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Correlation the incidence of major insect-pest and natural enemies with weather parameters

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Abstract
Major insect pest of okra *viz.*, jassid (*Amrasca bigutulla biguttula*), whitefly (*Bemisia tabaci*), and shoot and fruit borer (*Earias vittella*) damaged heavily during the *kharif.* The incidence of leafhopper, whitefly, shoot and fruit borer and natural enemies show correlation with weather parameters, minimum temperature showed significantly positive correlation (r = 0.611* and 0.807**) with jassid incidence during both the year of study. Maximum temperature showed non-significant negative correlation with jassid incidence during 2018 and significantly positive correlation during 2019 and correlation values in respective years were (r= -0.234 and 0.836**). Relative humidity and rainfall showed negative non-significant correlation with Whitefly incidence during both the years and correlation values in respective years were (r= -0.323, -0.092 and r= -0.562, -0.580). Minimum temperature showed positive significant correlation (r= 0.757** and 0.835**) during both the years. Maximum temperature showed non-significant negative correlation with per cent shoot damage during 2018 and significantly positive correlation during 2019 and correlation values in respective years were (r= -0.138 and 0.810**). Whereas, wind speed and sunshine showed positive non-significant correlation (r= 0.040 and 0.171) during first year and negative non-significant correlation (r= -0.373 and -0.064) during second year. minimum temperature and *Clubiona* sp. showed positive significant correlation (r= 0.438 and 0.493) during both the years.

Keywords: correlation, major insect pest, natural enemies, weather parameters

Introduction

Okra *Abelmoschus esculentus* L. (Moench) (Family: Malvaceae). It is mostly grown for its immature green and non-fibrous edible seed pod fruits in tropical crop. This crop is suitable for cultivation as a kitchen garden crop as well as on large high-tech commercial farms. It is an economically significant crop cultivated in India and is used all over the world as vegetable [1]. It is commercially cultivated in many parts of the world and almost at all the states in our country in both *kharif* as well as *summer* season [10]. It is a vital sector of national economics as source of employment, local income and foreign exchange earning. Besides being a vegetable, it acts as clarifying agent in jaggery preparation [3]. Okra is native to north eastern Africa in the general area of Ethiopia and Sudan. Existence of a large number of related species with wide variability and dominant characters suggest possible role of India as a secondary centre of origin. Now, its cultivation is widespread in tropical, subtropical and warm temperate regions, but is particularly popular in West Africa, India, the Philippines, Thailand and Brazil [4, 6]. The major constraint for the low productivity of okra is its more vulnerable to attack of pests. Which becomes unfit for consumption and as a result the reduction in the production is about 35-76 per cent. Among all pests, shoot and fruit borer, *Earias vitella* (Fabricius) is the most destructive pest of okra as young larva bores the growing shoot of okra plant prior to fruit formation resulting in withering and drying of shoot. On availability of fruit, larva starts feeding to the okra fruit and thus causes direct loss of yield. The larva bores into shoot or fruit and start eating on internal contents causing withering of plant and reduction in marketable value of the fruit [9]. Despite large area and quite a good number of cultivars the supply of okra in Indian market is not matching to its demand. Lower productivity would be a major reason for such unmatching demand and supply. Critical analysis for such low productivity revealed that major portion of fruits produced are being damaged by dreaded insect pests. The okra crop

is infested by a number of insect pests like *Amrasca devastans*, *Earias vittella*, *Bemisia tabaci*, *Helicoverpa armigera*, *Acrocercopsbi fasciata*, *Thrips tabaci*, *Aphis gossypii*, *Podagrica*, *Anomis* flava, *Sylepta derogata*, *Haritalodes derogata*, *Dysdercus koengii* and *Nezara viridula*. But *Amrasca devastans*, *E. vittela*, *H. armigera* and *B. tabaci* are the notorious and major insect pests of okra [7]. Many of the pests occurring on cotton are also found on okra crop. As high as, 72 species of insects have been recorded on okra, [20] of which, the sucking pests comprising of leafhopper, *Amrasca biguttula biguttula* (Ishida), whitefly, *Bemisia tabaci* (Gennadius) and mite, *Tetranychus urticae* (Boisduval) cause significant damage to the crop. Leafhopper, a polyphagous, pest has been a serious pest on okra causing heavy loss during these years. The major constraint for the low productivity of okra is its more vulnerable to attack of pests. The aim of this experiment was to determine the role of weather parameters on major insect pest and natural enemies' population on bhindi. This will facilitate to execute proper time of application of insecticides and other control strategies for *Amrasca biguttula biguttula*, *E. vittela*, *H. armigera* and *B. tabaci* on okra.

Material and Methods

Arka Anamika was sown in plot size 10 x 10 m in first week of July during *kharif* 2018 and 2019. Spacing between rows and plants will be 60 and 45 cm, respectively. All the agronomical practices, except the package recommended for insect pests management were adopt to grow a good crop. The influence of weather parameters on insect pests and natural enemies were worked out by Counting of major insect-pest and natural enemies population present on the crop chosen for study were recorded separately in the morning hours at weekly interval. It was usually done between 6.00 am to 10.00 Am because these insects are usually easy found on the surface of the leaves for feeding. Data on meteorological parameters viz., temperature (minimum and maximum °C), relative humidity (%), rainfall (mm), wind velocity (km/hr.) and sunshine hours were taken from the Department of Agrometeorology. Correlation was made between insect-pests population and mean weather parameter for every standard week (SW).

Result and Discussion

Effect of weather parameters on the incidence of Jassids.

Correlation between weather parameters and jassids in okra during *kharif* 2018 and 2019 are presented in table-1. The studies indicated that minimum temperature showed significantly positive correlation (r = 0.611* and 0.807**) with jassid incidence during both the year of study. Maximum temperature showed non-significant negative correlation with jassid incidence during 2018 and significantly positive correlation during 2019 and correlation values in respective years were (r= -0.234 and 0.836**). Relative humidity showed positive non-significant association with jassids incidence during 2018 and negative non-significant correlation during 2019 and correlation values in respective years were (r=0.421and -0.235). The positive non-significant correlation was found between jassids with rainfall (r=0.394) during 2018 and negative significant correlation (r=-0.708*) during 2019. However, wind speed and sunshine hour showed negative non-significant correlation (r=-0.528 and -0.390) with jassids incidence during 2018 and positive non-significant and positive significant correlation (r= 0.234 and r= 0.717*) respectively during 2019. Present finding was coordination with Mahmood *et al.* (2002) [11], Selvaraj *et al.* (2010) [16] reported that incidence of leafhopper, *A. biguttula biguttula* showed positive and significant correlation with maximum and minimum temperatures. Relative humidity and rainfall were negatively and non-significantly correlated with population fluctuation. Sunshine hours were also positive but nonsignificant.

Effect of weather parameters on the incidence of Whitefly.

Correlation between weather parameters and Whitefly in okra during *Kharif* 2018 and 2019 are presented in table-1. The studies indicated that minimum temperature showed non-significant negative correlation (r = -0.197) with Whitefly incidence during 2018 and significantly positive correlation (r = 0.741**) during 2019. Maximum temperature showed non-significant positive correlation with Whitefly incidence during 2018 and significantly positive correlation during 2019 and correlation values in respective years were (r= 0.065 and 0.738**). Relative humidity and rainfall showed negative non-significant correlation with Whitefly incidence during both the years and correlation values in respective years were (r= -0.323, -0.092 and r= -0.562, -0.580). However, wind speed (r= 0.205 and 0.009) showed positive non-significant correlation with Whitefly incidence during both the years. Sunshine hour showed positive non-significant and positive significant correlation (r= 0.518 and r= 0.687*) respectively during 2019. The present findings is in agreement with Rajesh et al., (2016) [14] studied correlation regression between weather (abiotic) factors and the major insect pests of okra showed that population of *Bemisia tabaci* had a significant positive correlation with minimum temperature (r=0.67) and (byx0.34).

Effect of weather parameters on the incidence of shoot and fruit damage.

It is evident from table-1 that minimum temperature showed positive significant correlation (r= 0.757** and 0.835**) during both the years. Maximum temperature showed non-significant negative correlation with per cent shoot damage during 2018 and significantly positive correlation during 2019 and correlation values in respective years were (r= -0.138 and 0.810**). Relative humidity and rainfall showed positive non-significant correlation (r= 0.331 and 0.361) during 2018 and negative non-significant correlation (r= -0.449 and -0.547) during 2019. However, wind speed and sunshine showed negative non-significant correlation (r= -0.422 and -0.473) during first year and positive non-significant correlation (r= 0.171 and 0.598) during second year. The result was in accordance with the findings of Pathan *et al.* (2018) [13] reported *Earias vittella* (Fabricius) study revealed that BSS (r = 0.88) and Max Tem. (0.86) exhibited highly significant positive impact whereas, WS (-0.75) and RH2 (-0.90) had highly significant negative association during *Kharif*, 2014. It is evident from table-1 that minimum temperature showed positive significant correlation (r= 0.353 and 0.280) during both the years. Maximum temperature showed negative non-significant correlation with per cent fruit damage during 2018 and positive non-significant correlation during 2019 and correlation values in respective years were (r= -0.096 and 0.189). Relative humidity showed positive non-significant correlation (r= 0.050) during 2018 and negative non-significant correlation (r= -0.056) during 2019. Rainfall and wind speed showed negative non-significant correlation (r= -0.264, -0.013 and -0.030, -0.398) during both the years. whereas sunshine showed positive non-significant correlation

(r= 0.121 and 0.009) during both the years. The present findings is in agreement with Rajesh *et al*., (2016) [14] studied correlation regression between weather (abiotic) factors and the major insect pests of okra showed that population of *Amrasca biguttula biguttula* had a significant positive correlation with maximum temperature (r=0.58) and (byx=18.15) while *Bemisia tabaci* had a significant positive correlation with minimum temperature (r=0.67) and (byx0.34). While *Aphis gossypii* and *Earias vittella* showed that non-significant relationship with weather parameter. Mohanasunadaram and Sharma (2011) [12] reported the incidence of fruit borer showed significant negative correlation with relative humidity (r = -0.906) and significant positive correlation with sunshine hours. Positive correlation was observed between the minimum (r = +0.994) and mean temperature (r = +0.889). Archunan *et al*., (2018) [2] indicated that per cent shoot damage and fruit damage of bhendi was positively non-significant association with RH and rain fall, while negatively non-significant correlation with minimum temperature (-0.43 and-0.309) and sunshine hours (-0.265 and-0.283) was recorded.

Effect of weather parameters on the incidence of Coccinellids.

Correlation with minimum temperature and *Coccinella septempunctata* showed positive significant correlation (r= 0.196 and 0.329) during both the years (Table 1). Maximum temperature showed negative non-significant correlation with *C. septempunctata* during 2018 and positive non-significant correlation during 2019 and correlation values in respective years were (r= -0.096 and 0.251). Relative humidity showed positive non-significant correlation (r= 0.038) during 2018 and negative non-significant correlation (r= -0.267) during 2019. Rainfall showed negative non-significant correlation (r= -0.246 and -0.097) during both the years. Whereas wind speed and sunshine showed positive non-significant correlation (r= 0.040 and 0.171) during first year and negative non-significant correlation (r= -0.373 and -0.064) during second year. The findings of Shukla *et al.* (2014) [14] revealed that Aphids showed positive correlation with relative humidity. With population of Chrysoperla, correlation coefficient of r = 0.147 and -0.530 respectively. Observation between population of aphids and their natural enemies (Coccinellids and Chrysoperla) related to humidity in morning +0.295, -0.043 and 0.462 and afternoon +0.401, -0.099, -0.281 respectively.

Correlation with minimum temperature and *C. sexmakulata* showed positive significant correlation (r= 0.153 and 0.493) during both the years (Table 1). Maximum temperature showed negative non-significant correlation with *C. sexmakulata* during 2018 and positive non-significant correlation during 2019 and correlation values in respective years were (r= -0.016 and 0.163) respectively. Relative humidity, rainfall and wind speed showed negative non-significant correlation (r= -0.006, -0.436, -0.232 and -0.232, -0.190, -0.303) during both the years. Whereas, sunshine also showed positive non-significant correlation (r= 0.219 and 0.052) during both the years. Mohansundaram *et al*. (2011) [12] and Sardana *et al*. (2005) [15] who had reported that a large build-up of natural enemies viz, spider, and coccinellids were observed in unprotected crop module. Singh *et al*. (2013) [19] reported that the coccinellids showed negative correlation with minimum and maximum temperature, rainfall and relative humidity.

Effect of weather parameters on the incidence of spiders

Correlation with minimum temperature and *Clubiona* sp. showed positive significant correlation (r= 0.438 and 0.493) during both the years. Maximum temperature showed negative non-significant correlation with *Clubiona* sp. during 2018 and positive non-significant correlation during 2019 and correlation values in respective years were (r= -0.069 and 0.515) respectively. Relative humidity and rainfall showed positive non-significant correlation (r= 0.290 and 0.116) during 2018 and negative non-significant correlation (r= -0.454 and -0.348) during 2019. Whereas, wind speed showed negative non-significant correlation (r= -0.361 and -0.229) during both the years. However, sunshine showed negative non-significant correlation (r= -0.136) during 2018 and positive non-significant correlation (r= 0.289) during 2019. Correlation with minimum temperature and *O. javanus* Thorell. Showed positive significant correlation (r= 0.235 and 0.432) during both the years. Maximum temperature showed negative non-significant correlation with *O. javanus* during 2018 and positive non-significant correlation during 2019 and correlation values in respective years were (r= -0.117 and 0.372) respectively. Relative humidity showed positive non-significant correlation (r= 0.171 and 0.028) during both the years. Rainfall showed negative non-significant correlation (r= -0.075 and -0.216) also during both the years. Whereas, wind speed showed positive non-significant correlation (r=0.011) during 2018 and negative non-significant correlation (r= -0.320). However, sunshine showed positive non-significant correlation (r=0.053) during 2018 and positive non-significant correlation (r= 0.269) during 2019. The results are in accordance with the fndings of Sinde *et al*. (2007) [18] found that neem seed powder and NSKE 5% recoded maximum population of lady bird beetle and spider on okra. Abdalla (2012) [1] reported that the Chrysopids and spider were the predominant predators in autumn and summer seasons, whereas syrphids, chrysopids and coccinellids were abundant group during winter.

Table 1: Correlation of major insect-pest and natural enemies in relation to weather parameters

Arka anamika (varieties)	Abiotic Factor-2018						Abiotic Factor-2019					
	Min. tem.	Max. Tem.	R.H.	Rainfall	Wind Speed	Sun Shine	Min. tem.	Max. Tem.	R.H.	Rainfall	Wind Speed	Sun Shine
Jassid	0.611*	-0.234	0.421	0.394	-0.528	-0.390	0.807**	0.836**	-0.235	-0.708*	0.234	0.717*
Whitefly	-0.197	0.065	-0.323	-0.562	0.205	0.518	0.741**	0.738**	-0.092	-0.580	0.009	0.687*
Shoot damage	0.757**	-0.138	0.331	0.361	-0.422	-0.473	0.835**	0.810**	-0.449	-0.547	0.171	0.598
Fruit damage	0.353	-0.096	0.050	-0.264	-0.030	0.121	0.280	0.189	-0.056	-0.013	-0.398	0.009
C.septempunctata	0.196	-0.096	0.038	-0.246	0.040	0.171	0.329	0.251	-0.267	-0.097	-0.373	-0.064
C.sexmaculata	0.153	-0.016	-0.006	-0.232	-0.197	0.219	0.194	0.163	-0.436	-0.190	-0.303	0.052
Clubiona sp	0.438	-0.069	0.290	0.116	-0.361	-0.136	0.493	0.515	-0.454	-0.348	-0.229	0.289
Lynx spider (*Oxyopes javanus*)	0.235	-0.117	0.171	-0.075	0.011	0.053	0.432	0.372	0.028	-0.216	-0.320	0.269

Conclusion

It is concluded that the *A. biguttula biguttula, B. tabaci and* shoot and fruit borer were observed as causing major damage on okra. The incidence of leafhopper, whitefly, shoot and fruit borer show correlation with weather parameters, minimum temperature showed significantly positive correlation (r = 0.611* and 0.807**) with jassid incidence during both the year of study. Maximum temperature showed non-significant negative correlation with jassid incidence during 2018 and significantly positive correlation during 2019 and correlation values in respective years were (r= -0.234 and 0.836**). Relative humidity and rainfall showed negative non-significant correlation with Whitefly incidence during both the years and correlation values in respective years were (r= -0.323, -0.092 and r= -0.562, -0.580). Minimum temperature showed positive significant correlation (r= 0.757** and 0.835**) during both the years. Maximum temperature showed non-significant negative correlation with per cent shoot damage during 2018 and significantly positive correlation during 2019 and correlation values in respective years were (r= -0.138 and 0.810**).

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