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Population dynamics of sucking pest complex of okra with relation to abiotic factors

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Abstract

The population dynamics of sucking pest complex of okra with relation to abiotic factors was accessed and found that whitefly appearance on okra crop was first noticed during 27th standard week (1.96/3 leaves) whereas its peak was observed (7.59/3 leaves) during 31st standard week. Similarly, the jassid infestation was first observed during 27th standard week (1.81 jassid/ 3 leaves) but its peak population was found during 34th standard week (14.38 jassid/ 3 leaves). The mite incidence was initially noticed during 27th standard week (1.70 mite/ 2 cm^2) and continued till the end of cropping season. However, the highest mite population was found during 36th standard week (13.97 mite/ 2 cm^2). Correlation study showed that the maximum temperature and minimum temperature (r = 0.521) had positive and significant correlation with whitefly. However, relative humidity at 7 hrs (r = 0.151) and 14 hrs (r = 0.008) were showed positive but non-significant correlation. Further, whitefly population was found negatively correlated with rainfall (r = -0.020) and had non-significant effect. The jassid population had positive and highly significant correlation with maximum temperature (r = 0.690) while minimum temperature (r = 0.447) and relative humidity at 7 hrs (r = 0.343) showed positive and non-significant correlation. Further, relative humidity 14 hrs (r = -0.366) and rainfall (r = -0.413) showed negative and non-significant correlation. The mite population had positive and non-significant correlation with maximum temperature, minimum temperature and relative humidity at 7 hrs (r = 0.296, 0.171 and 0.215 respectively). Contrary to this, relative humidity at 14 hrs (r = -0.206) and rainfall (r = -0.321) showed negative and non-significant correlation with mite population.

Keywords: Population dynamics, sucking pests, okra, abiotic factors

1. Introduction

Okra is an important vegetable crop belongs to family Malvacea. Its fruit is mainly used for culinary preparations which are rich source of calcium, vitamin C, iron, magnesium, potassium and carbohydrates [1]. Beside it roots of okra is used for cane juice cleaning [2]. It is an essential item in our diet to overcome the problem of malnutrition especially in developing countries like India, where malnutrition is a major health problem particularly in children and general in adults. In India, okra is cultivated in 528.4 thousand hectare with annual production of 6146.0 MT and productivity 11.60 MT/ha [3]. In Bihar, okra is cultivated in 58.48 thousand hectare with annual production 770.63 MT and productivity 13.18 MT/ha [3].

Nearly, 72 species of insects have been recorded on okra [4]. Infestation of sucking pest's viz. jassid, whitefly and mites are one of the major bottlenecks in successful production of okra which desap the plants, make them weak and reduce the yield to the tune of 54.04 per cent [5]. Jassid, a polyphagous insect pest, has become a serious pest on okra during recent years inflicting heavy loss [6]. Jassid population is found on the crop during the reproductive stage and remain available up to crop maturity stage [7]. Okra crop is prone to its attack in early stage of the crop. Jassid suck the sap from under surface of leaf and make them weak resulting in poor flowering and fruit set and simultaneously reduce economic yield [8]. Jassid (nymphs and adults) usually suck the sap from the ventral surface of leaf and inject toxic saliva into plant tissues due to which affected leaves turn yellowish and curl [9]. Whitefly (nymph and adult) suck the cell sap from the leaves and the affected leaves curled and dried. Besides cell sap sucking, whiteflies are also involved in yellow vein mosaic virus transmission [10]. Other than insect pests, many species of mites belonging to the genus *Tetranychus* renders a loss of 7 to 48 per cent in okra fruit yield [11]. Among all the vegetable crops, okra and brinjal are the most prone to attack by mites causing economic loss throughout the country [12]. The mite produces white spots on leaves due to sucking of plant sap and as feeding continues the white spots coalesce, the leaves losses its green colour, dry and drop. All this leads to decreased vitality, growth, flowering and fruiting. The mites web profusely cover the entire plant with thick sheath of webs [13].

Since the pest population is remarkably influenced by ecological factors viz. biotic and abiotic. It is necessary to know the impact of abiotic factors on pests for proper management. The research works done on this aspect during *Kharif* season on okra is almost negligible in Bihar. Hence, the present study was carried, to work out the population dynamics of sucking pests with relation to abiotic factors and to develop a suitable management strategy against the sucking pests of okra during *Kharif*.

2. Materials and Methods

In order to study the population dynamics of sucking pests of okra, a fixed plot survey was carried out at Research Farm, Tirhut College of Agriculture, Dholi, Muzaffarpur (Bihar) by growing Kashi Pragati as test variety. The crop was sown during two consecutive *Kharif* seasons i.e. 2018 and 2019, respectively. The row to row and plant to plant spacing was 50 cm and 20 cm, respectively. The whole plot was divided into 4 small sub-plots each measuring 5×5 m^2. All the recommended package of practices were adopted except insecticide application.

Jassid population was recorded by counting both nymphs and adults on three leaves i.e. top, middle and bottom of each ten tagged plants at weekly interval and average population (in number) per three leaves was worked out. Similarly, the population of whitefly was also recorded by counting both nymphs and adults on three leaves i.e. top, middle and bottom of each ten tagged plants with the help of a magnifying lens (10 x) and average population per three leaves were worked out at weekly interval. The mite (nymph and adult) population, was observed on three leaves (top, middle and bottom) of each ten tagged plants by placing a card board sheet having a window of 2 cm^2 on the ventral surface of the leaf. Counting was done with the help of a magnifying hand lens (10 x). The pests population was recorded after their appearance till harvest of the crop. Major abiotic factors viz. minimum and maximum temperature (ºC), rainfall (mm) and relative humidity (%) were also recorded during the crop period.

Data analysis

The collected data, related to pests population and abiotic factors were finally subjected to statistical analysis by using OPSTAT online software. The correlation coefficients were calculated to establish the relation between individual abiotic factors and pests population while regression coefficients indicates the cumulative effect of all the factors on pests.

3. Results and Discussion

From the data presented in Table 1 it is obvious that the whitefly population was remarkably influenced by prevailing weather parameters during crop season under study. During *Kharif*, 2018 the whitefly population varied from 1.20 to 5.50 per three leaves with the lowest and the highest being in 27th and 31st standard week, respectively. The corresponding weather parameters with peak whitefly population were maximum temperature (35.20 ºC), minimum temperature (25.20 ºC), relative humidity at 7 hrs (99.10%) relative humidity at 14 hrs (83.10%) and rainfall (11.14 mm), respectively. However, the whitefly population was continued up to 35th standard week (2.20 whitefly/ 3 leaves) and by 36th standard week it become untraceable. During the next crop season i.e., *Kharif*, 2019 the trend of population build up of whitefly on okra variety Kashi Pragati showed more or/less similar pattern as recorded in previous year i.e. *Kharif*, 2018. Data pertaining to mean number of whitefly population per 3 leaves was summarized in Table 2 clearly indicated that the pest was first appeared during 27th standard week (2.80 whitefly/ 3 leaves) and increased gradually with its peak (9.67 whitefly/ 3 leaves) during 31st standard week when the corresponding weather parameters were maximum temperature (32.80 ºC), minimum temperature (27.30 ºC), relative humidity at 7 hrs (96.40%) relative humidity at 14 hrs (83.40%) and rainfall (0.00 mm). Afterwards, population started declining up to 35th standard week (3.17 whitefly/ 3 leaves) and pest become unnoticeable from 36th standard week. A comparative perusal of data summarized in Table 3 clearly showed that the pooled analysis of two years data on whitefly population had more or less similar trend as on yearly basis. The activity of whitefly was first appeared during 27th standard week (1.96 whitefly/ 3 leaves) and increased gradually up to 31st standard week (7.59 whitefly/ 3 leaves). Afterwards, a declining trend was observed till 35th standard week (2.69 whitefly/ 3 leaves). From the foregoing results, it may be inferred that whitefly population gradually increased from 27th standard week (1.96/3 leaves) and reached its peak (7.59/3 leaves) during 31st standard week when the mean corresponding weather parameters viz. maximum, minimum temperature, relative humidity at 07 and 14 hrs and rainfall prevail around 34.0 ºC, 26.3 ºC, 97.8 per cent, 83.3 per cent and 5.6mm, respectively. Thereafter, it gradually declined from 32nd standard week to 35th standard week (6.60 – 2.69 whitefly/3 leaves) when crop start hardy and leaves becomes hardening and brownish.

On the basis of the present findings it may be inferred that the population of whitefly start increasing with increase in temperature and when leaves became soft and tender and decreased when leaves start hardening. The results in respect of early whitefly infestation during early growth stage and its continuance with varied population up to peak reproductive stage are in close proximity, to the reports of [14, 15, 16] but their observation related to an entirely different set of ecological conditions. The present findings, however, varied from the reports of [17, 18, 19]. These differences in results of whitefly population at different places were might be due varied agro-climatic condition.

Unlike, whitefly the jassid population during *Kharif*, 2018 (Table 1) was first noticed in 27th standard week (1.32 jassid/ 3 leaves) and continued throughout the crop season with its peak (10.95 jassid/ 3 leaves) during 34th standard week when weather parameters were maximum temperature (36.60 ºC), minimum temperature (27.50 ºC), relative humidity at 7 hrs (96.50%) relative humidity at 14 hrs (62.20%) and rainfall (0.00 mm). Further, the pest activity started declining and reached up to 1.52 jassid/ 3 leaves during 41st standard week. It is evident from Table 2 that during *Kharif*, 2019 a remarkable increase in jassid activity was found throughout the crop period. The jassid activity was first noticed during 27th standard week (2.30 jassid/ 3 leaves). Further, population increases progressively and reached to its maximum (17.80 jassid/ 3 leaves) during 34th standard week when the corresponding weather parameters were maximum temperature (34.90 ºC), minimum temperature (27.20 ºC), relative humidity at 7 hrs (98.70%) relative humidity at 14 hrs (76.20%) and rainfall (0.00 mm), respectively. The jassid population after 35th standard week start decreasing a gradual decrease but it remains continued till end of the crop season i.e. 41st standard week (7.72 jassid/ 3 leaves). Pooled mean of both the consecutive crop seasons (Table 3) indicated that the jassid population was initially observed in 27th standard week (1.81 jassid/ 3 leaves). However, population build up progressively up to 34th standard week (14.38 jassid/ 3 leaves) and reached to its peak when the corresponding weather parameters were maximum temperature (35.75 ºC), minimum temperature (27.35 ºC), relative humidity at 7 hrs (97.60%) relative humidity at 14 hrs (69.20%) and rainfall (0.00 mm), respectively. Thereafter, the population was reduced continuously but it remains up to the end of crop season (4.62 jassid/ 3 leaves).

On the basis of the present findings it may be said that the population of jassid was maximum (14.38 jassid/3 leaves) at 34th standard week when corresponding weather parameters viz. maximum, minimum temperature, relative humidity at 7 hrs and 14 hrs and rainfall were 35.75 ºC, 27.35 ºC, 97.60 per cent, 69.20 per cent and nil, respectively [20]. Observed that the incidence of leafhopper increased with the age of the crop. In general, the vegetative stage comparatively had less population in okra than near maturing crops. This may be due to the thinner leaf veins in the early crop stage, which further developed into thicker and thereby favoured more number of leafhoppers on leaf. Similarly, as the age of plants increases, size of leaf lamina increases, hair density decreases and thereby increases the leafhoppers population which lent a good support to the present investigation. The present findings was in accordance with the results of [14] who revealed that activity of jassid commenced from twenty one days after sowing and continued throughout the crop season. More or less similar results were also reported by [6, 21, 16].

It is obvious from Table 1 that the mite activity during *Kharif*, 2018 was first commenced during 29th standard week with least population (1.72 mite/ 2cm^2). It was further noted that the population build up progressively up to 38th standard week and reached its peak (10.10 mite/ 2 cm^2) when the prevailing abiotic factors viz. maximum temperature, minimum temperature, relative humidity at 7 hrs and 14 hrs and rainfall were 33.20 ºC, 25.00 ºC, 98.50%, 76.50% and 10.00 mm, respectively. Later, the mite activity was reduced and showed a sharp decline after 39th standard week but its population could be noticed till the end of the crop season. Unlike previous season, the mite population during *Kharif*, 2019 (Table 2) was found to be active throughout the crop period with comparatively higher population. The mite activity was started from 27th standard week (3.40 mites/ 2 cm^2) and build up progressively up to 36th standard week (19.82 mite/ 2 cm^2) when maximum temperature, minimum temperature, relative humidity at 7 hrs and 14 hrs and rainfall were 32.50 ºC, 27.10 ºC, 97.70%, 83.40% and nil, respectively. Thereafter, a declining trend was observed till the end of the crop season i.e. 41st standard week (7.12 mite/ 2 cm^2). The pooled data pertaining to mite population was summarized in Table 3. The data given in table clearly indicated that the mite population was initially noticed during 27th standard week (1.70 mite/ 2 cm^2) and observed throughout the crop season. The highest mite population was observed during 36th standard week (13.97 mite/ 2 cm^2) when mean maximum temperature, minimum temperature, relative humidity at 7 hrs and 14 hrs and rainfall were 32.50 ºC, 27.05 ºC, 95.70%, 75.25% and 6.70 mm, respectively. Thereafter, the population gradually decline up to 37th standard week. After that the mite population decreased sharply and continued till harvest. On the above observation it was found that mite population was more in later stage of the crop.

The findings presented above however, in partial accordance with those of [22, 14, 18, 23] who stated that the mite population on okra was observed during the later crop growth stage and continued till maturity. The interactions between mite population and prevailing abiotic factors as obtained in the present investigation also lent a good support to the earlier reports of [24, 25, 26, 27, 12].

4. Correlation

The experimental data related to values of correlation coefficient (r) between whitefly and prevailing meteorological parameters during *Kharif*, 2018 have been presented in Table 4. It clearly indicated that whitefly population had positive and highly significant correlation with maximum temperature (r = 0.681) whereas minimum temperature (r = 0.196), relative humidity at 7 hrs (r = 0.347) and 14 hrs (r = 0.238) had positive and non-significant correlation. Further, it was inferred that the rainfall (r = -0.102) had negative and non-significant effect on whitefly population. While, all the weather parameters viz. maximum temperature, minimum temperature, relative humidity at 7 hrs, 14 hrs and rainfall together contributed 71.06 per cent towards whitefly infestation (R^2 = 0.7106). It is evident from Table 5 that during *Kharif*, 2019 maximum temperature (r = 0.456) had positive and non-significant correlation with whitefly population while minimum temperature (r = 0.575) inferred positive and significant effect. In addition, the correlation of whitefly with remaining weather parameters viz. relative humidity at 7 hrs, 14 hrs and rainfall was found negative non-significant (r = -0.222, -0.192 and -0.055 respectively). However, effect of all the weather parameters together constituted 40.75 per cent towards whitefly population build up (R^2 = 0.4075). The correlation results of pooled data (Table 6) showed more or less similar trend comparative to both the years. The results clearly indicated that maximum temperature and the minimum temperature (r = 0.521) showed positive correlation with whitefly. Relative humidity at 7 hrs (r = 0.151) and 14 hrs (r = 0.008) were found positive but non-significant correlation with whitefly population. Further, whitefly population was found negatively correlated with rainfall (r = -0.020) and had non-significant effect. However, the effect of all aforesaid weather parameters together governed 64.67 per cent towards whitefly population (R^2 = 0.6467).

The findings of [14] provide strong support to the present findings and showed positive correlation between minimum and mean temperature with density count of whitefly. Further, the present investigation also lent a good support from [28, 29, 12] who reported that the whitefly population had positive and significant correlation with maximum temperature, minimum temperature and morning relative humidity. Additionally, whitefly also had negative significant correlation with evening relative humidity and rainfall. Further, [19] reported that minimum temperature, maximum temperature and relative humidity had positive and significant correlation with whitefly population. In contrast, rainfall, relative humidity at evening hours and sunshine had negative and significant effect on whitefly population which is broadly corroborated with the present findings. The present results, however, differed from the results of [30, 10, 16, 7] who claimed negative effect of maximum and minimum temperature on whitefly population whereas positive correlation with rainfall.

It is obvious from Table 4 that during *Kharif*, 2018 jassid population had positive and highly significant correlation with maximum temperature (r = 0.783). While, minimum temperature (r = 0.470), relative humidity at 7 hrs (r = 0.073) and 14 hrs (r = 0.352) showed positive and non-significant correlation with jassid population. Further, the jassid population was found negatively correlated with rainfall (r =-0.060), but had non-significant effect. However, all the weather parameters viz. maximum temperature, minimum temperature, relative humidity at 7 hrs, 14 hrs and rainfall together contributed 66.15 per cent towards jassid population (R^2 = 0.6615). During the next crop season i.e. *Kharif*, 2019 the data significantly varied from that of previous crop. It is evident from Table 5, that maximum temperature and minimum temperature showed positive and non-significant correlation with jassid population (r = 0.455) and (r = 0.244), respectively. However, jassid population was found positive significant correlation with relative humidity at 7 hrs (r = 0.591). Unlike earlier discussed weather parameters relative humidity at 14 hrs (r = -0.127) and rainfall (r = -0.510) was found negatively correlated with jassid population but significant effect was showed only by rainfall. All the weather parameters together constituted 70.67 per cent towards jassid population build up (R^2 = 0.7067). A perusal of pooled data (Table 6) showed more or less similar results comparative to both the years. The results clearly indicated that jassid population had positive and highly significant correlation with maximum temperature (r = 0.690) while minimum temperature (r = 0.447) and relative humidity at 7 hrs (r = 0.343) showed positive and non-significant correlation. Further, relative humidity 14 hrs (r = -0.366) and rainfall (r = -0.413) showed negative and non-significant correlation. The cumulative effect of all the weather parameters collectively contributed 53.78 per cent towards jassid population as indicated by R^2 value (R^2 = 0.5378).

The present findings in respect of jassid correlation with prevailing abiotic factors are in agreement with the observations of [31, 32, 33 21, 34] who inferred that jassid population was found non-significantly positive correlation with minimum temperature, maximum temperature, relative humidity and non-significant but negative correlation with rainfall. Further, [19] reported that minimum temperature, maximum temperature and relative humidity had positive and significant correlation with jassid population. In addition, rainfall and relative humidity at evening hours had negative and significant effect on jassid population which is in partial agreement with the present findings. However, the reports of [16, 10, 35, 7] strongly varied from the result of present investigation.

Correlation studies indicated that during *Kharif*, 2018 the fluctuation in mite population showed positive but non-significant correlation (Table 4) with maximum temperature (r = 0.197), minimum temperature (r = 0.300). Unlike it, relative humidity at 7 hrs, 14 hrs and rainfall inferred negative and non-significant correlation with mite population (r = -0.363, -0.335 and -0.201 respectively). While, all the weather parameters together governed 29.37 per cent towards mite population (R^2 = 0.2937). More or less similar results were also observed during next crop season i.e. *Kharif*, 2019. The data pertaining to mite correlation with abiotic factors was presented in Table 5, indicated that maximum temperature (r = 0.352) and minimum temperature (r = 0.261) had positive but non-significant correlation with mite population. While, relative humidity at 7 hrs showed positive and significant correlation with mite (r = 0.597). Further, relative humidity at 14 hrs (r = -0.049) and rainfall (r = -0.309) showed negative effect on mite population. However, the effect of all the weather parameters together constituted 70.50 per cent towards mite population (R^2 = 0.7050). The pooled data (Table 6) clearly indicated that mite population had positive and non-significant correlation with maximum temperature, minimum temperature and relative humidity at 7 hrs (r = 0.296, 0.171 and 0.215 respectively). Contrary to this, relative humidity at 14 hrs (r = -0.206) and rainfall (r = -0.321) showed negative and non-significant correlation with mite population. While, all the prevailing weather parameters viz. maximum temperature, minimum temperature, relative humidity at 7 hrs, 14 hrs and rainfall together contributed 16.25 per cent towards mite population (R^2 = 0.1625).

[24] Reported that mean temperature, sunshine hours, wind velocity and predatory mite population had significant positive correlation with mite population on okra and a negative correlation with relative humidity and rainfall which lent good support to the present investigation. More or less similar results were also made by [22, 18, 25, 12]. However, the reports of [26] inferred different results from the present findings and reported that the mite population had positive and significant correlation with minimum temperature, relative humidity 7hrs, 14 hrs and mean relative humidity. However, bright sunshine hours, maximum temperature, rainfall and wind speed showed negative correlation with mite population. But correlation between the mite population and mean temperature was found negative.

5. Conclusion

From the above mentioned facts, it is concluded that whitefly population on okra crop was more during early stages whereas population showed a decline trend when the crop goes to maturation. The whitefly first appears during 27th standard week (1.96/3 leaves) and reached to its peak (7.59/3 leaves) during 31st standard week. Unlike whitefly, the jassid incidence was observed throughout the cropping season and persists till the end of crop. Jassid infestation was first found during 27th standard week (1.81 jassid/ 3 leaves) and continued till end of the crop i.e. 41st standard week (4.62 jassid/ 3 leaves). However, its peak population was noticed during 34th standard week (14.38 jassid/ 3 leaves). The mite infestation was registered throughout the cropping season while it was more pronounced in later stage of the crop. The mite incidence was initially noticed during 27th standard week (1.70 mite/ 2 cm^2) whereas, the highest mite population was found during 36th standard week (13.97 mite/ 2 cm^2). Correlation study showed that the maximum temperature and minimum temperature (r = 0.521) had positive and significant correlation with whitefly. However, relative humidity at 7 hrs (r = 0.151) and 14 hrs (r = 0.008) were showed positive but non-significant correlation. Further, whitefly population was found negatively correlated with rainfall (r = -0.020) and had non-significant effect. The effect of all the weather parameters viz. maximum temperature, minimum temperature, relative humidity at 7 hrs, 14 hrs and rainfall together governed 64.67 per cent towards whitefly population (R^2 = 0.6467). The jassid population had positive and highly significant correlation with maximum temperature (r = 0.690) while minimum temperature (r = 0.447) and relative humidity at 7 hrs (r = 0.343) showed positive and non-significant correlation. Further, relative humidity 14 hrs (r = -0.366) and rainfall (r = -0.413) showed negative and non-significant correlation. The cumulative effect of all the weather parameters collectively contributed 53.78 per cent towards jassid population as indicated by R^2 value (R^2 = 0.5378). The mite population had positive and non-significant correlation with maximum temperature, minimum temperature and relative humidity at 7 hrs (r = 0.296, 0.171 and 0.215 respectively). Contrary to this, relative humidity at 14 hrs (r = -0.206) and rainfall (r = -0.321) showed negative and non-significant correlation with mite population. While, all the prevailing weather parameters together contributed 16.25 per cent towards mite population (R^2 = 0.1625).

Table 1: Population dynamics of jassids, *Amrasca biguttula biguttula* (Ishida), whitefly, *Bemisia tabaci* (Gennadius) and mite, *Tetranychus urticae* (Koch) on okra cv Kashi Pragati in relation to prevailing weather parameters during *Kharif* 2018

Standard week	Mean number/ 3 leaves whitefly/three leaves		Mean number of mite/ 2 cm²	Weather parameters				
				Temperature (˚C)		Relative humidity (%)		Rainfall (mm)
	Whitefly	Jassid		Maximum	Minimum	7 hrs	14 hrs	
27	1.12	1.32	0	32.50	26.00	96.00	73.00	0.00
28	2.22	3.42	0	33.20	25.50	99.10	76.10	27.71
29	3.50	4.90	1.72	33.30	25.80	99.00	76.50	0.00
30	3.95	5.42	2.20	34.50	26.30	98.50	81.20	9.06
31	5.50	6.80	3.92	35.20	25.20	99.10	83.10	11.14
32	4.70	7.40	4.40	33.50	26.00	98.40	78.80	0.00
33	4.50	9.20	6.50	35.80	26.00	98.50	77.20	2.63
34	3.82	10.95	6.80	36.60	27.50	96.50	62.20	0.00
35	2.20	8.32	7.60	34.60	25.70	98.50	76.80	1.43
36	0.00	7.12	8.12	32.50	27.00	93.70	67.10	13.40
37	0.00	6.20	9.77	33.30	25.60	98.80	74.50	6.63
38	0.00	5.47	10.10	33.20	25.00	98.50	76.50	10.00
39	0.00	3.90	9.12	33.70	25.30	85.10	72.70	0.00
40	0.00	2.22	4.07	33.40	26.60	99.00	74.50	1.57
41	0.00	1.52	3.22	31.50	24.40	99.10	83.70	0.00

Table 2: Population dynamics of jassids, *Amrasca biguttula biguttula* (Ishida), whitefly, *Bemisia tabaci* (Gennadius) and mite, *Tetranychus urticae* (Koch) on okra cv Kashi Pragati in relation to prevailing weather parameters during *Kharif* 2019

Standard week	Mean number/ 3 leaves		Mean number of mite/ 2 cm²	Weather parameters				
				Temperature (˚C)		Relative humidity (%)		Rainfall (mm)
	Whitefly	Jassid		Maximum	Minimum	7 hrs	14 hrs	
27	2.80	2.30	3.40	33.30	27.20	87.20	80.80	10.97
28	3.47	3.63	5.72	30.00	24.90	95.50	83.50	33.37
29	5.10	5.15	6.35	29.30	27.60	94.80	71.20	0.00
30	9.22	7.50	8.92	32.80	26.30	97.00	92.10	34.23
31	9.67	12.72	10.45	32.80	27.30	96.40	83.40	0.00
32	8.50	13.37	11.50	33.20	27.10	94.20	74.50	10.83
33	6.65	16.22	14.52	32.80	26.10	97.00	82.70	11.40
34	5.25	17.80	15.80	34.90	27.20	98.70	76.20	0.00
35	3.17	15.95	18.27	33.80	27.40	98.50	73.80	0.00
36	0.00	15.20	19.82	32.50	27.10	97.70	83.40	0.00
37	0.00	13.42	17.17	32.00	26.00	98.00	82.10	9.57
38	0.00	11.75	13.45	30.20	24.90	97.50	86.50	7.91
39	0.00	10.47	11.67	28.20	23.30	99.00	96.20	27.60
40	0.00	9.77	8.60	29.20	23.70	97.10	85.50	0.00
41	0.00	7.72	7.12	32.00	22.40	99.10	79.00	0.00

Table 3: Population dynamics of jassids, *Amrasca biguttula biguttula* (Ishida), whitefly, *Bemisia tabaci* (Gennadius) and mite, *Tetranychus urticae* (Koch) on okra cv Kashi Pragati in relation to prevailing weather parameters (Based on pooled mean of two crop seasons i.e. *Kharif* 2018 and 2019)

Standard week	Mean number/ 3 leaves whitefly/three leaves		Mean number of mite/ 2 cm²	Weather parameters				
				Temperature (˚C)		Relative humidity (%)		Rainfall (mm)
	Whitefly	Jassid		Maximum	Minimum	7 hrs	14 hrs	
27	1.96	1.81	1.70	32.90	26.60	91.60	76.90	5.49
28	2.85	3.52	2.86	31.60	25.20	97.30	79.80	30.54
29	4.30	5.03	4.04	31.30	26.70	96.90	73.85	17.12
30	6.59	6.46	5.56	33.65	26.30	97.75	86.65	4.53
31	7.59	9.76	7.19	34.00	26.25	97.75	83.25	5.57
32	6.60	10.39	7.95	33.35	26.55	96.30	76.65	5.42
33	5.58	12.71	10.51	34.30	26.05	97.75	79.95	7.02
34	4.54	14.38	11.30	35.75	27.35	97.60	69.20	0.00
35	2.69	12.14	12.94	34.20	26.55	98.50	75.30	0.72
36	0.00	11.16	13.97	32.50	27.05	95.70	75.25	6.70

37	0.00	9.81	13.47	32.65	25.80	98.40	78.30	8.10
38	0.00	8.61	11.78	31.70	24.95	98.00	81.50	8.96
39	0.00	7.19	10.40	30.95	24.30	92.05	84.45	13.80
40	0.00	6.00	6.34	31.30	25.15	98.05	80.00	0.79
41	0.00	4.62	5.17	31.75	23.40	99.10	81.35	0.00

Table 4: Correlation coefficient and regression equation between weather parameters (X) and incidence of sucking pests of okra (Y) during *Kharif* 2018

Sl. No.	Pests	Correlation coefficient (r)					Multiple regression equation	R^2 (%)
		(X_1)	(X_2)	(X_3)	(X_4)	(X_5)		
1.	Whitefly	0.681**	0.196	0.347	0.238	–0.102	$Y = -82.503 + 0.986 (X_1) + 1.103 (X_2) - 0.044 (X_3) + 0.246 (X_4) - 0.019 (X_5)$	71.06
2.	Jassid	0.783**	0.470	0.073	0.352	–0.060	$Y = -41.941 - 1.540 (X_1) - 0.194 (X_2) + 0.119 (X_3) - 0.145 (X_4) - 0.001 (X_5)$	66.15
3.	Mite	0.197	0.300	–0.363	–0.335	–0.201	$Y = -3.330 + 0.123 (X_1) + 1.643 (X_2) - 0.425 (X_3) + 0.045 (X_4) - 0.065 (X_5)$	29.37

Weather parameters: X_1 - maximum temperature (ºC), X_2 - minimum temperature (ºC), X_3 - relative humidity at 7 hrs (%), X_4 – relative humidity at 14 hrs (%) and X_5 - rainfall (mm)
Coefficient of determination (R^2)
**Significant at P = 0.01

Table 5: Correlation coefficient and regression equation between weather parameters (X) and incidence of sucking pests of okra (Y) during *Kharif* 2019

Sl. No.	Pests	Correlation coefficient (r)					Multiple regression equation	R^2 (%)
		(X_1)	(X_2)	(X_3)	(X_4)	(X_5)		
1.	Whitefly	0.456	0.575*	–0.222	–0.192	–0.055	$Y = -64.193 - 0.867 (X_1) + 0.986 (X_2) + 0.038 (X_3) + 0.125 (X_4) + 0.082 (X_5)$	40.75
2.	Jassid	0.455	0.244	0.591*	–0.127	–0.510*	$Y = -149.008 + 0.512 (X_1) + 1.131 (X_2) - 1.170 (X_3) + 0.013 (X_4) - 0.066 (X_5)$	70.67
3.	Mite	0.352	0.261	0.597*	–0.049	–0.309	$Y = -180.151 + 0.472 (X_1) + 1.580 (X_2) + 1.216 (X_3) + 0.236 (X_4) - 0.104 (X_5)$	70.50

Weather parameters: X_1 - maximum temperature (ºC), X_2 - minimum temperature (ºC), X_3 - relative humidity at 7 hrs (%), X_4 – relative humidity at 14 hrs (%) and X_5 - rainfall (mm)
Coefficient of determination (R^2)
*Significant at P = 0.05

Table 6: Correlation coefficient and regression equation between weather parameters (X) and incidence of sucking pests of okra (Y) (Based on pooled mean of two crop seasons i.e. *Kharif* 2018 and 2019)

Sl. No.	Pests	Correlation coefficient (r)					Multiple regression equation	R^2 (%)
		(X_1)	(X_2)	(X_3)	(X_4)	(X_5)		
1.	Whitefly	0.624**	0.521*	0.151	0.008	–0.020	$Y = -110.451 + 1.254 (X_1) + 1.234 (X_2) + 0.158 (X_3) + 0.305 (X_4) + 0.111 (X_5)$	64.67
2.	Jassid	0.690**	0.447	0.343	–0.366	–0.413	$Y = -61.030 + 1.420 (X_1) + 0.032 (X_2) + 0.329 (X_3) - 0.123 (X_4) - 0.041 (X_5)$	53.78
3.	Mite	0.296	0.171	0.215	–0.206	–0.321	$Y = -15.669 + 0.305 (X_1) - 0.007 (X_2) + 0.256 (X_3) - 0.124 (X_4) - 0.112 (X_5)$	16.25

Weather parameters: X_1 - maximum temperature (ºC), X_2 - minimum temperature (ºC), X_3 - relative humidity at 7 hrs (%), X_4 – relative humidity at 14 hrs (%) and X_5 - rainfall (mm)
Coefficient of determination (R^2)
*Significant at P = 0.05 and **Significant at P = 0.01

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