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Effect of biotic and abiotic factors on the incidence of major sucking insect pests of mothbean, *Vigna aconitifolia* (Jacq.) Marechal

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Abstract
A field experiment was conducted at Agronomy Farm, S.K.N. College of Agriculture, Jobner (Rajasthan) during *Kharif*, season 2019 - 20. To study the effect of biotic and abiotic factors on the incidence of major sucking insect pests of mothbean, *Vigna aconitifolia* (Jacq.) Marechal during *Kharif*, 2019 and 2020. The infestation of major insect pests, leafhopper, *Empoasca motti* Pruthi and whitefly, *Bemisia tabaci* (Genn), commenced in the second week of August in 2019 and first week of August in 2020 (32nd standard meteorological week, SMW) and reached their peak in first week of September. The population of leafhopper (r=0.71) and whitefly (r= 0.71, 0.72) revealed significant positive correlation with relative humidity in 2019 and 2020. The correlation of leafhopper (r=-0.76) and whitefly (r=-0.78) with maximum temperature was significantly negative in the second year only. The ladybird beetle, *Coccinella septempunctata* L. had significantly positive correlated with leafhopper (r=0.77, 0.76), whitefly (r=0.75, 0.82) and thrips (r=0.90, 0.75) during both years. The green lacewing population showed positive significant correlation with leafhopper (r=0.75, 0.76), whitefly (r=0.72, 0.79) and thrips (r=0.94, 0.80) during both the years.

Keywords: Mothbean, leafhopper, whitefly, thrips

Introduction

Mothbean or dewbean, *Vigna aconitifolia* (Jacq.) Marechal (Family: Leguminosae, sub family Papilionaceae) is one of the most important *Kharif* pulse crops grown in the arid and semi-arid regions of the country, because of high drought tolerance capacity. It is considered to be originated from India and cultivated in China, India, Pakistan, Sri Lanka and United States of America. India occupied about 1.11 M hectares area with annual production of 0.31 metric tonnes and average productivity of 277 kg/ha (Anonymous, 2018) [2]. In India, its cultivation is mainly confined to the states of Maharashtra, Karnataka, Madhya Pradesh, Gujarat, Rajasthan and Uttar Pradesh (Anonymous, 2017) [1].

Mothbean is a source of food, fodder, feed, green manuring and used as pasture, hence serves as a multi-purpose crop. Mothbean is known for higher proportion of albumin and glutamin fractions of protein. The crop is damaged at various stages of plant growth by a number of insect pests, such as white grub, *Holotrichia consanguinea* Blanchard; Termite, *Odontotermes obesus* Rambur; jassid, *Empoasca motti* Pruthi; whitefly, *Bemisia tabaci* (Gennadius); galerucid beetle, *Madurasia obscurella* Jac; thrips, *Caliothrips indicus* Bagnall; stem fly, *Ophiomyia phaseoli* Tryon; red hairy caterpillar, *Amsacta moorei* Butler; flea beetle, *Phyllotreta cruciferae* Goeze and pod borer, *Catochrysops cnejus* Fabricius which have been reported to cause moderate to severe damage right from germination to maturity (Bindra and Singh, (1969) [1], Puttaswami *et al*. (1977) [17], Parihar, (1979) [14], Satyavir (1980) [19] and Pareek *et al.*, 1983) [15]. Among them leafhopper, whiteflies and thrips are major insect pests causing moderate to severe damage right from germination to maturity of the crop and bring considerable decrease in yield (Puttaswami *et al.*, 1977, Dhamaniya *et al*. (2005) [17, 8], Naga (2012) [12] and Batheaser *et al*. 2021). Leafhopper, whitefly and thrips are cosmopolitan in distribution and are found wherever mothbean is grown. The whiteflies apart from sucking the sap of plants also transmit yellow mosaic virus (YMV) which causes 30 – 70 per cent yield loss (Satyavir *et al*. 1984) [20]. The study on effect of biotic and abiotic factor on the incidence of major sucking insect pests is important due to variation in the climatic conditions and changing insect pest status. The knowledge of the influence of weather parameters on the incidence of major sucking insect pests on mothbean also helps to develop a forecasting system to implement timely protection measures.

Material and Method

In order to study the effect of biotic and abiotic factors on the incidence of major sucking insect pests of mothbean, five separate plots of 3.0 x 2.5 m^2 size keeping row to row and plant to plant distance of 30 x 10 cm, respectively were maintained. The variety RMO-257 was sown on 20^{th} July, 2019 and 16^{th} July, 2020, at Agronomy farm, Shri Karan Narendra College of Agriculture, Jobner, Rajasthan.

Methods of observation

The observations on population of leafhopper, whitefly and thrips was recorded soon after their appearance. All the observations was recorded early in the morning.

Leafhopper, *Empoasca motti* Pruthi

The population of leafhopper was recorded on each five randomly selected and tagged plants in each plot. Three leaves, *viz.*, one each from top, middle and lower canopy of the plants were taken into account for recording the leafhopper population. (Rawat and Sahu, 1973) [18].

Whitefly, *Bemisia tabaci* (Genn.)

The population of whitefly was recorded by counting the nymphs and adults on five randomly selected plants permanently tagged in each plot. Three leaves, *viz.*, one each from top, middle and lower canopy of the plants were taken into account to record the populations (Butter and Vir, 1990) [5].

Thrips, *Caliothrips indicus* Bagnall

The population of thrips was recorded on each five randomly selected and tagged plants in each plot. Three leaves, *viz.*, one each from top, middle and lower canopy of the plants were taken into account for recording the thrips population.

Natural enemies

The population of natural enemies of insect pests was recorded on five randomly selected and tagged plants in each plot.

Interpretation of data

To interpret the results of effect of biotic and abiotic factors on the incidence of major sucking insect pests of mothbean, *Vigna aconitifolia* (Jacq.) Marechal The simple correlation was computed between the mean population of leafhopper, whitefly, thrips and natural enemies with weather parameters, *viz.*, maximum and minimum temperature, average relative humidity and rainfall. The following formula was used for calculating correlation coefficient (Gupta, 1996).

$$r = \frac{N\,\Sigma xy - (\Sigma x)\,(\Sigma y)}{\sqrt{N\Sigma x^2 - (\Sigma x)^2 . N\,\Sigma y^2 - (\Sigma y)^2}}$$

Where
r = Simple correlation coefficient
x = Independent variables *i.e.* abiotic components
y = Dependent variables *i.e.* pests
N = Number of observations

Results and Discussion

The data presented in table 4.1 and 4.2 revealed that three insect pest species, *viz*., leafhopper, *Empoasca motti* Pruthi; whitefly, *Bemisia tabaci* (Genn.) and thrips, *Caliothrips indicus* Bagnall were recorded on three leaves. Two predatory species were recorded during the crop seasons, *Kharif*, 2019 and 2020, *viz*., *Coccinella septempunctata* L.; *Chrysoperla zastorwi arabica* (Henery *et al*.). The findings of the present study and the related discussion are explained hereunder.

Leafhopper, *Emposaca motti* Pruthi

The infestation of leafhopper *E. motti*, commenced in the second week of August (32^{nd} SMW) in *Kharif*, 2019 and first week of August (32^{nd} SMW) in *Kharif*, 2020 and remained active throughout the crop season, *i.e.* last week of september 2019 and 2020 respectively. The maximum leafhopper population (12.20 and 11.33 per three leaves during 2019 and 2020, respectively) was recorded at maximum temperature of 33.8 °C and 31.7 °C, minimum temperature of 22.9 °C and 21.3 °C, mean relative humidity of 83.0 per cent and 84.0 per and 6.6 mm and 24.4 mm rainfall in the 2019, 2020 respectively. The results of present study got full support from the findings of Yadav and Kumawat (2008) [27] who reported that the leafhopper population appeared in second week of August. Nitharwal and Kumawat (2009) [13], Jakhar and Chaudhary (2013) [9], Yadav and Singh (2013), Kumar *et al.* (2017), Suman *et al.* (2018) [24], Singh *et al*. (2019), Bhathesar *et al*. (2021), Choudhary *et al*. (2021) [6] and Dawar *et al*. (2022) [7] recorded population of leafhopper in first week of August and which peak in first week of September which support the present findings.

The maximum and minimum temperature had a non-significant correlation with leafhopper population in the first year. The maximum temperature had negative significant correlation (r=-0.76) in second year. The results of present study was in agreement with the findings of Yadav and Kumawat (2008) [27], Nitharwal and Kumawat (2009) [13], Jakhar and Chaudhary (2013) [9], Singh *et al*. (2019) and Choudhary *et al.* (2021) [6] who reported negative correlation with maximum temperature. The mean relative humidity had a significantly positive correlation (r= 0.71) during both years. The present results fully corroborated with the observations of Yadav and Kumawat (2008) [27], Nitharwal and Kumawat (2009) [13], Jakhar and Chaudhary (2013) [9] and Bhathesar *et al*. (2021) who reported significantly positive correlation with relative humidity. The minimum temperature and rainfall had a non-significant correlation with the population of leafhopper in *Kharif*, year 2019 and 2020. The result of present study got support from the observation of Nitharwal and Kumawat (2009) [13], Yadav and Singh (2013) [26], Yadav *et al.* (2015) [25], Singh *et al.* (2019), Bhathesar *et al*. (2021), Prajapati *et al*. (2020) [16] and Choudhary *et al.* (2021) [6] who reported non-significant correlation of leafhopper population with weather parameters.

Whitefly, *Bemisia tabaci* (Genn.)

The infestation of whitefly, *B. tabaci* commenced in the second week of August (32nd SMW) in 2019 and first week of August (32nd SMW) in 2020 and remained active throughout the crop season, *i.e.* last week of september during 2019 and 2020. The maximum whitefly population 11.67 and 12.00 during 2019 and 2020 respectively, was recorded at maximum temperature of 33.8 °C and 31.7 °C, minimum temperature of 22.9 °C and 21.3 °C, mean relative humidity of 83.0 per cent and 84.0 per and 6.6 mm and 24.4 mm rainfall in the 2019, 2020 respectively. The population of whitefly reached to low level in the last week of september during both the years. The result of present study got support from the observations of Yadav and Kumawat (2008) [27], reported infestation of whitefly started from 2nd week of August (32th SMW) with its peak population from month of September. Nitharwal and Kumawat (2009) [13], Jakhar and Chaudhary (2013) [9], Yadav and Singh (2013) [26], Suman *et al.* (2018) [24], Singh *et al.* (2019) and Bhathesar *et al.* (2021) recorded population of whitefly in first week of August and its peak of first week of September which support the present findings.

The whitefly population exhibited non-significant correlation with the maximum temperature in 2019, however, it revealed significantly negative correlation (r= -0.78) in 2020. The present results fully corroborated with the observations of Yadav and Kumawat (2008) [27], Nitharwal and Kumawat (2009) [13], Jakhar and Chaudhary (2013) [9] and Singh *et al*. (2019) who reported negative correlation with the maximum temperature. The relative humidity during both years of study was significantly positive correlated (r= 0.71, 0.72) with whitefly. The results of present study was in full agreement with the findings of Yadav and Kumawat (2008), Nitharwal and Kumawat (2009) [13] and Bhathesar *et al.* (2021).

The minimum temperature and rainfall had a non-significant correlation with the population of whitefly during both years which got full support from the observation of Nitharwal and Kumawat (2009) [13], Yadav *et al.* (2015) [25], Singh *et al.* (2019), Prajapati *et al*. (2020) [16], Bhathesar *et al*. (2021) and Chaudhary *et al.* (2021) [9].

Thrips, *Caliothrips indicus* Bagnall

The infestation of thrips, *C. indicus* commenced in the second week of August (32nd SMW) in 2019 and first week of August (32nd SMW) in 2020 and remained active throughout the crop season, *i.e.* last week of September during 2019 and 2020. The peak thrips population of 8.20 and 8.06 per three leaves were recorded during 2019 and 2020, respectively was recorded at maximum temperature of 36.3 °C, minimum temperature of 24.9 °C and 21.1 °C, mean relative humidity of 70.0 per cent and 67.0 per cent and 0.00 mm rainfall during 2019, 2020 respectively. The results of present study got partially support from the findings of corroborated with the observations of Sharma *et al.* (2019). Nitharwal and Kumawat (2009) [13], Suman *et al.* (2018) [24], Singh *et al.* (2019), Bhathesar *et al.* (2021) and Dawar *et al*. (2022) [7], who investigated that the thrips population were started to appear from first week of August and reached to its peak level in the month of September.

The correlation matrix indicated a non-significant correlation of thrips with maximum temperature, minimum temperature, relative humidity and rainfall during both years of study, *i.e.* 2019 and 2020. The present findings got fully support the observations of Nitharwal and Kumawat (2009) [13], Jakhar and Chaudhary, (2013) [9] and Bhathesar *et al.* (2021) who reported non-significant correlation of thrips population with maximum temperature, minimum temperature and rainfall.

Natural enemies

The observations on population of predatory species, *viz.*, ladybird beetle, *Coccinella septempunctata* L. and *Chrysoperla zastrowi arabica* (Henry *et al.*) have been found preying on insect pests of mothbean crop under field conditions during both the years.

Ladybird beetle, *Coccinella septempunctata* L.

The population of *C. septempunctata* commenced in the second week of August with a population of 2.00, 1.20 / five plants in 2019 and 2020, respectively. The population started to increase in the subsequent observations and reached to its peak in the first week of September with a count of 3.80/ five plants in 2019 and first week of September with a count of 4.20/ five plants in 2020. The maximum ladybird bettle population was recorded at 33.8 °C and 22.9 °C maximum and minimum temperature, respectively, 83 per cent mean relative humidity and 6.6 mm rainfall in the first year, *i.e.* 2019 and at 31.7 °C maximum and 21.3 °C minimum temperature and 84 per cent relative humidity and 24.4 mm rainfall during second year, *i.e.* 2020. The result of present study got fully support from the findings of Nitharwal and Kumawat (2009) [13], Ganus *et al*. (2014) and soratur *et al*. (2017) who reported the appearance of *C. septempunctata* in the second week of August and its peak in month of September.

The maximum, minimum temperature, mean relative humidity and rainfall showed non-significant correlation with coccinellid population during both year study 2019, 2020 which got support from the observation of Nitharwal and Kumawat (2009) [13] who reported non-significant correlation with maximum temperature, minimum temperature, mean relative humidity and rainfall. The coccinellid population had significantly positive correlation with leafhopper (r=0.77, 0.76), whitefly (r=0.75, 0.82) and thrips (r=0.90, 0.75), respectively during both year study. The result of present study got full support from the findings of Singh *et al*. (2019) and Choudhary *et al*. (2021) [6] who reported the population of sucking pest and *C. septempunctata* had a significant positive correlation.

Green lacewing, *Chrysoperla zastrowi arabica* (Henry *et al.*)

The population of green lacewing commenced in the second week of August with a populations of 2.50, 1.33 / five plants in 2019 and 2020, respectively. The present findings get fully support the observation of Nitharwal and Kumawat (2009) [13] who reported that the appearance of green lacewing in the second week of August and its peak in last week of September. The peak population of green lacewing (4.67 and 5.67/ five plant), maximum and minimum temperature, mean relative humidity and rainfall were 33.8 °C and 31.7 °C, 22.9 °C and 21.3 °C, 83 per cent and 84 per cent and 6.6 mm and 24.4 mm raifall prevailed, respectively. The maximum temperature, minimum temperature, mean relative humidity and rainfall showed non-significant correlation with green lacewing population. The present findings got full support from the observations reported by Nitharwal and Kumawat (2009) [13]. The green lacewing population showed positive significant correlation with leafhopper (r=0.75, 0.76), whitefly (r=0.72, 0.79) and thrips (r=0.94, 0.80), respectively, during both the years of study.

Table 4.1: Effect of biotic and abiotic factors on the incidence of major sucking insect pests of mothbean during *Kharif*, 2019

S. No.	Date of observation	SMW	Meteorological parameters				Mean leafhopper population/3 leaves	Mean whitefly population /3 leaves	Mean thrips population/3 leaves	Mean *Coccinella septempunctata*/ 5 plant	Mean *Chrysoperla zastrowi arabica*/ 5 plant
			Temperature (°C)		Relative humidity (%)	Rainfall (mm.)					
			Maximum	Minimum							
1.	8/8/2019	32	32.0	20.0	82	95.6	3.93	4.20	2.00	0.00	0.00
2.	15/8/2019	33	30.5	19.8	87	43.0	8.67	8.90	5.40	2.00	2.50
3.	22/8/2019	34	34.0	20.0	75	00.8	6.00	6.41	7.20	2.60	3.00
4.	29/8/2019	35	33.9	19.5	83	44.2	11.33	10.20	8.00	3.33	4.00
5.	5/9/2019	36	33.8	22.9	83	06.6	12.20	11.67	8.06	3.80	4.67
6.	12/9/2019	37	36.3	24.9	70	00.0	4.00	4.00	8.20	2.40	3.20
7.	19/9/2019	38	35.2	23.3	63	00.0	3.00	3.90	5.00	1.60	2.00
8.	26/9/2019	39	32.8	24.3	75	12.2	4.50	5.70	2.60	1.33	1.20
Correlation coefficient with mean maximum temperature (r)							NS	NS	NS	NS	NS
Correlation coefficient with mean minimum temperature (r)							NS	NS	NS	NS	NS
Correlation coefficient with mean relative humidity (r)							0.71*	0.71*	NS	NS	NS
Correlation coefficient with mean rainfall (r)							NS	NS	NS	NS	NS
Correlation coefficient with *Coccinella septempunctata* (r)							0.77*	0.75*	0.90*		
Correlation coefficient with *Chrysoperla zastrowi arabica* (r)							0.75*	0.72*	0.94*		

* Significant at 5% level
* *Significant at 1% level
NS- non significant

Table 4.2: Effect of biotic and abiotic factors on the incidence of major sucking insect pests of mothbean during *Kharif*, 2020

S. No.	Date of observation	SMW	Meteorological parameters				Mean leafhopper population/3 leaves	Mean whitefly population /3 leaves	Mean thrips population/3 leaves	Mean *Coccinella septempunctata*/ 5 plant	Mean *Chrysoperla zastrowi arabica*/ 5 plant
			Temperature (°C)		Relative humidity (%)	Rainfall (mm.)					
			Maximum	Minimum							
1.	06.08.2020	32	32.9	23.0	83	47.4	2.96	2.55	2.80	0.00	0.00
2.	13.08.2020	33	33.1	23.5	86	57.4	8.20	7.67	4.50	1.20	1.33
3.	20.08.2020	34	30.2	22.0	87	39.4	9.40	8.60	7.40	2.00	2.90
4.	27.08.2020	35	31.1	21.5	83	27.8	10.60	10.80	7.90	3.50	4.20
5.	03.09.2020	36	31.7	21.3	84	24.4	11.33	12.00	8.00	4.20	5.67
6.	10.09.2020	37	36.3	21.1	67	00.0	7.30	4.90	8.06	2.00	3.00
7.	17.09.2020	38	37.3	21.5	63	01.3	2.30	2.50	3.00	1.80	2.60
8.	24.09.2020	39	36.9	20.8	59	03.2	1.10	1.50	1.20	1.00	0.80
Correlation coefficient with mean maximum temperature (r)							-0.76*	-0.78*	NS	NS	NS
Correlation coefficient with mean minimum temperature (r)							NS	NS	NS	NS	NS
Correlation coefficient with mean relative humidity (r)							0.71*	0.72*	NS	NS	NS
Correlation coefficient with mean rainfall (r)							NS	NS	NS	NS	NS
Correlation coefficient with *Coccinella septempunctata* (r)							0.76*	0.82*	0.75*		
Correlation coefficient with *Chrysoperla zastrowi arabica* (r)							0.76*	0.79*	0.80*		

* Significant at 5% level
NS- non significant

Conclusion

The leafhopper, *E. motti*, whitefly, *B. tabaci* and thrips, *C. indicus* were the major sucking insect pests of mothbean. The peak population of leafhopper and whitefly were recorded in the first week of September, whereas, thrips were recorded in the second week of September during both years. The correlation coefficient worked out revealed that the relative humidity showed positive significant correlation with leafhopper and whitefly population on moth bean crop during both years while, maximum temperature negatively significant with leafhopper and whitefly during 2020. Two predatory species were recorded during the crop seasons, *C. septempunctata* and *C. zastorwi arabica* and positively correlated with leafhopper, whitefly and thrips.

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