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Seasonal incidence of insect pests and natural enemies of clusterbean associated with meteorological parameters

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Abstract
A field experiment conducted at Research Farm, Rajmata Vijyaraje Scindia Krishi Vishwa Vidyalaya, Gwalior, Madhya Pradesh during *kharif,* season 2019-20.To study the seasonal incidence of insect pests on clusterbean during kharif 2019, incidence of insect pests were observed on *kharif* clusterbean, namely flea beetle, *Phyllotetra vittula*, thrips, *Megleurothrips distalis* (karny), Jassid, *Empoasca kerri* (Pruthi) aphid, *Aphis craccivora* (Koch),whiteflies, *Acaudaleyrodes rachipora* (Singh) and mite, *Polyphgotarsonemus latus* (Banks). Peak population of Jassid, whitefly and mite were observed during 37th SMW (1st week of September) (5.66, 5.67 and 3.68 individuals/plant, respectively); while peak population of thrips were observed during 38th SMW (2nd week of September) (4.75 individuals/plant respectively), aphid peak population was observed 36th SMW (5th week of August) (4.61 leaves/plant) and flea beetle were observed during 39th SMW (3 rd week of September) (5.20%). Population of thrips, Jassid, and flea beetle showed strong positive significant correlation with rainfall (r= 0.701**), (r= 0.519*), and (0.583*) respectively. Population of jassid and showed highly significant positive correlation with maximum temperature, morning & evening RH (r= 0.795**), (r= 0.802**) and (r= 0.803**) respectively. Population of jassid showed significant negative correlation with minimum temperature (r= -0.643**). Aphid population morning and evening RH showed positive and significant value of correlation coefficient (0.531*), (0.550*). Whitefly population evening RH and rainfall was found only significant (0.596*), (0.636*).population of flea beetle morning RH and rainfall (0.867**), (0.583*) significant to highly significant while strong negative correlated (-0.710**).

Keywords: cluster bean, pest incidence, sucking pest, *phyllotetra vittula* and *Polyphgotarsonemus latus*

1. Introduction

Cluster bean [*Cyamopsis tetragonoloba* (Linn.) Taub.], commonly known as guar, has come to be recognized as one of the most important commercial crop of arid and semi-arid region. The crop is mainly grown during rainy season, but it can also be grown successfully during summer season under irrigated condition. India is one of the main producers of clusterbean accounting 82% of the total production of the world, Cluster bean is being grown in the area of 4.26 million hectares with production of 2.42 million tonnes of cluster bean seed and average productivity of 567 kg/ha. in Madhya Pradesh. The various pests attacking the crop, sucking pest viz., leafhopper, *Empoasca kerri* (Pruthi), whitefly, *Acaudaleyrodes rachipora* (Singh), thrips, *Megaleurothrips distalis* (Karny), black weevil, *Cyrtozemia dispar* (Pascoe) and termite, *Odontotermus obesus* (Rambur) and three natural enemies viz., *Chrysoperla*, spider and ladybird beetle were recorded on cluster bean crop (Pawar *et al.,* 2017) [11]. Clusterbean is attacked by different insect pests at various growth stages of the crop and cumulatively it causes heavy losses in yield. Pandey *et al.,* (1991) [10] reported 73.86 per cent yield loss due to its pest complex. The yield infestation relationship of Indian bean revealed that every unit increase in aphid population resulted in a yield loss of 3.54-4.68 kg/ha (Sharma *et al.,* 2000) [13]. The thrips was one of main mungbean pests in dry season and significantly reduce the yield of 65 per cent, when severe incidence of this pest was observed (Indiati, 2004) [2].

2. Material and Methods

The field preparation was done by standard package and practices; fertilizer dose was given before sowing the crop as recommended dose. Experimental plots were kept free from insecticidal spray throughout the crop season.

The population of sucking pests was recorded by counting on three leaves (top, middle and bottom of plant) on ten randomly selected plants. Number of flea beetle and mite were counted separately from three leaves one each from top, middle and bottom region per plant at weekly interval. The observation on the incidence of pest and natural enemies was recorded from germination till maturity of the crop at weekly interval on 10 randomly selected plants during morning hours. The data on meteorological parameters were utilized to work out simple correlation coefficient. Weekly data on meteorological parameter viz., maximum and minimum temperature, relative humidity, rainfall and evaporation was collected from the meteorological observatory of the college of Agriculture, Gwalior.

Table 1: Weather data *Kharif,* 2019-20.

WAS	SMW	Months and weeks	Temperature		Humidity (%)		Rainfall (mm)	Evaporation (mm)
			Maximum	Minimum	Morning	Evening		
2nd	31	July	33.2	25.9	91.3	64.3	9.2	4.8
3rd	32	August I	32.9	24.9	89.1	66.1	22.4	3.8
4th	33	August II	31.1	24.1	91.1	84.0	69.8	2.8
5th	34	August III	32.3	24.4	89.9	72.1	117	3.6
6th	35	August IV	33.5	25.2	90.1	67.7	20.8	3.5
7th	36	September I	33.4	25.1	90.9	67.6	67.4	3.6
8th	37	Sept. II	32.8	24.8	94.9	78.3	37	3.0
9th	38	Sept. III	30.2	23.0	94.1	77.1	123.8	3.1
10th	39	Sept. IV	29.0	22.2	95.1	80.0	89.8	1.1
11th	40	October I	31.64	21.5	90.8	66.0	31.4	3.4
12th	41	October II	33.2	17.98	80.2	40.4	0	5.2
13th	42	October III	32.6	17.5	90.5	44.4	0	5.0
14th	43	October IV	31.44	14.1	89.4	31.7	0	4.0
15th	44	October V	32.0	16.4	89.0	42.3	0	4.0

3. Result and Discussion
In the pests complex of important insect pests of clusterbean five pests *viz.* flea beetle, *Phyllotreta vittula*, thrips, *Megleurothrips ditalis* (Karny), jassid, *Empoasca kerri* (Pruthi), aphid, *Aphis craccivora* (Koch), whiteflies, *Acaudaleyrodes rachipora* (Singh) and mite, *Polyphgotarsonemus latus* (Banks) and two natural enemies *viz.*, spider and ladybird beetle were recorded on clusterbean crop.

3.1. Thrips, *Megleurothrips ditalis* (Karny)
The incidence of thrips started from 3rd weeks after sowing (WAS) i.e. 1st week of August (32nd SMW) with (0.85 thrips/flower) and reached to a peak level (4.75 thrips/flower) during 9th WAS i.e. 2nd week of September (38th SMW); Thereafter, its population gradually declined from 10th WAS i.e. 3rd week of September (39th SMW) and finally disappeared 14th WAS i.e. 3rd week of October (43rd SMW) (Table 1) when maximum and minimum temperature 30.2 ℃ and 23.0 ℃, morning and evening humidity 94.1% and 77.1%, rainfall 123.8 mm and evaporation 3.1 mm, respectively.

Among meteorological parameters, the value of simple correlation coefficient of meteorological parameters with different pest populations were estimated and presented in table 2 among meteorological parameter only weekly rainfall. Showed strong positive and significant association with thrips population but rest of the meteorological parameters like maximum, minimum temperature and RH did not show any association with thrips population.

3.2. Jassid, *Empoasca kerri* (Pruthi)
The population of jassid (2.97 jassid/leaf) commenced on 3rd WAS coinciding with 1st week of August (32nd SMW) and increased gradually up to 8th WAS. Thereafter, its population gradually declined from 2nd week of September coinciding with 1st week of September (37th SMW) and attained the peak level (5.66/leaf) in the very next week (Table 2) when maximum and minimum temperature 32.8 ℃ and 24.8 ℃, morning and evening relative humidity 94.9% and 78.3%, rainfall 37 mm and evaporation 2.97 mm, respectively.

Estimate of the coefficient of correlation values indicates that maximum temp., morning and evening RH, and rainfall had significant to highly significant correlation with Jassid population, while mini. temperature. Showed highly significant negative association with Jassid population (Table 2). The population of jassid (2.97 jassid/leaf) commenced on 3rd WAS coinciding with 1st week of August (32nd SMW) and increased gradually up to 8th WAS. Thereafter, its population gradually declined from 2nd week of September coinciding with 1st week of September (37th SMW) and attained the peak level (5.66/leaf) in the very next week (fig. 1).

Similar to the present finding Jakhar *et al.,* (2017) [3] and Mohapatra *et al.,* (2018) [8] reported peak population of jassid reached in the month of September.

Similar, Manju *et al.,* (2016) [6] reported the infestation of jassid started from month of August and reached their peak in the month of September (37th SMW).

Estimate of the coefficient of correlation values indicates that maximum temp., morning and evening RH, and rainfall had significant to highly significant correlation with Jassid population, while mini. temperature. Showed highly significant negative association with jassid population.

Similar to the present finding Marabi *et al.,* (2017) [7]; Sujata and Bharpoda, (2017) [14] and Kumar *et al.,* (2017) [5] reported significant positive correlation of whitefly population with maximum temperature.

3.3. Aphid, *Aphis craccivora* (Koch)
The aphid appeared (1.45 aphid/leaf) on cluster bean crop during 4th WAS coinciding with 2nd week of August (33th SMW) and its activity continued till 11th WAS coinciding with last week of September (40th SMW). The population of aphid reached the peak level (4.61 aphid/leaf) during 7th WAS i.e. last week of August (36th SMW) (Table 3) when maximum and minimum temperature 33.4 ℃ and 25.1 ℃, morning and evening relative humidity 90.9% and 67.6%, rainfall 67.4 mm and evaporation 3.6 mm, respectively.

The results presented in Table 3 Aphid population positively and significantly influenced by morning and evening RH as indicated by positive and significant value of correlation coefficient of these two meteorological parameters with aphid population. However, maximum minimum temperature and rainfall showed positive and negative association with aphid population but not statistically significant. The aphid appeared (1.45 aphid/leaf) on cluster bean crop during 4th WAS coinciding with 2nd week of August (33rd SMW) and its activity continued till 11th WAS coinciding with last week of September (40th SMW). The population of aphid reached the peak level (4.61aphid/leaf) during 7th WAS i.e. last week of August (36th SMW) (fig. 1).

Similar to the present finding Bairwa and Singh, (2017) [1] and Jat *et al.,* (2017) [4] reported aphid population attained its peak population on 2nd in the month of September (37th) SMW.

Aphid population positively and significantly influenced by morning and evening RH as indicated by positive and significant value of correlation coefficient of these two meteorological parameters with aphid population. However, maximum minimum temperature and rainfall showed positive and negative association with aphid population but not statistically significant.

3.4. Whitefly, *Acaudaleyrodes rachipora* (Singh)
The population of whiteflies (2.99 whiteflies/leaf) commenced on 3rd WAS coinciding with 1st week of August (32nd SMW) and increased gradually up to 8th WAS coinciding with 1st week of September (37th SMW) and reach the peak level (5.67 Whiteflies/leaf) in the very next week (Table 4) when maximum 32.8 ºC and minimum temperature 24.8 ºC, morning 94.9% and evening relative humidity 78.3%, rainfall 37 mm and evaporation 2.97 mm, respectively.

All the meteorological parameter exhibited positive correlation with whitefly but that correlation of evening relative humidity and rainfall with whitefly population found only significant. The population of whiteflies (2.99 whiteflies/leaf) commenced on 3rd WAS coinciding with 1st week of August (32nd SMW) and increased gradually up to 8th WAS coinciding with 1st week of September (37th SMW) and reach the peak level (5.67 whiteflies/leaf) in the very next week (fig. 1).

Similar to the present finding Pai and Dhuri, (1991) [9] noticed that the pest appeared after first week of germination and continued throughout the crop growth period with a peak activity during the last week of October under Maharashtra conditions.

Similar to the present finding Sardana and Verma, (1986) [12] reported that *A. rachipora* was active during vegetative stage of cowpea in *Kharif* season. Manju *et al.,* (2016) [6] reported infestation of whitefly started from 2nd week of august (32th SMW) with its peak population from month of September. The variation in the time of peak population may be due to the climatic conditions of the region, stage of the crop and time of sowing. Mohapatra *et al.,* (2018) [8] also reported that whitefly attained its peak population in the month of September.

All the meteorological parameter exhibited positive correlation with whitefly but that correlation of evening relative humidity and rainfall with whitefly population found only significant. The contradiction in the results might be due to difference in environmental conditions of the locations.

3.5. Mite, *Polyphgotarsonemus latus* (Banks)
The population of mite were recorded during the *Kharif* season indicated that the pest appeared (1.90 mite/leaf) on cluster bean crop for the first time during 6th WAS coinciding with 4th week of August (35th SMW) and its activity was continued till 12th WAS coinciding with 1st week of September (37th SMW) with its peak (3.68 mite/leaf) during (8th WAS) was noted (Table 4) when maximum 32.8 ºC and minimum temperature 24.8 ºC, morning 94.9% and evening relative humidity 78.3%, rainfall 37 mm and evaporation 2.97 mm.

None of the meteorological parameters were found correlated with mite population (Table 4). The population of mite were recorded during the *kharif* season indicated that the pest appeared (1.90 mite/leaf) on cluster bean crop for the first time during 6th WAS coinciding with 4th week of August (35th SMW) and its activity was continued till 12th WAS coinciding with 1st week of September (37th SMW) with its peak (3.68 mite/leaf) during (8th WAS) was noted (fig. 1).

3.6. Flea beetle, *Phyllotreta vittula*
The incidence of flea beetle (Table 4) commenced in 8th WAS coinciding with 1st week of September (37th SMW) during *Kharif,* 2019 with 1.90% leaf infestation due to this pest. The infestation gradually increased and reached to the peak level (5.20%) during 10th WAS i.e. 3rd week of September (39th SMW) when maximum 29.0 ºC and minimum temperature 22.2 ºC, morning 95.7% and evening relative humidity 80%, rainfall 89.8 mm and evaporation 1.08 mm.

Morning RH and rainfall exhibited positive and significant to highly significant correlation with flea beetle population while minimum temperature had strongly negative correlation with flea beetle. The incidence of flea beetle commenced in 8thWAS coinciding with 1st week of September (37th SMW) during *Kharif,* 2019 with 1.90% leaf infestation due to this pest. The infestation gradually increased and reached to the peak level (5.20%) during 10th WAS i.e. 3rd week of September (39th SMW) (fig. 1).

3.6.1. Natural enemies of pests on cluster bean
3.6.1.1. Spider
The results (Table 4) clearly indicated that the higher population of spider was noted during 8th WAS coinciding from 1st week of September (37th SMW) to 14th WAS coinciding from 3rd week of October (43th SMW). Thereafter, spider population started decreasing and completely disappeared from 15th WAS i.e. 4th week of October (44th SMW). when maximum and minimum temperature 31.44 ºC and 14.1 ºC, morning and evening relative humidity 89.4% and 42.28%, rainfall 31.4 mm and evaporation 4.0 mm, respectively.

3.6.1.2. Ladybird beetle
The ladybird beetle population commenced from 6th WAS i.e. 4th week of August (35th SMW) on cluster bean crop (1.10 beetle/plant) and reached to the peak level (2.08 beetle/plant) in next week i.e. 7th WAS coinciding with last week of August (36th SMW). Subsequently, its population declined and completely disappeared from 11th WAS i.e. last week of September (40th SMW). When maximum 33.4 ºC and minimum temperature 25.1 ºC, morning 90.9% and evening relative humidity 67.6%, rainfall 67.4 mm and evaporation 3.6 mm.

3.6.2. Correlation coefficient between important insect pests and natural enemies

The results presented in Table 4 revealed that spider significant positive correlation with thrips (r = 0.75**), jassid (r= 0.86**), aphid (r= 0.76**) and white flies (0.86**). Spider population had highly significant positive, whereas ladybird beetle showed significantly positive correlation with thrips (r= 0.79**), jassid (r= 0.71**), aphid (r= 0.87**) and whiteflies (0.71**). It is cleared from the data that as the population of insect pests was increased in the cluster bean, their natural enemies responded numerically and higher population of spider and ladybird beetle was observed in the field providing natural control of the respective insect pests.
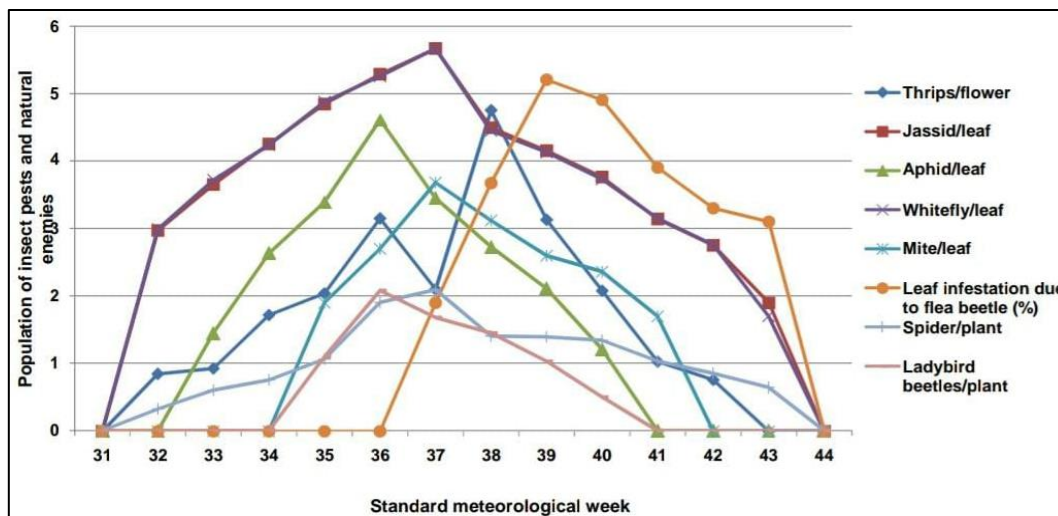

Fig 1: Incidence of insect pests and natural enemies population on clusterbean with meteorological weeks

Table 2: Periodic insect pests and natural enemies population on cluster bean during *Kharif*, 2019-20.

WAS	SMW	Months and Weeks	Population of Sucking Insect Pests/leaf					Leaf infestation due to flea beetle (%)	Natural enemies/plant	
			Thrips	Jassid	Aphid	Whitefly	Mite		Spider	Ladybird beetles
2	31	July IV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	32	August I	0.85	2.97	0.00	2.99	0.00	0.00	0.32	0.00
4	33	August II	0.93	3.65	1.45	3.72	0.00	0.00	0.60	0.00
5	34	August III	1.72	4.25	2.63	4.24	0.00	0.00	0.75	0.00
6	35	August IV	2.04	4.84	3.39	4.88	1.90	0.00	1.06	1.10
7	36	August V	3.15	5.28	4.61	5.26	2.70	0.00	1.90	2.08
8	37	September I	2.10	5.66	3.45	5.67	3.68	1.90	2.09	1.68
9	38	September II	4.75	4.49	2.73	4.45	3.12	3.67	1.40	1.45
10	39	September III	3.13	4.15	2.11	4.13	2.60	5.20	1.39	1.03
11	40	September IV	2.08	3.76	1.21	3.73	2.36	4.90	1.34	0.50
12	41	October I	1.03	3.14	0.00	3.15	1.70	3.90	1.03	0
13	42	October II	0.76	2.75	0.00	2.76	0.00	3.30	0.85	0
14	43	October III	0.00	1.90	0.00	1.70	0.00	3.10	0.64	0
15	44	October IV	0.00	0.00	0.00	0.00	0.00	0.00	0	0

WAS= Week after sowing, SMW= Standard Meteorological week

Table 3: Correlation between pest population and weather parameters during *Kharif*, 2019-20.

Sr. No.	Pests	Temperature (⁰C)		Relative Humidity %		Rainfall (mm)
		Maximum	Minimum	Morning	Evening	
1.	Thrips	-0.109	0.171	-0.001	0.063	0.701**
2.	Jassid	0.795**	-0.643**	0.802**	0.803**	0.519*
3.	Aphid	0.497	-0.379	0.531*	0.550*	0.471
4.	White fly	0.028	0.483	0.086	0.596*	0.636*
5.	Mite	-0.391	0.445	-0.280	-0.201	0.336
6.	Flea beetle	-0.280	-0.710**	0.867**	0.448	0.583*

* = significant, **= highly significant

Table 4: Correlation between pest population and natural enemies in *Kharif*, 2019-20.

Sr. No.	Pests	Natural Enemies	
		Spider	Ladybird Beetle
1.	Thrips	0.752**	0.797**
2.	Jassid	0.867**	0.718**
3.	Aphid	0.764**	0.871**
4.	White fly	0.861**	0.714**

4. Conclusion

This paper concludes the insect pests infesting cluster bean observed were thrips, jassid, aphid and whitefly. Studies on seasonal incidence of insect pests on *kharif* cluster bean indicated the onset of incidence of thrips and jassid in 10 days old crop (32th SMW) and population prevailed till crop maturity. Peak population of thrips and jassid were observed during month of September while peak population of aphid

was observed during 36th SMW. The morning and evening relative humidity had positive significant correlation with aphid and whitefly.

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