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Seasonal incidence of insect pests on okra, *Abelmoschus esculentus* (L.) and its relationship with weather parameters in gird region of Madhya Pradesh, Indian

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Abstract
An experiment was conducted to observe the seasonal incidence of insect pests on okra in *Kharif*- 2018 and 2019 at the College of Agriculture, RVSKVV, Gwalior (M.P.). The activity of red cotton bug was recorded from in the month of September and its peak population of bug was recorded from month of October, in both the years. Showed that the population of mealybug from third week of august (34th SMW) with population 0.6 bugs/plant and its peak population was observed from first week of October in 2018 (40th SMW) and fourth week of September in 2019 (39th SMW) with 0.4 beetles/plant in both the years. The red cotton bug showed negatively non-significant correlated with maximum temperature, minimum temperature, evening relative humidity and evaporation in both the years. Significantly positive correlated with minimum temperature and evaporation (r= 0.34, 0.82 and r= 0.41, 0.79, respectively) with mealybug in both the years and blister beetle had significant positive correlation (r= 0.37, 0.72, r= 0.27, 0.21, r= 0.40, 0.78 and r= 0.42, 0.69) with minimum temperature, morning and evening relative humidity and evaporation in 2018 and 2019, respectively.

Keywords: Insect pests, correlation, seasonal incidence, okra

Introduction
Okra, *Abelmoschus esculentus* (L.) Moench is a common vegetable in India. Okra locally known as 'Bhindi' also known as "Lady's Finger" is a popular and most common annual vegetable crop in tropical and subtropical parts of the world (Sree *et al*., 2019).
It has good nutritional value of 100 g of edible protein of okra contains 2 g of protein, 0.19 g fat, 7.45 g carbohydrate, 1.48 g of sugars, 0.7 g minerals and 3.2 g fiber, 90.19 g of water and other like K (299 mg), Ca (82 mg), Mg (57 mg), Fe (0.62 mg), Zn (0.58 mg), Vitamin A (36 µg), Thiamine (B1- 0.2 mg) & (B2- 0.06 mg), C (23 mg), E and K (Patel *et al*., 2018) [8]. Okra crop is cultivated for its young tender fruits, used in curry and soups after cooking. Fruits are also dried or frozen for use during off-season. The root and stem are used for clearing cane juice in preparation of jiggery/gur. Seeds are a source of oil, protein and are also used as a coffee substitute, while ground up okra seeds has been used as a substitute for aluminum salts in water purification. India is second larger producer of vegetable production after China in the world. Okra is widely cultivated in plans of the India with average area of 5.06 lakh ha and production 60.73 lakh MT and productivity 12.00 tonnes ha^{-1}. In Madhya Pradesh okra is grown in 0.4012 lakh ha area with production 5.3673 lakh MT and 13.02 tonnes ha^{-1} productivity (Anonymous, 2018-2019) [1].
It is attacked by a number of insect pests right from germination to harvesting, *viz.*, jassid (*Amrasca biguttula biguttula* Ishida); aphids (*Aphis gossypii* Glover); whitefly (*Bemisia tabaci* Gennadius); shoot and fruit borer (*Earias insulana* Boida.), (*Earias vittella* Fab.); leaf roller, (*Sylepta derogate* Fab.); red cotton bug (*Dysdercus koenigii*); mite (*Tetranychus cinnabarinus* Boisduval); green plant bug (*Nezara viridula* (Linn.); blister beetle (*Mylabris pustulata* Thund.); and green semilooper (*Anomis flava* Fab.) (Meena and Kanwat, 2005) [6].
To minimize the losses caused by insect pests in okra crop, the weather conditions prevailing in a region play an important role in occurrence and subsequent build-up of pest population (Nagar *et al*., 2017) [7]. The role of biotic and abiotic factors for reducing the pest population is one of the methods of IPM (Lal *et al*., 2019) [4]. The predator insects like lady bird beetle, spider and aphid lion or green lace wing feeds on aphid and other soft bodied insects, which helps to control pests which feed on okra (Khating *et al*., 2016) [3]. Keeping this in view, the present studies were undertaken to the effect of abiotic factors on pests on okra.

Material and Methods

The field experiment was conducted at Entomological Research Farm, Department of Entomology, Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya (RVSKVV), College of Agriculture, Gwalior (Madhya Pradesh) in *Kharif*-2018 and 2019. Okra variety Arka Anamika was sown in an area of 9.0 x 9.0 m^2 with 60 x 60 cm row to row and plant to plant 45 x 45 cm spacing. All Agronomical practices were followed to raise a crop except the plant protection measures. Observations on incidence of insect pests were recorded at weekly interval from their appearance to last picking of fruits of the crop. The population of *viz*., red cotton bug, mealy bug and blister beetle were recorded on five plants selected randomly at weekly interval each observation in early morning hours by visually counting. The Pearson's correlation coefficient between weekly weather parameters and pests population were also calculated.

Results and Discussion

Seasonal incidence of insect pests on okra

Seasonal incidence of insect pests was observed with weather parameters *viz*., maximum and minimum temperature, morning and evening relative humidity, rainfall and evaporation. Data presented in Table 1.

Red cotton bug, *Dysdercus spp.*

The activity of red cotton bug was initiated from in the month of September till the crop maturity in both the years. Similar results were also obtained by earlier investigator Raghuwanshi *et al*. (2019) [9], who observed the infestation of red cotton in the month of September. The peak population of bug was recorded from fourth week of October 6.2 bugs/plant in 2018 and second week of October 2.0 bugs/plant in 2019 (Table 1). The weather parameters *i.e.* maximum and minimum temperature, morning and evening relative humidity and evaporation were 34.5 ºC, 14.9 ºC, 80.7%, 28.7% and 4.3 mm in the year 2018 and at maximum and minimum temperature, morning and evening relative humidity and evaporation were 33.2 ºC, 17.9 ºC, 82.2%, 40.7% and 5.2 mm, respectively in the year 2019.

Mealybug, *Phenacoccus solenopsis* (Tensley)

Observations recorded on mealy bug population revealed that it appeared on third week of August (34th SMW) and continued to during crop period in the both years. The peak population of mealy bug was recorded in the month of October 3.2 bugs/plant in 2018 and September 1.0 bugs/plant in 2019 (Table 1). While, Singh and Kumar (2012) and Makwana (2012) [5] observed that the infestation of mealy bug was started appearing in the month of August, which progressively increased on host plants cotton and okra. The maximum population was recorded in the month of October on the cotton and okra. The pest population was reached at maximum and minimum temperature, morning and evening relative humidity and evaporation were 35.4 ºC, 18.7 ºC, 81.6%, 38.6% and 5.3 mm, respectively in the year 2018 and at maximum and minimum temperature, morning and evening relative humidity, rainfall and evaporation were 30.2 ºC, 23.8 ºC, 94.1%, 77.1%, 123.8 mm and 3.1 mm, respectively in the year 2019.

Blister beetle (*Mylabris* sp.)

Incidence of blister beetle (*Mylabris, pustulata* and *Mylabris phalerata*) was recorded in the month of September and its damage began to decline as the crop approached last phase of growth in both years. These results are agreement with the findings of Badiyyala (2011) [2], who showed that *Mylabris* sp. was active on okra crop from last week of July to last week of September at Palampur, and active from first week of July to first week of September at Kachhiari, during the two seasons. The peak population of blister beetle was observed from first week of October 2018 (40th SMW) and fourth week of September 2019 (39th SMW) with 0.4 beetles/plant in both the years, during this period maximum and minimum temperature, morning and evening relative humidity and evaporation were 36.8 ºC, 21.1 ºC, 79.6%, 44.1% and 6.0 mm, respectively, in the year 2018 and at maximum and minimum temperature, morning and evening relative humidity, rainfall and evaporation were 29.0 ºC, 22.2 ºC, 91.7%, 80.0%, 89.8 mm and 1.1 mm, respectively, in the year 2019 (Table 1).

Correlation studies with incidence of insect pests on okra

Red cotton bug was noticed negative non-significant correlation with maximum temperature, minimum temperature, evening relative humidity and evaporation during both the years. While positive significant correlation was observed with morning relative humidity in 2018 and rainfall in 2019. Correlation studies revealed that the minimum temperature and evaporation were found to be significantly positive correlated (r= 0.34, 0.82 and r= 0.41, 0.79, respectively) with mealy bug. Whereas, negative non-significant correlation was observed (r= - 0.01, -0.30) with rainfall in both the years. The present findings are close that of Zia and Haseeb (2019) [11], who also observed that the mealybug population significantly positive correlation with minimum temperature, while, negative non-significant correlation with rainfall. Makwana (2012) [5] also observed that the non-significantly negative with rainy days (r= - 0.5693).

The blister beetle exhibited had positive significant correlation (r= 0.37, 0.72, r= 0.27, 0.21, r= 0.40, 0.78 and r= 0.42, 0.69, respectively) with minimum temperature, morning and evening relative humidity and evaporation in 2018 and 2019. Similarly, Badiyyala (2011) [2] reported the correlation of beetle population significantly and positive correlated with temperature.

Table 1: Seasonal incidence of insect pests on okra in *Kharif*- 2018 and 2019

SMW	No. of pests/plant								
	Red cotton bug			Mealy bug			Blister beetle		
	2018	2019	Mean	2018	2019	Mean	2018	2019	Mean
32	-	-	-	-	-	-	-	-	-
33	-	-	-	-	-	-	-	-	-
34	-	-	-	0.6	0.6	0.6	-	-	-
35	-	-	-	1.2	0.4	0.8	-	-	-
36	-	0.2	0.2	1.8	0.8	1.3	-	-	-
37	0.2	0.2	0.2	2.2	0.6	1.4	-	0.2	0.2
38	0.4	0.4	0.4	2.6	1.0	1.8	0.2	0.2	0.2
39	0.8	0.8	0.8	1.6	0.2	0.9	0.2	0.4	0.3
40	1.2	1.0	1.1	1.4	0.4	0.9	0.4	0.2	0.3
41	3.2	2.0	2.6	3.2	0.2	1.7	0.2	0.2	0.2
42	4.2	0.6	2.4	1.8	-	1.8	0.2	-	0.2
43	6.2	0.2	3.2	0.4	-	0.4	0.2	-	0.2
44	5.8	0.2	2.5	0.2	-	0.2	0.2	-	0.2
45	4.6	-	4.6	0.4	-	0.4	0.2	-	0.2
46	2.8	-	2.6	0.2	-	0.2	-	-	-
Correlation co-efficient value (r)									
Temperature (Max.)	NS	NS		0.34*	NS		0.25*	NS	
Temperature (Min.)	NS	NS		0.51*	0.82*		0.37*	0.72*	
R.H. (Morning %)	0.11*	NS		NS	0.49*		0.27*	0.21*	
R.H. (Evening %)	NS	NS		0.31*	0.74*		0.40*	0.78*	
Rainfall (mm)	NS	0.29*		NS	NS		NS	NS	
Evaporation (mm)	NS	NS		0.41*	0.79*		0.42*	0.69*	

SMW= Standard Meteorological Week
NS= Non Significant
*Significant at 5% Level

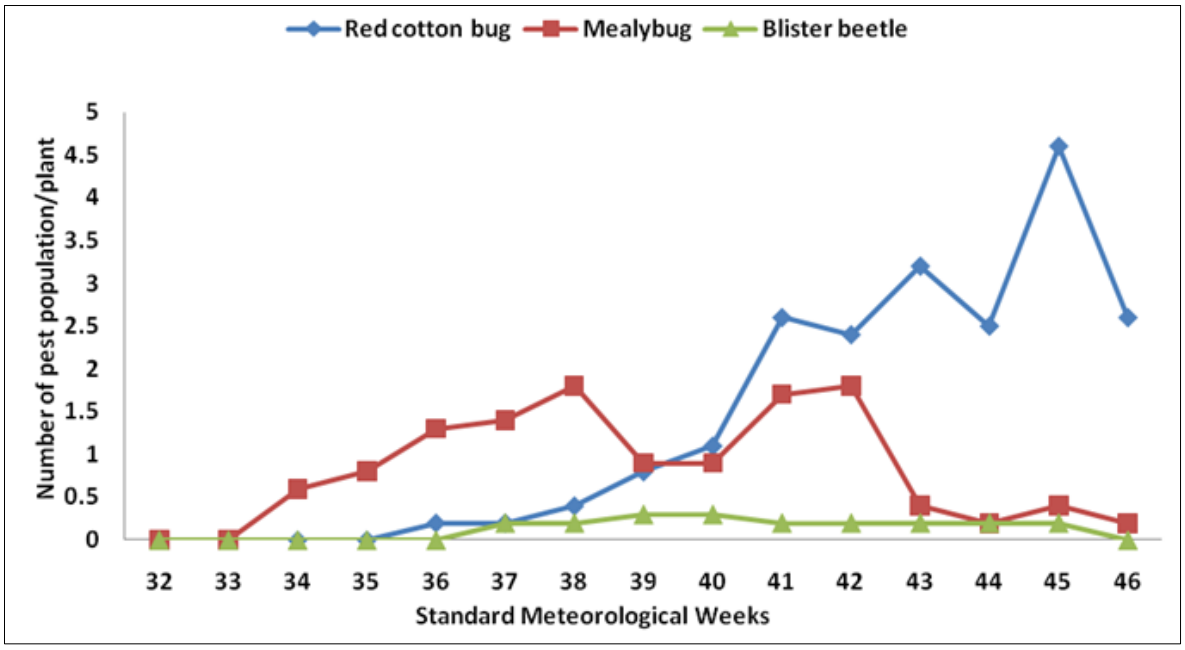

Fig 1: Incidence of insect pests on okra with standard meteorological weeks

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