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Sougata Kundu
Research Scholars, Department of Agriculture Entomology, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal, India

Ayan Das
Research Scholars, Department of Agriculture Entomology, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal, India

Mrinmoy Mahanty
Research Scholars, Department of Agriculture Entomology, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal, India

Apurba Das
Research Scholars, Department of Agriculture Entomology, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal, India

Lakhindra Tudu
Research Scholars, Department of Agriculture Entomology, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal, India

Arijit Misra
Research Scholars, Department of Agriculture Entomology, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal, India

Arup Chattopadhyay
Professor, Department of Vegetable Science, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal, India

Shantanu Jha
Professor, Department of Agriculture Entomology, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal, India

Corresponding Author:
Ayan Das
Research Scholars, Department of Agriculture Entomology, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal, India

Population dynamics of major insect pests of Teasle Gourd (*Momordica subangulata* Blume. Subsp. *Renigera*) and study the reaction of different genotypes against Fruit fly infestation

Sougata Kundu, Ayan Das, Mrinmoy Mahanty, Apurba Das, Lakhindra Tudu, Arijit Misra, Arup Chattopadhyay and Shantanu Jha

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Abstract
The present investigation was carried out at of AICRP on Vegetable Crops, Bidhan Chandra Krishi Viswavidyalaya, Kalyani, Nadia to study the seasonal incidence of important insect pests of Teasle gourd and its correlation with different weather parameters alongside, eighteen genotypes were subjected for screening against the fruit fly infestation during the summer season of 2018 and 2019. The highest population of Red pumpkin beetle (1.41 adult/plant), epilachna beetle (2.0 adult/plant) were recorded during second week of July while highest population of pumpkin caterpillar (2.9 larva/plant) was recorded during the end of June and higher fruit damage due to fruit fly infestation (57.75% fruit damage) and subsequent higher maggot population (12.53 maggot/fruit) was recorded during the third week of July. Minimum relative humidity plays a significant role in population development of red pumpkin beetle (r = 0.578), epilachna beetle (r = 0.822) and maggot population (r = 0.923) while maximum relative humidity is highly significant relation with epilachna beetle (r = 0.728) and maggot (r = 0.833) population and the minimum temperature have significant relation with red pumpkin beetle (r = 0.624) and pumpkin caterpillar (r = 0.698) population build up. Fruit fly incidence was significantly lower in case BCTG-1 (15.7%) and BCTG-13 (18.3%) compared to highly susceptible one BCTG-10 (76.2%). Genotypes with lower fruit fly infestation had low larval numbers in the fruits, and there was a highly negative correlation (r = 0.96) between percentage fruit infestation and ascorbic acid content (r = -0.896) and total sugar (r = -0.977) in fruit.

Keywords: Teasle gourd, insect pests, seasonal incidence, varietal evaluation

Introduction
Cucurbits are vegetables crops belonging to family Cucurbitaceae. The family consists of about 118 genera and 825 species. Cucurbits share about 5.6% of the total vegetables production in India, among them teasle gourd, *Momordica subangulata* Blume subsp. *renigera* (G. Don) de Wilde, is a perennial dioecious cucurbit vegetable, valued for its nutritional and medicinal properties having a wide range of adaptability (Ram *et al*., 2001) [15]. This high quality minor crop could play an important role in food and nutritional security than many currently commercially produced crops, which are low in vitamins and minerals (Chattopadhyay *et al*., 2016; Padulosi *et al*., 2002) [3, 13]. It is native to South East Asia, especially India and Bangladesh (Thiruvengadam and Chung, 2011) [16]. The average nutritional value per 100g edible fruit was found to 84.1 per cent moisture, 7.7g carbohydrate, 3.1g protein, 3.1g fat, 3.0g fiber and 1.1g minerals. It also contained small quantities of essential vitamins like ascorbic acid, carotene, thiamine, riboflavin and niacin. Immature green fruits, young leaves, flowers and tubers are considered for consumption purpose (Ram *et al*., 2001) [15]. Low productivity in teasle gourd is attributed to several constrain but loss due to pest alone is quite significant. Extent of yield loss by the pests to cucurbitaceous vegetables ranged from 30-100% depending upon cucurbit species and the season in different parts of the world as noted by Dhillon *et al*., (2005) [4]. The pest profile of teasle gourd is complex with more than 293 insect and mite species debilitating the crop in the field as well as in storage. Teasle gourd are infested with various insect pests right from the primordial stage of the crop to harvest of the crop. Several pest species causes significant yield losses among them, Melon fruit fly, Epilachna beetle, Red pumpkin beetle, Pumpkin caterpillar are important insect pest of teasle gourd. They poses a major threat to the cucurbit crops.

The maximum damage by Red pumpkin beetle is done when the crop is at the cotyledon stage. The adult insect also feed on the leaves of grown up plant by scrapping off their chlorophyll and make the leaves net like appearance they also feed voraciously on flowers and flower buds. But the larvae feed on root tissue and cause direct damage to the newly developed seedlings (Narayanan and Batra, 1960) [11]. Early symptoms of Epilachna beetle infestation are the development of lace-like patches of networks of intact small leaf veins. Damage is most serious in the early stages of fruit formation, when the pests feed on and puncture the skin of young fruit, particularly where they touch leaves or the soil, but well developed fruits with hard rinds may escape attack (Patel and Kulkarny, 1956) [14]. Pumpkin caterpillar feed on leaves where they cluster and fold and weave the leaves together. They can also feed on and puncture the skin of young fruit, especially the fruits that touch leaves Adult female fly select soft and young fruits for oviposition by puncturing the rind with the ovipositor. Such damaged fruits show signs of raised and brown resinous encrustation at the sites of ovipositional punctures due to discharge and drain out fruit juice through punctures. After egg hatching, the maggots bore into the pulp tissue and make the feeding galleries. The fruit subsequently rots or becomes distorted Miyatakeet *et al*., (1993) [10]. The incidence of insect pests in teasle gourd and the role of the abiotic factors influencing the population dynamics of the same is to be studied which will give us a vivid idea. The susceptibility of the genotype of teasle gourd towards major pests is an important study to be uptaken for the further breeding approaches to be carried forward. The identification of resistant or susceptible genotypes is a step forward for advanced pest management strategy. So, field screening of the teasle gourd genotypes is to be done for assessment of their susceptibility towards fruit fly. The basic objective of the study is to study the population dynamics of major insect pests in the pertaining season and to study the susceptibility of different teasle gourd varieties against fruit fly.

Materials and Methods

The present investigation was carried out in order to study the insect-pest problems of teasle gourd and their varietal susceptibility. Eighteen genotypes of teasle gourd, collected from eastern India, were tested and evaluated at the C Block experimental research farm of Bidhan Chandra Krishi Viswavidyalaya (22.5^0 N, 88.22^0 E, and 9.75 AMSL), Kalyani, Nadia, West Bengal, India. As per the objectives the experiment was divided into two parts-

i) Studies on population dynamics of major insect pests of Teasle gourd in relation to the weather parameters, plots of 4.5 m X 2.5 m was laid out with a spacing of 1.50 m between pit rows and 1.25 m between plants in plots where root cuttings were planted separately in the month of February, 2018 and similar was repeated on 2019. The number of grub as well as adult of red pumpkin beetle and epilachna beetle were recorded on weekly interval from three selected plants of each replication similarly the number of larva of pumpkin caterpillar were recorded on weekly interval from three selected plants of each replication and converted per plant basis.

$$\text{Average no. of grub/larva/adult per plant} = \frac{\text{Total number of grub/larva/adult counted}}{\text{Total number of plant observed}}$$

Observations on incidence of fruit fly were recorded on the basis of average no. of maggots per fruit and percentage of fruits damage (Fruit damage = $\frac{\text{No.of infested fruits}}{\text{Total number of fruit}}$ x 100) from five randomly selected tagged plants. Data on weather parameters were obtained from department of Agricultural Meteorology and Physics of the university and correlation of weather parameters were computed.

ii) Screening of Teasle gourd genotypes against fruit fly infestation -The experiment was laid down in RBD with plot size 4.5m X 2.5m with spacing of 1.50m x 1.25m with eighteen genotypes planted in the month of February. Screening of the following accession i.e. BCTG-1, BCTG-2, BCTG-3, BCTG-4, BCTG-5, BCTG-6, BCTG-7, BCTG-8, BCTG-9, BCTG-10, BCTG-11, BCTG-12, BCTG-13, BCTG-14, BCTG-15, BCTG-16, BCTG-17 and BCTG-18 was done. Red pumpkin beetle, epilachna beetle, pumpkin caterpillar and fruit fly incidence were recorded upto stipulated time period of research work, i.e. end of July. The statistical analysis, was carried out under the assistance of SPSS ® version 25.

Results

Seasonal Incidence of insect pests: The initial population of the epilachna beetle grub and adult started from third week of May. Initially quite low population of both grub and adult was recorded (Grub 0.3/plant and Adult 0.2/plant) in third week of May. Then from fourth week of May to second week of July, during both of year, the population of both grub and adult was gradually increased (Grub/plant - 0.7 to 3.5 and Adult/plant-0.4 to 2.0). After which population of both grub and adult found declined. The peak population of both grub (3.5 / plant) and adult (2.0 / plant) per plant were observed in the second week of July.

The pumpkin caterpillar population initiated from first week of May. A low population of larva was recorded (0.2/ plant) in first week of May. Then from second week of May to fourth week of June, the population of larva was gradually increased (0.6 – 2.9/ plant). After which population of larva found declined (2.6 - 0.6/ plant). The peak larval population (2.9/ plant) were observed in the fourth week of June. In case of red pumpkin beetle, initial population started from third week of May. A quite low population was recorded (0.2/ plant) in first week of May. Then from second week of May to second week of July the population of red pumpkin beetle was gradually increased (0.3 – 1.4/ plant). After which population of red pumpkin beetle found declined (0.4 - 0.3/ plant). The peak population of red pumpkin beetle (1.4/ plant) were observed in the second week of July. The incidence of fruit fly was started from the second week of June (1.43 maggot / fruit) (Fig: 1) and reached its peak in the third week of July (12.53 Maggot/ fruit) and again declined subsequently. Similar trend was observed in case of percent fruit damage where initial appearance leads to 13.38% fruit damage at second week of June where it reach it peak to 57.75 at third week of July the percent damage reduce gradually thereafter.

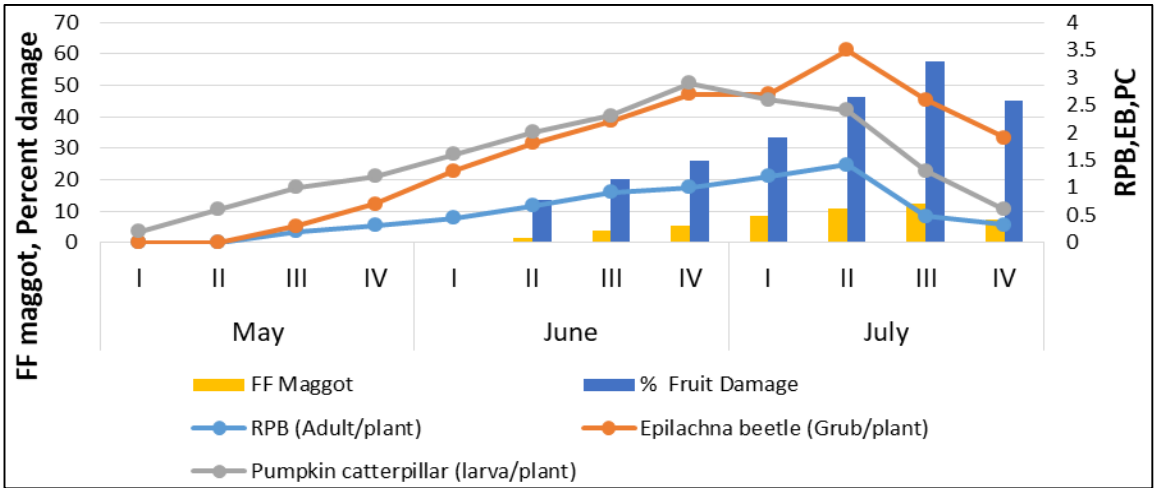

Fig 1: Seasonal distribution of various Insect pests and fruit damage due to fruit fly infestation

Correlation of incidence of major insect pests with different weather parameters

The data on weather parameters taken was correlated with the incidence of maggot percentage and the correlation values were worked out statistically for test of significance too (Table: 1). Minimum temperature (r_{Tmin} = 0.624*) and minimum relative humidity ($r_{RH\ min}$ = 0.578*) has a positive significant correlation value while maximum temperature ($r_{T\ max}$ = 0.294), maximum relative humidity ($r_{RH\ max}$ = 0.556) and average daily rainfall ($r_{RF\ mm}$ = 0.343) have a positive role for the development over red pumpkin beetle population. Similarly epilachna beetle population have a highly significant correlation value with relative humidity ($r_{RH\ max}$ = 0.723** and $r_{RH\ min}$ = 0.822**) while temperature ($r_{T\ max}$ = 0.007 and r_{Tmin} = 0.501) and average daily ($r_{RF\ mm}$ = 0.560) are only positively significant with abundance of epilachna beetle population in teasle gourd ecosystem, while in case of pumpkin caterpillar population build up only minimum temperature (r_{Tmin} = 0.698*) has a significant correlation value while rest of other weather parameters found to be only positively correlated ($r_{T\ max}$ = 0.545; $r_{RH\ max}$ = 0.352; $r_{RH\ min}$ = 0.395 and $r_{RF\ mm}$ = 0.242). The incidence of maggot/fruit was found to be highly significant ($r_{RH\ min}$ = 0.923**) with minimum relative humidity and only positively significant with maximum relative humidity ($r_{RH\ max}$ = 0.833**).

Table 1: Correlation of incidence of major insect pests of teasle gourd with different weather parameters

Insect pests	Temp Max	Temp Min	RH Max	RH Min	RF (mm)
Red pumpkin beetle	0.294	0.624*	0.556	0.578*	0.343
Epilachna beetle	0.007	0.501	0.728**	0.822**	0.560
Pumpkin caterpillar	0.545	0.698*	0.352	0.395	0.242
Fruit fly (maggot/fruit)	-0.480	0.110	0.833**	0.923**	0.686

The incidence was found positively correlated with average daily rainfall ($r_{RF\ mm}$ = 0.686) and minimum temperature (r_{Tmin} = 0.110) while maximum temperature correlates negatively with values ($r_{T\ max}$ = - 0.480). It was observed that among all weather parameters increase in relative humidity percentage have resulted in multiplication over fruit fly population. It was also observed that a highly positive significant correlation in between fruit fly damage with maggot population ($r_{maggot\ -\ \%\ damage\ fruit}$ = 0.943**) during the experimental period (Table: 2)

Table 2: Fruit fly damage in relation with maggot population

	Maggot/Fruit
% of Fruit damage	0.943 **

Screening of Teasle gourd genotypes against Fruit fly infestation: During the investigation, the first fruit damage by fruit fly was observed in third week of June which continues upto fourth week of July in different genotypes. The maximum percentage fruit damage by fruit fly was recorded on third week of July in all genotypes except BCTG-8 whose maximum infestation seen in second week of July. Among eighteen genotypes, the average fruit damage percentage by fruit fly was recorded highest in genotype BCTG10 (28.3%/plant) followed by BCTG9 (22.8%/plant), and lowest in genotype BCTG1 (4.8%/plant) in flowering to first picking stage. During the harvesting stage the average fruit damage percentage by fruit fly was recorded highest in BCTG-10 (86% / plant) followed by BCTG-9 (79.3% / plant), BCTG-18 (69% / plant) and lowest in genotype BCTG-1 (18.8%/plant) among eighteen genotypes. While among eighteen genotypes, the average fruit damage by fruit fly in throughout the season was recorded highest in BCTG-10 (76.2%/plant) followed by BCTG-9 (68%/plant), BCTG-18 (58.8%/plant) and lowest in genotype BCTG-1 (15.7%/plant). Grouping of Teasle gourd genotypes into different categories on the basis of per cent fruit infestation seems that BCTG -1 and BCTG -14 was appeared as resistant to fruit fly infestation, hence this is better to recommend this variety as promising varieties in future breeding programme in fruit fly prone areas where BCTG-10 appears to be highly susceptible one; while BCTG-5, BCTG-9, BCTG-18 appears to be susceptible one and rest others appeared as moderately resistant (Table: 3).

Correlation between fruit fly damage and different Bio-chemical parameters: In the laboratory experiment correlation analysis with bio-chemical parameters showed that, fruit damage had highly significant negative correlation with ascorbic acid and total sugar. Nath *et al*., (2017) [12] also reported similar result on bitter gourd (Table: 4)

Table 3: Screening of Teasle gourd genotypes against fruit fly infestation (% of infestation) (Mean data of both 2018 and 2019)

Genotypes	June (3rd Week)	June (4th Week)	July (1st week)	July (2nd Week)	July (3rd Week)	July (4th Week)	Mean (Genotype)	Vegetative Stage	Flowering to 1st picking Stage	Harvesting Stage	Yield (kg/plant)	Remarks
BCTG-1	8.0	11.0	13.0	19.0	26.0	17.0	15.7	0.0	4.8	18.8	3.4	**R**
BCTG-2	19.0	27.0	37.0	36.0	41.0	33.0	32.2	0.0	11.5	36.8	2.7	MR
BCTG-3	22.0	29.0	40.0	53.0	67.0	41.0	42.0	0.0	12.8	50.3	2.0	MR
BCTG-4	17.0	26.0	42.0	58.0	67.0	51.0	43.5	0.0	10.8	54.5	2.3	MR
BCTG-5	28.0	39.0	52.0	71.0	80.0	68.0	56.3	0.0	16.8	67.8	1.7	S
BCTG-6	19.0	27.0	41.0	55.0	64.0	41.0	41.2	0.0	11.5	50.3	2.0	MR
BCTG-7	14.0	23.0	38.0	52.0	66.0	47.0	40.0	0.0	9.3	50.8	2.1	MR
BCTG-8	11.0	21.0	37.0	44.0	41.0	28.0	30.3	0.0	8.0	37.5	2.8	MR
BCTG-9	34.0	57.0	72.0	79.0	88.0	78.0	68.0	0.0	22.8	79.3	1.8	S
BCTG-10	52.0	61.0	77.0	89.0	91.0	87.0	76.2	0.0	28.3	86.0	1.4	HS
BCTG-11	12.0	17.0	22.0	30.0	33.0	20.0	22.3	0.0	7.3	26.3	2.9	MR
BCTG-12	14.0	23.0	33.0	41.0	47.0	32.0	31.7	0.0	9.3	38.3	2.5	MR
BCTG-13	11.0	16.0	20.0	27.0	32.0	27.0	22.2	0.0	6.8	26.5	3.1	MR
BCTG-14	9.0	14.0	18.0	23.0	29.0	17.0	18.3	0.0	5.8	21.8	3.2	**R**
BCTG-15	17.0	22.0	37.0	44.0	66.0	41.0	37.8	0.0	9.8	47.0	2.4	MR
BCTG-16	12.0	26.0	33.0	48.0	57.0	44.0	36.7	0.0	9.5	45.5	2.5	MR
BCTG-17	14.0	19.0	23.0	28.0	34.0	22.0	23.3	0.0	8.3	26.8	2.9	MR
BCTG-18	34.0	43.0	57.0	71.0	82.0	66.0	58.8	0.0	19.3	69.0	1.8	S
Mean	19.3	27.8	38.4	48.2	56.2	42.2	38.7	0.0	11.8	46.3		

Table 4: Correlation between biochemical parameters in relation with fruit damage

Bio-chemical parameters of Teasel Gourd	Fruit damage
Ascorbic acid	-0.896**
Total sugar	-0.977**

Discussion

The above findings were supported by the studies of Jha (2008) [7] who reported Epilachna beetle (*Henosepilachna sp*) was found to be active in summer crop while Atwal & Dhaliwal (2008) [1] stated peak population is attained during end of June-early July. Ghule *et al*., (2012) [5] reported peak population of pumpkin caterpillar (*Diaphania indica*) 0.78 larva / plant on Pumpkin but in case of teasle gourd the present study found that the peak population of pumpkin caterpillar larva (2.1/ plant) considerably more. Johri and Johri (2003) observed that red pumpkin beetle incidence was more during the period from March to September ranging from 27.70 to 47.49 per cent infestation and the lowest as 3.92 per cent in February, similarly here the maximum beetle population was found during end of June to middle of July. Mahmood and Mishkatullah (2007) [9] studied population dynamics and reported that the fruit flies showed an increased level of population from March to August. The population peak appeared in July and August and maximum declined was observed in October depending on the host fruit maturity temperature and rainfall, more or less we found similar result in teasle gourd also. Banerji *et al.*, (2005) [2] reported that fruit fly have a positive correlation with relative humidity percentage in their development here we also depicted the high significant correlation between fruit fly abundance and maximum and minimum relative humidity also. It was suggested that the required degree day is quickly fulfilled during the season in the combination of moisture and temperature that leads to quicker development and reproduction among fruit fly species and further abundance in the cropping ecosystem. The study made by Haldhar *et al*., (2013) [6] on biochemical parameters of musk melon on fruit fly abundance shows that presence of total sugar present have a highly significant relation with fruit fly abundance similarly here we also found a similar relation between two factors.

Conclusion

Among the all insect pests Fruit fly *(Bactrocera cucurbitae* Coquillett) is an important insect pest causing extensive losses of production in Teasle gourd. Among the various weather parameters relative humidity have a critical role in the population development of important pests. Among eighteen genotypes evaluated against fruit fly damage revealed that BCTG-1 and BCTG-14 was found to be resistant against fruit fly damage and gives a higher yield (3.4 kg/plant and 3.2 kg/plant respectively) compared to other accession seems to be a promising genotypes for future fruit fly tolerant breeding programme.

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