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Short Communication

Abundance and distribution of sucking pests complex of okra in relation to meteorological parameters

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Okra [*Abelmoschus esculentus* (L.) Moench], also known as lady's finger, is one of the most important traditional vegetable in India. The crop losses owing to insect pests is a major constrain in agricultural production and productivity. Amongst the different insect pests, sucking pests are gaining importance as besides sucking the sap and there by devitalizing the plants, many of them also serve as a vector in transmitting the many viral diseases (Halder *et al.,* 2011; Rai *et al*., 2014).Okra jassid, *Amrasca biguttula biguttula* Ishida (Hemiptera: Cicadellidae) and whitefly, *Bemisiatabaci* Gennadius (Hemiptera: Aleyrodidae) are important ones causing damage from early seedling to till fruit maturity (Halder *et al*., 2015). The insect pest incidence is an outcome of interaction among host, insect and weather over a period of time.Different meteorological parameters *viz*., temperature, rainfall, wind velocity and relative humidity greatly influence the insect population. Keeping this in view, the present investigation was aimed to elucidate the effect of different weather parameters on the population buildup of these duonefarious sucking pests of okra and also to develop a weatherbased prediction model for the sepersistent sucking pests. This will beuseful to take suitable control measures well in advance,thus reducing the excessive and unnecessary usage of insecticides, cost of cultivation as well as environmental hazards.

The field experiments were carried out at experimental farm of ICAR-Indian Institute Vegetable Research, Varanasi(82°52' E longitude and 25°12' N latitude), Uttar Pradesh, India during *kharif* seasons of 2017 and 2018. The experimental site comes under the alluvial zone of Indo-Gangetic plains having soils silt loam in texture and low inorganic carbon (0.43%) and available nitrogen (185 kg ha^{-1}). Mean weekly meteorological parameters recorded during cropping seasons at I.I.V.R.meteorological observatory were used. Seeds of okra(*cv.* KashiPragati) were sown in a plot with plant to plant spacing of 45 cm and row to row distance 60cm with three replications during first fortnight of June. The recommended doses of fertilizers (N:P:K = 120:60:60) were applied.Hand weeding and irrigations were provided as required and usual crop husbandry measures were undertaken except plant protection measures.

The regular monitoring at weekly intervals for both the insect incidences was recorded during morning hours (in between 7 to 8 am). The population of jassid and whitefly were counted on three leaves per plant, one each from top, middle and bottom regions from ten randomly selected plants expressed as number of insects $leaf^{-1}$(Halder *et al*. 2016). The data were recorded from germination onwards till crop maturity.

The data on weather parameters during the crop seasons were collected from meteorological observatory located in the institute. The weather parameters included are daily maximum temperature (T_{max}) (°C), daily minimum temperature (T_{min}) (°C), average daily temperature (T_{mean}) (°C), average day relative humidity at 7.00 am and 2.00 pm($RH_{I,II}$), bright sun shine hour (SSH), evaporation (EP) (mm), rainfall(RF) (mm) and wind velocity (WV).The independent parameters which followed an exponential or power curve pattern are attempted and compared based on AIC (Akaike Information Criterion)(Akaike, 1974) values.

The AIC is expressed as:

$$AIC = -2ln\,(l(\hat{\theta})) + 2q$$

Where $l(\hat{\theta})$ was the model's likelihood *i.e.,* the likelihood of the sample for the values estimated from the model parameters and q was the number of weather parameters estimated. A smaller value of AIC suggests a better model and thus exponential model was found the best suited in all the cases.Regression diagnostics were also conducted to validate the model. The data regarding weather parameters were correlated with jassid and whitefly population to find

Table 1: Correlation coefficients (r) between whiteflies and jassids incidences in okra with different meteorological parameters and agroclimatic indices (pooled data 2017 and 2018)

Meteorological parameters	Correlation co-efficient (r)	
	Whitefly	Jassid
Maximum temperature (T_{max})	0.669*	0.680*
Minimum temperature (T_{min})	0.518*	0.488*
Mean temperature (T_{mean})	0.591*	0.576*
Relative humidity at 7 am (RH_I)	0.499*	0.279
Relative humidity at 2 pm (RH_{II})	-0.757*	-0.561*
Rainfall (RF)	-0.591*	-0.652*
Sunshine hour (SSH)	0.421	0.619*
Evaporation (EP)	0.519*	0.119
Wind velocity (WV)	-0.452*	-0.063

* Significant at the 0.05 level (2-tailed)

out their relation with its incidence. Similarly, a final regression model was developed using forward selection method with both the insect population *vis-à-vis* various weather parameters. SAS software version 9.3 was used for statistical analysis following the standard procedure.

The incidences of jassids and whiteflies on okra were started during 32nd standard meteorological week (SMW)and gradually increased and reached maximum population during 37thSMW (second week of September), whereas highest jassid population was recorded during 39th SMW (last week of September). From first week of October (40th SMW) onwards its population started declining and from last week of October onwards (44thSMW) coinciding with winter in this region and at crop maturity almost no pest population was recorded okra.

It is evident from Table 1 that maximum, minimum and average temperatures had positive and significant correlation with whitefly and jassid population and the corresponding correlation co-efficient (r) values were 0.669, 0.518,0.591and 0.680, 0.488, 0.576 respectively. Halder *et al.*, 2017 (a) (b) also reported increase in cucumber moth, *Diaphania indica* (Saunders) on bitter gourd and *Nesidiocoris cruentatus* (Ballard) on bottle gourd associated with period of high temperature.Singh and Singh (1993) also reported increase in red spider mite, *Tetranychus cinnabarinus* (Boisd) population infesting okra had strong positive correlation with prevalent high temperature.

In contrast, rainfall,wind velocity as well as relative humidity at evening had negative correlations(- 0.591, -0.452 and -0.757, respectively) with white fly population and observed significant correlations.Similarly, negative and significant correlations were recorded with jassid population and rainfall and relative humidity at evening and the corresponding values were -0.652, -0.561 whereas non-significant and negative correlation was recorded with wind velocity (r = - 0.063). Norris *et al*. (2002) also recorded that rainfall significantly decreased the number of thrips remaining on the plants and number of rainy days increased, the numbers of thrips on the plants also decreased and the majority of thrips were washed off the plants within 30 minutes.

Sunshine hourshad a positive and significant effect on jassid population (r=0.619)and non-significant effect (r=0.421) on whitefly population. The present observations are corroborated with the findings of Kumar *et al*. (2017) who reported that sunshine hours influenced positive and non-significantly with the abundance of aphids, jassids and whiteflies in okra. Almost same trend was also observed in case of heliothermal unit. In case of whitefly and jassid the observed correlations were significant and positive(r = 0.637 and 0.806, respectively). Recently, Yadav and Singh (2013) recorded that the correlations of spotted pod borer, *Maruca vitrata* infesting mungbean with weather factors exhibited positive significant correlation with sunshine hours.

The results depicted in the Table 1 revealed existence of positive correlation between whitefly and jassid populations and morning relative humidity.Interestingly, the morning relative humidity had also shown significant positive correlation (r = 0.499) with the whitefly population. Sharma and Rishi (2004) reported a significant positive correlation of whitefly population buildup with morning and evening relative humidity.

The stepwise forward selection method of model fitting was followed which begins with no variables in themodel and then variables are added one by one to the model,and the F statistic for a variable to be added must be significant with improvement in coefficient of determination (R^2) of the model. The model thus obtained for whitefly incidence (Y_1) with AIC value of 24.80 is as follows

$$Y_1 = 2.96 - 0.54T_{max} + 0.42SSH + 0.52EP + 0.42T_{mean} \qquad R^2 = 0.72^{**}$$

It has also been observed that the maximum temperature, sunshine hour,evaporation and average temperature had direct influence (72%) on distribution and abundance of *B. tabaci* on okra.

Similarly, in case of okra jassids, the model was predicted for its abundance (Y_2) with AIC value of 32.60 is as follows

$$Y_2 = -0.46 - 0.59T_{max} - 0.46WV + 0.69SSH + 0.54T_{min} - 0.07RH_1 \qquad R^2 = 0.912^{**}$$

Here, maximum temperature, wind velocity, sunshine hour, minimum temperature and relative humidity during morning had direct influence (91.2%) on abundance of *A. biguttulabiguttula*on okra.

It can be concluded that the information so generatedfrom the present study could be useful to predict the population of two important nefarious sucking pests of okra *viz.*, white fly and jassid at any given time and the developed model will be effective to initiate the suitable control practice to avoid the substantial yield loss.

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