Influence of dates of sowing and varieties or hybrids on incidence of insect pests of cotton in scarce rainfall zone

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ABSTRACT : A field experiment was conducted at Regional Agriculture Research Station, Nandyal, Andhra Pradesh during *kharif* 2017-2018 on vertisols in factorial randomized block design with 2 factors *i.e.*, dates of sowing as first factor and varieties as second factor which were replicated thrice to study the influence of different dates of sowing on incidence of insect pests of cotton wherein two dates of sowing (normal and delayed sowing) with two varieties and two hybrids at their recommended spacings were tested for their influence. The results revealed that crop sown during normal sowing (20th July) recorded more mean leafhopper population *i.e.*, 4.22 leafhoppers/3 leaves as against 3.87 leafhoppers/3 leaves, recorded during delayed sowing (8th August). The correlation studies revealed a significant and positive correlation between leafhopper population and minimum temperature under both normal sowing and delayed sowing conditions (r=0.822 and r= 0.716, respectively). Among the varieties and hybrids studied, varieties recoded low leafhopper population *i.e.*, 4.20 mean leafhoppers/3 leaves as against 4.72 mean leafhoppers/3 leaves observed in hybrids. The populations of whitefly, pink bollworm, American bollworm and spotted bollworm did not cross ETL (Economic threshold levels) on both the varieties and hybrids at different dates of sowings

Key words : *Bt* cotton, correlation, dates of sowing, sucking pests

Cotton (*Gossypium hirsutum* L.) is the most important cash crop of India, Due to assured protection of bollworms in *Bt* cotton hybrids the area under *Bt* cotton is increasing day by day but at the same time sucking pests has emerged as major threat for cotton growers causing heavy yield losses. Cotton crop was known to attacked by 162 species of insect pests which can be primarily divided into bollworms and sucking pests from sowing to harvesting accounting a loss upto 50-60 per cent in India. Leafhopper, *Amrasca biguttula biguttula* (Ishida), aphid, *Aphis gossypii* (Glover), thrips *Thrips tabaci* (Lind.) and whitefly, *Bemisia tabaci* (Genn.) are of major importance among sucking pests which occur at all the stages of crop growth and responsible for indirect yield losses (Ambarish *et al.*, 2017). *Bt* cotton succumbs to yield loss due to the sap feeders spread throughout the growing season, right from seedling emergence to harvest, as the biotic potential of sucking pests being high, they are potential threat to *Bt* cotton. Early detection of incidence of insect pests *i.e.*, most probable incidence periods and the resistance of the varieties or hybrids available locally is of prime importance to formulating management strategies against seasonal and regular pests which was given priority in formulating this study of influence of different sowing dates on incidence of insect pests of cotton.

MATERIALS AND METHODS

The experiment was laid out in factorial randomized block design with 2 factors *i.e.*, dates of sowing as first factor and varieties as second factor which were replicated thrice with a plot size of 5.4 × 4.5 m (24.3 m²).The normal sowing was taken up in the first fortnight of July (20th July) and delayed sowing in first fortnight of August (8th August) was done with two varieties *i.e.*, Suraj, Srirama and two hybrids *i.e.*, RCH 2 *Bt* BG II, Bunny BG II with recommended spacings (60 × 30 cm and 90× 45 cm for varieties and *Bt* hybrids, respectively) during *kharif*, 2017. Standard agronomic practices were adopted to raise a good crop. The experiment was conducted under unprotected conditions. Incidence of sucking pests *viz.,* leafhoppers, whiteflies, aphids, thrips and natural enemies such as spiders and ladybird beetles were recorded on five randomly selected plants in each plot at weekly intervals starting from 30 days after sowing in all the treatments. The population of both nymphs and adults of leafhoppers, whiteflies, aphids and thrips were recorded from three leaves *viz.*, one each from top, middle and bottom canopies of the plant. The natural enemies population was recorded on whole plant basis. The average of all the five observations was calculated and expressed as mean population. The data obtained was subjected to suitable statistical analysis for drawing conclusions.

RESULTS AND DISCUSSION

Sucking pests : During the normal sowing (20.07.2017) the incidence of leafhoppers ranged from 0.62 to 9.62 leafhoppers /3 leaves and the peak incidence was observed during 38th SMW (9.62 leafhoppers/3 leaves). In delayed sowing (08.08.2017), the incidence of leafhoppers ranged from 0.00 to 10.03 leafhoppers /3 leaves and the peak incidence was observed during 46th SMW (10.03 leafhoppers/3 leaves). It can be the data in observed from Table 1 that crop sown during normal sowing recorded more mean leafhopper population *i.e.*, 4.22 leafhoppers /3 leaves as against 3.87 leafhoppers /3 leaves , which was recorded during delayed sowing (Table 1).

Among the varieties tested, variety Suraj horboured a mean leafhopper population of 4.80 leafhoppers /3 leaves , whereas variety Srirama horboured a mean leafhopper population of 3.60 leafhoppers /3 leaves . Among the hybrids tested, RCH 2 *Bt* BG II has horboured a mean leafhopper population of 4.80 leafhoppers /3 leaves , whereas Bunny BG horboured a mean leafhopper population of 4.63 leafhoppers /3 leaves . The data revealed (based on the mean leafhoppers / 3 leaves) that among varieties tested, Suraj horboured more leafhoppers than variety Srirama and among hybrids RCH 2 *Bt* BG II horboured more leafhopper population than Bunny BG II. Among the varieties and hybrids tested, the leafhopper population in varieties ranged from 0.63 to 9.87 leafhoppers /3 leaves and the peak incidence was observed in Suraj variety during 35th SMW (9.87 leafhoppers /3 leaves) whereas in hybrids the leafhopper population ranged from 0.47 to 12.60 leafhoppers /3 leaves and the peak incidence was observed in RCH 2 *Bt* BG II during 46th SMW (12.60 leafhoppers /3 leaves) (Table 1). The correlation studies (Table 2) revealed a significant and

Table 1. Incidence of leafhopper on cotton at different dates of sowing during *kharif*, 2017

Treatment	Mean population of leafhoppers/3 leaves (Standard Meteorological Weekwise)												
	34	35	36	37	38	39	40	41	42	43	44	45	46
Factor 1													
Normal sowing	5.10 (2.37)	8.70 (3.03)	5.43 (2.44)	7.18 (2.77)	9.62 (3.18)	5.95 (2.54)	4.37 (2.21)	5.37 (2.42)	4.62 (2.26)	2.90 (1.84)	5.48 (2.45)	5.23 (2.39)	7.22 (2.78)
Delayed sowing	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	3.63 (2.03)	4.63 (2.27)	5.43 (2.44)	6.02 (2.55)	7.00 (2.74)	5.78 (2.51)	4.40 (2.21)	8.15 (2.94)	8.97 (3.08)	10.03 (3.25)
Factor 2													
Variety													
Suraj	5.67 (2.46)	9.87 (3.22)	5.67 (2.47)	5.53 (2.46)	7.87 (2.89)	5.37 (2.42)	4.90 (2.32)	6.17 (2.58)	6.27 (2.60)	3.27 (1.94)	8.33 (2.97)	7.97 (2.91)	9.57 (3.17)
Srirama	4.33 (2.18)	7.40 (2.81)	4.33 (2.19)	4.23 (2.18)	7.00 (2.74)	5.10 (2.37)	4.10 (2.14)	5.10 (2.37)	3.67 (2.04)	3.17 (1.91)	5.27 (2.40)	5.27 (2.40)	4.87 (2.32)
Mean	**5.00**	**8.64**	**5.00**	**4.88**	**7.43**	**5.23**	**4.50**	**5.63**	**4.97**	**3.22**	**6.80**	**6.62**	**7.22**
Hybrid													
RCH 2 *Bt* BGII	5.47 (2.43)	8.27 (2.95)	5.47 (2.43)	6.47 (2.64)	6.87 (2.71)	6.30 (2.61)	5.60 (2.47)	6.33 (2.61)	5.57 (2.46)	4.60 (2.26)	6.77 (2.70)	7.77 (2.88)	12.60 (3.62)
Bunny BG II	4.93 (2.30)	9.27 (3.13)	6.27 (2.58)	5.40 (2.43)	6.77 (2.70)	6.00 (2.55)	6.17 (2.58)	7.13 (2.76)	5.30 (2.41)	3.57 (2.02)	6.90 (2.72)	7.40 (2.81)	7.47 (2.82)
Mean	**5.20**	**8.77**	**5.87**	**5.93**	**6.82**	**6.15**	**5.88**	**6.73**	**5.43**	**4.08**	**6.83**	**7.58**	**10.03**
SEm (±)	0.11	0.12	0.10	0.13	0.14	0.11	0.12	0.15	0.10	0.11	0.14	0.15	0.14
CD (p=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	0.31	NS	NS	NS	0.42
Interaction factor													
SEm (±)	0.15	0.17	0.14	0.18	0.20	0.16	0.17	0.21	0.14	0.16	0.20	0.21	0.19
CD (p=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
CV (%)	17.06	15.38	15.65	13.12	12.66	13.44	11.27	14.43	10.53	13.44	12.90	13.71	11.30

Figures in parentheses are square root (x+0.5) transformed values, NS: Non significant

Contd......

Table 1 contd...

Treatment	Mean population of leafhoppers/3 leaves (Standard Meteorological Week wise)										Mean
	47	48	49	50	51	52	1	2	3	4	
Factor 1											
Normal sowing	3.82	3.05	4.13	1.73	1.73	1.32	1.47	1.10	0.82	0.62	**4.22**
	(2.08)	(1.88)	(2.15)	(1.49)	(1.49)	(1.35)	(1.40)	(1.26)	(1.15)	(1.06)	
Late sowing	4.95	3.97	4.87	2.25	2.42	0.92	1.85	1.48	1.38	0.87	**3.87**
	(2.33)	(2.11)	(2.32)	(1.66)	(1.71)	(1.19)	(1.53)	(1.41)	(1.37)	(1.17)	
Factor2											
Variety											
Suraj	4.77	3.73	5.73	1.73	1.93	0.87	1.60	1.33	1.15	1.20	**4.80**
	(2.29)	(2.06)	(2.50)	(1.49)	(1.56)	(1.17)	(1.45)	(1.35)	(1.28)	(1.30)	
Srirama	3.37	2.87	4.03	1.23	1.47	1.23	1.70	1.40	0.97	0.63	**3.60**
	(1.97)	(1.83)	(2.13)	(1.32)	(1.40)	(1.32)	(1.48)	(1.38)	(1.21)	(1.06)	
Mean	**4.07**	**3.30**	**4.88**	**1.48**	**1.70**	**1.05**	**1.65**	**1.37**	**1.06**	**0.92**	4.20
Hybrid											
RCH 2 *Bt* BG II	4.63	3.50	3.60	2.67	2.53	1.30	1.50	1.23	0.90	0.47	**4.80**
	(2.27)	(2.00)	(2.02)	(1.78)	(1.74)	(1.34)	(1.41)	(1.32)	(1.18)	(0.98)	
Bunny BG II	4.77	3.93	4.63	2.33	2.37	1.07	1.83	1.20	1.13	0.67	**4.63**
	(2.29)	(2.11)	(2.27)	(1.68)	(1.69)	(1.25)	(1.53)	(1.30)	(1.28)	(1.08)	
Mean	**4.70**	**3.72**	**4.12**	**2.50**	**2.45**	**1.18**	**1.67**	**1.22**	**1.02**	**0.57**	**4.72**
SEm (±)	0.12	0.11	0.10	0.07	0.07	0.08	0.06	0.06	0.08	0.05	
CD (p=0.05)	NS	NS	NS	0.21	0.22	NS	NS	NS	NS	NS	
Interaction factor											
SEm (±)	0.18	0.15	0.15	0.10	0.10	0.11	0.09	0.09	0.11	0.07	
CD (p=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	
CV (%)	13.88	13.64	11.27	11.06	10.97	14.80	10.35	11.28	15.17	10.58	

Figures in parentheses are square root (x+0.5) transformed values, NS: Non significant

positive correlation between leafhopper population and minimum temperature under both normal sowing and delayed sowing conditions (r= 0.822 and r= 0.716, respectively). Under normal sowing conditions leafhopper population had a significant and positive correlation with rainfall (r= 0.469) and a significant negative correlation with sunshine hours (r= -0.566) during *kharif,* 2017. The correlation studies under normal sowing conditions indicated that leafhopper population showed significant and positive correlation with minimum temperature and rainfall (r= 0.822 and r= 0.469). The present findings are in agreement with Babu and Meghwal (2014) and Mohapatra (2008) who reported a positive correlation between leafhopper population and minimum temperature.

Other sucking pests : The incidence of other sucking pests such as whitefly, thrips and aphids was very low during the period of experimentation.

Bollworms : Among the bollworms, the incidence of pink bollworm was there which was

Table 2. Correlation between leafhopper incidence and weather parameters during *kharif* , 2017

Weather parameters	Leafhopper population/3 leaves	
	Normal sowing	Delayed sowing
Temp. Max (ºc)	0.162	0.102
Temp. Min (ºc)	0.822**	0.716**
RH Mor. (%)	-0.025	-0.060
RH Eve. (%)	0.051	0.140
Rainfall (mm)	0.469*	0.215
Wind velocity (kmph)	0.124	-0.271
Sunshine hours	-0.566**	-0.402

r_{tab}(18 df, 0.05)= 0.444 r_{tab}(18 df, 0.01)= 0.562
*Significant at 5%   **significant at both 5% and 1%

very low and below ETL. However, the incidence of other bollworms such as spotted bollworm, American bollworm was almost nil. During the normal sowing the incidence of pink bollworm ranged from 0.03 to 0.35 pink bollworm larvae/ 20 bolls whereas in delayed sowing the incidence pink bollworm ranged from 0.00 to 0.33 pink bollworm larvae/20 bolls (Table 3). Though there was no significant difference between the treatments with respect to incidence levels of pink bollworm, the higher no. of pink bollworm larvae were recorded during the peak boll formation stage to till harvest of the crop *i.e.,* from 43rd SMW to till end of the crop which confirms that the late sown crop will be the worst hit by pink bollworm. Among the varieties, the incidence of pink bollworm ranged from 0.03 to 0.40 pink bollworm larvae/20 bolls whereas in hybrids the incidence of pink bollworm ranged from 0.00 to 0.40 pink bollworm larvae/20 bolls.

Among the varieties tested variety Suraj has recorded a mean pink bollworm population of 0.16 pink bollworm larvae/20 bolls whereas variety Srirama has recorded a mean pink bollworm population of 0.22 pink bollworm larvae/20 bolls. Among the hybrids tested, RCH 2 *Bt* BG II has recorded a mean pink bollworm population of 0.08 pink bollworm larvae/20 bolls, whereas Bunny BGII has recorded a mean pink bollworm population of 0.10 pink bollworm larvae per 20 bolls. The data showed (based on the mean pink bollworm larvae/20 bolls) that among varieties tested, Srirama has more incidence of pink bollworms than variety Suraj and among hybrids Bunny BG II has more pink bollworm population than RCH 2 *Bt* BG II. However the pink bollworm incidence in all the test hybrids/ varieties at different periods of sowing was very

Table 3. Incidence of pink bollworm on cotton at different dates of sowing and in different varieties and hybrids during *kharif*, 2017

Treatment	Mean population of pink bollworm larvae/20 bolls (Standard Meteorological Week wise)										
	38	39	40	41	42	43	44	45	46	47	48
Factor 1											
Normal sowing	0.03	0.07	0.08	0.13	0.15	0.13	0.08	0.05	0.12	0.07	0.10
	(0.73)	(0.75)	(0.76)	(0.80)	(0.81)	(0.80)	(0.76)	(0.74)	(0.79)	(0.75)	(0.77)
Late sowing	0.00	0.00	0.00	0.00	0.00	0.25	0.13	0.20	0.18	0.15	0.17
	(0.71)	(0.71)	(0.71)	(0.71)	(0.71)	(0.87)	(0.80)	(0.84)	(0.83)	(0.81)	(0.82)
Factor 2											
Variety											
Suraj	0.03	0.03	0.07	0.07	0.03	0.20	0.17	0.13	0.23	0.20	0.13
	(0.73)	(0.73)	(0.75)	(0.75)	(0.73)	(0.84)	(0.82)	(0.80)	(0.86)	(0.84)	(0.80)
Srirama	0.03	0.10	0.07	0.10	0.20	0.37	0.20	0.17	0.27	0.17	0.23
	(0.73)	(0.77)	(0.75)	(0.77)	(0.84)	(0.93)	(0.84)	(0.82)	(0.88)	(0.82)	(0.86)
Mean	**0.03**	**0.06**	**0.07**	**0.09**	**0.12**	**0.29**	**0.19**	**0.15**	**0.25**	**0.19**	**0.18**
Hybrid											
RCH 2 *Bt* BG II	0.00	0.00	0.03	0.03	0.00	0.03	0.03	0.10	0.07	0.03	0.07
	(0.71)	(0.71)	(0.73)	(0.73)	(0.71)	(0.73)	(0.73)	(0.77)	(0.75)	(0.73)	(0.75)
Bunny BG II	0.00	0.00	0.00	0.07	0.07	0.17	0.03	0.10	0.03	0.03	0.10
	(0.71)	(0.71)	(0.71)	(0.75)	(0.75)	(0.82)	(0.73)	(0.77)	(0.73)	(0.73)	(0.77)
Mean	**0.00**	**0.00**	**0.02**	**0.05**	**0.03**	**0.10**	**0.03**	**0.10**	**0.05**	**0.03**	**0.08**
SEm (±)	0.02	0.03	0.03	0.03	0.04	0.04	0.04	0.03	0.02	0.04	0.04
CD (p=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Interaction factor											
SEm (±)	0.02	0.04	0.04	0.05	0.06	0.06	0.05	0.04	0.03	0.05	0.05
CD (p=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
CV (%)	8.39	8.56	8.68	10.69	14.02	13.52	10.94	9.72	9.40	11.09	10.94

Figures in the parentheses are square root (x+0.5) transformed values . NS: Non significant

Table 3. contd.....

Treatment	Mean population of pink bollworm larvae/20 bolls (Standard Meteorological Week wise)								
	49	50	51	52	1	2	3	4	Mean
Factor 1									
Normal sowing	0.05	0.07	0.35	0.20	0.13	0.27	0.20	0.13	**0.13**
	(0.74)	(0.75)	(0.92)	(0.84)	(0.80)	(0.88)	(0.84)	(0.80)	
Late sowing	0.20	0.15	0.32	0.18	0.25	0.22	0.33	0.25	**0.16**
	(0.84)	(0.81)	(0.90)	(0.83)	(0.87)	(0.85)	(0.91)	(0.87)	
Factor 2									
Variety									
Suraj	0.13	0.20	0.37	0.23	0.20	0.20	0.27	0.20	**0.16**
	(0.80)	(0.84)	(0.93)	(0.86)	(0.84)	(0.84)	(0.88)	(0.84)	
Srirama	0.17	0.17	0.40	0.20	0.37	0.40	0.33	0.30	**0.22**
	(0.82)	(0.82)	(0.95)	(0.84)	(0.93)	(0.95)	(0.91)	(0.89)	
Mean	**0.15**	**0.19**	**0.39**	**0.22**	**0.29**	**0.30**	**0.30**	**0.25**	**0.19**
Hybrid									
RCH 2 *Bt* BGII	0.10	0.03	0.17	0.20	0.03	0.20	0.23	0.13	**0.08**
	(0.77)	(0.73)	(0.82)	(0.84)	(0.73)	(0.84)	(0.86)	(0.80)	
Bunny BG II	0.10	0.03	0.40	0.13	0.17	0.17	0.23	0.13	**0.10**
	(0.77)	(0.73)	(0.95)	(0.80)	(0.82)	(0.82)	(0.86)	(0.80)	
Mean	**0.10**	**0.03**	**0.28**	**0.17**	**0.10**	**0.18**	**0.23**	**0.13**	**0.09**
SEm (±)	0.03	0.04	0.05	0.03	0.04	0.03	0.05	0.04	
CD (p=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	
Interaction factor									
SEm (±)	0.04	0.05	0.06	0.04	0.06	0.04	0.08	0.04	
CD (p=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	
CV (%)	9.72	11.09	12.30	9.81	13.52	9.54	15.31	11.32	

Figures in parentheses are square root (x+0.5) transformed values,NS: Non significant

Table 4. Population of spiders on cotton at different dates of sowing and in different varieties and hybrids during *kharif*, 2017

Treatments	Mean population of spiders/3 leaves (Standard Meteorological Week wise)												
	34	35	36	37	38	39	40	41	42	43	44	45	46
Factor 1													
Normal sowing	0.03	0.05	0.07	0.03	0.16	0.02	0.05	0.03	0.03	0.03	0.16	0.07	0.05
	(0.73)	(0.74)	(0.75)	(0.73)	(0.82)	(0.72)	(0.74)	(0.73)	(0.73)	(0.73)	(0.82)	(0.75)	(0.74)
Late sowing	0.00	0.00	0.00	0.03	0.05	0.08	0.08	0.02	0.02	0.02	0.05	0.00	0.08
	(0.71)	(0.71)	(0.71)	(0.73)	(0.74)	(0.76)	(0.76)	(0.72)	(0.72)	(0.72)	(0.74)	(0.71)	(0.76)
Factor 2													
Variety													
Suraj	0.00	0.07	0.00	0.03	0.08	0.10	0.07	0.00	0.00	0.00	0.08	0.00	0.07
	(0.71)	(0.75)	(0.71)	(0.73)	(0.76)	(0.77)	(0.75)	(0.71)	(0.71)	(0.71)	(0.76)	(0.71)	(0.75)
Srirama	0.00	0.07	0.13	0.03	0.13	0.00	0.10	0.03	0.03	0.00	0.13	0.13	0.10
	(0.71)	(0.75)	(0.79)	(0.73)	(0.80)	(0.71)	(0.77)	(0.73)	(0.73)	(0.71)	(0.80)	(0.79)	(0.77)
Mean	**0.00**	**0.07**	**0.07**	**0.03**	**0.11**	**0.05**	**0.09**	**0.02**	**0.02**	**0.00**	**0.11**	**0.07**	**0.09**
Hybrid													
RCH 2 *Bt* BGII	0.07	0.07	0.07	0.07	0.08	0.00	0.03	0.07	0.07	0.03	0.08	0.07	0.03
	(0.75)	(0.75)	(0.75)	(0.75)	(0.76)	(0.71)	(0.73)	(0.75)	(0.75)	(0.75)	(0.76)	(0.75)	(0.73)
Bunny BG II	0.07	0.00	0.07	0.00	0.15	0.10	0.07	0.00	0.00	0.03	0.15	0.07	0.07
	(0.75)	(0.71)	(0.75)	(0.71)	(0.81)	(0.77)	(0.75)	(0.71)	(0.71)	(0.73)	(0.81)	(0.75)	(0.75)
Mean	**0.07**	**0.04**	**0.07**	**0.03**	**0.12**	**0.05**	**0.05**	**0.04**	**0.04**	**0.03**	**0.12**	**0.07**	**0.05**
SEm (±)	0.02	0.02	0.02	0.02	0.04	0.02	0.03	0.02	0.02	0.02	0.04	0.02	0.03
CD (p=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Interaction factor													
SEm (±)	0.02	0.03	0.03	0.02	0.05	0.03	0.04	0.03	0.03	0.02	0.05	0.03	0.04
CD (p=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
CV (%)	5.39	6.33	5.73	5.65	10.92	7.84	8.83	6.33	6.33	5.39	10.92	5.73	8.83

Figures in parentheses are square root (x+0.5) transformed values, NS: Non significant

Table 4. contd…

Treatments	Mean population of spiders/3 leaves (Standard Meteorological Week wise)										
	47	48	49	50	51	52	1	2	3	4	Mean
Factor 1											
Normal sowing	0.03	0.02	0.07	0.03	0.03	0.02	0.16	0.03	0.16	0.05	**0.06**
	(0.73)	(0.72)	(0.75)	(0.73)	(0.73)	(0.72)	(0.82)	(0.73)	(0.82)	(0.74)	
Late sowing	0.03	0.08	0.00	0.00	0.02	0.08	0.05	0.00	0.05	0.08	**0.03**
	(0.73)	(0.76)	(0.71)	(0.71)	(0.72)	(0.76)	(0.74)	(0.71)	(0.74)	(0.76)	
Factor 2											
Variety											
Suraj	0.03	0.10	0.00	0.00	0.00	0.10	0.08	0.00	0.08	0.07	**0.04**
	(0.73)	(0.77)	(0.71)	(0.71)	(0.71)	(0.77)	(0.76)	(0.71)	(0.76)	(0.75)	
Srirama	0.03	0.00	0.13	0.00	0.03	0.00	0.13	0.00	0.13	0.10	**0.06**
	(0.73)	(0.71)	(0.79)	(0.71)	(0.73)	(0.71)	(0.80)	(0.71)	(0.80)	(0.77)	
Mean	**0.03**	**0.05**	**0.07**	**0.00**	**0.02**	**0.05**	**0.11**	**0.00**	**0.11**	**0.09**	**0.05**
Hybrid											
RCH 2 *Bt* BGII	0.07	0.00	0.07	0.07	0.07	0.00	0.08	0.07	0.08	0.03	**0.05**
	(0.75)	(0.71)	(0.75)	(0.75)	(0.75)	(0.71)	(0.76)	(0.75)	(0.76)	(0.73)	
Bunny BG II	0.00	0.10	0.07	0.07	0.00	0.10	0.15	0.07	0.15	0.07	**0.07**
	(0.71)	(0.77)	(0.75)	(0.75)	(0.71)	(0.77)	(0.81)	(0.75)	(0.81)	(0.75)	
Mean	**0.03**	**0.05**	**0.07**	**0.07**	**0.04**	**0.05**	**0.12**	**0.07**	**0.12**	**0.05**	**0.06**
SEm (±)	0.02	0.02	0.02	0.02	0.02	0.02	0.04	0.02	0.04	0.03	
CD (p=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	
Interaction factor											
SEm (±)	0.02	0.03	0.03	0.02	0.03	0.03	0.05	0.02	0.05	0.04	
CD (p=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	
CV (%)	5.65	7.84	5.73	5.39	6.33	7.84	10.92	5.39	10.92	8.83	

Figures in parentheses are square root (x+0.5) transformed values,NS: Non significant

low (no significant differences were observed). The present findings are in line with the reports of Santhosh *et al.*, (2009) who reported that percentage of rosette flowers, green boll, locule damage and pink bollworm larvae were lowest in *Bt* cotton compared to non *Bt* cotton hybrids

The present results obtained *i.e.*, as the age advanced under delayed sowing, the larval incidence increased are in contradiction to the findings of Verma *et al.*, 2017 who reported that the pink bollworm larvae reduced with the age of the crop incidence

Incidence of natural enemies:

Spiders : The population of spiders in experimental plots during *kharif*, 2017 was very minimal. During the normal sowing the population of spiders ranged from 0.02 to 0.16 spiders /3 leaves with a mean population of 0.06 spiders /3 leaves . During delayed sowing the population of spiders ranged from 0.00 to 0.08 spiders /3 leaves with a mean population of 0.03 spiders /3 leaves (Table 4). Among the varieties, the population of spiders ranged from 0.00 to 0.13 spiders /3 leaves . Among the hybrids the population of spiders ranged from 0.00 to 0.15 spiders /3 leaves . However, the spider population in all the test hybrids/varieties at different periods of sowing was very low (no significant differences were observed).

Among the varieties tested variety Suraj has a mean spider population of 0.04 spiders /3 leaves , whereas variety Srirama has a mean spider population of 0.06 spiders /3 leaves .

Among the hybrids tested, RCH 2 *Bt* BG II has a mean spider population of 0.05 spiders /3 leaves , whereas Bunny BG II has a mean spider population of 0.07 spiders /3 leaves . The data showed (based on the mean spiders /3 leaves) that among varieties tested, Srirama has more population of spiders than variety Suraj and among hybrids Bunny BG II has more spiders population than RCH 2 *Bt* BG II. The results of the present investigation are in accordance with findings of Kengegowda *et al.* (2005) who reported the predator population *i.e.* spiders, coccinellids and chrysopa were almost similar in all the test hybrids.

CONCLUSION

The results obtained can be summarized and concluded as the crop sown during normal sowing (20th July) recorded more mean leafhopper population /3 leaves than delayed sowing (8th August). The abiotic factors such as minimum temperature had influenced the incidence of leafhoppers positively under both the conditions of sowings and varieties were found promising than hybrids in arresting the leafhoppers population.

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