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Population dynamics of sucking pests in brinjal ecosystem under new gangetic alluvial zone

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Abstract
Brinjal is attacked by number of sucking insects and in our study we find four pests diversified into four different families of the order Hemiptera from the both May sown and July sown crop. The pests include whitefly, aphid, leaf hopper and mealy bug. For all the recorded pests their population was observed on weekly interval. In case of leaf hopper no significant correlation was observed in both the May and July sow crops, but highest leaf hopper population was recorded in 44th and 49th standard week (SW) respectively. Aphid population was observed highest in 35th SW for May sown brinjal and for July sown brinjal the peak population was recorded on 51st SW. Aphid was found to be negatively correlated with temperature when it is sown in July. The white fly population reached its peak in 35th and 49th SW respectively for May and July sown crops and found to be negatively correlated with temperature and rainfall. Finally, the mealy bug peak population was recorded at in 43rd and 34th SW respectively for May and July sown crop and mealy bugs are positively correlated with temperature and relative humidity.

Keywords: Brinjal, Hemiptera, whitefly, aphid, leaf hopper and mealy bug

1. Introduction
Brinjal, egg plant or aubergine (*Solanum melongena* L.) occupies a pride of place among the vegetable crops. Brinjal is popular in many countries viz., Central, South and South East Asia, some parts of Africa and Central America [1]. Brinjal is attacked by number of sucking insect pest like whitefly, aphid, leaf hopper and mealy bug. The loss caused by sucking pests varies from 10-15 percent depending on the intensity of infestation [2]. Apart from the direct damage caused by sucking the cell sap and prohibiting the normal crop growth, several of the sucking pests also act as vectors of virus diseases. Direct feeding by whitefly induced physiological disorders resulted in shedding of immature fruiting parts. Its nymphs produced honeydew, on which black sooty mould grow, reducing the photosynthetic capabilities of plants [3]. Aphids suck the cell sap and prohibit the normal crop growth. The infested plants become weak, pale and stunted in growth which consequently resulted in reduced fruit size [4]. Both nymphs and adults of the leaf hopper suck the sap from the lower leaf surfaces through their piercing and sucking mouthparts. While sucking the plant sap, they also inject toxic saliva into the plant tissues, which leads to yellowing. They are also responsible for transmission of some viral diseases in the brinjal. Mealy bugs infest the lower leaf surfaces of egg plant. The adult female had very little dorsal wax and secreted a white, waxy ovisac up to six times as long as the body of the female (Janaki *et al*., 2012).
The weather parameters such as temperature, relative humidity, rainfall influences the various growth and development stages of a crop and may also affect the distribution, development, survival, behavior, migration, reproduction, population dynamics, and outbreaks of arthropods. Information regarding seasonal activity of sucking insect pests helps in taking effective management strategies. In winter pest population is normally low due to weather conditions so losses due to insects attack are also meager but in summer with favorable weather condition population of insect increases. So in this research we use two different date of sowing in summer season to find out the differences of insect population. Keeping this in view present study was undertaken.

2. Material and Methods
The experiment was conducted at the Central Research Farm of Bidhan Chandra Krishi Viswavidyalaya, Gayeshpur, Nadia, West Bengal, using brinjal variety, “Muktokeshi” which

is popular among the farmers of the region. Seedlings of brinjal were sown on two different dates i.e., 20th May and 20th July 2015 and duration of the crop was six month from date of transplanting. The experiment was laid out in Randomised Block Design (RBD) with three replication and recommended agronomical practices. The plot size was 5m x 4m with spacing of 90 cm x 60 cm between rows and plants respectively. Observation was made at weekly intervals for the incidence of leaf hopper (population per three leaves), aphid (population per three leaves), whitefly (population per three leaves) and mealybug (population per three leaves) on five randomly selected plants from each plant during 6 a.m. to 8 a.m. From each plant top, middle and lower leaves were considered for taking observation. The weekly meteorological data (May to January) was recorded from AICRP on Meteorology, Directorate of Research, Bidhan Chandra Krishi Viswavidylaya, Kalyani, West Bengal. The correlation between insects population and weather parameters was done using SPSS version 16.0 software.

3. Result and discussion

The result revealed that there were four sucking insect pests (Table 1) from one order and four families. These include whitefly, aphid, leaf hopper and mealy bug.

3.1 Leaf hopper (*Amrasca biguttula biguttula* Ishida.): It was found that the insect was active throughout the crop season from the starting of transplanting. For May sowing crop the peak incidence was found in 44th standard week (SW) (Table 4). For July sowing crop the peak incidence was recorded in 49th (SW) (Table 5). Maximum and minimum temperature was observed during peak activity of the incidence was 32 ^{0}C and 19^{0}C for May sowing crop (Table 4) and 30 ^{0}C and 16 ^{0}C for July sowing crop (Table 5). Maximun and minimum relative humidity was 82% and 59% for May sowing crop (Table 4) and 98% and 60% for July sowing crop (Table 5). There was no significant negative correlation found with maximum and minimum temperature, humidity and rainfall for May sowing crop (Table 2) but for July sowing crop non-significant positive correlation found except maximum temperature (Table 3). A non- significant correlation of leaf hopper population with rainfall was observed by [6, 7] Recorded peak population of leaf hopper on the first week of November; coincide with the average temperature of 22.57 ^{0}C and 69.0 percent relative humidity [8]. Recorded negative association of leaf hopper with minimum temperature and rainfall. The multiple regression analysis revealed that weather parameters contributed for 19.8 and 10.6% of total variation in the incidence in May and July, respectively (Table 2 and 3).

3.2 Aphid (*Aphis gossypii* Glover.): Population of aphid was observed from 23rd (SW). The peak activity was in 35th (SW) for May sowing crop (16.50 per 3 leaves) (Table 4) and 51st (SW) for July sowing crop (19.45 per 3 leaves) (Table 5). The pest active throughout the season with a fluctuation range 0.05 to 16.50 aphid per 3 leaves for May sowing crop (Table 4) and 0.30 to 19.45 aphid per 3 leaves for July sowing crop (Table 5). The maximum and minimum temperature and relative humidity was 34 ^{0}C and 25 ^{0}C and 95 percent and 77 percent respectively during peak incidence of the insect for May sowing crop (Table 4). In July sowing crop the maximum and minimum temperature and relative humidity was 27 ^{0}C and 16 ^{0}C and 96 percent and 63 percent respectively during peak incidence of the insect (Table 5). There was no significant correlation of aphid population found for May sowing crop with weather (Table 2). These finding are in conformity with those of [8] who reported that there was no significant relationship between the population of aphid and weather parameter.

There was negative significant correlation found for July sowing crop (Table 3) with maximum and minimum temperature (r=-.687**, -.572**). This finding corroborate with those of [9] who found a significant negative correlation of maximum and minimum temperature with aphid population in okra [9]. Observed the peak population of aphid in cotton during third week of August. The multiple regression analysis revealed that weather parameters contributed for 16.7 and 61.5% of total variation in their population in May and July, respectively (Table 2 and 3).

3.3 Whitefly (*Bemisia tabaci* Genn.): Infestation was observed from 22nd (SW) for May sowing crop with population ranging from 1.05 to 2.80 whitefly per 3 leaves. The peak population was recorded 3.50 per 3 leaves (35th SW) (Table 4). In July sowing crop insects appeared 33rd SW with population ranging from 0.10 to 4.25 whitefly per 3 leaves. Peak population was found in 49th SW (Table 5). Maximum and minimum temperature was observed during peak activity of the incidence was 34 ^{0}C and 25 ^{0}C for May sowing crop (Table 4) and 30 ^{0}C and 16 ^{0}C for July sowing crop (Table 5). Maximun and minimum relative humidity was 95% and 77% for May sowing crop (Table 4) and 98% and 60% for July sowing crop (Table 5). There was non-significant negative correlation found with maximum and minimum temperature and rainfall for May sowing crop (Table 2). In July sowing crop there was significant negative correlation found with maximum and minimum temperature (r= -.607**and -.639**) rainfall(r=-.528**) and minimum relative humidity(r=-.609**) (Table 3) [10]. recorded negative significant correlation of whitefly with maximum and minimum temperature in brinjal [11]. observed that *B tabaci* was found from the first WAT (week after transplanting) and continued throughout the season. The multiple regression analysis revealed that weather parameters contributed for 33.2 and 60% of total variation in the incidence in May and July, respectively (Table 2 and 3).

3.4 Mealy bug (*Coccidohystrix insolita* Green.): Initial infestation was observed during 22nd (SW) with 0.25 mealy bugs per 3 leaves for May sowing crop. Thereafter the incidence was fluctuated but it reached its peak 91.80 mealy bugs per 3 leaves during 43rd (SW) (Table 4). Maximum and minimum temperature was 32 ^{0}C and 21 ^{0}C respectively at that time. The incidence (3.85 mealy bug per 3 leaves) was started during 34th (SW) and it was the highest population for July sowing crop (Table 5). After that the population fluctuated and became nil during 2nd (SW). The maximum and minimum temperature and relative humidity was 32 ^{0}C and 21 ^{0}C and 98 percent and 65 percent respectively during peak incidence of the insect for May sowing crop (Table 4). In July sowing crop the maximum and minimum temperature and relative humidity was 34 ^{0}C and 26 ^{0}C and 94 percent and 77 percent respectively during peak incidence of the insect (Table 5). It is found that May sowing crop exhibited the same correlation with weather parameter like aphid population with weather. But July sowing crop showed a positive significant correlation with maximum and minimum

temperature (r=.527** and. 539**), minimum relative humidity (r=.538**) and rainfall (r=.689**) (Table 3) [12]. observed that maximum temperature had positive influence on mealy bug population. The multiple regression analysis revealed that weather parameters contributed for 49.6 and 58.6% of total variation in the incidence in May and July, respectively (Table 2 and 3).

Table 1: Sucking insect pest associated with brinjal (variety-Muktokeshi) – May and July (2015) sowing crop.

Common name	Scientific name	Order:Family	Feeding site
Whitefly	*Bemisia tabaci* (Genn.)	Hemiptera: Aleryrodidae	Leaf
Aphid	*Aphis Gossypii* (Glover.)	Hemiptera: Aphididae	Leaf and flower
Leaf hopper	*Amrasca biguttula biguttula*(Ishida)	Hemiptera: Coccidellidae	Leaf
Mealybug	*Coccidohystrix insolita* (Green)	Hemiptera: Pseudococcidae	Leaf

Table 2: Correlation coefficient (r) and regression equation for insect pests of brinjal vs. weather parameters for May (2015) sowing crop.

Insect Pests	Temperature (^{0}C)		Relative Humidity (%)		Total Rainfall (mm)	R^2 (%)
	Maximum	Minimum	Maximum	Minimum		
Whitefly	-0.244 y=6.123-0.127x	-0.291 y=5.612-0.154x	0.319 y=-5.036+0.073x	0.045 y=1.478+0.005x	-0.189 y=2.014-0.003x	33.2
Aphid	-0.038 y=7.561-0.090x	-0.171 y=14.463-0.407x	0.079 y=3.193+0.082x	-0.146 y=10.172-0.075x	-0.288 y=5.590-0.020x	16.7
Leafhopper	-0.140 y=5.625-0.103x	-0.364 y=8.783-0.271x	0.037 y=1.049+0.012x	-0.193 y=4.500-0.031x	-0.236 y=2.444-0.005x	19.8
Mealybug	-0.113 y=64.958-1.435x	-0.252 y=96.174-3.249x	0.359 y=171.958+2.013x	-0.156 y=49.350-0.430x	-0.285 y=22.610-0.105x	49.6

Table 3: Correlation coefficient (r) and regression equation for insect pests of brinjal vs. weather parameters for July (2015) sowing crop.

Insect Pests	Temperature (^{0}C)		Relative Humidity (%)		Total Rainfall (mm)	R^2 (%)
	Maximum	Minimum	Maximum	Minimum		
Whitefly	-0.607** Y=7.915-0.195x	-0.639** y=4.144-0.116x	0.319 y=-9.369+0.119x	-0.609** y=5.371-0.053x	-0.528** y=2.323-0.041x	60.0
Aphid	-0.687** Y=38.611-0.982x	-0.572** y=17.437-0.461x	0.123 y=10.593+0.205x	-0.357 y=17.730-0.139x	0.113 y=8.772+0.039x	61.5
Leafhopper	-0.055 Y=2.540-0.017x	0.010 y=2.000+0.002x	0.144 y=2.901+0.052x	0.013 y=1.968+0.001x	0.098 y=1.982+0.007x	10.6
Mealybug	0.527** Y=3.951+0.158x	0.539** y=0.845+0.091x	0.065 y=-1.343+0.074x	0.538** y=-1.939+0.044x	0.689** y=0.465+0.050x	58.6

Table 4: Population dynamics of insect pests of brinjal vs. weather parameter for May (2015) sowing crop

Date of observation	Standard week	Temperature (ºC)		Relative humidity (%)		Rainfall (mm)	White fly	Aphid	Leaf hopper	Mealybug
		Max	Min	Max	Min					
27.05.2015	22	37.51	26.91	86.00	67.28	0.00	1.05	0.00	3.20	0.25
03.06.2015	23	37.41	27.64	84.42	58.42	0.00	1.25	3.75	1.95	1.25
10.06.2015	24	38.40	26.85	86.85	59.14	0.00	0.00	0.00	0.10	0.00
17.06.2015	25	33.95	22.20	90.57	71.42	33.90	1.45	0.00	0.15	6.45
24.06.2015	26	32.40	25.58	93.57	81.14	58.90	2.55	1.45	0.43	2.15
01.07.2015	27	30.78	24.25	98.85	86.14	137.80	0.05	0.08	1.75	0.00
08.07.2015	28	33.58	24.48	97.00	81.85	127.50	1.25	0.05	1.10	0.00
15.07.2015	29	33.11	24.64	97.71	90.42	275.10	1.75	0.45	1.20	1.45
22.07.2015	30	32.25	24.64	98.57	83.85	85.40	0.70	0.95	2.25	0.00
29.07.2015	31	31.44	24.10	96.42	87.85	106.10	2.95	2.10	0.50	0.10
05.08.2015	32	31.52	24.64	94.57	86.57	190.30	0.10	2.75	1.75	0.00
12.08.2015	33	34.42	25.77	91.00	76.00	0.00	1.20	3.65	2.10	0.00
19.08.2015	34	33.60	26.52	94.42	75.71	9.31	1.05	2.25	0.00	0.10
26.08.2015	35	34.21	25.17	95.57	77.71	27.40	3.50	16.50	3.20	44.00
02.09.2015	36	32.50	24.74	98.00	83.85	66.00	2.15	14.75	5.65	56.50
09.09.2015	37	34.91	24.31	95.42	69.85	33.80	3.50	13.75	4.35	38.50
16.09.2015	38	32.88	25.12	93.28	81.71	11.50	2.70	5.95	1.85	13.75
23.09.2015	39	32.24	24.65	97.57	83.85	112.10	3.40	3.65	2.05	12.85
30.09.2015	40	34.47	24.70	93.85	69.42	10.10	2.50	4.50	0.65	15.50
07.10.2015	41	34.70	24.64	93.42	69.14	0.40	1.60	6.95	3.55	35.20
14.10.2015	42	32.37	22.97	97.85	74.14	8.40	2.80	4.00	3.30	77.85
21.10.2015	43	32.20	21.84	98.28	65.00	0.00	2.75	9.35	3.20	91.80
28.10.2015	44	31.88	19.25	82.30	59.71	0.00	1.60	9.60	4.45	6.00
04.11.2015	45	30.17	19.42	96.57	67.57	0.00	2.80	2.35	3.45	3.45

Table 5: Population dynamics of insect pests of brinjal vs. weather parameter for July (2015) sowing crop

Date of observation	Standard week	Temperature (ºC)		Relative humidity (%)		Rainfall (mm)	White fly	Aphid	Leaf hopper	Mealybug
		Max	Min	Max	Min					
18.08.2015	34	33.74	26.20	94.14	77.85	9.31	0.10	0.30	0.35	0.00
25.08.2015	35	34.10	25.38	95.42	77.57	27.40	0.10	1.00	0.10	3.85
01.09.2015	36	32.58	25.20	96.85	84.00	66.00	0.10	13.50	3.25	2.45
08.09.2015	37	34.62	23.92	97.00	71.57	33.80	1.25	12.50	3.65	3.40
15.09.2015	38	33.46	25.26	93.29	77.57	0.74	1.40	9.40	2.90	1.45
22.09.2015	39	32.16	24.81	96.00	83.43	12.01	1.75	7.35	1.30	1.20
29.09.2015	40	34.16	24.16	96.00	74.57	6.34	1.25	8.55	0.70	2.00
06.10.2015	41	34.29	25.07	92.00	66.86	0.06	1.25	3.75	1.70	0.85
13.10.2015	42	32.61	23.47	97.43	74.86	1.20	1.20	3.25	2.60	0.20
20.10.2015	43	32.09	21.73	98.43	67.00	0.00	1.80	3.45	1.05	1.10
27.10.2015	44	32.09	19.89	83.59	60.00	0.00	1.15	4.95	1.75	0.05
03.11.2015	45	30.17	19.42	96.57	67.57	0.00	1.25	5.05	2.95	0.00
10.11.2015	46	31.31	18.74	97.85	52.00	0.00	3.20	5.50	2.75	0.00
17.11.2015	47	31.11	16.32	98.57	48.71	0.00	2.85	6.60	2.20	0.00
24.11.2015	48	29.90	15.67	99.00	53.71	0.00	2.60	8.20	1.65	1.15
01.12.2015	49	29.87	16.18	98.00	59.57	0.00	3.60	9.85	2.25	0.50
08.12.2015	50	28.80	16.91	98.14	60.28	0.00	4.25	15.75	4.50	0.00
15.12.2015	51	27.47	15.62	95.57	63.14	0.00	4.00	13.25	3.60	0.10
22.12.2015	52	23.51	10.62	96.57	59.00	12.90	2.95	19.45	1.20	0.05
29.12.2015	01	23.68	10.08	92.71	41.00	0.00	2.70	18.80	2.50	1.00
05.01.2016	02	25.27	9.41	95.57	54.85	0.00	3.25	15.75	1.85	0.25
12.01.2016	03	24.34	8.56	97.14	46.43	0.00	2.25	12.45	2.25	0.00
19.01.2016	04	24.33	5.79	94.14	38.71	0.00	1.85	9.45	1.50	0.00
26.01.2016	05	26.89	8.03	96.71	40.86	0.00	2.75	9.00	0.25	0.00

4. Conclusion

It is found from the observation that peak population of whitefly and aphid appeared during 35th (SW); leaf hopper and mealy bug population reached its peak during 44th and 43rd (SW) for May sowing crop. In July sowing crop whitefly and leaf hopper attained its peak during 49th (SW) and aphid during 51st (SW). One important incidence found from this observation that initial incidence of mealy bug found in July sowing crop and then it spread to May sowing crop.

Incase of leaf hopper, no significant correlation found with maximum and minimum temperature, humidity and rainfall for May sowing crop. However, July sown crop shows positive correlation for all the weather parameter except maximum temperature. Whereas, for aphid negative significant correlation was recorded in July sown crop with maximum and minimum temperature. White flies shows non-significant negative correlation found with maximum and minimum temperature and rainfall for May sown crop with addition to rainfall and relative humidity for July sown crop. Lastly, Mealy bugs show the same response like that of aphid for May sown crops but for July sown crops positive significant correlation with maximum and minimum temperature, minimum relative humidity and rainfall was observed.

The multiple regression analysis revealed that weather parameters contributed for 19.8 and 10.6% of total variation in the incidence in May and July respectively for Leaf hopper, 16.7 and 61.5% of total variation in their population in May and July respectively for aphids, 33.2 and 60% of total variation in the incidence in May and July respectively for white flies and finally, 49.6 and 58.6% of total variation in the incidence in May and July respectively for mealy bugs.

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