species of insects had been reported on cotton worldwide [9]. In India 162 insects and acarine species have been reported to infest cotton resulting in 50-60 per cent yield loss [7]. Among the arthropod pests, sucking insect viz., jassids, *Amrasca biguttula biguttula* (Ishida); whiteflies, *Bemisia tabaci* (Genn.); aphids, *Aphis gossypii* (Glover) and thrips, *Thrips tabaci* (Linn.) are the serious pests and cause losses in tune of 21.20 to 22.86 per cent [5, 11]. Adoption of Bt cotton has not only changed the cultivation profile, but also the pest scenario. While there is a decline in the pest status of bollworms; the sap feeders, *viz*. aphids, jassids, mirids and mealy bugs are emerging as serious pests. While the direct effects of sucking pest during early season are visualized in terms of the poor crop stand and yield reduction, their late season attack especially aphids and white flies indirectly decreases cotton fibre quality due to deposits of honey dew on lint. In addition to lint contamination, whitefly transmits leaf curl disease. The incidence and development of these insect pests is very much dependent upon the prevailing environmental factors and crop stand. These insets multiply tremendously during the favorable weather conditions and take huge toll. The continuous and indiscriminate use of large quantities of synthetic insecticides, besides creating health hazards to human and animal life, as well as environmental population has also resulted in the crop failure in different parts of the world, outbreak of secondary pests and development of resistance against insecticides in large number of insects. In view of existing situation it is necessary prerequisite for developing effective pest management program to know the proper and appropriate plant spacing and ecological requirements, particularly weather factors like temperature, relative humidity and precipitation play the key role in multiplication and distribution of insect pests. The effect of these factors on the incidence and development of insect pests has given a great momentum to research approach.

Owing to lack of information, the present study has been initiated not only to study an overall population situation of sucking insect pests of cotton in different plant spacing, but also to sort out the exact relationship between pest populations. These aims are to help the entomologist to develop the best IPM strategy for the control of the notorious insect pests of cotton.

Materials and Methods

Present investigation on effect of plant spacing on incidence of whitefly, *B. tabaci* on Bt cotton were recorded at the Research farm College of Agriculture, Swami Keshwanand Rajasthan Agricultural University Bikaner, (Rajasthan). The experiment was laid out in a simple randomized block design and plant spacing's were considered as treatments. There were five such treatments and each replicated four times. The seeds of NCS-855 BG ll were sown in the plot size 6.0 x 4.05 m on 22th May in 2018. The recommended package of practices, except spraying of insecticides were followed for raising the crop (Anonymous, 2018). The populations of whitefly, *B. tabaci* were recorded on five randomly selected tagged plants in morning hours (Before 8 AM), when insects has minimum activity. The observations were recorded on whole plant in the initial stage and on three leaves two from upper, middle and lower portion of randomly selected and tagged plants. The population was counted by holding the base of leaves gently until the entire underside of leaf was clearly visible. Population was estimated with least disturbance at early hours of the day. From this, the average population per leaf was worked out. The data on whitefly population recorded at weekly interval from experimental plots were transformed into $\sqrt{x} + 0.5$ values and subjected to analysis of variance. Seed cotton yield per plot per kg was converted into per hectare and then subjected to statistical analysis.

Results and Discussion

The occurrence of adults of whitefly started in 26th standard week *i.e*. last week of June. Initially the population was very low but increased week after week and attained to its peak population in the 38th standard week which was third week of September then declined till the crop maturity (table 1.1). At the peak, the maximum population 66.49 adults/3 leaves were noticed in the plots having plant spacing 67.5 cm x 30 cm and the minimum population 39.08 adults/3 leaves of were noticed in the plots having plant spacing 67.5cm x 105 cm. On the basis of over all season mean of whitefly, it was indicated that maximum number of adults 29.78 adults/3 leaves were observed in the plots having plant spacing 67.5 cm x 30 cm followed by 67.5cm x 45 cm (27.61adults/3 leaves). Minimum population of adults 16.55 adults/3leaves were noticed in the plots having plant spacing 67.5cm x 105 cm followed by 67.5 cm x 90 cm(17.96 adults/3 leaves). These results are in conformity with those of Thakare *et al.* (1986) who found that closer spacing led to high population of whitefly, *B. tabaci* in cotton, Giri *et al* (1993) studied that the greater numbers of adults of whitefly, *B. tabaci* was observed in plots having 60 cm x 15 cm compared with 60cm x 30 cm spacing, Arif *et al* (2006) observed that the population of whitefly, *B. tabaci* effected by plant spacing and decreasing with the increase in plant spacing, Singh (2015) revealed that 67.5 cm x 75 cm plant spacing was most susceptible while, 67.5 cm x 105 cm plant spacing was least susceptible against whitefly, *B. tabaci.* The population of whitefly, *B. tabaci* was recorded significantly higher in the plant spacing 67.5 cm x 30 cm and significantly lower in 67.5 cm x 105 cm.

Table 1.1: Effect of plant spacing on incidence of whitefly, *B. tabaci* on Bt cotton during *Kharif*, 2018

Plant Spacing (cm)	Population / 3 leaves on different standard weeks																				Mean
	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	
67.5 × 105	7.16 (2.77)*	4.16 (2.16)	10.18 (3.26)	5.56 (2.46)	5.52 (2.45)	6.04 (2.54)	4.24 (2.18)	6.84 (2.71)	9.87 (3.21)	7.06 (2.74)	24.68 (5.00)	32.45 (5.72)	27.55 (5.28)	39.08 (6.27)	34.74 (5.92)	36.91 (6.11)	36.69 (6.09)	17.54 (4.24)	11.75 (3.50)	2.92 (1.85)	16.55
67.5 × 90	8.16 (2.92)	4.74 (2.29)	10.60 (3.33)	6.54 (2.64)	6.54 (2.65)	6.21 (2.59)	4.80 (2.30)	7.39 (2.81)	10.56 (3.32)	8.04 (2.92)	27.46 (5.28)	34.13 (5.87)	30.51 (5.56)	41.71 (6.49)	36.90 (6.10)	39.46 (6.30)	39.46 (6.30)	20.22 (4.54)	12.68 (3.63)	3.16 (1.91)	17.96
67.5 × 67.5	10.35 (3.29)	6.47 (2.62)	13.83 (3.78)	8.46 (2.98)	8.12 (2.93)	8.23 (2.95)	6.16 (2.58)	9.94 (3.22)	13.22 (3.70)	10.36 (3.29)	34.51 (5.92)	42.56 (6.55)	38.22 (6.21)	52.12 (7.24)	46.40 (6.83)	49.22 (7.04)	49.19 (7.04)	25.87 (5.12)	15.84 (4.03)	4.20 (2.16)	22.66
67.5 × 45	12.35 (3.58)	7.79 (2.88)	17.83 (4.27)	10.48 (3.31)	9.71 (3.19)	9.66 (3.19)	7.55 (2.84)	10.97 (3.38)	15.86 (4.04)	13.35 (3.72)	42.17 (6.52)	51.53 (7.20)	46.68 (6.86)	63.03 (7.96)	55.77 (7.49)	59.86 (7.76)	61.23 (7.85)	32.15 (5.71)	19.04 (4.41)	5.13 (2.37)	27.61
67.5 × 30	14.11 (3.82)	8.91 (3.07)	20.64 (4.60)	11.49 (3.46)	10.42 (3.30)	10.10 (3.25)	8.41 (2.97)	11.62 (3.48)	17.46 (4.24)	15.24 (3.97)	46.86 (6.88)	55.23 (7.46)	50.29 (7.12)	66.49 (8.18)	58.78 (7.69)	62.59 (7.94)	65.66 (8.13)	35.32 (5.98)	20.49 (4.58)	5.61 (2.47)	29.78
S.Em.±	0.13	0.08	0.12	0.09	0.09	0.10	0.08	0.10	0.11	0.12	0.17	0.20	0.19	0.23	0.21	0.22	0.22	0.16	0.12	0.06	
C.D.at 5 %	0.39	0.25	0.37	0.29	0.27	0.30	0.24	0.30	0.35	0.36	0.54	0.62	0.58	0.70	0.65	0.68	0.69	0.49	0.37	0.19	

* Figures in parenthesis are $\sqrt{x} + 0.5$ values

Effect of plant spacing on seed cotton yield

The data of seed cotton yields obtained from the treatments having different plant spacing revealed that maximum seed cotton yield 16.40 q ha^{-1} (table 1.2) was obtained from the plots having plant spacing of 67.5 x 67.5 cm and the minimum seed cotton yield (10.85 q ha^{-1}) in the plots having 67.5 x 105 cm plant spacing followed by 67.5 x 90 cm (11.55 q ha^{-1}) and 67.5 x 45.0 cm (14.25 q ha^{-1}). However, these were at par and inferior to the other treatments. The seed cotton yields in other plants spacing 67.5 x 30 cm was (13.50 q ha^{-1}) The present results are in agreement to that of Acharya and Bhargawa (2008) who reported that maximum seed cotton yield was observed in the treatment where plant spacing was 67.5 x 60cm and minimum seed cotton yield was obtained in the treatment where plant spacing was 67.5 x 100cm contrary to the present investigation, the maximum seed cotton yield was recorded in the plots having plant spacing of 0.675 x 0.30 m. However, significant higher seed cotton yield was obtained in the plots having plant spacing of 0.675 x 0.60 m which was comparable to that of 0.675 x 0.30 m spacing and minimum seed cotton yield was obtained in the plots having spacing of 1.00 x 0.60 m (Anonymous, 2001) support these findings.

Table 1.2: Effect of plant spacing on seed cotton yield

S. No.	Plant Spacing (cm)	Yield (q ha^{-1})
1	67.5 × 105.0	10.85
2	67.5 × 90.0	11.55
3	67.5 × 67.5	16.40
4	67.5 × 45.0	14.25
5	67.5 × 30.0	13.50
	S.Em.±	0.45
	C.D.at 5 %	1.38

Conclusion

The incidence of whitefly, *B. tabaci* on different plant spacing i.e. 67.5 cm ×105 cm, 67.5 cm × 90 cm, 67.5 cm × 67.5 cm, 67.5 cm × 45 cm and 67.5 cm × 30 cm was studied. The maximum population of whitefly, *B. tabaci* was noticed in the plant spacing of 67.5 cm × 30 cm followed by 67.5 cm × 45 cm. Whereas, minimum population of whitefly was noticed in plant spacing 67.5 cm × 105 cm followed by 67.5 cm × 90 cm. The maximum seed cotton yield was reported from the plots having plant spacing of 67.5 cm × 67.5 cm. The minimum seed cotton yield was recorded from the plots having plant spacing of 67.5 cm × 105 cm.

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