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Pest spectrum and population dynamics of major pests occurring on snake gourd (*Trichosanthes cucumerina* var. *anguina*)

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ABSTRACT: A field investigation was carried out to study different insect pests occurring on snake gourd (*Trichosanthes cucumerina* var. *anguina*) during *kharif* 2018-19 at the University of Agricultural Sciences, GKVK, Bengaluru. The study revealed the occurrence of 17 species of insect pests belonging to four economically important orders such as Lepidoptera (three species), Coleoptera (five species), Diptera (two species) and Hemiptera (seven species) which are of both major and minor importance. The major defoliator insects such as semilooper, *Anadevidia peponis* (Fab.) population showed significant positive correlation with morning relative humidity (RH) (r=0.69*), while, leaf miner, *Liriomyza trifolii* (Burgess) and population of pumpkin caterpillar, *Diaphania indica* (Saunders) and plume moth, *Sphenarches caffer* (Zeller) were significantly positively correlated with afternoon RH (r=0.60* and 0.59*, respectively), pumpkin beetle, *Aulacophora* spp. population showed significant positive correlation with total rainfall (r=0.69*), leaf hopper species had significant negative correlation with total rainfall (r=-0.60*), whereas, mirid bug, *Nesidiocoris tenuis* (Reuter) population exhibited significant negative correlation with sunshine hours (r=-0.65*).

Keywords: *Anadevidia peponis*, *Aulacophora* sp., leaf miner, *Diaphania indica*, correlation

INTRODUCTION

Snake gourd also known as serpent gourd, is an annual, rapid growing vine of the Cucurbitaceae family, grown for its edible fruits. The *kharif* crop is mainly sown during June-July and the winter crop in October-November. Snake gourd grows well under warm and humid climate and is best suited for high rainfall areas. Temperature range of 30 to 35°C is found to be optimum for better growth and fruiting (Bharathi *et al*., 2014). Compared to other vegetables under cucurbitaceous family, snake gourd plays a vital role in human nutrition providing significant amount of proteins, fats, carbohydrates and soluble fibre etc. Snake gourd is also used as an abortive, stomachic, purgative, laxative, hydragogue, hemagglutinant, emetic, anthelminthic and cathartic agent and also in the treatment of malaria and bronchitis (Adebooye, 2008).

Insect pests and diseases are the two major limiting factors (Dhandapani *et al.,* 2003) in realising the yield potential in cucurbits and cole crops. Overall, insect pests inflict crop losses to the tune of 30-40 per cent in vegetable production (Srinivasan, 1993) in particular, yield losses due to insect pests in snake gourd crop is estimated to be 63 per cent, whereas, in other cucurbits like bitter gourd, cucumber, muskmelon and sponge gourd the yield loss is 60-80 per cent, 20-39 per cent, 76-100 per cent and 50 per cent, respectively (Shivalingaswami *et al.,* 2002).

The cucurbitaceous vegetables are attacked by different insect pests throughout the crop growth period, among them the melon fly, *Zeugodacus cucurbitae* (Coq.) is a serious pest occurring in India (Ingoley *et al.,* 2005). Defoliators are also serious problem in snake gourd (Nair, 1999). Dhillon *et al*. (2005) and Sapkota *et al*. (2010) recorded 30-100 per cent and 32.9 per cent yield losses in cucurbits, respectively due to attack by cucurbit fruit fly, depending upon the cucurbit species and the season. A thorough understanding of the crop dynamics as well as indigenous practices adopted by farmers will be helpful in chalking out a suitable pest management strategy. Hence the current study mainly focuses on recording various insect pests occurring on snake gourd at different crop growth stages and to study the population dynamics of major pests.

MATERIALS AND METHODS

The field investigation was carried out at the Department of Horticulture, UAS, GKVK, Bengaluru. The snake gourd variety 'Baby' was chosen for the present study and the crop was raised in a plot of size 12 m × 18 m with spacing of 1 m x 0.9 m, between the rows and from plant to plant, respectively. Agronomic practices were carried out as per the recommended package of practices, except for the plant protection

Table 1. List of Insect pests recorded on snake gourd crop

Sl. No.	Common name	Scientific name	Systematic position (Order: Family)
1.	Snake gourd semilooper	*Anadevidia peponis* (Fab.)	Lepidoptera: Noctuidae
2.	Pumpkin caterpillar	*Diaphania indica* (Saunders)	Lepidoptera: Crambidae
3.	Plume moth	*Sphenarches caffer* (Zeller)	Lepidoptera: Pterophoridae
4.	Pumpkin beetles	*Aulacophora foveicollis* (Lucas)	Coleoptera: Chrysomelidae
		Aulacophora cincta (Fabricius)	
	Leaf beetles	*Monolepta signata Olivier*	
		Clytra sp.	
5.	Weevil	*Xanthochelus faunus* (Olivier)	Coleoptera: Curculionidae
6.	Mirid bug	*Nesidiocoris tenuis* (Reuter)	Hemiptera: Miridae
7.	Horned coreid bug	*Cletus* sp.	Hemiptera: Coreidae
8.	Leaf hoppers	*Empoasca* sp.	Hemiptera: Cicadellidae
		Empoasca simbava (Dworakowska)	
		Hajra iridescens (Dworakowska)	
		Batracomorphus sp.	
		Balclutha sp.	
9.	Serpentine leaf miner	*Liriomyza trifolii* (Burgess)	Diptera: Agromyzidae
10.	Melon fruit fly	*Zeugodacus cucurbitae* (Coquillet)	Diptera: Tephritidae

measures. The insect pests infesting snake gourd crop were observed and collected by making frequent field visits (the first visit made on 1st September) during *kharif*, 2018 at different crop growth stages *viz.,* germination and emergence stage, vegetative (vining) stage, flower initiation stage and fruiting and maturity stage. The adult stages of the insects were collected and preserved through proper mounting in the insect cabinet boxes for further identification. Various collection techniques employed in the collection includes hand picking (caterpillars), hand net or aerial nets (beetles) and by using aspirator (sucking insect pests). The insects collected through above methods were identified based on morphological characters at All India Network Project on Insect Biosystematics, Department of Agricultural Entomology, UAS, GKVK, Bengaluru. The population of different insect pests occurring on snake gourd was recorded at weekly intervals by counting the number of individual insects on twenty randomly selected and labelled plants.

The incidence of defoliators such as semilooper, *Anadevidia peponis* (Fab.) and pumpkin caterpillar, *Diaphania indica* (Saunders) and plume moth, *Spenarches caffer* (Zeller) (the latter two also known to feed on immature fruits in the later instars) were recorded by counting the total number of larvae on entire plant, and for pumpkin beetles such as *Aulacophora foveicollis* (Lucas) and *Aulacophora cincta* (Fab.), the adult beetles found on the entire plant were counted in each of the twenty randomly selected and labelled plants. The population of leaf hoppers, mirid bugs and leaf miners were recorded by counting the number of leaf hoppers, mirid bugs (both nymphs and adults) and total number of live mines respectively, on 15 leaves at three different strata of the plant *i.e.,* from top, middle and bottom strata by taking five leaves at each strata of twenty randomly selected and labelled plants.

The data collected at weekly intervals on the populations of defoliators, sucking insects and tissue borers was correlated with abiotic factors *viz.,* minimum and maximum temperature, morning and afternoon relative humidity, total rainfall, sunshine hours, wind speed and cloud amount of corresponding week and the correlation matrix for the same was computed for further interpretation.

RESULTS AND DISCUSSION

Totally 17 species of insect pests belonging to four economically important orders such as Lepidoptera (three species), Coleoptera (five species), Diptera (two species) and Hemiptera (seven species) were found

Table 2. Incidence of defoliators of snake gourd in relation to weather parameters of the corresponding week during *kharif* 2018

SMW	Date of observation (2018)	Mean No. of caterpillars / plant			Mean No. of adults/damage plant	Temperature (°C)		Relative Humidity (%)		TRF (mm)	WS (Km/hr.)	SSH	Cloudiness (octas)	
		Semilooper	Pumpkin caterpillar	Plume moth	Pumpkin beetle	Max.	Min.	MN	AN				MN	AN
36	8th Sep.	0.65	0.00	0.00	0.25	29.40	18.50	92.00	51.00	00.00	6.50	8.90	3.00	3.00
37	16th Sep.	0.30	0.15	0.00	0.10	30.00	19.80	90.00	48.00	51.40	3.60	5.60	3.00	3.00
38	24th Sep.	5.30	0.40	0.00	0.50	28.30	19.40	94.00	51.00	26.00	6.00	5.50	3.00	5.00
39	1st Oct.	3.35	0.20	0.10	0.05	29.20	19.20	92.00	50.00	67.80	3.40	6.10	2.00	3.00
40	8th Oct.	2.95	0.75	0.45	1.10	28.00	20.00	91.00	59.00	05.20	7.00	5.70	3.00	3.00
41	15th Oct.	2.85	0.30	0.20	0.30	29.90	18.20	91.00	49.00	12.00	3.40	8.30	1.00	1.00
42	22th Oct.	4.40	0.35	0.35	0.35	28.50	18.50	93.00	54.00	12.00	4.50	6.10	2.00	1.00
43	29-Oct.	0.65	0.50	0.30	1.20	29.30	15.60	88.00	53.00	00.00	6.60	9.70	0.00	0.00
44	5th Nov.	0.85	0.65	0.25	1.00	28.50	17.10	88.80	52.20	00.00	7.90	7.50	2.70	2.00
45	12th Nov.	1.05	0.45	0.15	0.65	29.10	16.20	89.00	48.00	00.00	5.80	9.00	1.00	1.00
46	19th Nov.	0.15	0.30	0.30	0.55	29.00	15.30	85.00	53.00	00.00	6.40	8.00	1.00	1.00
	Mean	2.05	0.37	0.19	0.55	29.02	17.98	90.35	51.65	15.85	5.55	7.31	1.97	2.09
	Max	5.30	0.75	0.45	1.20	30.00	20.00	94.00	59.00	67.80	7.90	9.70	3.00	5.00
	Min	0.15	0.00	0.00	0.05	28.00	15.30	85.00	48.00	0.00	3.40	5.50	0.00	0.00
	SD	1.80	0.22	0.15	0.40	0.64	1.68	2.55	3.17	23.38	1.57	1.56	1.07	1.45

SMW= Standard meteorological week, SD= Standard deviation

Max=Maximum, Min=Minimum, MN=morning, AN=Afternoon, TRF= Total rainfall, WS= Wind speed, SSH= Sunshine hours.

feeding and damaging the crop, although few species were considered to be having economically minor importance. The weevil, *Xanthochelus faunus* (Olivier) was found to attack snake gourd crop only in the crop initiation/seedling stage and disappeared as the crop stage advanced, whereas, semilooper, sucking insects (leaf hoppers and mirid bugs), leaf miner and pumpkin beetles population were seen almost throughout the crop growing period. The population *of D. indica* and *S. caffer*, occurred mainly in the vegetative stage (one and three week after sowing, respectively). An important and a major pest of reproductive stage was melon fruit fly, *Z. cucurbitae* causing economical damage (Table 1; Fig. 1-4).

Population dynamics of major insect pests of snake gourd in relation to meteorological data

Major insect pests observed during the cropping period were only considered for studying the population dynamics in relation to weather parameters. The major pests considered for the study was categorised as defoliators (*A. peponis*, *D. indica* and *S. caffer*), sucking pests (leaf hoppers and mirid bugs) and tissue borer (*L. trifolii*). Fruit fly, though an economically important and major pest of snake gourd, is excluded from this list as the crop taken up was of short duration and the data obtained were very less to be considered for studying its population dynamics.

Defoliator pests

a. Snake gourd semilooper, *Anadevidia peponis* (Lepidoptera: Noctuidae)

The incidence of semilooper was observed throughout the crop growth period during *kharif* 2018, wherein, the mean number of caterpillars varied from 0.15 to 5.30 per plant. However, highest number of caterpillars were recorded during third week of September, 2018 *i.e.*, 38th Standard Meteorological Week (SMW), whereas, minimum number of caterpillars were recorded during third week (46th SMW) of November, 2018 (Table 2). When correlated with the weather parameters of corresponding week, correlation between semilooper incidence and morning relative humidity (r=0.69*) was found to be significantly positive and correlation between semilooper and minimum temperature (r= 0.55), wind speed (r=0.30) and afternoon cloud amount (r= 0.43) was found to be positive but non-significant, whereas, semilooper population was negatively correlated with maximum temperature (r= -0.48), total rainfall (r= -0.29) and sunshine hours (r= -0.59) (Table 4).

Similarly, in an experiment carried out at Banswara during *kharif* 2012 and 2013, on soybean, the maximum population of semilooper was recorded in the 36th and 39th SMW, respectively and the semilooper population exhibited a significant positive correlation with minimum temperature, morning evening humidity and rainfall during both the years (Kalyan and Ameta, 2017). Therefore, it could be inferred that differences in the incidence pattern varies with the geographical locations and also the weather conditions prevailing in that particular location.

Pumpkin caterpillar, *Diaphania indica* (Lepidoptera: Crambidae)

The *D. indica* incidence was observed throughout the crop growth period during *kharif,* 2018. The mean number of caterpillars per plant varied upto 0.75 during 36th to 46th SMW. However, highest number of caterpillars per plant were recorded during 2nd week (40th SMW) of October, 2018, whereas, no caterpillars were recorded during second week (36th SMW) of September, 2018 (Table 2). The *D. indica* population had a significantly negative correlation with maximum temperature (r= -0.68*), whereas, it showed a non-significant negative correlation with minimum temperature (r= -0.14), morning relative humidity (r= - 0.18), wind speed (r= -0.41), afternoon cloud amount (r= -0.14) sunshine hours (r= -0.07) and morning cloud amount (r= -0.07). The afternoon relative humidity (r= 0.60*) exhibited significantly positive correlation. Total rainfall (r= -0.56) had a negative, but non-significant correlation with the larval number per plant (Table 4).

In the present study, the maximum population of *D. indica* was observed during the 40th SMW, similarly, Halder *et al.* (2017) who studied the population fluctuation of cucumber moth, *D. indica* in bitter gourd during *kharif* 2014 and 2015 in Varanasi and reported that the maximum population was recorded during 38th SMW (in 2014), during 39th SMW (in 2015) *i.e.,* during September in both the years. Further, Soumya *et al*. (2017) reported that the population dynamics of *D. indica*, was positively correlated with morning relative humidity and rainfall and was negatively correlated with evaporation which are in partial agreement with the present findings.

Plume moth, *Sphenarches caffer* (Zeller) (Lepidoptera: Pterophoridae)

The plume moth incidence was observed during *kharif* 2018. The mean number of caterpillars varied upto 0.45 per plant throughout the crop growth. However, highest number of caterpillars were recorded during second and fourth week (40th and 42th SMW) of October, 2018, whereas, lowest number of caterpillars were observed

Table 3. Incidence of sucking pests and tissue borers of snake gourd in relation to weather parameters of the corresponding week during *kharif* 2018

SMW	Date of observation (2018)	Mean. No. /15 leaves/ plant at 3 different strata			Temperature (°C)		Relative Humidity (%)		TRF (mm)	WS (Km/hr.)	SSH	Cloudiness (octas)	
		Mirid bugs	Leaf hoppers	Leaf miner	Max.	Min.	MN	AN				MN	AN
36	8th Sep.	4.33	4.66	10.33	29.40	18.50	92.00	51.00	0.00	6.50	8.90	3.00	3.00
37	16th Sep.	18.65	0.66	16.33	30.00	19.80	90.00	48.00	51.40	3.60	5.60	3.00	3.00
38	24th Sep.	16.00	3.33	31.33	28.30	19.40	94.00	51.00	26.00	6.00	5.50	3.00	5.00
39	1st Oct.	13.75	0.33	16.67	29.20	19.20	92.00	50.00	67.80	3.40	6.10	2.00	3.00
40	8th Oct.	21.00	5.66	34.67	28.00	20.00	91.00	59.00	5.2.00	7.00	5.70	3.00	3.00
41	15th Oct.	12.50	3.00	27.00	29.90	18.20	91.00	49.00	12.00	3.40	8.30	1.00	1.00
42	22th Oct.	13.55	2.00	25.33	28.50	18.50	93.00	54.00	12.00	4.50	6.10	2.00	1.00
43	29-Oct.	9.60	3.40	71.33	29.30	15.60	88.00	53.00	0.00	6.60	9.70	0.00	0.00
44	5th Nov.	15.60	3.67	54.00	28.50	17.10	88.80	52.20	0.00	7.90	7.50	2.70	2.00
45	12th Nov.	12.35	4.00	36.67	29.10	16.20	89.00	48.00	0.00	5.80	9.00	1.00	1.00
46	19th Nov.	7.40	4.33	46.66	29.00	15.30	85.00	53.00	0.00	6.40	8.00	1.00	1.00
	Mean	13.16	3.19	33.67	29.02	17.98	90.35	51.65	15.85	5.55	7.31	1.97	2.09
	Max	21.00	5.66	71.33	30.00	20.00	94.00	59.00	67.80	7.90	9.70	3.00	5.00
	Min	4.33	0.33	10.33	28.00	15.30	85.00	48.00	0.00	3.40	5.50	0.00	0.00
	SD	4.81	1.63	18.07	0.64	1.68	2.55	3.17	23.38	1.57	1.56	1.07	1.45

SMW= Standard meteorological week, SD= Standard deviation
Max=Maximum, Min=Minimum, MN=morning, AN=Afternoon, TRF= Total rainfall, WS= Wind speed, SSH= Sunshine hour.

Table 4. Correlation between incidence of insect pests of snake gourd and weather parameters of the corresponding week during *kharif* 2018

Weather parameter	Semilooper	Pumpkin caterpillar	Plume moth	Pumpkin beetle	Mirid bug	Leaf hopper	Serpentine leaf miner
Maximum temperature	-0.48	-0.68*	-0.48	-0.52	-0.35	0.01	-0.25
Minimum temperature	0.55	-0.14	-0.28	-0.42	0.60*	-0.67*	-0.72*
Morning relative humidity	0.69*	-0.18	-0.34	-0.39	0.30	-0.52	-0.66*
Afternoon relative humidity	0.20	0.60*	0.59*	0.60*	0.22	-0.28	0.31
Wind speed	0.30	-0.41	-0.48	0.65*	0.38	-0.59	-0.54
Total rainfall	-0.29	-0.56	0.33	-0.69*	-0.13	-0.60*	0.60
Sunshine hours	-0.59	-0.07	0.06	0.30	-0.65*	0.64	0.45
Morning cloud amount	0.26	-0.07	-0.34	-0.25	0.45	-0.36	-0.58
Afternoon cloud amount	0.43	-0.14	-0.55	-0.31	0.39	-0.50	-0.53

**Correlation is significant at $P \leq 0.01$ level (2-tailed); *Correlation is significant at the $P \leq 0.05$ level (2-tailed)

during second, third and fourth week (36th, 37th and 38th SMW) of September, 2018 (Table 2). Correlation between plume moth incidence and afternoon relative humidity (r= 0.59*) was found to be positive and significant and it was positively and non-significantly correlated with total rainfall (r= 0.33) and sunshine hours (r= 0.06), whereas, plume moth larval population was negatively correlated with maximum temperature (r= -0.48), minimum temperature (r= - 0.24), wind speed (r= -0.48), afternoon cloud amount (r= -0.55), morning relative humidity (r= -0.34) and morning cloud amount (r= -0.34) (Table 4).

The findings of the present study are not in agreement with respect to the incidence pattern of *S. caffer* but are in near agreement with correlation studies as reported by Reddy *et al.* (2017), wherein, during *kharif* 2015-16, its highest incidence was recorded with two peaks *i.e.,* once at 47th SMW and second one at 49th SMW with 3.0 and 3.3 larvae per plant, respectively and there was a significant negative correlation with maximum temperature (r= -0.427*) and evaporation (r= -0.517*) at 5 % level of significance, whereas it showed significant positive correlation with evening relative humidity (r= 0.074*). During *kharif* 2016-17 the highest incidence of *S. caffer* was observed with two peaks *i.e.* once at 49th SMW and second one at 50th SMW with 2.8 and 3.7 larvae per plant, respectively and minimum temperature (r= -0.293*) and evaporation (r= -0.676**) were negatively significantly correlated with *S. caffer* larval population, respectively while evening relative humidity (r= 0.186*) was positively significant. The variation in the incidence pattern may be due to changes in the weather conditions and also due to changes in the geographical locations where the crop has been raised.

Pumpkin beetles, *Aulacophora cincta* (Fab.) and *Aulacophora foveicollis* (Lucas) (Coleoptera: Chrysomelidae)

The mean number of adult beetles per plant varied from 0.05 to 1.20 throughout the crop growth. However, highest numbers of beetles were recorded during 40th, 43th SMW of October, 2018, whereas, lowest beetle numbers were recorded during 39th SMW of October, 2018 (Table 2). When correlated with the corresponding week weather parameters, correlation between pumpkin beetle population and afternoon relative humidity (r=0.60*) and total rainfall (r= -0.69*) was found to be negative and significant and it was non-significant and positively correlated with sunshine hours (r= 0.30), whereas, the pest incidence was negatively correlated with maximum (r= -0.52) and minimum temperature (r= -0.42), morning relative humidity (r= -0.39), morning cloud amount (r= -0.25) and afternoon cloud amount (r= -0.31), while it was negatively and significantly correlated with wind speed (r= -0.65*) (Table 4, Fig. 2). Similar results were obtained by Bhowmik *et al.*, (2017) in bottle gourd, wherein he reported that red pumpkin beetle adults appeared in the middle of September and attained peak numbers during the end of October to mid November and gradually disappeared during the middle of December (Table 4).

The results of the present findings are partially in agreement with the findings of Dubale *et al.* (2018) who reported that the correlation between mean infestation of red pumpkin beetle showed positive correlation with minimum temperature (*r*= 0.362) and it was negatively correlated with maximum temperature, evening relative humidity, bright sunshine hours and rainfall, but this relationship was non-significant. Similarly, Shinde *et al.* (2018) reported that the infestation of red pumpkin beetle on cucumber exhibited significant negative correlation (r= -0.576) with maximum temperature and morning relative humidity (r= -0.675) while, other meteorological parameters *viz*., minimum temperature, evening relative humidity, bright sunshine hours and rainfall were found to have non-significant and negative correlation, which are in near conformity with the present findings.

Sucking pests and tissue borers

Mirid bug, *Nesidiocoris tenuis* (Hemiptera: Miridae)

During *kharif* 2018, the incidence of mirid bug was seen throughout the crop growth period both in vegetative as well as reproductive stages. The mean number of mirid bugs (both nymphs and adults) at three different strata per plant varied from 4.33 to 21.00 throughout the crop growth. However, highest numbers of bugs were recorded during 40th SMW of October, 2018, whereas, lowest number of mirid bugs were recorded during 46th SMW of November, 2018 (Table 3). When correlated with corresponding week weather parameters, correlation between number of mirid bugs and minimum temperature (r= 0.60*) was found to be positive and significant however, with sunshine hours (r= -0.65), correlation was significantly negative and it was also positively correlated with morning relative humidity (r= 0.30), afternoon relative humidity (r= 0.22), wind speed (r= 0.38), morning cloud amount (r=0.45) and afternoon cloud amount (r= 0.39), whereas, it was negatively correlated with maximum temperature (r= -0.35) and total rainfall (r= -0.13) (Table 4).

The present findings are in agreement with the results obtained by Sridhar *et al.* (2013) wherein incidence of *N. tenuis* mean population/plant on tomato crop indicated positive correlation with minimum temperature and

Fig.1. Lepidopteran defoliators recorded on snake gourd
a. *Anadevidia peponis* (Fabricius), b. *Diaphania indica* (Saunders), C. *Spenarches caffer* (Zeller)

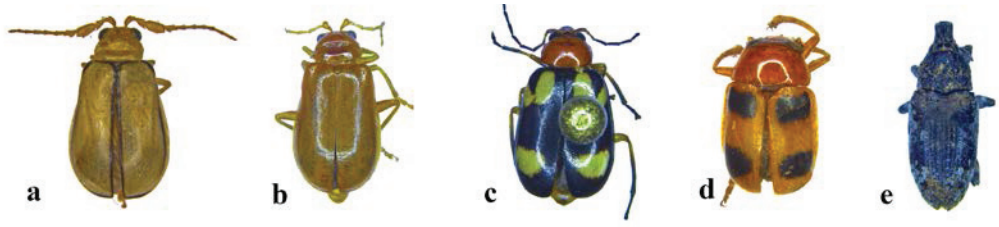

Fig.2. Coleopteran defoliators recorded on snake gourd
a. *Aulacophora Cincta* (Fabricius), b. *Aulacophora foveicollis* (Lucas), c. *Monolepta signata* Olivier, d. *Clytra* Sp., e. *Xanthochelus faunus* (Olivier)

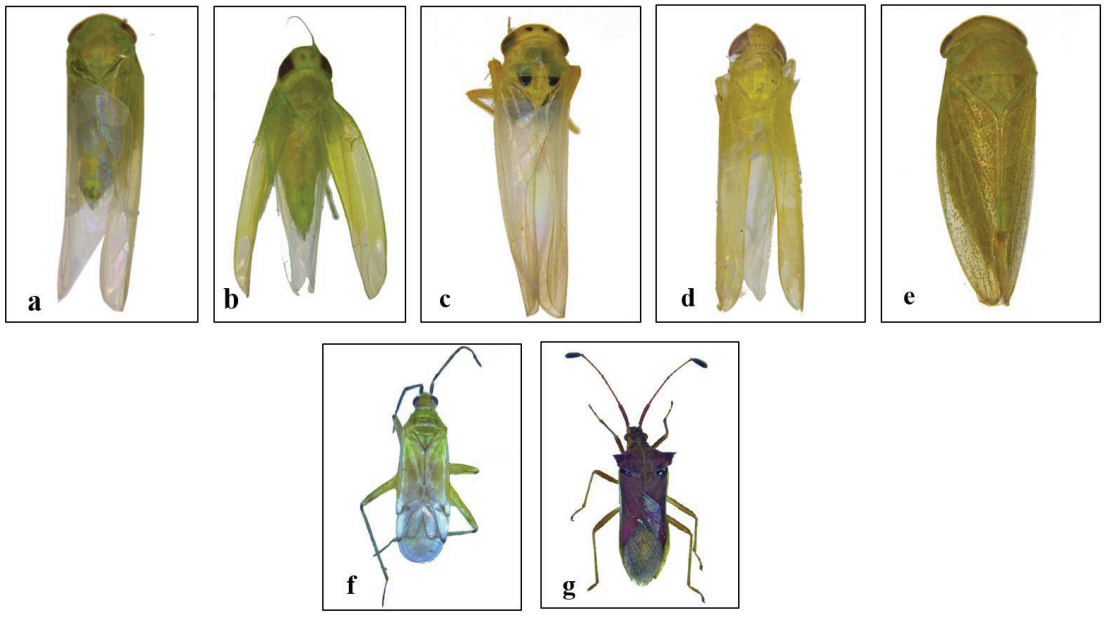

Fig. 3. Hempiteran sucking pests recorded on snake gourd. a. *Balclutha* Sp., b. *Empoasca* sp., c. *Hajra iridescens* (Dworakowska), d. *Empoasca simbava* (Dworakowska), e. *Batracomorphus* sp., f. *Nesidiocoris tenuis* (Reuter), g. *Cletus* sp.

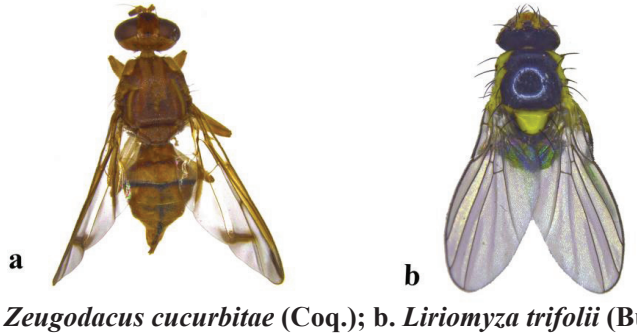

Fig. 4. Dipteran pests a. *Zeugodacus cucurbitae* (Coq.); b. *Liriomyza trifolii* (Burgess)

wind velocity, whereas maximum temperature, evening humidity, wind velocity, evaporation and rainfall showed non-significant negative correlation with *N. tenuis* while morning relative humidity exhibited significant negative correlation. This may be due to the reason that mirid bugs exhibited more aggregation under cool weather, as they avoided high temperature regimes. Hence the population was expected to be low under maximum temperature.

Leaf hoppers, *Empoasca* sp., *Empoasca simbava* (Dworakowska), *Hajra iridescens* (Dworakowska), *Batracomorphus* sp. and *Balclutha* sp. (Hemiptera: Cicadellidae).

The mean number of leaf hoppers (both nymphs and adults) at three different strata per plant varied from 0.33 to 5.66 throughout the crop growth. However, highest number of hoppers were recorded during 40th SMW of October, 2018, whereas, lowest number of hoppers were recorded during 39th SMW of October, 2018 (Table 3). When correlated with corresponding week weather parameters, correlation between number of leaf hoppers with total rainfall (r= -0.60*) and minimum temperature (r= -0.67*) was significantly negative and also exhibited a non-significant negative correlation with morning relative humidity (r= -0.52), afternoon relative humidity (r= -0.28), wind speed (r= -0.59), morning cloud amount (r= -0.36) and afternoon cloud amount (r= -0.50), *Nesidiocoris* whereas, there significant positive correlation was seen with maximum temperature (r= 0.01) (Table 4). The above results partially agree with the findings of Bhamare *et al.* (2018) who reported that the population of *Empoasca kerri* infesting soybean intercropped with pigeon pea indicated a negative correlation with maximum temperature, morning relative humidity and afternoon relative humidity.

Similarly, Pawar *et al.* (2017) observed that among different meteorological parameters, morning (r = 0.71**) and evening relative humidity (r= 0.77**) and rainfall (r= 0.59*) had significant positive influence on leafhopper population, while maximum temperature (r= -0.78**) and sunshine hours (r= -0.64*) exhibited significant negative influence on the leaf hopper population in cluster bean which are not in agreement with the present findings.

Serpentine leaf miner, *Liriomyza trifolii* (Burgess) (Diptera: Agromyzidae)

The incidence of the leaf miner was seen throughout the crop growth period both in vegetative as well as reproductive stages during *kharif* 2018. The mean number of live leaf mines at three different strata per plant varied from 10.33 to 71.33 throughout the crop growth. However, highest number of leaf mines were recorded during 42nd SMW of October, 2018, whereas, lowest number of leaf mines were recorded during 35th SMW of October, 2018 (Table 3).

When correlated with corresponding week weather parameters, leaf miner population had significant negative correlation with minimum temperature (r= -0.72**) and morning relative humidity (r= -0.66*) and non-significant negative correlation with maximum temperature (r= -0.25), wind speed (r= -0.54), morning (r= -0.58) and afternoon cloud amount (r= -0.53). However, the leaf miner incidence had positive, non-significant correlation with afternoon relative humidity (r= 0.31), total rainfall (r= 0.60) and sunshine hours (r= 0.45) (Table 4)

Nearly similar results were observed by Selvaraj *et al.,* 2016 who reported that sunshine hours exhibited a significant positive correlation (r = 0.578*) with *L. trifolii* population, while morning relative humidity (r= -0.603**) and evening relative humidity (r= 0.758**) had a significant, negative correlation. Similarly, Shilpakala *et al.* (2016) observed that the leaf miner incidence showed a significant positive correlation with sunshine hours and morning relative humidity, while it exhibited a non-significant positive correlation with the maximum temperature, whereas, minimum temperature, rainfall, wind velocity and evening relative humidity exhibited non-significant negative correlation. These results partially comply with the findings of the present study.

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