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Seasonal incidence of insect Pestsin Mesta, *Hibiscus sabdariffa* L. (Roselle)

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Abstract
Field trials were conducted at Agricultural Research Station, Amadalavalasa for six consecutive years during *Kharif*2015-16, 2016-17, 2017-18, 2018-19, 2019-20 and 2020-21 to assess the seasonal incidence of sucking pests and semiloopers in mesta crop. Insect pests, mealybugs and semiloopers were the dominant pests of Mesta Cropas their activity lasted throughout the crop growth period with peak population levels (26.67% incidence and 43.33% leaf damage, respectively) observed at 37th and 26th standard weeks, respectively. The activity of aphids was observed from 28thstandard week attaining peak (8.05 no./plant) during 34thstandard week. The incidence of whitefly and leafhopper continued throughout the crop growth period with whitefly had two peaks at 28th standard week (0.70 no./ plant) and38th standard week (0.78 no./ plant) and leafhoppers attained its high incidence (0.72 no./plant) during 26th standard week. Among the various weather parameters, maximum temperature exerted significant positive influence on leafhoppers (r = 0.589**)and semiloopers (r= 0.638**) and aphid population showed significant positive association (r= 0.484*) with minimum temperature. Morning relative humidity had a significant positive influence on the leafhopper (r= 0.454*) and mealybug population (r= 0.731). Both evening relative humidity and rainfall exerted positive influence on mealybug, which is significant. The multiple linear regression analysis indicated that the total influence of all the weather variables *viz.*, maximum and minimum temperatures, morning and evening relative humidities, and rainfall accounted for 55.3, 66.0, 74.3, 72.8and 56.9per cent variation in aphid, whitefly leafhopper, mealybug and semilooper populations, respectively.

Keywords: Correlation, insect pests, Mesta, seasonal incidence

Introduction
Roselle, *Hibiscus sabdariffa* L. is locally known as 'Mesta' or 'Meshta' in the Indian Subcontinent. Roselle is the important bast fibre crop of the world (Halimatul *et al*., 2007) [7]. It is known as golden fibre and is one of the important natural fibre after cotton in terms of usage. Most widely used in the world due to its low price and characteristics like good strength and moisture absorption. It is not only used for fibre crop but also each and every part of the roselle plant is useful in one way or the other. Roselle or Jamaica sorrel (*Hibiscus sabdariffa*) is a unique species cultivated in many tropical regions for its leaves, seeds, stem and calyces. The dried calyces are used to prepare tea, syrup, jams and jellies as beverages (Ansari *et al*., 2013) [2]. Unfortunately, roselle ishighly vulnerable to insect pests at different growth stages. Aphids, *Aphis gossypii* (Glover); leafhoppers, *Amrasca biguttula biguttula* (Ishida); whiteflies, *Bemisia tabaci* Genn.; mealybug, *Phenacoccus solenopsis* Tinsley and semilooper, *Anomis flava* L are the important insect pests of roselle. The insects multiply tremendously during the favourable weather conditions and take huge toll (Aheer *et al*., 1994) [1]. A thorough understanding of fluctuations of population of these insect pests at field level in relation to the weather parameters would provide an idea about the peak period of pest activity and it will help in developing an appropriate strategy for the management of these insect pests. Keeping this in view, the present study was undertaken to assess the seasonal incidence of insect pests on mesta crop.

Material and Methods
The investigation was carried out at Agricultural Research Station (ARS), ANGRAU Amadalavlasa, Srikakulam district of Andhra Pradesh for six seasons during *Kharif* 2015-16, 2016-17, 2017-18, 2018-19, 2019-20 and 2020-21. A bulk crop of mesta with AMV-5 variety was raised in an area of 500 m^2 under normal agronomic practices without any insect

pest management practices during all the years. Population of aphids and whiteflies (no./top 3 leaves/plant), leafhoppers (number/6 leaves from 3 different strata*i.e.*, top, middle and bottom strta), mealybug (number of plants effected and expressed in%) and semilooper (leaf damage in terminal six leaves and expressed in%.) was recorded on 25 randomly selected and tagged plants in bulk plot at weekly interval up to 50 per cent flowering. The meteorological data (*viz*., maximum and minimum temperatures, morning and evening relative humidities and rainfall) was recorded simultaneously from the Meteorological observatory of ARS, Amadalavalasa and used for correlation and multiple linear regression analysis studies.

Results and Discussions

Seasonal incidence of insect pests

Aphids

The average data of six years indicated that the aphid incidence started from 28th standard week (2ndweek of July) and found throughout the season, however its peak (8.05 no./plant) period was observed during 34th standard week (4thweek of August) (Table 1). The present findings are in accordance with the results of Chavan *et al*. (2010) [4] who observed that aphid incidence was lasted throughout the cotton crop growth period with 0.80 to 27.45 no. per three leaves per plant with highest incidence (12.17-27.45 aphids/3 leaves/plant) during 32nd (6-12 Aug.) - 35th (27Aug. - 2Sept.) std. weeks which supports the present investigation.

Whiteflies

The average data of six years indicated that whiteflies appeared from 4thweek of June and continued throughout the crop growth period with two peaks at28th standard week (0.70 no./plant) and 38th standard week (0.78no./plant) (Table 1). Sana *et al.* (2011) [17] observed the activity of whitefly throughout the cotton growth period which supports the present investigation. The present results are close to the investigations of Dhaka and Pareek (2008) [6] showed that whitefly incidence started from 25th (18-24 June, 2001) and 23rd (04-10 June, 2002) std. weeks and remained throughout the crop period with the highest population of 78.55 and 68.33 whiteflies per three leaves per plant during 39th (24-30 Sept.) and 40th (1-7 Oct.) std. weeks in the respective years on RST-9 cotton variety.

Leafhoppers

The average data of six years showed that the activity of the leafhoppers was lasted throughout the crop period with highest incidence of 0.72 no. per plant (Table 1) was recorded during 26th standard week (last week of June) then declined in the subsequent standard weeks up to 29th standard week and again incidence was raised from 30th standard week onwards, the sudden decline in leafhopper population might be due to high rainfall received during that period. Sana *et al.* (2011) [17] recorded the activity of leafhopper throughout the cotton growth period which supports the present investigation.

Mealybug

The average data of six years showed that mealybug incidence was lasted throughout the crop growth period (Table 1). The present results are in line with the findings of Shahid *et al*., (2012) [19] who reported that occurrence of cotton mealybug observed throughout the crop period. Incidence of mealybug was initiated at 26th standard week (last week of June) then declined in the subsequent standard weeks up to 31st standard week and again incidence was raised from 32nd standard week onwards. Mealybug was more between33rd to 40th standard weeks with per cent incidence ranging from 16.83 to 26.67 and incidence was found declined. The peak (26.67%) incidence of mealybug was observed during 37th standard week. The present findings are close to the reports of Kedar *et al*. (2011) [9] who observed that peak population of mealybug was recorded during 34th std. week (20-26 Aug.) on cotton at Chaudhary Chatan Singh Haryana Agricultural University (CCSHAU), Hisar.

Semilooper

The average data of six years indicated that semilooper incidence was present throughout the crop growth period with leaf damage ranged from 3.66 to 43.33per cent and first peak incidence (43.33% leaf damage) was observed during26th standard week followed by second peak incidence (22.00% leaf damage) during 38th standard week (Table 1). Sudden decline in incidence to 9.00 per cent leaf damage in 27th standard week after first peak incidence (26th std. week)might be due to high rainfall received in that week. The results of the present study are in accordance with the reports of the Channakeshava and Patil (2009) [5] who reported that peak occurrence of *Helicoverpa armigera* (more than 0.90 larvae/plant) observed during 38th standard week. Similarly, Prasad *et al*. (2008) [15] reported the peak incidence of *H. armigera* adults per trap per week from 36 to 48 standard weeks in cotton during 2001-06.

Influence of abiotic factors on incidence of insect pests

The weather parameters being density independent and are uniform to all the insect pests, correlation and multiple linear regression (MLR) analysis was followed to assess the influence of weather paramets on mean incidence of the insect pests from the six crop seasons. The results were presented in the Tables 2 and 3.

Aphids

Aphid incidence was positively and significantly correlated with minimum temperature (r=0.484*), while morning and evening relative humidities had positive but non-significant relation (r=0.090 and 0.361) (Table 2). Maximum temperature and rainfall had negative influence on aphid incidence but non-significant(r=-0.039 and -0.008). The present findings are in line with the reports of Harde *et al*. (2018) [8] who reported that cotton aphids shows strong positively significant correlation with minimum temperature. The present findings of positive relationship between relative humidity and population buildup of aphids corroborates with the observations of Mohapatra (2008) [11]; and Selvaraj and Adiroubane (2012) [18].

The multiple regression analysis revealed that weather parameters contributed 55.3 per cent of total variation in the incidence of aphids. Of the five variables, maximum and minimum temperatures, and evening relative humidity were found to have significant influence on variation of aphid population. One degree raise in maximum and minimum temperature, and evening relative humidity is expected to increase aphid population by 1.085, 1.122 and 0.340, respectively when all other variables are at their mean level (Table 3).

Whiteflies

The weather parameters *viz*., maximum and minimum temperatures, evening relative humidity and rainfall had non-significant positive influence on whitefly population(r= 0.324, 0.317, 0.040 and 0.232, respectively), while morning relative humidity exhibited non-significant but negative interaction (r= -0.325) with whitefly population (Table 2). The present results are in almost nearer with the findings of Rakesh kumar *et al.* (2010) [16] who reported that population of cotton whitefly negatively correlated with relative humidity. The present findings on positive relationship between evening relative humidity are in line with the findings of Makwana and Dulera (2018) [10].

The multiple regression analysis revealed that weather parameters contributed 66.0 per cent of total variation in the incidence of whiteflies. Of the five variables, maximum temperatures and evening relative humidity were found to have significant influence on variation of whitefly population. One degree raise in maximum temperature and evening relative humidity is expected to increase aphid population by 0.147 and 0.025, respectively when all other variables are at their mean level. Similarly one degree raise in morning relative humidity is expected to bring down the population by 0.036 (Table 3).

Leafhoppers

The population of leafhoppers showed significant positive correlation with maximum temperature and morning relative humidity(r=0.589** and 0.454*), while a non-significant and negative association with minimum temperature, evening relative humidity and rainfall (r= -0.129, -0.138 and -0.077) (Table 2). The results of the present investigation are in accordance with those of Purohit *et al*. (2006) [14] who reported that significant positive correlation was found between the leafhoppers and maximum temperature in cotton. Similarly, Bhute *et al.* (2012) [3] reported maximum temperature and relative humidity showed significant positive influence on cotton leafhoppers. Makwana and Dulera (2018) [10] reported that minimum temperature hadnon-significant negative influence on cotton leafhoppers which supports the findings of the present study.

The multiple regression analysis revealed that weather parameters contributed 74.3 per cent of total variation in the incidence of leafhoppers. Of the five variables, maximum and minimum temperatures, and morning relative humidity were found to have significant influence on variation of whitefly population. One degree raise in maximum and minimum temperatures and morning relative humidity is expected to increase leafhopper population by 0.071, 0.049 and 0.030, respectively when all other variables are at their mean level (Table 3).

Mealybug

Morning and evening relative humiditiesand rainfall(r=0.731**; 0.546* and 0.531*) had significant positive influence on the mealybug population while maximum temperature and minimum temperature (r=0.162 and -0.297) had non-significant positive and negative influence on mealybug population, respectively (Table 2). The present reports are in agreement with the findings of Muchhadiya *et al*. (2014) [13] who reported that mealy bug infestation found positive correlation with maximum temperature and negative correlation with minimum temperature. The present findings are in confirmation with those of Makwana and Dulera (2018) [10] observed that the morning and evening relative humidity exerted positive effect on mealybug population.

The multiple regression analysis revealed that weather parameters contributed 72.8 per cent of total variation in the incidence of mealybug. However, none of these variables exerted significant influence on the variation of mealybug inccidence independently (Table 3).

Semilooper

Maximum temperature had strong positive influence on the semilooper incidence (r= 0.638**) while morning relative humidity had exhibited non-significant but positive influence (r= 0070). Minimum temperature, evening relative humidity and rainfall showed non-significant negative influence on the semilooper (r= -0.057, -0.351 and -0.010, respectively) (Table 2). The findings of the present investigation are in accordance with the findings of Mahapatra *et al*. (2018) [12] who reported that lepidopteran pests like *Helicoverpaarmigera* Hub. and *Spodoptera litura*Fab. in Tomato had non-significant positive association with morning relative humidity and non-significant negative negative with minimum temperature, evening relative humidity and rainfall.

The multiple regression analysis revealed that weather parameters contributed 56.9 per cent of total variation in the incidence of semilooper. Of the five variables, maximum temperature was found to have significant influence on variation of semilooper incidence. One degree raise in maximum is expected to increase leafhopper population by 3.898 when all other variables are at their mean level (Table 3).

Table 1: Seasonal incidence of insect pests on Mesta (Six years mean from *kharif*, 2015-16 to 2020-21)

Standard week	Period	Aphids /Plant	Whiteflies /Plant	Leafhoppers /Plant	Mealybug (%incidence)	Semilooper (% leaf damage)	Max. temp. (OC)	Min. temp. (OC)	Morning R.H. (%)	Evening R.H. (%)	Rainfall (mm)
26	25 to July1	0.00	0.44	0.72	16.00	43.33	37.40	24.00	85.00	50.00	2.50
27	2 to 8	0.00	0.26	0.16	4.50	9.00	32.30	27.70	81.00	60.30	29.20
28	9 to 15	0.16	0.70	0.02	4.00	12.00	35.10	24.00	74.95	59.05	20.90
29	16 to 22	0.96	0.10	0.09	5.00	21.33	31.85	26.75	78.80	61.80	25.70
30	23 to 29	1.79	0.58	0.20	4.25	18.17	32.29	27.39	80.89	66.67	12.80
31	30 to Aug. 5	6.27	0.59	0.15	3.67	12.89	33.91	26.75	83.64	63.56	26.25
32	6 to 12	6.34	0.39	0.25	8.50	15.56	33.57	26.72	87.33	69.07	17.82
33	13 to 19	3.53	0.50	0.18	21.33	13.56	32.65	26.09	87.96	75.26	44.88
34	20 to 26	8.05	0.46	0.28	17.33	12.56	33.47	26.10	88.31	71.52	27.00
35	27 to Sept.2	4.63	0.33	0.38	16.83	12.62	33.03	26.13	89.14	76.70	27.32
36	3 to 9	1.52	0.29	0.27	22.00	18.33	34.29	25.60	88.99	71.01	43.20
37	10 to 16	1.83	0.41	0.26	26.67	21.22	34.07	25.56	88.18	71.59	52.77

38	17 to 23	0.31	0.78	0.29	20.67	22.00	33.08	25.44	88.52	72.85	59.70
39	Sept.24 to 30	0.59	0.23	0.25	17.17	19.67	33.20	24.91	91.30	73.73	60.42
40	Oct. 1 to 7	0.03	0.21	0.41	18.33	20.00	33.22	25.42	90.88	68.13	33.53
41	8 to 14	0.06	0.19	0.38	13.80	21.60	33.25	25.07	89.63	68.68	23.12
42	15 to 21	0.02	0.06	0.22	11.20	15.86	33.35	24.33	89.95	66.57	11.54
43	22 to 28	0.06	0.02	0.19	12.40	7.87	32.98	23.29	88.40	64.27	32.70
44	29 to Nov. 4	0.14	0.02	0.07	16.00	3.66	32.49	23.42	86.59	66.07	2.94

Table 2: Correlation between weather parameters and incidence of insect pests on mesta

Insect pests	Correlation coefficient values				
	Max. Temp. (^{O}C)	Min. Temp. (^{O}C)	Mor. RH (%)	Eve. RH (%)	Rainfall (mm)
Aphids	-0.039	0.484*	0.090	0.361	-0.008
Whiteflies	0.324	0.317	-0.325	0.040	0.232
Leafhoppers	0.589**	-0.129	0.454*	-0.138	-0.077
Mealybugs	0.162	-0.297	0.731**	0.546*	0.531*
Semiloopers	0.638**	-0.057	0.070	-0.351	-0.010

Note: *Significant at 5% level ** Significant at 1%

Table 3: Multiple linear regression analysis between weather parameters and incidence of insect pests on mesta

Insect name	Regression equation	R^2
Aphids	$-78.474^{*} + 1.085X_1^{*} + 1.122X_2^{*} - 0.061X_3 + 0.340X_4^{*} - 0.071X_5$	0.553
Whiteflies	$-4.526^{*} + 0.147X_1^{**} + 0.052X_2 - 0.036X_3^{**} + 0.025X_4^{*} + 0.002X_5$	0.660
Leafhoppers	$-5.278^{**} + 0.071X_1^{**} + 0.049X_2^{*} + 0.030X_3^{**} - 0.010X_4 - 0.001X_5$	0.743
Mealybugs	$-107.769 + 1.930X_1 - 0.986X_2 + 0.621X_3 + 0.375X_4 + 0.113X_5$	0.728
Semiloopers	$-199.445^{*} + 3.898X_1^{*} + 2.329X_2 + 0.807X_3 - 0.688X_4 + 0.108X_5$	0.569

Where X_1 = Maximum temperature
X_2 = Minimum temperature
X_3 = Morning relative humidity
X_4 = Evening relative humidity
X_5 = Rainfall

Conclusion

In the light of the results obtain through the present investigation, it can be concluded that the activity of mesta pests *viz*., whiteflies, leafhoppers, mealybug and semiloopers started from the 26th standard week while aphids started from 28th standard week and continued throughout the crop season. Peak incidence of leafhoppers and semiloopers was observed during 26th standard week. The incidence of whiteflies was observed with two peaks at 28th and 38th standard weeks. Whereas, aphids and mealybug population attained their peak activity at 34th and 37th standard weeks, respectively. Maximum temperature on both leafhoppers and semiloopers, minimum temperature on aphids showed significant positive influence. Similarly, morning and evening relative humidities, and rainfall exerted significant positive influence of mealybug population. The multiple linear regression analysis indicated that the total influence of all the weather variables *viz*., maximum and minimum temperatures, morning and evening relative humidities, and rainfall accounted for 55.3, 66.0, 74.3, 72.8 and 56.9 per cent variation in aphid, whitefly leafhopper, mealybug and semilooper populations, respectively.

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