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Insect-pests succession of spine gourd (*Momordica dioica* Roxb.) in northern hill region of Chhattisgarh

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Abstract
Among the Spine gourd cucurbit fruit fly, hadda beetle and leaf eating caterpillar population first commenced from first week of August and leaf miner was observed in second week of August, while red pumpkin beetle was noticed in third week of August. The population of cucurbit fruit fly and hadda beetle increased gradually afterwards to reached peak population of 3.0 adult/plant and 6.0 grubs/adult/plant in the second week of September, respectively. The peak occurrence of leaf eating caterpillar of 2.0 larva/plant was observed in third week of September. The population of leaf miner and red pumpkin beetle were observed 2.0 maggots/plant and 2.0 adult/plant in third week of September, respectively. The activity of bihar hairy caterpillar was observed short period during first to third week of October and highest (1.3 larva/plant) in second week of October. Weather parameters were found to be responsible for certain changes in the activities of insect-pests viz., cucurbit fruit fly, hadda beetle, leaf miner, red pumpkin beetle, leaf eating caterpillar and Bihar hairy caterpillar in spine gourd. The correlation was found positive and non-significant at various parameters such as temperature (maximum and minimum) and morning RH. While, in the case of Bihar hairy caterpillar, correlation was found negative and non-significant at minimum temperature. Similarly, the correlation was found negative and non-significant at both factors, RH (evening) and rainfall.

Keywords: Insect-pests, succession, spine gourd, Chhattisgarh

Introduction
Spine gourd (*Momordica dioica* Roxb.) is one of the most important potential cucurbitaceous vegetable crops**.** It is originated from Indo-Malayan region and distributed in India, Bangladesh, Srilanka, Myanmar, China, Japan, South East Asia, Polynesia, Tropical Africa, and South America. In India, it is grown commercially in the states of Chhattisgarh, Uttar Pradesh, Orissa, Jharkhand and Maharashtra. It has high food and medicinal value, cultivated for its fruits, which is used as vegetable and is known by various names such as kheksha (in Chhattisgarhi), kakoda, kankoda, kantola, kakrol, kartoli, kantoli, kankad, meetha karela, wild bitter gourd, padora, teasel gourd/spine gourd (English),etc. in different localities. An average yields of 40-50 q/ha can be obtained with good crop practices. In early domestication stage, spine gourd is generally cultivated in kitchen garden and small farmer field but as we know the economic importance area of this crop day by day as area are increasing, pest succession also increasing. Now a days spine gourd has been subjected to damage by various insect pest *viz.*, green stink bug, skin feeder, fruit borer epilachna beetle, red pumpkin beetle, leaf miner and fruit fly etc. that cause varying degrees of damage, that limiting the production and productivity of the crop reported by Shaw *et al.* 1998 [19], Deshmukh *et al.* 2012 [5] and Sandilya *et al.* 2018 [18]. Among them, fruit fly (Palada and Chang, 2003) [12].

Materials and Methods
A field experiment was conducted in Research-cum-Instructional Farm of RMD College of Agriculture and Research Station, Ambikapur (C.G.) during *kharif*, 2017-18. The succession of major insect-pests in spine gourd were recorded at seven days intervals after appearance of the pest infestation during the whole period of crop growing season from five plants in each three blocks. From each 5 plant nine leaves were considered *i.e.* three each from upper, middle and lower part of each selected plants for taking observations on hadda/epilachna beetle, red pumpkin beetle, leaf miner, cucurbit fruit fly and leaf eating caterpillar by adopting the techniques given by Singh and Kovadia (1989) [20].

Results and Discussion

The current finding revealed that the seasonal occurrence of various insect pests *viz*. cucurbit fruit fly (*Bactrocera cucurbitae* Coq.), hadda beetle (*Epilachna vigintioctopunctata* Fabricius), leaf miner (*Liriomyza trifolli* Burgess), red pumpkin beetle (*Aulacophora foveicollis* Lucas), bihar hairy caterpillar (*Spilosoma obliqua* Walker) and leaf eating caterpillar (*Diaphania indica* Saunders) were observed as major in spine gourd crop during *kharif* 2017-18 (Table 1).

Cucurbit fruit fly *Bactrocera cucurbitae* (Coquillett)

Cucurbit fruit fly was a regular pest of spine gourd crop. Its population first appeared in first week of August (31th Standard Meteorological Week) and remained in the field till third week of October (42th SMW). The average 0.2 to 3.0 adult/plant population was observed on the crop during course of investigation. The maximum population of cucurbit fruit fly was recorded with 3.0 adult/plant during second week of September (37th SMW), whereas the maximum and minimum temperature was recorded at 31.1 ^{0}C and 23.0 ^{0}C, rainfall 8.4 mm, and morning and evening relative humidity was 95% and 74%, respectively. However, after attaining peak, the population reduced and minimum level of none adult/per plant was recorded in last week of October (43th SMW).

The present finding was in accordance with Banerji *et al.* (2005) [1] who recorded the activity of melon fruit fly during first week of August, however the highest incidence was noticed during middle of October and then infestation started declining at Kalyani, West Bengal during *Kharif*.

Similarly, the present findings supported by the reports of Chaudhary and Patel (2012) [4] who studied incidences of melon fruit fly on cucurbits and found the population of melon fly fluctuated throughout the year with two peak population during July-September and February- March.

Hadda beetle *Epilachna vigintioctopunctata* (Fabricius)

In earlier, hadda beetle was reported as sporadic pest in different crops, but also noticed regular pest in spine gourd. It first occurrence with 0.4 grub/adult/plant was recorded from first week of August (31th SMW) and to continue till third week of October (42th SMW). Thereafter first occurrence, slowly increased in population and reached at peak with 6.0 grub/adult/plant populations in second week of September (37thSMW), whereas the maximum and minimum temperature was recorded at 31.1 ^{0}C and 23.0 ^{0}C, rainfall 8.4 mm, and morning and evening relative humidity was 95% and 74%, respectively. However, after attaining peak, the beetle population started declining and reached minimum level of 0.0 beetle/plant was recorded by the last week of October (43th SMW).

Epilachna vigintioctopunctata is a pest of spine gourd (*Momordica dioica*) reported by Desmukh *et al.* (2012) [5], but there is no found any report to the seasonal activity of the pest in spine gourd. Our current finding is supported by Iftekar and Khan (1980) [9] who reported epilachna beetle remained active from July to November on brinjal and was more prevalent during the month of August.

Singh and Kovadia (1989) [20] also observed maximum infestation of epilachna beetle during August to October on July planted brinjal crop. Also observed the incidence of epilachna beetle in brinjal from third week of August to middle of October with its maximum (0.22 beetle/leaf) population in the middle of September Mall *et al.* (1992) [11].

Leaf miner *Liriomyza trifolli* (Burgess)

The first appearance of leaf miner incidence was recorded at weekly interval during 2017-18 indicated that the infestation of leaf miner *Liriomyza trifoli* started from second week of August (32th SMW) and to continued till last week of October (43th SMW) with 0.2 to 2.0 maggot/plant. During the experiment peak occurrence of pest was noticed in third week of September (38th SMW) with 2.0 maggot/plant, which was associated with the maximum and minimum temperature was recorded at 29.4 ^{0}C and 22.6 ^{0}C, rainfall 94.4 mm, and morning and evening relative humidity was 96% and 63%, respectively. However, after attaining peak, the beetle population started declining and reached minimum level of 0.2 maggot/plant was recorded by the last week of October (43th SMW).

There is no report found to the seasonal activity of leaf miner on spine gourd. Rauf and Shepard (1999) [17] reported that *Liriomyza* is one of the most important pests on cucumber in Fukuoka Japan. Our finding is supported by Tran *et al.* (2005) [21] who revealed that the infestation of leaf miner occurrence found in the field during the rainy season with low densities and became more serious in the dry season. Similarly, Dubale *et al*. (2018) [7] found the highest infestation of leaf miner was in ridge gourd.

Red pumpkin beetle, *Aulacophora foveicollis* (Lucas)

Occurrence of red pumpkin beetle population recorded from third week of August (33th SMW), to continue till second week of October (41th SMW) ranged with 0.2 to 2.0 adult/plant. During the experiment peak occurrence of pest was noticed in third week of September (38th SMW) with 2.0 adult/plant, which was associated with the maximum and minimum temperature at 29.4 ^{0}C and 22.6 ^{0}C, rainfall 94.4 mm, and morning and evening relative humidity 96% and 63%, respectively. However, after attaining peak, the beetle population started declining and reached none of the adult/plant was recorded by the last week of October (43th SMW).

These results are similar to finding of the Bisen (2015) [2] who reported that the maximum activity of red pumpkin beetle noticed on ash gourd in fourth week of September. Borah (1999) [3] also supported the seasonality of red pumpkin beetle on cucumber, and reported highest number of beetles in rainy season fallowed by summer crop and winter season crop. While Rajak (2000) [15] reported the maximum activity was observed in winter season in the month of February.

Bihar hairy caterpillar, *Spilosoma obliqua* (Walker)

The seasonal activity of bihar hairy caterpillar population recorded at weekly interval indicated that the activity started with 0.6 larvae/plant in first week of October (40th SMW), whereas, peak activity of 1.3 larvae/plant was noticed during second week of October. Thereafter, there was an abrupt decline in the pest population (0.4 larva/plant) and the insect disappeared from the crop after the third week of October.

There is no report found to the seasonal activity of bihar hairy caterpillar on spine gourd. These results are similar to finding of Patel (2015) [13] who reported that seasonal abundance of bihar hairy caterpillar on caster was active from fourth week of September to third week of November, whereas the maximum activity was noticed during second week of October to third week of November.

Leaf eating caterpillar *Diaphania indica* (Saunders)

Leaf eating caterpillar is also known as cucumber moth. The first appearance of leaf eating caterpillar population on the crop noticed that from first week of August (31th SMW) and continue till second week of October (41th SMW) in the ranges of 0.1 to 0.2 larvae/plant. Leaf eating caterpillar population reached to its peak 2.0 larvae/plant in third week of September (38th SMW), whereas the maximum and minimum temperature was recorded at 29.4 ^{0}C and 22.6 ^{0}C, rainfall 94.4 mm, and morning and evening relative humidity was 96% and 63%, respectively. There after population noticed in decreasing trend and showed minimum of 0.8 larvae/plant in the second week of October (41th SMW). The population of leaf eating caterpillar disappeared in third week of October from the crop.

Present finding is in agreement with the finding of Bisen (2015) [2] who found that the most favorable for population buildup of *Diaphania indica* was the last week of October. Similar finding are also found by Kinjao and Arakaki (2002) [10] who found that the development of *D. indica* slowed down at high temperature, and the development time at 35 ^{0}C was significantly greater than 30 ^{0}C.

The correlation of insect pests of spine gourd with weather parameters

Seasonal activity of insect pest was recorded on spine gourd under vegetative to harvesting stage of crops. The data on seasonality of insect pests were correlated with prevailing temperature, relative humidity, and rainfall under Table 2 and 3.

The fruit fly population exhibit positive correlation with maximum temperature (r = 0.361), minimum temperature (r = 0.421) and morning RH (r = 0.284), while negative relationship with rainfall (r = -0.163) and evening RH (r = -0.023). But all the correlation was non-significantly.

The population of hadda beetle showed positive non-significant correlation with maximum temperature (r = 0.471), minimum temperature (r = 0.438), morning RH (r = 0.223) whereas, rainfall (r = -0.229) and evening RH (r = - 0.076) exhibited non-significantly negative correlation.

Simple correlation worked out between leaf miner and weather parameter on spine gourd crop. The result revealed that there was positive non-significant correlation with maximum temperature (r = 0.440) minimum temperature (r = 0.408), morning RH (r = 0.380), while non-significant negative correlation with evening RH and rainfall, (r = -0.266) and (r = -0.262), respectively.

The maximum temperature (r = 0.367), minimum temperature (r = 0.352) and morning RH (r = 0.216) were positively and non-significantly correlated with red pumpkin beetle population, while rainfall (r = -0.183) and evening RH (r = -0.146) were non-significantly and negatively and correlated.

The correlation between bihar hairy caterpillar and weather parameter are presented. The weather parameters, maximum temperature (r = 0.232) and morning RH (r = -0.163) were positively non-significantly correlated with red hairy caterpillar population. But, minimum temperature (r = -0.259, rainfall (r = -0.295) and evening RH (r = -0.439) were negatively and non-significantly correlated with bihar hairy caterpillar population**.**

The weather parameters, maximum temperature (r = 0.367), minimum temperature (r = 0.388) and morning RH (r = 0.293) were positively and non-significantly correlated with leaf eating caterpillar population. Whereas, rainfall (r = -0.226) and evening RH (r = -0.205) were negatively and non-significantly correlated.

Conclusion

Spine gourd *Momordica dioica* (Roxb.) is an important potential cucurbitaceous crop, its attacked by six species of various insect pests *viz.* cucurbit fruit fly (*Bactrocera cucurbitae* Coq.), hadda beetle (*Epilachna vigintioctopunctata* Fabricius), leaf miner (*Liriomyza trifolii* Burgess), red pumpkin beetle *(Aulacophora foveicollis* Lucas), bihar hairy caterpillar (*Spilosoma obliqua* Walker) and leaf eating caterpillar (*Diaphania indica* Saunders) as major and their first commenced from mostly in month of August. Among these, the regular pest of cucurbit fruit fly and hadda beetle increased gradually afterwards to reached peak population in second week of September, while leaf miner, red pumpkin beetle and leaf eating caterpillar was noticed in third week of September. In case of bihar hairy caterpillar activity observed on short period during first week of October to third week of October. Hence, the maximum plant protection measures should be applied in the month of September for suppression of major pest.

It may also be concluded that the weather factors found to be responsible for certain changes in the activities of insect-pests *viz.*, fruit fly, hadda beetle, leaf miner, red pumpkin beetle, leaf eating caterpillar and bihar hairy caterpillar on spine gourd. The correlation was found positive and non-significant at various parameters such as temperature (maximum and minimum) and morning RH. While, in the case of bihar hairy caterpillar, correlation was found negative and non-significant at minimum temperature. In other hand, the correlation was found negative and non-significant at RH (evening) and rainfall as well.

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Table 1: Insect pest succession of spine gourd *Momordica dioica* (Roxb.) during *kharif* 2017-18

S. No.	Name of insect	Scientific name, order and family	Active period	Peak activity period	Nature of damage	Pest status
1	Fruit fly	*Bactrocera cucurbitae* (Coq.) (Diptera: Tephritidae)	First week of August to third week of October	Second week of September	Maggot feed on fruits pulp and adult puncture the fruit for egg laying	Regular
2	Hadda beetle	*Epilachna vignitioctopunctata* (Fabricus) (Coleoptera: Coccinellidae)	First week of August to third week of October	Second week of September	Grub and adult feed on leaves and fruits	Regular
3	Leaf miner	*Liriomyza trifolii* (Burgess) (Diptera: Agromyzidae)	Second week of August to last week of October	Third week of September	Maggot feed on leaves	Regular

4	Red pumpkin beetle	*Aulacophora foveicollis* (Lucus) (Coleoptera: Chrysomelidae)	Third week of August to second week of October	Third week of September	Grubs and adult feed on leaves, flowers and fruits	Regular
5.	Bihar hairy caterpillar	*Spilosoma obliqua* (Walker) (Lepidoptera: Arctiidae)	First week of October to third week of October	Second week of October	Larva feed on leaves and flowers	Sporadic
6.	Leaf eating caterpillar	*Diaphania indica* (Saunders) (Lepidoptera: Pyralidae)	First week of August to second week of October	Third week of September	Larva feed on leaves, flower-buds and fruits	Regular

Table 2: Insect pest succession of spine gourd *Momordica dioica* (Roxb.) during *kharif* 2017-18

Observation date	SMW	Average pest population per plant						Temperature (^{0}C)		Relative Humidity (%)		Rainfall (mm)
		Cucurbit Fruit fly	Hadda beetle	Leaf miner	Red pumpkin beetle	Bihar hairy caterpillar	Leaf eating caterpillar	Max.	Min.	Mor.	Eve.	
25/07/2017	30	0	0	0	0	0	0	25.9	21.4	97	80	260.4
01/08/2017	31	0.2	0.4	0	0	0	0.1	29.5	23.3	91	76	28
08/08/2017	32	0.4	0.8	0.2	0	0	0.3	28.8	23.2	95	88	170.4
15/08/2017	33	0.6	1.5	0.4	0.2	0	0.4	28.3	23.6	92	76	54
22/08/2017	34	0.8	1.8	0.6	0.6	0	0.5	28.1	23.5	90	76	10.8
29/08/2017	35	1.0	3.0	0.8	0.8	0	0.8	29.8	23.2	93	81	62.4
05/09/2017	36	1.5	4.8	1.2	1.3	0	1.0	31.9	23.1	89	78	43.8
12/09/2017	37	3.0	6.0	1.5	1.8	0	1.2	31.1	23	95	74	8.4
19/09/2017	38	2.1	5.6	2.0	2.0	0	2.0	29.4	22.6	96	63	94.4
26/09/2017	39	0.8	3.5	1.3	1.2	0	1.5	30.3	22	91	70	0
03/10/2017	40	0.4	2.3	0.8	0.4	0.6	1.2	30.9	22.2	92	76	16
10/10/2017	41	0.3	1.5	0.6	0.2	1.3	0.8	29.9	21.3	95	62	1.6
17/10/2017	42	0.2	0.6	0.3	0	0.4	0	31.4	17.7	90	64	10.6
24/10/2017	43	0	0	0.2	0	0	0	29.9	17.7	86	63	0
Overall mean	-	0.80	2.27	0.70	0.60	0.16	0.70	-	-	-	-	-

Table 3: Correlation between insect pest populations of spine gourd with meteorological data during *Kharif* 2017-18

Name of insect	Temperature (^{0}C)		Relative Humidity (%)		Rainfall (mm)
	Max.	Min.	Morn.	Even.	
Cucurbit fruit fly	0.361	0.421	0.284	-0.023	-0.163
Hadda beetle	0.471	0.438	0.223	-0.076	-0.229
Leaf miner	0.440	0.408	0.380	-0.266	-0.262
Red pumpkin beetle	0.367	0.352	0.216	-0.146	-0.183
Bihar hairy caterpillar	0.232	-0.259	0.163	-0.439	-0.295
Leaf eating caterpillar	0.367	0.388	0.293	-0.205	-0.226

Non-Significant (NS) at 5% level of significance

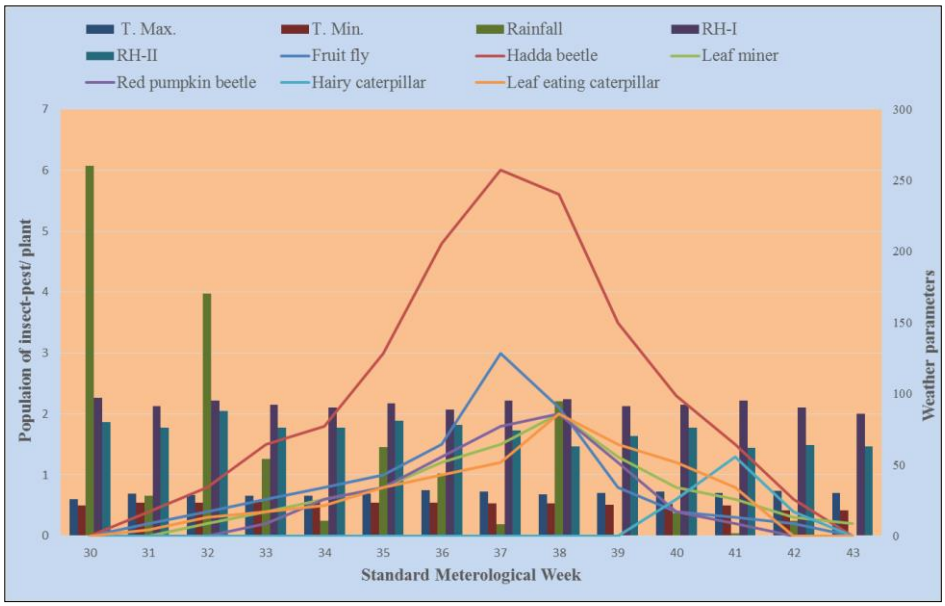

Fig 1: Correlation of insect-pests with weather parameters during *kharif* 2017-18.

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