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Studies on population dynamics of key pests of cotton

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The present investigation was aimed to study the population dynamics of key pests of cotton. The highest population of aphids, jassids, thrips, bollworm eggs and larval population of bollworms were recorded in last week of August, 3rd week of September, last week of August, mid September and last week in November, respectively in chemical fertilizer (CF) plot. Whereas, the highest population of whitefly was observed in CF plot and CF + farm yard manure (FYM) plot. *Chrysoperla carnea* and lady bird beetles were considered for recording their population dynamics. The highest population of *Chrysoperla* and lady bird beetles were recorded in CF and CF + FYM plots during mid August and mid September. It is clearly evident from the present investigations that the population of most of the sucking pests was maximum during the initial plant growth period and it decreased towards the later crop growth stages.

Keywords: Population dynamics, cotton, *Chrysoperla carnea*, lady bird beetles.

Introduction

Cotton is a soft, fluffy staple fiber that grows in a boll, or protective capsule, around the seeds of cotton plants. It belongs to the genus *Gossypium* of *Malvaceae* family. Cotton is popularly referred as white gold in India as it plays an important role in Indian economy (USDA, ERS 2011). It is single most cash crop which is cultivated extensively throughout the world. It is an important raw material for textile industry. The cotton seeds are utilized for extraction of oil and as a valuable feed concentrate for cattle (Osti and Pandey, 2006). Annually about 26.4 million tonnes of cotton is produced in the world of which

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two third is produced in five countries. India occupies the third place (14%) after USA (19.6%) and China (20.0%) (ICAC, 2013). Global area under cotton is accounting for 2.5% of the world's arable land and the production in 2013-14 has touched the ever highest of around 110 million bales. In India, the area under cotton has reached to 117.27 lakh hectares with an estimated production of 398 lakh bales. In Maharashtra, cotton grown over an area of 38.72 lakh hectares with total production of 84 lakh bales with an average productivity of 396 kg lint / ha (CCI, 2014).

Among several factors responsible for low yield of cotton in our country, the insect pests play a vital role (Khan and Rao, 1960). Although, as many as 326 species of insect pests infesting cotton are reported, only 130 species of insect and non-insect pests were recorded on this crop in India (Sohi, 1964). In India, insect pests of cotton are responsible for 30-40% of yield loss, in addition to significant deterioration of seed and lint quality (Mustafee, 1996). In Maharashtra state, 22 insect pest species infest cotton crop at various growth stages and cause damage to the extent of 63 to 95% and about 55-60% in Marathwada region (Kulkarni, 1979). Singh and Lakra (1992) reported that cotton bollworms are very serious destructive insect pests causing damage to an extent of 36.2% besides affecting fibre and seed qualities. In Marathwada region, aphids, jassids and thrips affect the yield considerably which cause loss to the tune of 20.90 to 11.20%. Bollworms are the major factor to share the losses. The highest infestation was to the extent of 23.95% due to spotted bollworm and 33.80% due to *Helicoverpa armigera* in green bolls. Infestation of pink bollworm in locules ranged up to 20.81% and percentage of bad kapas was up to 42.80%. The loss due to bollworms was ranged from 55.60 to 63.95% in yield (Kulkarni, 1979). Important insect pests of cotton crop causing severe loss are sucking pests and bollworm complex. Among the sucking pests, aphids, jassids, thrips and whiteflies are very important and they attack the crop during its early vegetative stage. Whereas, American bollworm (*Helicoverpa armigera* Hub.), spotted bollworm (*Earias vittella*) and pink bollworm (*Pectinophora gossypiella*) are most serious during reproductive stage of the crop. American bollworm, (*Helicoverpa armigera)* has attained the status of national pest (Sharma and Jalan, 1997). The bollworms usually damage the fruiting bodies like buds, flowers and immature bolls.

In the above pretext, knowledge of population dynamics of these pests is very much necessary. This investigation was undertaken to study the seasonal incidence of sucking pests and bollworms on cotton, as well as the effect of chemical fertilizer (CF), farm yard manure (FYM) and their combination on the incidence of cotton pests.

Materials and methods

The field experiment was conducted to know the population dynamics of key pests on cotton var. PHH 316. It was conducted during the kharif season of 2004-2005 at experimental fields of Cotton Research Station, Marathwada Agricultural University, Parbhani.

Climatic condition

Parbhani has subtropical climate and is situated on 408.50 m above mean sea level. It lies between 18° 58' to 20° 2' North latitude and 76° 4' to 77° 42' East longitude. The mean annual rainfall is about 829.38 mm in 61 rainy days mostly during June to September. The rainfall is assured for kharif and rabi crops. The mean maximum temperature vary from 28.7°C during December to 41.2 °C in May. The mean minimum temperature vary from 11.32 °C to 25.77 °C in winter and summer respectively. Summer is hot and dry while winter is cool. The relative humidity ranges from 30 to 90%.

Soil characteristics

All the experiments were conducted on well drained clay soils. The depth of the soil varied from 2 to 3 metres.

Experimental details

This experiment was conducted in unprotected 5 different plots with size 10 m x 5 m each which was non replicated one. The cotton variety used was PHH-316.

Details of plots

Plot 1: Recommended dose of chemical fertilizers for studying sucking pest population dynamics, Plot 2: Recommended dose of chemical fertilizers for studying bollworm population dynamics, Plot 3: CF + FYM for both sucking pests and bollworms, Plot 4 : FYM for both sucking pests and bollworms @ 5 t/ha and Plot 5 : Control for both sucking pests and bollworms.

Sampling and collection of experimental data

Twenty plants were randomly selected from each plot and the observations were recorded on these plants.

Population of sucking pest complex

Populations of aphids, jassids, thrips and whiteflies were recorded at weekly interval from 3 leaves (top, middle and bottom canopy) on the randomly selected plants.

Infestation of bollworm complex

All the shed material (squares, flowers, bud, bolls, etc.) were collected at weekly interval and observed for infestation. Infested shed material was separated from healthy one and percentage of infestation was worked out. The observations were also recorded on number of bollworm eggs/plant, besides counting the number of larvae/plant in different plots. The data so obtained was compared among different plots receiving different kind of nutrient sources to see the effect of the same on the infestation.

Statistical analysis

Observations on population of aphids, jassids, thrips and whiteflies were subjected to $\sqrt{x + 0.5}$ transformation and the data on per cent infestation by bollworms were transformed into angular transformation values before statistical analysis. The data were statistically analysed by standard analysis of variance method for Randomised Block Design and treatments were compared by using 'F' test (Panse and Sukhatme, 1967).

Results and Discussion

Cotton is an important commercial crop in India and occupies prime position in our agro-industrial economy. The crop is grown over 8.0 million hectares in India but with a yield well below other countries. Cotton is damaged by a large number of insect pests causing losses upto 87% in seed cotton yield (Taley et al., 1988). Insect pests are well known as the major constraint to crop production. One of the problems in addressing pest management is inadequate knowledge about the factors influencing pest population dynamics. To understand pest dynamics, scientists collect pest surveillance data and related agricultural operations regarding crops, farming practices and other weather parameters. Population dynamics play an importat role in sustainable integrated pest management module for the insect pest control in cotton crop (Fakhri and Jamal, 2012).

Population dynamics of key pests of cotton

The observations on population fluctuations of aphids, jassids, thrips and whiteflies are presented in Tables 1-4. The first appearance of aphids, thrips and whiteflies was recorded during 32nd meteorological week (MW), whereas that of jassids was recorded during 34th meteorological week (MW) in different treatments.

Population of aphids

Aphids, once a secondary pest in cotton are now a major problem for growers in some regions of the world (Wilson et al., 2008). The data presented in Table 1 showed that the highest incidence (41.4/3 leaves) of aphids was noticed in plot applied with chemical fertilizers during 36th MW. In case of control plot, the highest incidence (25.8/3 leaves) was noticed during 37th MW. In general, aphid population increased during initial plant growth period (August) in all plots and then it decreased towards the reproductive stage of the crop. The 2nd peak was observed during 43rd MW (2nd fortnight of October).

The first appearance of aphids was noticed during 32nd MW in all the plots when temperature (maximum) and rainfall were 30.5 °C and 11.5 mm respectively. The maximum aphid population was noticed in CF plot (41.4 aphids/3 leaves) during 36th MW. In general, the aphid population decreased as the crop growth advanced. No aphids were recorded during 45th MW in CF, FYM and control plots when there was a rainfall of about 52.9 mm.

Table 1. Population dynamics of aphids on cotton var. PHH 316

Obs No.	Met. Week	Treatments			
		No. of aphids/3 leaves			
		CF	FYM	CF + FYM	Control
1	32	19.6	7.2	20.2	5.4
2	33	15.6	13.6	10.8	14.4
3	34	18.4	13.2	11.0	15.2
4	35	21.2	13.2	13.2	12.2
5	36	41.4	27.6	32.2	21.4
6	37	35.00	25.6	31.2	25.8
7	38	18.60	17.4	16.60	16.60
8	39	9.80	8.80	7.0	5.60
9	40	4.40	5.60	1.80	1.00
10	41	1.0	0.8	2.4	0.0
11	42	1.8	2.4	2.2	1.2

12	43	3.4	2.8	2.2	0.6
13	44	2.4	0.6	0.2	1.6
14	45	0.0	0.0	1.4	0.0
15	46	0.6	0.4	0.6	0.2
16	47	1.2	0.6	1.6	0.8
17	48	3.2	1.8	3.0	2.4
Average		**1.25**	**0.70**	**1.65**	**0.85**
Grand mean		**11.62**	**8.33**	**9.27**	**7.32**

Population of jassids

The jassid attacks cotton crop from germination to harvest. Jassid *Amrasca biguttula* deposits its eggs inside veins of the leaves and pesticides can hardly reach them whereas the parasitoids are able to locate their target. They seem promising in controlling jassids (Sahito et al., 2010). It is evident from the data presented in Table 2, that the highest population (2.8/3 leaves) of jassids was recorded during 39th MW in the chemical fertilizer applied plot. The population of jassids in FYM plot was also higher (2.2/3 leaves) during 39th MW. Whereas, in case of CF + FYM plot and control the highest populations (1.8/3 leaves and 1.2/3 leaves, respectively) were recorded during 40th MW and 38th MW, respectively. In all the plots it is observed that mean populations of jassids was more during September. The second peak (2.2, 1.4, 1.6 and 1.0/3 leaves in CF, FYM, CF + FYM and control, respectively) was recorded during last week of November. In general, the jassid population was below ETL in all the plots throughout the season. The highest population of jassids in the present investigations were recorded from CF plot (2.8/plant) during 39th MW and this was followed by FYM plot (2.2/plant) during the same week (2nd fortnight of September). The first appearance of jassids was noticed during 34th MW.

Population of thrips

The population of thrips was very much high during late August (79.2, 72.0, 66.2 and 65.4/3 leaves, respectively) in all treatments viz., chemical fertilizer (CF) plot, FYM plot, CF + FYM plot and control plot. Afterwards, it decreased to nil in all the plots during 46th MW (2nd week of November). The data presented in Table 3 showed that highest thrips population was recorded in CF plot (79.2/3 leaves) during 36th MW followed by FYM plot (72.0/3 leaves), CF + FYM plot (66.2/3 leaves) and control plot. During the whole season CF plot recorded highest mean (16.54/3 leaves) thrips population.

Table 2. Population dynamics of jassids on cotton var. PHH 316

Obs No.	Met. Week	Treatments			
		No. of jassids/3 leaves			
		CF	FYM	CF + FYM	Control
1	32	0	0	0	0
2	33	0	0	0	0
3	34	0.2	0	0.2	0
4	35	0.4	0	0.2	0.2
5	36	0.4	0.2	0.2	0.6
6	37	2.2	1.4	1.6	1.0
7	38	1.6	0.4	1.4	1.2
8	39	2.8	2.2	1.4	0.4
9	40	1.4	1.2	1.8	0.4
10	41	0.6	0.4	0.8	0.6
11	42	0.8	0.6	0.8	0.6
12	43	0.2	0.2	0	0.4
13	44	0.2	0.0	0.0	0.0
14	45	0.4	0.2	0.0	0.0
15	46	0.6	0.4	0.6	0.0
16	47	1.4	0.8	0.8	0.2
17	48	2.2	1.4	1.6	1.0
Average		**1.15**	**0.70**	**0.75**	**0.30**
Grand mean		**0.90**	**0.55**	**0.67**	**0.39**

Table 3. Population dynamics of thrips on cotton var. PHH 316

Obs No.	Met. Week	Treatments			
		No. of thrips/3 leaves			
		CF	FYM	CF + FYM	Control
1	32	10.6	6.80	6.4	4.6
2	33	21.0	18.60	14.8	9.8
3	34	39.8	23.2	28.4	22.8
4	35	54.8	37.6	32.8	26.8
5	36	79.2	72	66.2	65.4
6	37	43.2	34.6	40.6	37.8
7	38	16.6	15.8	14	10.6

8	39	7.2	5.2	4.8	3.8
9	40	2.0	1.4	2.6	0.8
10	41	1.4	1.0	0.6	0.6
11	42	2.2	0.4	1.8	0.6
12	43	0.6	0.0	0.2	0.0
13	44	1.0	0.6	0.2	0.0
14	45	0.0	0.2	0.0	0.0
15	46	0.0	0.0	0.0	0.0
16	47	0.2	0.0	0.4	0.2
17	48	1.4	1.0	0.6	0.6
Average		**0.40**	**0.30**	**0.25**	**0.20**
Grand mean		**16.54**	**12.85**	**12.61**	**10.85**

Population of whiteflies

The population of whitefly was recorded and presented in Table 4. It was observed that incidence of whitefly was first noticed on 32nd MW and it increased upto 39th MW. The highest incidence was noticed during 46th and 47th MW in CF plot (3.2/3 leaves), 47th MW in CF + FYM (3.2/3 leaves) and FYM plot (1.8/3 leaves). In control plot it was highest (2.8/3 leaves) during 45th MW. In general, more whitefly incidence was observed in CF plot followed by CF + FYM plot, control and FYM plot. The later plant growth period recorded highest whitefly population in all the plots.

Table 4. Population dynamics of whiteflies on cotton var. PHH 316

Obs No.	**Met. Week**	**Treatments**			
		No. of whiteflies/3 leaves			
		CF	**FYM**	**CF + FYM**	**Control**
1	32	0.2	0.2	0.0	0.2
2	33	0.2	0.0	0.2	0.0
3	34	0.2	0.2	0.2	0.0
4	35	0.2	0.2	0.2	0.0
5	36	0.6	0.2	0.4	0.4
6	37	0.8	0.0	0.0	0.4
7	38	1.4	0.6	1.0	0.0
8	39	2.2	1.4	2.2	0.6
9	40	1.0	1.4	2.4	0.2
10	41	2.4	1.6	2.6	2.0
11	42	2.2	1.0	2.4	2.4
12	43	1.8	0.8	2.6	1.0

13	44	2.4	1.2	1.8	0.6
14	45	3.0	1.6	2.4	2.8
15	46	3.2	1.6	2.8	2.4
16	47	3.2	1.8	3.2	2.6
17	48	2.6	1.4	2.8	1.8
Average		**3.00**	**1.6**	**2.8**	**2.4**
Grand mean		**1.62**	**0.89**	**1.60**	**1.02**

Number of bollworm eggs

As per the data presented in Table 5, the first appearance of bollworm eggs was noticed during 35th MW in all the plots. The maximum number of eggs (6/plant) were recorded in CF plot followed by FYM plot (5.4/plant), control (5.2/plant) during 38th MW. The CF + FYM plot recorded highest number of bollworm eggs (4.6/plant) during 39th MW. Number of eggs/plant decreased towards the remaining growth period of the crop. During 48th MW the 2nd peak of bollworms eggs was noticed in all the treatments (0.8, 0.6, 0.8 and 0.6 eggs/plant in CF, FYM, CF + FYM and control plots, respectively).

Table 5. Number of bollworm eggs on cotton var. PHH 316

Obs No.	**Met. Week**	**Treatments**			
		No. of eggs/plant			
		CF	**FYM**	**CF + FYM**	**Control**
1	35	1.2	1.2	1.6	1.2
2	36	0.4	0.0	0.4	0.0
3	37	2.2	2.4	1.6	1.6
4	38	6.0	5.4	3.8	5.2
5	39	4.0	2.0	4.6	2.8
6	40	0.2	0.6	0.6	0.2
7	41	0.4	0.2	1.2	0.6
8	42	2.0	0.2	0.6	0.8
9	43	0.8	0.6	0.0	0.0
10	44	0.0	0.0	0.0	0.0
11	45	0.0	0.0	0.0	0.0
12	46	0.0	0.0	0.0	0.0
13	47	0.4	0.2	0.6	0.4
14	48	0.8	0.6	0.8	0.6
Average		**0.30**	**0.20**	**0.35**	**0.25**
Grand mean		**1.31**	**0.96**	**1.10**	**0.96**

Population of bollworm larvae

The data on population of bollworm larvae in cotton was recorded and presented in Table 6. The highest larval population was recorded in CF plot (1.2/plant) during 48th MW followed by CF + FYM plot (1.0/plant) during 36th and 48th MW. The lowest larval population (0.00/plant) was recorded in all plots during 42nd MW. In general, the larval population reached 2 peaks during 36th MW and 48th MW. The lowest mean larval population was recorded in control plot (0.23/plant).

Table 6. Population of bollworm larvae on cotton var. PHH 316

Obs No.	Met. Week	Treatments			
		No. of larvae/plant			
		CF	FYM	CF + FYM	Control
1	35	0.6	0.2	0.8	0.2
2	36	1.0	0.8	1.0	0.8
3	37	1.0	0.4	0.2	0.4
4	38	0.0	0.0	0.0	0.0
5	39	0.2	0.2	0.0	0.0
6	40	0.2	0.2	0.0	0.0
7	41	0.0	0.2	0.0	0.0
8	42	0.0	0.0	0.0	0.0
9	43	0.6	0.4	0.4	0.2
10	44	0.4	0.0	0.4	0.2
11	45	0.0	0.0	0.0	0.0
12	46	0.6	0.4	0.6	0.4
13	47	0.6	0.8	0.8	0.4
14	48	1.2	0.8	1.0	0.6
Average		**0.60**	**0.50**	**0.60**	**0.35**
Grand mean		**0.46**	**0.31**	**0.33**	**0.23**

Per cent bollworm infestation in fruiting bodies

The highest bollworm infestation was recorded in CF plot (88.89%) during 37th MW followed by CF + FYM plot (65%), control plot (60.71%) during 37th MW and 36 MW, respectively and the obtained data are presented in Table 7. The infestation percentage increased during 36th to 37th MW and then it decreased to the lowest (0.55, 0.00, 2.48 and 0.0% in CF, FYM, CF + FYM and control plots, respectively) during 45th MW. Again the increasing infestation trend was observed towards later stages of crop growth period. The

results of present investigation showed the maximum (88.89%) bollworm infestation in fruiting bodies during 37th MW in CF plot. The heavy rainfall was recorded during this period, and the infestation was also found to be more in remaining plots.

Table 7. Per cent bollworm infestation in fruiting bodies on cotton var. PHH 316

Obs No.	Met. Week	Treatments % infestation			
		CF	**FYM**	**CF + FYM**	**Control**
1	35	46.88	14.28	32.30	33.33
2	36	68.57	47.83	63.63	60.71
3	37	88.89	34.62	65.00	33.33
4	38	25.93	0	0	0
5	39	14.29	13.11	8.79	11.11
6	40	9.10	6.45	1.60	5.95
7	41	6.66	1.52	3.26	1.03
8	42	4.66	2.97	3.37	1.30
9	43	3.70	2.09	2.49	1.37
10	44	1.47	0.0	1.70	0.74
11	45	0.55	0.0	2.48	0.0
12	46	22.22	9.89	12.53	6.25
13	47	14.52	12.50	8.97	8.57
14	48	20.33	16.40	18.38	13.41
Average		**14.41**	**9.70**	**10.59**	**7.06**
Grand mean		**23.41**	**8.22**	**16.04**	**12.62**

Per cent bollworm infestation in shed material

The highest incidence (100%) of bollworm infestation was recorded in all the four plots during 35th 37th and 38th MW. This is evident from Table 8. Chemical fertilizer plot recorded cent per cent bollworm infestation in shed material during 36th, 40th and 42nd MW also. The lowest mean (27.62%) bollworm infestation in shed material was observed in FYM plot during November. Overall data in the table revealed decreasing trend towards final crop growth period. The present findings revealed that the per cent infestation of bollworm in shed material was maximum (100%) in all the plots during 35th

to 38th MW, but the maximum infestation frequency was noticed in the plot receiving only CF.

Table 8. Per cent bollworm infestation in shed material on cotton variety. PHH-316

Obs No.	Met. Week	Treatments % infestation			
		CF	**FYM**	**CF + FYM**	**Control**
1	35	100	100	100	100
2	36	100	96.15	96.42	96.88
3	37	100	100	100	100
4	38	100	100	100	100
5	39	75	37.5	75	70
6	40	100	91.67	72.72	88.89
7	41	72.72	37.5	70.0	54.54
8	42	100	46.67	66.67	61.90
9	43	60.00	50.00	48.15	50.00
10	44	57.89	57.89	47.62	68.75
11	45	46.43	28.57	45.16	41.38
12	46	42.10	29.17	32.50	20.83
13	47	41.94	23.08	48.15	44.44
14	48	44.58	29.64	52.36	38.79
Average		**43.76**	**27.62**	**44.54**	**36.36**
Grand mean		**74.33**	**59.14**	**68.19**	**66.89**

Population dynamics of natural enemies in cotton

Population of Chrysoperla carnea

The data recorded and presented in Table 9, revealed that highest (2.4/plant), *Chrysoperla carnea* were recorded in CF + FYM plot during 38th MW followed by FYM plot (1.8/plant) during the same week. But, the mean population of *Chrysoperla* (1.05/plant) was more in CF plot during September and lowest mean population (0.00/plant) was recorded in control during November. In general, the population of the natural enemy decreased towards terminal crop growth period. The present findings revealed that mean

maximum population of *Chrysoperla* (1.05/plant) was noticed in chemical fertilizer plot. But the highest Aphid lion population was recorded in CF + FYM plot (2.4/plot). The highest population of *Chrysoperla* in general was recorded in September. CF plot recorded highest *Chrysoperla* population during whole crop growth period.

Table 9. Population dynamics of *Chrysopa* on cotton var. PHH 316

Obs No.	Met. Week	Treatments			
		No. of *Chrysopa*/plant			
		CF	**FYM**	**CF + FYM**	**Control**
1	32	0.0	0.0	0.0	0.0
2	33	0.0	0.0	0.0	0.0
3	34	0.4	0.4	0.2	0.2
4	35	0.2	0.2	0.2	0.0
5	36	0.6	0.0	0.4	0.0
6	37	1.6	0.6	0.4	0.2
7	38	0.8	1.8	2.4	0.2
8	39	1.4	0.6	1.2	1.4
9	40	0.4	0.2	0.0	0.4
10	41	0.2	0.4	0.6	0.8
11	42	0.8	0.6	1.2	0.4
12	43	0.2	0.2	0.0	0.0
13	44	0.0	0.0	0.0	0.0
14	45	0.0	0.0	0.0	0.0
15	46	0.0	0.0	0.0	0.0
16	47	0.0	0.2	0.0	0.0
17	48	0.4	0.9	0.2	0.0
Average		**0.1**	**0.05**	**0.05**	**0.0**
Grand mean		**0.41**	**0.32**	**0.40**	**0.21**

Population of lady bird beetles

The ladybird beetle, Eriopis connexa (Germar) (Coleoptera: Coccinellidae), is one of the commonest predators of aphids (Hemiptera: Aphididae) in the cotton agroecosystem and in many other row and fruit crops (Spíndola et al., 2013). The data of population of lady bird beetle are presented in Table 10. This data showed that lady bird population was high in the initial stage (August) of crop growth and decreased as the crop attained its

reproductive stage and after that. The highest number (1.00/plant) of the natural enemy were recorded in CF plot and CF + FYM plot during 34th MW. Control plot showed lowest lady bird beetle population throughout the season.

Table 10. Population dynamics of lady bird beetle on cotton var. PHH 316

Obs No.	Met. Week	Treatments			
		No. of ladybird beetle/plant			
		CF	FYM	CF + FYM	Control
1	32	0.0	0.8	0.8	0.8
2	33	0.8	0.6	0.0	0.0
3	34	1.0	0.2	1.0	0.0
4	35	0.6	0.2	0.0	0.0
5	36	0.8	0.4	0.0	0.0
6	37	0.6	0.0	0.4	0.0
7	38	0.2	0.4	0.8	0.4
8	39	0.6	0.4	0.6	0.2
9	40	0.4	0.6	0.0	0.2
10	41	0.4	0.2	0.4	0.0
11	42	0.4	0.2	0.4	0.0
12	43	0.4	0.0	0.6	0.2
13	44	0.0	0.2	0.2	0.0
14	45	0.0	0.0	0.2	0.0
15	46	0.2	0.2	0.0	0.0
16	47	0.0	0.0	0.0	0.0
17	48	0.4	0.2	0.4	0.2
Average		**0.15**	**0.10**	**0.15**	**0.05**
Grand mean		**0.40**	**0.27**	**0.34**	**0.11**

Conclusion

The present investigation clearly confirmed that the population of most of the sucking pests is maximum during the initial plant growth period and it decreased towards the later crop growth stages. Chemical fertilizers alone increased the susceptibility of seedlings to the attack of these pests. Luxurious growth of plants on application of only chemical fertilizers attracted large populations of sucking pests and adult bollworm moths, besides rendering the plants more susceptible to their attack. Highest sucking pest population attracted more number of natural enemies.

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