Effect of intercrops on damage potential of major insect pest of brinjal under the Gangetic alluvial zone of West Bengal

Praveen Kumar Maurya, Partha Choudhuri, Arup Chattopadhyay, Swadesh Banerjee, Tridip Bhattacharjee, Kanu Murmu and Sanket Kumar

DOI: https://doi.org/10.22271/j.ento.2020.v8.i6c.8349

Abstract

Brinjal shoot and fruit bore and leaf hopper is the most destructive and the major limiting factor in quantitative as well as qualitative harvest of brinjal. The objective of the study was to estimate the effect of intercrops on damage potential of major insect pest of brinjal. Field experiments was carried out with 7 treatments [T1 (Sole Brinjal), T2 (Brinjal + Cowpea), T3 (Brinjal + Garlic), T4 (Brinjal + Fenugreek), T5 (Brinjal + onion), T6 (Brinjal + Coriander), T7 (Brinjal + French bean)] following randomized block design with three replications. The results indicated that major insect-pest attributes were significantly influenced by intercropping system. Significant reduction of fruit and shoot borer and leaf hopper infestations was observed in brinjal + garlic intercropping system. Based on the performance of brinjal under different intercropping combinations, growing of brinjal with french bean was adjudged as the best treatment combination to maximize the growth, yield, quality and least infestation of major insect-pest.

Keywords: intercrop, brinjal, fruit and shoot borer, leaf hopper

Introduction

With shrinking farm sizes farmers find it difficult to generate enough income to provide for their households. The average size of farm size of operational holding has declined to 1.08 ha. in 2015-16 as compared to 1.15 in 2010-11 (Anonymous, 2018) [3]. On the other hand, the cultivable land is very limited as compared to current population. In the present context, farmers can be benefited economically by proper utilization of the resources as well as contributing to national food security and nutritional aspect for raising population within a short time.

The use of cultural practices like intercropping is one of alternative control measures. In West Bengal, the important vegetable crops are brinjal, cabbage, cauliflower, tomato, root crops, cucurbits, potato, peas, beans, leafy greens, etc. and spice crops such as turmeric, ginger, chilli, garlic, cumin black and coriander. The per capita land resources in India are very limited (0.12 ha) that will further be decreased by the turn of century due to explosive increase in population, which is an alarming situation.

At present, only 3% of our total arable land is under vegetable cultivation. Moreover, 76% farmers are marginal in West Bengal. In this context, an attempt may be made for increasing the area, but due to tremendous population pressure it is not an easy task to get horizontal expansion of cultivation area for vegetables. In addition to this, natural hazards, market fluctuations, pest and disease outbreak, etc. are also serious threats for getting the targeted output of the vegetable crops. Hence, effective land utilization through intensive cropping is urgently needed. Comprehending all these, multiple cropping may be one of the most important approaches to feed the billions of our country.

Brinjal or eggplant (Solanum melongena L.) is one of the common vegetable crops cultivated extensively by virtue of its wide adaptability to grow from plains to an altitude up to 1500 MSL. It is an important solanaceous crop of sub-tropics and tropics (Anonymous, 2008) [4]. It is a good source of minerals and vitamins and is rich in total water soluble sugars, free reducing sugars, amide proteins among other nutrients. It is locally known as “Begoon” and its early European name is “Egg plant” grown extensively in India, Bangladesh, Pakistan, China
and the Philippines. It is also popular in other countries like Japan, Indonesia, Turkey, Italy, France, United States, Mediterranean and Balakan area (Bose and Som, 1986) [10]. India is one of the largest brinjal producing countries in the world covering an area of 0.66 million hectares with a production of 12.515 million tones and productivity of 18.96 t/ha (Anonymous, 2017) [5]. Among the Indian States, West Bengal covers the maximum area (1.62 lakh hectares) and production (30.03 lakh tonnes) having the productivity of 18.53 t/ha (Anonymous, 2017) [5] which is slightly below than national average. It is a long duration and wide spaced crop. So, there is a great possibility to cultivate minimum canopy spread herbaceous plant like coriander, garlic, fenugreek etc. in the inter-row space of brinjal. Productivity can be increased through utilization of these intercrops.

The brinjal crop is attacked by about 140 species of insect pests. Out of numerous insects, brinjal shoot and fruit borer (Leucinodes orbonalis), leaf hopper (Amarasca bigutulla biguttula) aphid (Aphis gossypii), Hadda beetle (Epilachna spp.) and brinjal stem borer (Eucosmera pertialis) have been reported as important insect pests of the brinjal (Alpuerto, 1994; Bustamante et al., 1994; Bhadauria et al., 1999 and Bharadiya and Patel, 2005) [1, 11, 7, 8]. Among these, L. orbonalis is the most destructive and the most limiting factor in quantitative as well as qualitative harvest of brinjal (Atwal and Dhalwil, 2002; Chakraborty and Sarkar, 2011) [6, 12]. Brinjal crop losses by this insect-pest have been reported to an extent of 20.70% to 88.70% (Kaur et al., 1998; Chatterjee and Roy, 2004; Raju et al., 2007; Dutta et al., 2011 and Latif et al., 2010) [21, 13, 25, 16, 22]. Intercropping is one of the important cultural practices in pest management, reducing insect pests by increasing the diversity of an eco-system (Altieri and Letourneau, 1982) [2]. Intercropping affects the pests by changing micro-climate through change in crop canopies (Wu et al., 1999; Srinivas Rao et al., 2003) [31, 27], influencing the pest population build-up through physical factors like protection from wind, shading, sheltering, prevention of dispersal, alteration of colour, shape of the stand etc. and through biological factors like presence of natural enemies, production of adverse chemical stimuli, availability of alternate food etc. The present investigation was undertaken to determine the effect of intercrops on damage potential of major insect pest of brinjal.

Materials and Methods
Field experiments of the present investigation were carried out at Bidhan Chandra Krishi Viswavidyalaya, Kalyani, Nadia, West Bengal under the research field of All India Coordinated Research project on Vegetable Crops. The farm is located at 23.5° N latitude and 89° E longitude at an elevation of 9.75 m above MSL.

Topographic situation of the experimental site comes under the Gangetic new alluvial plains of West Bengal. Field experiments was carried out with 7 treatments [T1 (Sole Brinjal), T2 (Brinjal + Cowpea), T3 (Brinjal + Garlic), T4 (Brinjal + Fenugreek), T5 (Brinjal + Onion), T6 (Brinjal + Coriander), T7 (Brinjal + French bean)] following randomized block design with three replications during 2016-17 and 2017-18. Agronomical practices were according to recommendations of Chattopadhyay et al. (2007) [14].

Data recording
Recording of fruit borer infestation
In case of fruit infestation, numbers of infested and non-infested fruits of each harvest was recorded and per cent damage was calculated. The grades were assigned for the fruit damage percentage based on the following rating (Mishra et al., 1988) [23].

| Grade       | Reaction     | Fruit infestation (%) |
|-------------|--------------|-----------------------|
| Grade 1     | Immune       | 0%                    |
| Grade 2     | Highly resistant | 1-10%                |
| Grade 3     | Moderately resistant | 11-20%             |
| Grade 4     | Tolerant     | 21-30%                |
| Grade 5     | Susceptible  | 31-40%                |

Recording of leaf hopper infestation
For counting of leaf hopper population, ten plants in each replication was selected at random and tagged. The leaves was observed in such a way that, two leaves at upper portion of the first plant, two leaves in middle portion from the second plant and two leaves from bottom portion of the third plant of each variety was taken in to account. The average population was calculated by simple arithmetic means. The observation for mean leaf hopper (nymphs) and adult population per leaf was counted in the early morning hours at an interval of 15 days from three observational plants of each genotype starting by taking 6 leaves per plant at random (two each from top, middle and bottom) at 7±1 days interval. The leaf hopper injury index was calculated according to Bindra and Mahal (1979) [9].

Statistical analysis
The data were subjected to analysis of variance (Gomez and Gomez, 1984) [28]. The treatment variations were tested for significance by adopting F test (Cochran and Cox, 1957) [15]. For determination of critical difference at 5 per cent level of significance, Fisher and Yates (1963) [18] table was consulted. Least significant difference (LSD) was used to separate the treatment means at 5% level of probability by Tukey’s HSD test. The analysis was performed by SAS (version 9.3).

Results and Discussion
Brinjal shoot borer infestation (%)
Experimental results related to brinjal shoot borer infestation presented in Table 1 and Fig 1 showed that minimum infestation of brinjal shoot borer was observed in brinjal grown with garlic (0.10% in 2016-17 and 0.13% in 2017-18 and 0.11% in pooled) preceded by brinjal + coriander system (0.21% in 2016-17 and 0.19% in 2017-18 and 0.20% in pooled) and brinjal with onion (0.31% in 2016-17 and 0.28% in 2017-18 and 0.30% in pooled) combination, and they were significantly superior to all other treatments. However, sole brinjal recorded with maximum brinjal shoot borer infestation value (0.60% in 2016-17 and 0.63% in 2017-18 and 0.62% as pooled). Intercropping affects the pests by changing micro-climate through change in crop canopies, influencing the pest population build-up through physical factors like protection from wind, shading, sheltering, prevention of dispersal, alteration of colour, shape of the stand etc. and through biological factors like presence of natural enemies, production of adverse chemical stimuli, availability of alternate food etc. The present investigation was undertaken to determine the effect of intercrops on damage potential of major insect pest of brinjal.
resulting less incidence of insect pests, as reported in various intercropping systems like mustard + coriander on mustard and garlic (Goel and Tiwari, 2004)\(^{19}\).

### Table 1: Effect of intercropping on insect pest infestation of brinjal.

| Treatments               | Shoot borer infestation (%) | Fruit borer infestation (%) | Leaf hopper infestation (%) |
|--------------------------|------------------------------|-----------------------------|----------------------------|
|                          | Y1   | Y2   | Pooled | Y1     | Y2   | Pooled | Y1     | Y2   | Pooled |
| Sole Brinjal             | 0.60* | 0.63* | 0.62*  | 27.21* | 25.94* | 26.58* | 3.25*  | 3.19* | 3.22*  |
| Brinjal + Cowpea         | 0.42* | 0.44* | 0.43*  | 23.80* | 24.46* | 24.13* | 2.83*  | 2.90* | 2.86*  |
| Brinjal + Garlic         | 0.10* | 0.13* | 0.11*  | 19.97* | 18.61* | 19.29* | 2.16*  | 2.11* | 2.14*  |
| Brinjal + Fenugreek      | 0.34* | 0.32* | 0.33*  | 20.46* | 19.46* | 19.96* | 2.37*  | 2.40* | 2.39*  |
| Brinjal + Onion          | 0.31* | 0.28* | 0.30*  | 21.25* | 22.24* | 21.75* | 2.51*  | 2.48* | 2.50*  |
| Brinjal + Coriander      | 0.21* | 0.19* | 0.20*  | 25.40* | 24.67* | 25.04* | 3.08*  | 3.14* | 3.11*  |
| Brinjal + French bean    | 0.55* | 0.56* | 0.56*  | 21.89* | 22.87* | 22.38* | 2.70*  | 2.57* | 2.64*  |
| SKM (±)                  | 0.02  | 0.03  | 0.02   | 0.88   | 0.60   | 0.55   | 0.07   | 0.04  | 0.05   |
| CD at 5%                 | 0.06  | 0.09  | 0.07   | 2.70   | 1.85   | 1.70   | 0.22   | 0.14  | 0.16   |

Values in columns followed by the same letter are not significantly different, \( p < 0.0001, \) Tukey’s post hoc test; \( Y_i = 2016-17; \) \( Y_j = 2017-18 \)

**Fig 1:** Effect of intercropping on shoot borer infestation (%) of brinjal

**Brinjal fruit borer infestation (%)**

The data pertaining to brinjal fruit borer infestation of brinjal based intercropping experiments have been presented in Table 1 and Fig 2. Among intercropping systems, maximum infestation of brinjal fruit borer was observed in brinjal + garlic (19.97% in 2016-17 and 18.61% in 2017-18 and 19.29% in pooled) preceded by brinjal + fenugreek (20.46% in 2016-17 and 19.46% in 2017-18 and 19.96% in pooled) and brinjal with onion (21.25% in 2016-17 and 22.24% in 2017-18 and 21.75% in pooled) systems of intercropping. Maximum infestation of brinjal fruit borers was observed in sole brinjal system (27.21% in 2016-17 and 25.94% in 2017-18 and 26.58% in pooled). This was further supported by the findings of Elanchezhyan et al. (2008)\(^ {17}\) who recorded least infestation of fruit borer when brinjal intercropped with cluster bean (4:1). On the other hand, minimum infestation of shoot borer in brinjal + coriander system was recorded by Paul et al. (2015)\(^ {24}\). More host preference of fruit borer to sole brinjal crop might be due to less biosynthesis of phenols in fruits. Higher amount of phenol biosynthesis in brinjal + garlic and brinjal + fenugreek systems and the smell emitted from garlic and fenugreek plants might be responsible for deterrent effect of fruit borer to these hosts or reduced rate of oviposition by the female adults which finally could have lead to least borer damage in these systems. The higher enzymatic activity is important firstly in the biosynthesis of orthodihydroxy phenols from monophenols and secondly in the oxidation of phenols to more toxic quinines which might have reduced fruit borer infestation and increased pest control in brinjal intercropped with garlic and fenugreek.

**Fig 2:** Effect of intercropping on fruit borer infestation (%) of brinjal
Brinjal leaf hopper infestation (%)  
The data pertaining to leaf hopper infestation of brinjal based intercropping experiments have been presented in Table 1 and Fig 3. Among intercropping systems, brinjal + garlic recorded with minimum infestation of leaf hopper (2.16 in 2016-17 and 2.11 in 2017-18 and 2.14 in pooled) followed by brinjal + fenugreek (2.37 in 2016-17 and 2.40 in 2017-18 and 2.39 in pooled) and brinjal + onion (2.51 in 2016-17 and 2.48 in 2017-18 and 2.50 in pooled) systems and they were significantly different to all other treatments. Maximum infestation of leaf hopper was recorded in brinjal + french bean (3.25 in 2016-17 and 3.19 in 2017-18 and 3.22 in pooled) intercropping system. Results showed that all the intercropping models recorded leaf hopper infestation values less than sole crop, signifying intercropping was advantageous over sole cropping. Our results are in accordance with the findings of Sujayanand et al. (2015) [28] who observed the least cumulative mean leaf hopper population when maize was sown as border crop, and coriander was intercropped with brinjal. The repellent effects of garlic and fenugreek resulted least infestation of leaf hopper in these intercropping systems. It was accepted by some researchers that herbivore damage was reduced in diverse systems because of increased efficiency by natural enemies (Root, 1973 and Tahvanainen and Root, 1972) [26, 29]. It was also hypothesized that diverse environments would provide a greater variety of habitats and victims to predators and parasitoids through time, as well as alternate food sources such as pollen and nectar (van Emden, 1965) [30], and so sustain more stable populations of natural enemies than monocultures which supported the present proposition.

![Graph showing leaf hopper infestation (%) in various treatments](http://www.entomoljournal.com)

**Fig 3:** Effect of intercropping on leaf hopper infestation (%) of brinjal

**Conclusion**

Observation on the incidence of brinjal fruit and shoot borer and leaf hopper infestation started in the month of November and continued up to March in 2016-17 and 2017-18. It was found that the level of fruit infestation was always higher than that of shoot infestation.

The shoots and fruits of brinjal plant were found to be infested by brinjal fruit and shoot borer throughout the year although the level of infestation varied. The shoot infestation was highest 0.62% in sole brinjal and minimum in brinjal + garlic based intercropping system (0.11%). Then it started to increase steadily up to the month of November when maximum shoot infestation was observed. Then a marked decline was observed in December which showed a further slow decline thereafter up to the month of January. In case of fruit infestation, numbers of infested and non-infested fruits of each harvest were recorded and per cent damage was calculated at 150 days after transplanting (DAT). The fruit infestation was found maximum in sole brinjal (26.58%) and minimum in brinjal + garlic based intercropping system (19.29%). Then it started to increase steadily up to the month of November when maximum fruit infestation was observed. Then a marked decline was observed in December which showed a further slow decline thereafter up to the month of January.

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. It was found that the insect was active throughout the crop season. Maximum infestation of leaf hopper was observed in sole brinjal (3.22%), whereas minimum infestation was found for brinjal + garlic based intercropping system (2.14%). Therefore, significant reduction of FSB and leaf hopper infestations was observed in brinjal + garlic intercropping system.

**References**

1. Alpuerto AB. Ecological studies and management of brinjal fruit and shoot borer, *Leucinodes orbonalis* Guenee. Indian Journal of Agricultural Sciences 1994;52(6):391-395.
2. Altieri MA, Letourneau DK. Vegetation management and biological control in agro ecosystems. Crop Protection 1982;1(4):405-430.
3. Anonymous. Agriculture Census 2015-16. All India Report on Number and Area of Operational Holdings, Agriculture Census Division Department of Agriculture, Co-Operation and Farmers Welfare, Ministry of Agriculture and Farmers Welfare, Government of India 2018; pp. 4-7.
4. Anonymous. Biology of brinjal. Department of Biotechnology, Ministry of Science and Technology, Government of India 2008.
5. Anonymous. Indian Horticulture Database, National Horticulture Board. Government of India, Gurugram 2017.
6. Atwal AS, Dhaliwal GS. Agricultural pests of South Asia and their management, Kalyani Publishers, New Delhi 2002; p. 258.
7. Bhaduria NKS, Bhaduria NS, Jakhmola SS. Insect pest complex of brinjal, *Solanum melongena* L. in North West
M.P. Advances in Plant Sciences. 1999; 12(2):607-608.
8. Bhuradaya AM, Patel BR. Study on the efficacy of certain insecticides against brinjal shoot and fruit borer, *Leucinodes orbonalis* Guenee. Journal of Plant Protection and Environment 2005;2:113-115.
9. Bindra OS, Mahal MS. Investigation on varietal resistance in okra, *Abelmoschus esculentus* (L.) Moench to the cotton jassid, *Amrasca biguttula biguttula*. Indian Journal of Horticulture 1979;36:212-219.
10. Bose TK, Som MG. Vegetable Crops in India. B. Mitra, Nava Prokash, 206, Bidhan Sarani, Calcutta, India 1986, pp. 4-293.
11. Bustamante RC, Luzaran PB, Gruber LT, Villanueva E. Field evaluation on different control methods against brinjal fruit and shoot borer. Philippine Journal of Plant 1994;59(1-2):119-125.
12. Chakraborty S, Sarkar PK. Management of *Leucinodes orbonalis* Guenee on eggplant during the rainy season in India. Journal of Plant Protection Research 2011;51(4):325-328.
13. Chatterjee ML, Roy S. Bioefficacy of some insecticides against brinjal shoot and fruit borer (*Leucinodes orbonalis* Guenee) and effect of Novaluron on natural enemies of brinjal pests. Pestology 2004;28:52-56.
14. Chattopadhyay A, Dutta S, Bhattacharya I, Karmakar K, Hazra P. Technology for Vegetable Crop Production, All India Coordinated Research Project on Vegetable Crops, Directorate of Research, Bidhan Chandra Krishi Viswavidyalaya, Kalyani, Nadia, West Bengal, India 2007, p. 226.
15. Cochran GW, Cox MG. Experimental Design. John Wiley and Sons. Inc., New York 1957.
16. Dutta P, Singha AK, Das P, Kalita S. Management of brinjal fruit and shoot borer, *Leucinodes orbonalis* Guenee in agro-ecological condition of West Tripura. Scholarly Journal of Agricultural Science 2011;1(2):16-19.
17. Elanchezhyan K, Murali, Baskaran RK. Evaluation of intercropping system based modules for the management of major insect pests of brinjal. Pest Management in Horticultural Ecosystems 2008;14(1):67-73.
18. Fisher SRA, Yates F. Statistical Tables for Biology, Agricultural and Medical Research, Edn 6, London 1963.
19. Goel R, Tiwari M. Effect of intercropping on the incidence of *Lipaphis erysimi* in mustard. Annals of Plant protection Sciences 2004;12(2):435-436.
20. Gomez KA, Gomez AA. Statistical Procedures for Agricultural Research. Edn 2, John Wiley and Sons, New York 1984, p. 657.
21. Kaur S, Bal S, Singh G, Sidhu AS, Dhillon TS. Management of brinjal shoot and fruit borer, *Leucinodes orbonalis* Guenee through net house cultivation. Annual Review of Entomology 1998;43:243-270.
22. Latif MA, Rahman MM, Alam MZ. Efficacy of nine insecticides against shoot and fruit borer, *Leucinodes orbonalis* Guenee (Lepidoptera: Pyralidae) in eggplant. Journal of Pest Science 2010;83(4):391-397.
23. Mishra PN, Singh YV, Nautiyal MC. Screening of brinjal varieties for resistance to shoot and fruit borer (*Leucinodes orbonalis* Guen.) (Pyralidae: Lepidoptera). South Indian Horticulture 1988;36(4):188-192.
24. Paul SK, Mazumder S, Mondal S, Roy SK, Kundu S. Intercropping coriander with brinjal for brinjal fruit and shoot borer insect suppression. World Journal of Agricultural Sciences 2015;11(5):303-306.
25. Raju SVS, Bar UK, Shanker U, Kumar S. Scenario of infestation and management of eggplant shoot and fruit borer, *L. orbonalis* Guen. in India. Resistant Pest Management Newsletter 2007;16(2):14-16.
26. Root R. Organization of a plant-arthropod association in simple and diverse habitats. The fauna of collards (*Brassica oleracea*). Ecological Monographs 1973;43:95-124.
27. Srinivas Rao M, Dharma Reddy K, Singh TVK. Impact of intercropping on *Empoasca kerri* of pigeon pea in rainy and post rainy season. Indian Journal of Entomology 2003;65(4):506-512.
28. Sujayanand GK, Sharma RK, Shankarganesh K, Saha S, Tomar RS. Crop diversification for sustainable insect pest management in eggplant (Solanales: Solanaceae). Florida Entomologist 2015, 305-314.
29. Tahvanainen JO, Root RB. The influence of vegetational diversity on the population ecology of a specialized herbivore, *Phyllotreta cruciferae*. Oecologia 1972;10:321-346.
30. Van Emden HF. The effect of uncultivated land on the distribution of cabbage aphid on an adjacent crop. Journal of Applied Ecology 1965;2:171-196.
31. Wu W, Chen JX, Songh DL, Guen ZH. Oviposition behaviour of cabbage butterfly, *Pieris brassicae rapae* and the effects of biological factors. Journal of China Agricultural University 1999;4(3):93-96.