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Effect of different dates of sowings and weather parameters on population of cotton leafhopper, *Amrasca biguttula biguttula* (Ishida)

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Abstract
The field experiment on cotton was conducted during two cropping seasons of *kharif*, 2013 and *kharif*, 2014 sown at two different dates namely July second fort night and august first fortnight. Data was collected on weather parameters and population of leafhoppers in cotton under no pesticide spray condition. Results revealed that population of leafhoppers were significantly affected by sowing dates and weather parameters. The pooled data of both years revealed that maximum leafhoppers population (6.03 leafhopper s/plant) was recorded in late sown crop while minimum (5.60 leafhoppers/plant) population was recorded in early sown cotton. In both the years *i.e., Kharif*, 2013 and *Kharif*, 2014 peak leafhopper infestation was recorded at 38th standard week with 13.73 leafhoppers/plant in early sown crop and 20.40 leafhoppers/plant in late sown crop; 11.50 leafhoppers/plant in early sown crop and 16.10 leafhoppers/plant in late sown crop, respectively. Population of leafhopper showed significantly positive correlation with temperature, relative humidity, rainfall and negatively correlated with sunshine hours in early sown crop. While, in late sown crop minimum temperature and wind speed showed significant positive correlation.

Keywords: Leafhopper, *Amrasca biguttula biguttula*, weather parameters

1. Introduction
Cotton is one of the most important commercial crop grown in India. Among the various causes of low productivity of cotton in India, Insect pests are one of the major limiting factor for attaining the maximum crop potential. As the crop is vulnerable to attack by about 162 species of insects and mites (Satpute *et al.*, 1988) [1] and infestation occurs from seedlings to matured crop and some time the population of insect pest is so enormous that it becomes havoc to the crop and badly affects the economy of our country. Leafhoppers, *Amrasca biguttula biguttula* (Ishida) is one of the most serious sucking pests of cotton in India causing reduction in yield to an extent of 20 per cent (Dhawan *et al.*,1988) [2]. Nymphs and adults suck sap from the under surface of the leaves there by causing yellowing and reddening of leaf lamina initially followed by downward curling, which in turn results hopper burn and in severe cases the leaves may dry and drop down. The manipulation of planting time helps to minimize pest damage by producing asynchrony between host plant and the pest. Early planted cotton had lower Leafhopper population than later-planted cotton recorded by Karavina *et al.* (2012) [3]. Weather based pest forewarning systems can act as an effective tool in developing suitable control measures against pest incidence in crops. Information on abundance and distribution of pest in relation to meteorological parameters is the basic requirement for developing pest management program for a specific agro ecosystem, Both maximum and minimum temperatures, total rainfall, and relative humidity are the major weather parameters that largely control the dynamics of a given insect species. The knowledge about incidence of pest during the cropping season and its possible dynamics help in designing pest management strategies (Santhosh *et al.*, 2009) [4]. Hence, the present study on effect of sowing dates and their correlation with weather parameters on leafhopper population was undertaken during *kharif* seasons of 2013 and 2014 to best forecast and manage this pest.

Materials and Methods
The present study seeks to know the impact of weather parameters and sowing dates on population dynamics of leafhopper population on cotton. The experiment comprising two different sowing dates *i.e.*, July second fort night and august first fort night was conducted

during *kharif*, 2013 and *kharif*, 2014 at Agricultural research institute, Rajendranagar, Hyderabad which were replicated three times in a randomized block design. The Mallika *Bt* cotton was raised in a plots size of 10.8 X 4.8 m with a spacing of 90 X 60 cm under unprotected conditions following recommended agronomic practices to monitor dynamics of abundance of leafhopper population in relation to prevalent weather parameters.

The population of leafhoppers was recorded at weekly intervals from 10 randomly selected plants with the initiation of insect pest and continued till the end of crop growth. Leafhopper population were counted from three leaves, each from the top, middle and bottom canopies of the plant. Weather parameters like maximum temperature, minimum temperature, morning relative humidity, evening relative humidity, average wind speed, sunshine hours and rainfall recorded in the meteorological observatory, ARI, Rajendranagar were used. Two years pooled data of both leafhoppers and weather parameters were subjected to correlation and regression analysis by using SPSS to know the relationship between leafhopper population incidence and weather parameters.

Results and Discussion

Effect of sowing dates on population of leafhoppers, *Amrasca biguttula biguttula*

The data on population of leafhoppers of different sowing dates are present in Table 1 and 2. Results revealed that in *kharif*, 2013 incidence of leafhoppers in early sown crop was started at 29th standard meteorological week (SMW) with 2.47 leafhoppers/plant compared to late sown crop at 32nd SMW with 1.27 leafhoppers/plant. Similarly, in *kharif*, 2014 in early sown crop infestation started at 32nd SMW with 1.33 leafhoppers/plant compared to late sown crop at 34th SMW with 2.97 leafhoppers/plant. The population reached peak level at 38th SMW in both the sowing date with 13.73 leafhoppers/plant (Early sown crop) and 20.40 leafhoppers/plant (Late sown crop) in *kharif* 2013. But in *kharif*, 2014 peak activity of leafhopper in early sown crop recorded at 34th SMW with 15.93 leafhoppers/plant compared to late sown crop recorded peak activity at 38th SMW with 16.17 leafhoppers/plant. From the overall data with two sowing dates and from two cropping seasons, it was revealed that, the activity of leafhoppers was highest at September and October with some fluctuations. In *kharif*, 2013, the population of leafhoppers showed more than ETL level upto 52nd SMW in both the sowing dates, but in *kharif*, 2014 the population of leafhoppers showed more than ETL level upto 42nd SMW in both the sowing dates. The obtained results were corroborated with the findings of Rajesh soni and Dhakad (2016) [5] where they noticed peak activity of leafhoppers during September and October month on cotton. Similar findings are given by Reddy *et al.* (2011) [6].

The overall results revealed that in *kharif*, 2013, mean highest leafhopper infestation recorded in late sown crop (5.51 leafhoppers/plant) compared to early sown crop (4.97 leafhoppers/plant), similarly in *kharif*, 2014 late sown crop recorded 6.87 leafhoppers/plant than early sown crop with 6.35 leafhoppers/plant (Table 1 and 2). The present findings are in agreement with the findings of Butter *et al.*(1992) [7] who studied the effect of agronomic practices on the incidence of key pests of cotton under unsprayed condition and found that leafhopper population was lower in early sown and normal sown and highest in late sown crop. Singh *et a.* (1970) [8] studied effect of timing of sowing on incidence of pests and plant characters of cotton and recorded that highest population of leafhopper was on late sown crop and lowest was in early sown crop. Similar findings were observed by Suman Devi and Pala Ram (2018)[9] who recorded maximum population of leafhopper (*Amrasca biguttula biguttula*) nymphs (3.94 nymphs/leaf) was in late sown crop while minimum population (2.91 nymphs/leaf) was recorded in early sown cotton. The present findings are not in agreement with the findings of Dhawan *et al.* (1985) [10] who studied the effect of sowing dates (April 25, May 9 and May 23) on the incidence of leafhopper and reported that the population of cotton leafhopper was higher on May 9th sown crop than on May 23rd sown crop.

Effects of weather parameters on population of leafhopper, *Amrasca biguttula biguttula*

The results of correlation coefficient between leafhopper population and weather parameters are presented in Table 3 and 4. The pooled data (*Kharif*, 2013 and *Kharif*, 2014) of correlation coefficient between leafhopper population and weather parameters in early sown crop revealed that current week (r = 0.49**), one week lag (r = 0.53**) and two weeks lag (r = 0.42*) minimum temperature, Current week morning relative humidity (r = 0.42*), afternoon relative humidity (r = 0.46*), rainy days (r = 0.47) current week (r = 0.389*) and one week lag (r = 0.43*) mean temperature showed significant positive influence while current week sunshine hours (r = -0.440*) showed significant negative influence on leafhopper incidence. The pooled data (*Kharif*, 2013 and *Kharif*, 2014) of correlation coefficient between leafhopper population and weather parameters in late sown crop revealed that current week minimum temperature (r = 0.56*), current week (r = 0.54*), one weak (r = 0.66**) and two weeks lag (r = 0.51*) wind speed showed the significant positive correlation. The present findings are in agreement with Patel *et al.* (1997) [11] who reported significant positive correlation between leafhopper population and maximum temperature. The similar results also reported by Bhute *et al.* (2012) [12] where maximum temperature was significant positively correlated and minimum temperature was non significantly correlated with leafhopper population in both the years. The present findings also in confirmity with Ashaq *et al.* (2011) [13]; Simwat and Gill (1992) [14]; Gogoi and Dutta (2011) [15] who reported that leafhopper population was positively correlated with temperature. The positive correlation of wind speed with the leafhopper population is in conformity with the findings of Babu and Meghwal (2014) [1]. Selvaraj *et al.* (2011) [16] also reported significant positive correlation of relative humidity with the leafhopper population and non-significant negative correlation with sun shine hours.

Table 1: Incidence of leafhoppers in cotton at ARI, Rajendranagar under different dates of sowing during *kharif*, 2013

SMW	No. of Leafhoppers/leaf		Temperature (ºC)		Relative Humidity (%)		Rain Fall (mm)	Rain days (days)	Sun Shinehours	Wind speed (Km/hr)	Evaporation (mm)
	Ist sowing	IInd sowing	Max.	Min.	RH I	RH II					
29	2.47	0.0	25.3	22.0	91.4	92.1	59.0	5	0.3	11.6	3.9
30	6.53	0.0	30.9	25.0	81.4	60.6	24.0	1	3.9	12.4	4.3
31	5.80	0.0	27.8	21.6	86.1	77.9	28.5	4	3.5	14.5	4.4
32	3.47	1.27	29.0	22.2	89.0	66.1	54.4	3	5.7	6.4	4.9
33	2.07	2.40	28.1	22.1	89.7	77.6	72.8	5	2.2	5.3	3.6
34	0.73	4.60	29.2	22.0	91.7	77.3	1.4	0	3.4	5.8	3.6
35	7.07	9.47	30.2	21.4	90.6	80.4	9.0	1	3.6	2.2	3.5
36	6.13	7.53	31.5	21.2	87.6	61.0	8.6	1	4.8	1.8	5.0
37	4.27	9.93	31.4	20.7	87.0	62.0	45.5	2	6.0	2.2	4.9
38	13.73	20.40	29.9	20.5	90.0	70.0	56.5	5	2.9	4.0	4.0
39	8.27	5.40	31.5	19.9	84.0	60.2	0.0	0	9.0	4.8	5.1
40	2.33	5.27	30.5	22.0	84.0	63.0	2.0	0	4.8	4.0	4.5
41	4.13	5.20	31.1	20.8	87.0	62.0	18.0	2	6.4	3.8	4.4
42	1.93	2.60	31.8	17.7	87.0	53.0	11.2	1	8.1	2.4	5.1
43	2.93	3.93	26.3	19.4	96.0	81.0	222.0	6	1.4	2.4	1.5
44	3.80	4.63	30.1	17.5	87.0	56.0	0.0	0	7.4	1.1	3.3
45	3.13	3.13	28.5	14.3	84.0	49.0	0.0	0	7.2	2.1	3.0
46	7.33	3.47	27.8	11.4	84.0	37.0	0.0	0	8.1	1.7	2.9
47	3.53	3.33	28.4	15.1	89.0	58.0	28.8	2	5.8	1.1	2.5
48	4.60	4.07	28.4	14.8	90.0	51.0	2.2	0	6.3	2.0	1.9
49	4.67	8.00	27.6	11.2	77.0	37.0	0.0	0	8.5	2.3	2.8
50	4.67	8.00	29.1	7.5	86.0	27.0	0.0	0	9.6	1.4	2.8
51	6.87	8.47	28.1	8.8	81.0	35	0.0	0	9.3	1.4	2.9
52	8.87	11.07	27.1	11.0	87.0	40	0.0	0	8.5	1.9	2.5
Mean	4.97	5.51	29.1	84.0	59.7	20.81	643.9	38.0	5.7	4.1	3.6

Table 2: Incidence of leafhoppers in cotton at ARI, Rajendranagar under different dates of sowing during *kharif*, 2014

SMW	No. of Leafhoppers/leaf		Temperature (ºC)		Relative Humidity (%)		Raifall (mm)	Rain days (days)	Sun Shine hours	Wind speed (Km/hr)	Evaporation (mm)
	Ist sowing	IInd sowing	Max.	Min.	RH I	RH II					
32	1.33	0.0	32.0	22.7	83.0	61.0	8.6	2	7.0	11.6	2.9
33	8.10	0.0	33.3	24.5	81.0	53.0	25.5	2	6.4	6.6	3.9
34	15.93	2.97	34.0	24.0	88.0	58.0	12.2	2	6.8	1.9	3.9
35	10.40	3.03	28.1	22.1	92.0	80.0	160.6	6	1.5	6.0	1.4
36	9.70	10.70	27.5	22.6	86.0	66.0	12.2	1	5.1	8.2	2.6
37	9.53	14.13	31.0	22.8	87.0	62.0	12.6	3	5.8	5.4	3.2
38	11.50	16.17	31.1	22.2	90.0	63.0	9.4	1	4.2	3.8	2.9
39	6.47	13.20	32.3	22.1	86.0	51.0	15.0	1	6.4	2.0	3.8
40	5.73	9.37	34.1	21.9	80.0	45.0	40.2	1	7.6	1.3	5.3
41	5.63	9.33	32.4	20.3	78.0	49.0	0.8	0	4.3	3.9	4.5
42	0.77	9.20	32.8	19.2	85.0	47.0	6.2	1	8.2	2.5	5.6
43	0.73	1.73	28.3	19.0	89.0	68.0	22.0	1	4.0	2.0	4.0
44	0.70	1.53	30.4	18.4	80.0	24.0	0.0	0	8.3	2.3	4.8
45	1.1	0.70	30.9	16.4	76.0	42.0	0.0	0	6.8	2.3	5.4
Mean	6.35	6.87	30.7	32.3	77.4	47.6	325.3	21.0	6.2	3.9	3.7

Table 3: Correlation coefficients between leafhopper population and weather parameter in cotton sown during July second fort night (pooled data of *kharif*, 2013 and *kharif*, 2014)

Weather parameters	Current week	Preceding 1 week	Preceding 2 weeks
T max. (^{O}C)	0.09	0.14	-0.03
T min. (^{O}C)	0.49**	0.53**	0.42*
RH I (%)	0.42*	0.17	0.25
RH II (%)	0.46*	0.27	0.25
Rainfall (mm)	0.16	0.13	0.08
Rainy days (RD)	0.47*	0.26	-0.09
Sun shine hours (SSH)	-0.44*	-0.07	-0.06
Wind speed (km h^{-1}) (WS)	0.08	0.10	0.21
Evaporation (mm) (E_p)	-0.22	-0.065	-0.36
T mean (^{O}C)	0.38*	0.431*	0.23

** Significant at 0.01 level * Significant at 0.05 level

Table 4: Correlation coefficients between leafhopper population and weather parameter in cotton sown during August first fort night (pooled data of *kharif*, 2013 and *kharif*, 2014)

Weather parameters	Current week	Preceding 1 week	Preceding 2 weeks
T max. (^{O}C)	0.39	0.15	0.03
T min. (^{O}C)	0.56**	0.43	0.36
RH I (%)	-0.26	-0.01	0.14
RH II (%)	0.11	0.23	0.22
Rainfall (mm)	-0.27	-0.05	0.18
Rainy days (RD)	-0.16	0.23	0.42
Sun shine hours (SSH)	0.05	-0.17	-0.30
Wind speed (km h^{-1}) (WS)	0.54*	0.66**	0.51*
Evaporation (mm) (E_p)	0.25	-0.05	-0.14
T mean (^{O}C)	0.56*	0.38	0.31

** Significant at 0.01 level * Significant at 0.05 level

Conclusion

The leafhopper is most notorious sucking pest of cotton and remains throughout crop season. From the present study it is concluded that in all dates of sowing maximum sucking insect pests recorded in late sown cotton crop as compared to early and normal sown. The maximum activity recorded in the month of September-October where maximum temperature favors the activity of leafhopper population while minimum temperature, humidity, rainfall and wind velocity do not favors the population buildup of leafhopper. The present findings will help to warn the farmers about the population buildup during different months and will be helpful for devising pre-planned management strategies against this pest.

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