ABUNDANCE AND FLUCTUATION PATTERN OF INSECT PESTS AND NATURAL ENEMIES IN WINTER BRINJAL PLANT IN SYLHET

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ABSTRACT

A field experiment was conducted to study the seasonal incidence and fluctuation pattern of different insect pests and their natural enemies in winter brinjal grown in the experimental farm of Department of Entomology, Sylhet Agricultural University, Sylhet during October 2019 to March 2020. Observation was made in natural condition i.e.; no plant protection measures was taken. The counting of individual arthropod was performed by using visual searching. Eleven arthropod species were observed out of which 6 were insect pests (7 families under 3 orders) and 5 were natural enemies (10 families, 5 orders). The aphid (*Aphis gossypii* Glover), brinjal shoot and fruit borer (*Leucinodes orbonalis* Guenee), jassid (*Amrasca biguttula biguttula*), whitefly (*Bemicia tabaci* Genn.), epilachna beetle (*Epilachna vigintioctopunctata* Fab., *Epilachna dodecastigma* Most.), and leaf roller (*Anobata olevacea*) were observed as insect pests of brinjal field. Among the natural enemies, ladybird beetles (*Micraspis crocera* Muls., *Menochilus sexmaculatus*), spiders (*Lycosa pseudoannulata, Oxyopes javanus, Atypena formosana*), black ant (*Camponotus compressus*), dragonflies (*Crocothemis servilia*) were common. The total number of phytophagous insect was 2508 and their relative abundance was observed as aphid (15.31%) > epilachna beetle (10.06%) > leaf roller (7.39%) > jassid (6.30%) > whitefly (5.05%) > brinjal shoot and fruit borer (0.64%). On the other hand, the total number of all beneficial arthropods were 3093 and their relative abundance was found as ladybird beetle (40.22%) > black ant (10.65%) > dragonfly (1.55%) > spider (1.42%) > preying mantid (1.35%). Consequently, the highest number of Aphid (5.80), epilachna beetle (6.60), leaf roller (3.50), jassid (3.40) and whitefly (3.40) was found at 140 days after transplanting (DAT) on 170 days after sowing (DAS) while binjal shoot and fruit borer (0.45) was found at 130 DAT on 160 DAS. Subsequently, the highest number of ladybird beetle (13.85), black ant (4.0), dragonfly (1.15), spider (0.9) and preying mantid (0.95) was observed at 140 DAT on 170 DAS. Proper knowledge and monitoring of seasonal incidence and fluctuation of pest population and status of natural enemies are essential to manage the insect pest of brinjal.

Keywords: Seasonal incidence, *Solanum melongena,* phytophagous pests and beneficial arthropods

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INTRODUCTION

Brinjal *(Solanum melongena* L.), is commonly known as eggplant or aubergine is a plant belongs to the family Solanaceae. Among the vegetables, brinjal is the most popular and principal vegetable crop and it is regarded as "King of vegetables" (Kadgonkar *et al.* 2018). It is one of the widely used vegetable crops and economically important vegetable among small-scale farmers and low-income consumers of South Asia and this region accounts for nearly 60% and 53% of world's area and production, respectively. It is grown in many countries viz., Central South and South East Asia, some parts of Africa and Central America. It is native to Indian sub-continent and is grown throughout the country (Harish *et al.* 2011).

In the world, brinjal occupies an area of 1.72 m ha with a production of 43.17 m MT with an average productivity of 25 MT ha^{-1} (FAOSTAT 2011). In Bangladesh, over 1,15,424 hectare of total cultivable land is devoted to brinjal cultivation (BBS 2011 and 2019) and covers about 15% of the total vegetable area of the country (Rahman 2005) with an average yield of 6.03 ha^{-1} (Anon. 2009). But this production is insufficient to fulfill the nutritional requirements of the people.

Like any other crops, brinjal is subjected to attack by number of insect pests at various growth stages, which affects the cultivation of brinjal and act as a limiting factor in the profitable cultivation of this crop. The crop is attacked by about 140 species of insect and non-insect pests belonging to 50 families**.** Out of which numerous insect pests viz. the major ones are brinjal shoot and fruit borer (*Leucinodes orbonalis* Guenee), Epilachna beetle (*Epilachna vigintioctopunctata*), aphid (*Aphis gossypii* Glover), whitefly (*Bemicia tabaci* Genn.), jassid, (*Amrasca biguttula biguttula* Ishida), and the minor ones are leaf roller (*Antoba olevacea*).The natural enemies are ladybird beetle (*Micraspis crocera* Muls, *Menochilus sexmaculatus*), spiders (*Lycosa pseudoannulata*, *Oxyopes javanus, Argiope catenulate, Atypena formosana*), black ant (*Camponotus compressus*), dragonfly (*Crocothemis servilia*) have been reported these species play a vital role in reducing pest population which is free living organisms in brinjal field. Predator both their immature and adult stages of about 167 families of 14 orders are reported (Shepard *et al.* 1987).

The production losses caused by brinjal pests vary from season to season depending upon environmental factors. Different biotic and abiotic factors *viz*. temperature, climate change, relative humidity etc. are changing the insect-pests scenarios. Pest abundance and distribution changes with abiotic factors and therefore

weather elements play a crucial role in the biology of any insect-pest. Temperature and Relative humidity is the most vital abiotic factor influencing the rate of growth and development of any organism and is especially important for insect pests incidence. The impact of weather elements on pest is usually confounded (Narendra Reddy *et al.* 2001). Therefore, the present research work was under taken to know the seasonal abundance of different insect pests and natural enemies in brinjal ecosystem in winter season.

MATERIALS AND METHODS

Experimental site, duration and brinjal cultivation: This research was conducted during Rabi season, 2019-2020 in the experimental field of the Department of Entomology, Sylhet Agricultural University (SAU), Tilagorh, Sylhet. Seedlings of the brinjal variety BARI Begun-7 were collected from the Horticultural Research Center (HRC), Sylhet Sadar. The land was first opened by spade at 20 days before transplanting. Thereafter, the land was prepared thoroughly by ploughing followed by laddering to have a good tilth. Weeds and debris of previous crops were removed and the land was finally prepared with the addition of basal dose of cow-dung manures. The recommended doses of manure and fertilizers were applied in three splits (Rashid 1999). Thirty days old seedlings were transplanted in the well prepared experimental plots. A total of 240 seedlings were planted in 20 plots @ 12 seedlings plot^{-1}. The whole field was divided into 5 blocks of equal size having space of 2 meters between blocks and 0.5 meters between plots. The unit plot size was 3m x 2.5m accommodating 12 plants plot^{-1}. The distance between the plants maintained at 50 cm. In this experiment, no plant protection measures were taken. Irrigation was applied on newly transplanted seedling. Gap fillings were done with fresh and healthy seedling. Irrigation was applied as and when needed. Four weeding were done. Harvesting was done manually after 90 days of transplanting.

Monitoring and data collection of the insect pests and natural enemies: Arthropods species viz., insect pests were collected by visual searching method and counted from a random sample of 5 plants taken from each plot. In every stages (vegetative, flowering and reproductive), six leaves of each plant were chosen randomly two from the bottom (older leaves), two from the middle and two from the top canopy (younger leaves) plot^{-1}. Counting was done at morning to find the natural enemies with other insects. The observed data were recorded over the season and average was calculated to provide an overall mean density plot^{-1}. The population

density of each insect pest was expressed as number of individuals per 6 leaves of the plant. The population of ladybird beetle (grubs & adults), spiders, black ants, nymphs and larvae of insects on brinjal plants, were counted from 6 randomly selected leaves of 5 plants. Data were observed and collected at ten days intervals throughout the cropping season.

Relative abundance: Relative abundance is the percent composition of an organism of a particular kind relative to the total number of organisms in the area (Angelo and Canencia 2016). Relative abundance was calculated using formula:

$$\text{Relative abundance (\%)} = \frac{\text{Total no. of each species}}{\text{Total no. of all species}} \times 100$$

RESULTS AND DISCUSSION

Harmful arthropods species

In whole cropping season during October 2019 to March 2020 total 6 insect pest species were recorded from 6 families under 3 orders (Table 1). Observed insect pests species belong to the orders Homoptera, Coleoptera and Lepidoptera.

Table 1. List of harmful insect pests observed in winter brinjal field during October 2019 to March 2020

Sl.	Common Name	Scientific Name	Order	Family
1.	Epilachna beetle	*Epilachna 28-punctata* Fab. *Epilachna 12-punctata*	Coleoptera	Coccinellidae
2.	Brinjal shoot and fruit borer	*Leucinodes orbonalis* Guen.	Lepidoptera	Pyralidae
3.	Aphid	*Aphis gossypii* Glover	Homoptera	Aphididae
4.	Jassid	*Amrasca biguttula*	Homoptera	Cicadillidae
5.	Leaf roller	*Antoba olevacea*	Lepidoptera	Noctuidae
6.	Whitefly	*Bemicia tabaci (Genn.)*	Homoptera	Aleyrodidae

The comparative population density of different insect pests in brinjal agro-ecosystem during October 2019 to March 2020 is shown in Fig. 1. Aphid most frequently occurred during the study period. Epilachna beetle was ranked second followed by leaf roller, jassid, whitefly and brinjal shoot and fruit borer. Therefore, it was evident that the sucking insect pests such jassid, white fly and aphid occupied the top position in the brinjal agro ecosystem. Although the frequency of BSFB

larvae was ranked 6th (Figure 1) in the field, it was the major insect pest of brinjal reported by Saimandir and Gopal (2012).

Population abundance of phytophagous insect in the brinjal during winter season: The total number of harmful insect pests in the brinjal ecosystem during winter in 2019-2020, was in the decreasing rank order of aphid (858) > epilachna beetle (564) > leaf roller (414) > jassid (353) > whitefly (283) > brinjal shoot and fruit borer (36) (Figure 1).

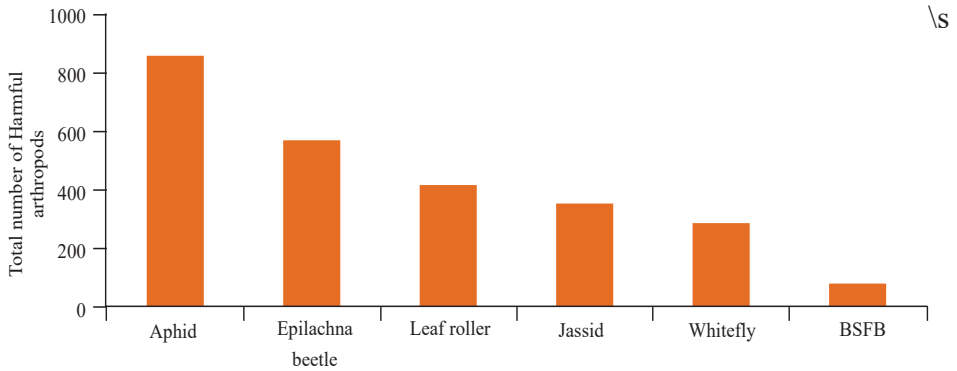


Fig. 1. Phytophagous insect species observed in the winter brinjal during October 2019 to March 2020

Natural enemy species: The natural enemy species in brinjal ecosystem are shown in Table 2. Total 5 predacious arthropods species were recorded from 7 families under 5 orders of insects and arachnid of spiders. Observed species belong to the orders Coleoptera, Odonata, Dictyoptera, Hymenopera, and Araneae. Five different species of spiders were found in three families of Lycosidae, Oxyopidae, Linyphiidae.

Table 2. List of natural enemy species recorded from brinjal field during October 2019 to March 2020

Sl.	Common Name	Scientific Name	Order	Family
1.	Ladybird beetle	*Micraspis crocea* Muls.	Coleoptera	Coccinellidae
2.	Dragonfly	*Crocothemis servilia*	Odonata	Aeshnidae
3.	Black ant	*Camponotus compressus*	Hymenoptera	Formicidae
4.	Lynx spider	*Oxyopes javanus*	Araneae	Oxyopidae
	Wolf spider	*Lycosa pseudoannulata*	Araneae	Lycosidae
	Dwarf spider	*Atypena formosana*	Araneae	Linyphiidae
5.	Preying mantids	*Stagmomantis carolina*	Dictyoptera	Mantidae

Single beneficial arthropod species was recorded from each family of Coccinellidae, Aeshnidae, Formicidae and Mantidae under the orders Coleoptera, Odonata, Hymenoptera and Dictyoptera, respectively (Table 2).

Population abundance of natural enemies species in the brinjal during winter season: The total number of each natural enemies observed in the brinjal agro ecosystem during winter in 2019-2020, was in the declining rank order of Ladybird beetle (2253) > Black ant (597) > Dragonfly (87) > Spider (80) > Preying mantid (76) (Figure 2).

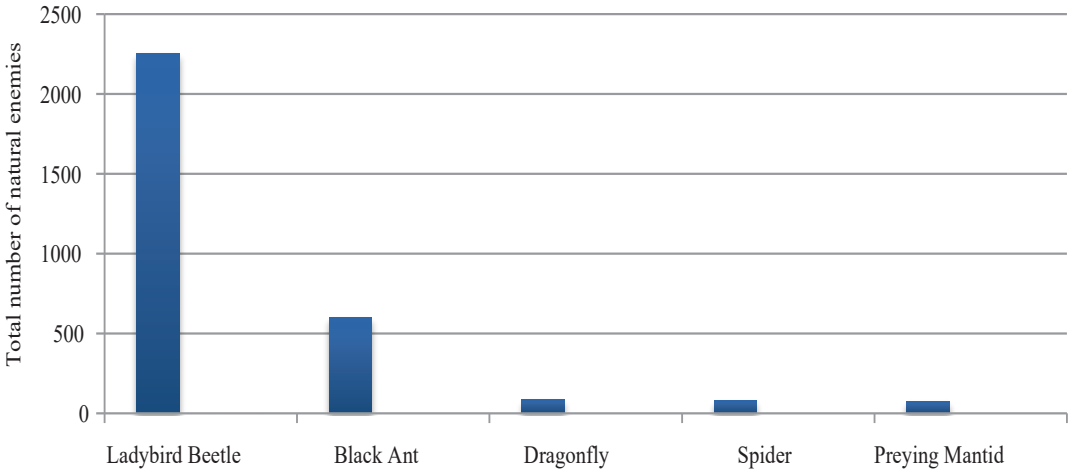


Fig. 2. Total number of natural enemy species observed in the winter brinjal during October 2019 to March 2020

Relative abundance of phytophagous insect pests and natural enemies in brinjal agro ecosystem : The relative abundance of insect pests in brinjal ecosystem during October 2019 to March 2020 was in the declining rank order of aphid (15.31%) > epilachna beetle (10.06%) > leaf roller (7.39%) > jassid (6.30%) > whitefly (5.05%) > brinjal shoot and fruit borer (0.64%) (Table 3). Similarly the relative abundance of natural enemies in brinjal ecosystem followed the rank order of ladybird beetle (40.22%) > black ant (10.65%) > dragonfly (1.55%) > spider (1.42%) > preying mantid (1.35%) (Table 3).

Table 3. Relative abundance of insect pests and natural enemies in the brinjal field during October 2019 to March 2020

Insects	Total no. of each arthropods	Relative abundance (%)
	Phytophagous	
Jassid	353	6.30
Whitefly	283	5.05
Aphid	858	15.31
BSFB	36	0.64
Epilachna beetle	564	10.06
Leaf roller	414	7.39
Total	2508	44.75
	Natural enemies	
Spider	80	1.42
Black ant	597	10.65
Ladybird beetle	2253	40.22
Dragonfly	87	1.55
Preying mantid	76	1.35
Total	3093	55.19

Note: Total no. of all arthropods = 5601

The study on the relative abundance of insect pest and their natural enemies in brinjal found scanty in Bangladesh. Higher values of the relative abundance don't indicate the mode of damage of the crop. Here, the relative abundance of BSFB (0.64%) was lower as compared to that of aphid (15.31%) which was too high but differ from the study of Choudhury *et. al.* (2016).

Incidence and fluctuation pattern of different arthropods in brinjal agro ecosystem Incidence and fluctuation of jassid, whitefly and aphid : Infestation of jassid on brinjal plant started from at 30 days after transplanting (DAT) i.e., 60 days crop age, on 13 November, 2019 2.00 jassids per 6 leaves were found and their population increased. The highest population (6.47 jassids per 6 leaves) at 140 DAT on 03 March, 2020 but the lowest population (1.14 jassids per 6 leaves) found at 60 DAT on 13 December, 2019 (Table 4). The highest population (6.47 whiteflies per 6 leaves) of whitefly was found at 140 DAT on 03 March, 2019. The whitefly population declined gradually and reached the lowest of 0.85 whiteflies per 6 leaves at 60 DAT on 13 December, 2019 (Table 4). Incidence of

aphid was first noticed at 30 DAT on 13 November, 2019 (2.76 aphids per leaves) and it was increased gradually and reached the highest population at 140 DAT on 03 March, 2020 (11.04 aphids per 6 leaves) and then declined while the lowest population counted as 2.76 aphids per 6 leaves at 30 DAT on 13 November, 2019 (Table 4).

Table 4. Incidence and fluctuation pattern of jassid, whitefly and aphid plot^{-1} in the winter brinjal field during October 2019 to March 2020

Observation date	DAT*	Crop age (Days)	Jassid	Whitefly	Aphid
13.11.2019	30	60	1.05	0.75	1.45
23.11.2019	40	70	0.90	1.00	2.25
03.12.2019	50	80	1.30	0.95	2.35
13.12.2019	60	90	0.60	0.45	4.45
23.12.2019	70	100	1.00	0.90	4.10
03.01.2020	80	110	0.85	0.60	3.80
13.01.2020	90	120	1.25	0.50	4.20
23.01.2020	100	130	0.95	1.00	3.65
03.02.2020	110	140	1.40	0.85	2.30
13.02.2020	120	150	2.30	1.75	4.10
23.02.2020	130	160	2.65	2.00	4.45
03.03.2020	140	170	3.40	3.40	5.80
SUM	-	-	17.65	14.15	42.9
MEAN	-	-	1.47	1.17	3.57

*DAT-Days After Transplanting

Incidence of epilachna beetle, BSFB and leaf roller: Activity of epilachna beetle on brinjal plant started from at 30 DAT on 60 days crop age, 13 November, 2019 (1.35 beetle per 6 leaves) and the highest population was recorded at 140 DAT on 03 March, 2020 (6.60 beetle per 6 leaves) while the lowest (0.85 beetle per 6 leaves) found at 60 DAT on 13 December, 2019. Population of epilachna was found throughout the entire cropping season (Table 5).

Table 5. Incidence and fluctuation pattern of epilachna beetle, BSFB and leaf roller plot^{-1} in the winter brinjal field during October 2019 to March 2020

Observation date	DAT*	Crop age (Days)	Epilachna beetle	BSFB	Leaf roller
13.11.2019	30	60	1.35	0.00	0.15
23.11.2019	40	70	1.40	0.00	0.75
03.12.2019	50	80	1.15	0.00	0.85
13.12.2019	60	90	0.85	0.00	2.10
23.12.2019	70	100	1.50	0.00	1.50
03.01.2020	80	110	1.85	0.00	1.35
13.01.2020	90	120	2.00	0.05	1.05
23.01.2020	100	130	1.95	0.25	1.95
03.02.2020	110	140	2.25	0.35	1.85
13.02.2020	120	150	3.05	0.30	2.65
23.02.2020	130	160	4.25	0.45	3.00
03.03.2020	140	170	6.60	0.40	3.50
SUM	-	-	28.2	1.80	20.7
MEAN	-	-	2.35	0.15	1.72

*DAT-Days After Transplanting,

Activity of brinjal shoot and fruit borer started from 90 DAT, i.e. on 120 days crop age on 13 January, 2020 (0.05 BSFB larva shoot^{-1}). The highest population (0.45 BSFB larva fruit^{-1}) was found low at 23 February, 2020. However, its incidence was low because of these areas were peri-urban. Activity of leaf roller on brinjal crop started from 30 DAT, 13 November, 2019 (0.15 leaf roller per 6 leaves). The highest population was recorded at 140 DAT, (3.5 leaf roller per 6 leaves). However, population was found frequent throughout the cropping season (Table 5). The present study revealed that aphid, epilachna beetle, leaf roller, BSFB, whitefly and jassid may be considered as major insect pests of brinjal for their frequent occurrence in the brinjal field throughout cropping season.

Incidence of spider, black ant and ladybird beetle : Observation at 10 days interval revealed that activity of spiders in brinjal field started from at 40 DAT, i.e. 70 days crop age on23 November, 2019 (0.5 spider per 6 branches). The highest population was found (0.90 spider per 6 branches) at 140 DAT i.e., 03 March, 2020 (Table 6).

Table 6. Incidence and fluctuation pattern of spider, back ant and ladybird beetle plot^{-1} in the winter brinjal field during October 2019 to March 2020

Observation date	DAT*	Crop age (Days)	Spider	Black ant	Ladybird beetle
13.11.2019	30	60	0.00	1.90	5.53
23.11.2019	40	70	0.5	1.95	6.25
03.12.2019	50	80	0.6	2.95	7.00
13.12.2019	60	90	0.3	1.75	8.00
23.12.2019	70	100	0.2	2.30	7.35
03.01.2019	80	110	0.15	2.90	8.50
13.01.2020	90	120	0.10	3.00	9.40
23.01.2020	100	130	0.25	2.00	9.40
03.02.2020	110	140	0.00	1.95	12.15
13.02.2020	120	150	0.35	2.45	12.05
23.02.2020	130	160	0.65	2.70	13.45
03.03.2020	140	170	0.90	4.00	13.85
SUM	-	-	4.00	29.85	112.93
MEAN	-	-	0.33	2.48	9.41

*DAT-Days After Transplanting

Spiders were more on the upper canopy of brinjal plant. Spiders such as wolf spider (*Lycosa pseudoannulata),* lynx spiders (*Oxyopes javanus*) and dwarf spider (*Atypena formosana)* has good predatory potentiality to control stem borer including most of the sucking pests like jassid (leaf hopper), white fly and aphid (Table 6). The highest population of black ant (4.0 black ants per 6 braches) was found at 140 DAT, i.e. on 03 March, 2020 but the lowest population (1.90 black ants per 6 branches) sat 60 DAT on 13 November 2019 (Table 6). Incidence of the ladybird beetle (Grub and adult) was first noticed at 30 DAT on 13 November, 2019 (5.53 ladybird beetle per 6 braches) while the highest population (13.85 ladybird beetle per 6 braches) was observed at 140 DAT on 03 March, 2020 (Table 6) and the *Menochilus sexmaculatus* species occurred frequently Ladybird beetles are most regulatory feeder against sucking pest like aphid (Table 6). The present study differed with Choudhury *et al.* (2016) who reported that incidence of ladybird beetle (35.50 @ plot^{-1} & per 6 branches) was found in the month of mid-March and continued till the end of the August.

Incidence of dragonfly and preying mantid: The highest population of dragonfly and preying mantid in brinjal field was found 1.15 per 6 branches and 0.95 per 6 branches at 140 DAT and 03 March, 2020, respectively (Table 7). Though, Shepard *et. al.* (1987) reported that preying mantids have immense potential to control leaf folder larvae, aphids, thrips and many caterpillars.

Table 7. Incidence of dragonfly and preying mantids plot^{-1} in the winter brinjal field during October 2019 to March 2020

Observation date	DAT*	Crop age (Days)	Dragonfly	Preying mantid
13.11.2019	30	60	0.00	0.15
23.11.2019	40	70	0.3	0.25
03.12.2019	50	80	0.45	0.20
13.12.2019	60	90	0.45	0.20
23.12.2019	70	100	0.25	0.15
03.01.2020	80	110	0.20	0.10
13.01.2020	90	120	0.15	0.25
23.01.2020	100	130	0.25	0.30
03.02.2020	110	140	0.10	0.00
13.02.2020	120	150	0.45	0.50
23.02.2020	130	160	0.60	0.75
03.03.2020	140	170	1.15	0.95
SUM	-	-	4.35	3.8
MEAN	-	-	0.36	0.32

DAT-Days After Transplanting

The results of the present study exposed that a total number of 11 arthropods were found in winter brinjal field. Among them aphid, epilachna beetle, leaf roller, jassid and whitefly were commonly found throughout the whole winter season. Brinjal shoot and fruit borer (BSFB) appeared in the field at middle age of the brinjal plant. Ladybird beetle incidence was varied over the season. Availability of the remaining natural enemies viz., black ant, dragonfly, spider, preying mantids were found throughout the entire cropping season following similar trend with the harmful insect pests other than Brinjal shoot and fruit borer. In summary, the present study illustrates that both harmful insect pests and natural enemies were present in the Brinjal field throughout the cropping season.

Based on the finding of the current study it could be recommended that the knowledge and proper monitoring of insect pests and natural enemies of the brinjal field may provide an opportunity to manage the insect pests of this crop effectively.

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