Scholarly Journal of Agricultural Science Vol. 5(2), pp. 53-58 February, 2015
Available online at http:// www.scholarly-journals.com/SJAS
ISSN 2276-7118 © 2015 Scholarly-Journals

Full Length Research Paper

Eco-friendly Management of Major Insect Pests of Brinjal with Polyculture Crop System

Razzak, M. A[1]., Alam, M.S.[2], Fatema, U.[3], Parvin, T.[4], Islam, M.A.[5], and Ali, M. M.[6]

[1]Teacher at the Maple Leaf International School, Dhanmondi, Dhaka, Bangladesh and Former MS student, Department. of Entomology, Sher-e-Bangla Agricultural University, Dhaka, Bangladesh
[2]Seed Analyst, Seed Certification Agency, Gazipur, Bangladesh
[3]Former Students, Carmichael College, Rangpur, Bangladesh.
[4]Former students, Sher-e-Bangla Agricultural University, Dhaka, Bangladesh.
[5]Assistant Project Coordinator- Agriculture, EPIA-ProjecT, SLPOB-Bangladesh
[6]Program Manager, BAS-USDA Program in Agricultural and Life Sciences, Bangladesh Academy of Sciences, Dhaka, Bangladesh

Accepted 5 February, 2015

The present study was conducted to evaluate the effectiveness of polyculture crop system in suppressing major insect pests of brinjal. Four Polyculture combinations, viz., brinjal + coriander, brinjal + fenugreek, brinjal + chili, brinjal + radhuni were tested. Five mono crops of brinjal, coriander, fenugreek, chili and radhuni were also grown to compare the effectiveness of polyculture crop system. The results revealed that polyculture had a lower pest population with more abundance of natural enemies as compared to mono crop. The maximum per cent reduction of fruit infestation of brinjal by brinjal shoot and fruit borer in weight over sole brinjal was found in brinjal + coriander (40.23%) followed by brinjal + radhuni (37.06%) combination. All the polyculture crop combinations showed higher biological efficiency than mono crop where brinjal + fenugreek provided the highest economic return (BDT-316320 ha^{-1}). It was demonstrated that a change in the cropping pattern or vegetation diversity could change the pests abundance effectively and eco-friendly suppressed the major insect pests of brinjal.

Key words: Polyculture crop system, insect pests of brinjal, mono crop.

INTRODUCTION

Bangladesh is an agro based country but it has a serious shortage in vegetables. The annual production is only 4.31 million tons but we need 11.5 million tons (Anon., 2002).

Brinjal (*Solanum melongena* L.) is one of the most popular and prime vegetable crops grown in Bangladesh. It is the second most important vegetable crops after potato in terms of production and consumption. Bangladesh produced 0.39 million tons of brinjal which was approximately 28.8% of the total vegetables (Anon., 2002). The major constraint of Brinjal production is that the crop is attacked by about 53 species of insect pests (Nayer *et al.*, 1995). Among them, brinjal shoot and fruit borer (BFSB), *Leucinodes orbonalis* (Guenee) is the most destructive pest of brinjal in Bangladesh (Chattopadhyay, 1987; Alam, 1969) and India (Tewari and Sandana, 1990) and also a major pest in other countries of the world (Dhanker, 1988).

Farmers usually spray chemical pesticides many times during the crop season to control the insect pests. This leads to environmental pollution and residual problems with consequent increase in health hazard to the growers and consumers. Moreover, it also leads to the development of resistance to target pests (David and Kumaraswami, 1989) with also a negative impact on natural enemies (Tewari and Moorthy, 1985) and other beneficial organism and causes disruption of biodiversity. The growing awareness of the shortcoming of chemical

*Corresponding author e-mail: arazzakbdr@gmail.com.

insecticides has necessitated with the exploration for alternative method of pest control, which is relatively safe from adverse side effects.

Among the various alternatives, the exploration of host plant resistance is perhaps the most effective, convenient, economical and environmentally acceptable method of insect control (Dhaliwal and Dilawary, 1993).

An agronomic practice like polyculture or intercropping of diverse growth habit has been found as a very useful technique in controlling a large number of crop pests. In intercropping, two or more plant species in the field may disrupt the host plant finding behavior of insects. Intercropping can affect the microclimate of the agro-ecosystem, which ultimately produce an unfavorable environment for pest (Singh and Singh, 1987). The olfactory stimulus offered by the main crop could be camouflaged by various intercrops (Aiyer, 1949). Therefore, the present study was aimed to find out the effect of polyculture on the incidence of insect pests and natural enemies in brinjal especially in relation to brinjal shoot and fruit borer management.

MATERIALS AND METHOD

Experimental site, growing environment and treatments

The experiment was conducted at the Experimental Field and Laboratory of Sher-e-Bangla Agricultural University, Dhaka. The experiment was laid out in a Randomized Complete Block Design with three replications. The whole area of experimental field was divided into three blocks and each block was again divided into nine unit plots (T_1- Brinjal + Coriander, T_2- Brinjal + Fenugreek, T_3- Brinjal + Chili, T_4- Brinjal + Radhuni, T_5- Sole fenugreek, T_6- Sole chili, T_7- Sole radhuni, T_8- Sole coriander, and T_9- Sole brinjal). Row to row distance for brinjal, chili (*Capsicum frutescence*), coriander (*Coriandrum sativum*), fenugreek (*Trigonella foenum-graecum*), radhuni (*Carum roxburgianum*) was 100-cm, 40-cm, 30-cm, 30-cm, and 30-cm, respectively and plant to plant distance within a row of brinjal and chilli was 60-cm and 30-cm, respectively. Coriander, fenugreek and radhuni were sown in continuous line.

Data collection

After incidence of brinjal shoot and fruit borer, eight plants were randomly selected in each sole and polyculture combination of brinjal for observing the number of infested shoot which was started from 22 January 2007 and continued every 10 days interval until 14 March 2007. From each harvest, data on the number of infested fruits by brinjal shoot and fruit borer was recorded started from 15 March 2007 and continued at seven days interval until 5 May 2007. Data were also collected from 10 leaves of brinjal from all the treatments for recording the number of aphid, jassid and whitefly. Natural enemies were counted at the same time as well.

Harvesting and yield of the crops

Brinjal: Fruits were harvested at an interval of seven days. At each harvest, data on the number of healthy and infested fruits and their weight were recorded separately per plot. The cumulative healthy, infested fruit and total fruit yield per plot were calculated.

Coriander, radhuni and fenugreek: Coriander, radhuni and fenugreek were harvested after 130, 125, and 135 days, respectively. The dry seed yield thus obtained was converted into per hectare yield.

Chili: Four harvests were done during the fruiting season. In each harvest, fruits were weighted separately for each plot. The cumulative fruit yield thus obtained was converted into per hectare yield.

Land equivalent ratio

Land equivalent ratio (LER) was used to assess the performance of an intercrop relative to the corresponding sole crop according the following formula.

$$\text{LER} = \sum_{i=0}^{n} \frac{Yji}{Yjs}$$

When the numbers of component crops are two,

$$\text{LER} = \frac{Yij}{Yis} + \frac{Yji}{Yjs}$$

Where *Yij* is the yield of component crop j in intercropping and *Yjs* is the yield of the crop in sole cropping.

Relative yield (RY) was calculated using the following formula.

$$\text{RY} = \frac{\text{Yield of component crop}}{\text{Yield of sole crop}}$$

Total edible yield

Harvested yield of an individual crop and intercrops that we consume considered as total edible yield.

Equivalent yield

Yield of an individual crop was converted into equivalent yield by converting yield of intercrops into the yield of the sole crops on the basis of prevailing market price of individual crop as follow.

$$\text{Brinjal equivalent yield for coriander} = \frac{Y_{co} \times P_{co}}{P_b}$$

Table 1. Effect of intercropping on shoot infestation by brinjal shoot and fruit borer at vegetative stage of brinjal

Crop combinations	Number of infested shoots by brinjal shoot and fruit borer recorded from eight plants						Mean of infested fruit during the crop season
	22nd January	2nd February	13th February	24th February	4th March	15th March	
Brinjal	5.67a	6.01a	5.33a	5.65 a	5.62 a	6.13 a	5.735 a
Brinjal +Coriander	2.333 c	3.03 b	2.85 c	3.000 c	3.01 c	2.333 c	2.75 c
Brinjal +fenugrick	5.52 b	6.000 b	5.12 b	6.02 ab	5.333ab	5.15 b	5.52 b
Brinjal + chilli	4.667 bc	4.527 b	4.333 b	5.667 b	4.627 bc	4.333 b	4.69 b
Brinjal + Radhuni	3.102 bc	2.667 b	4.001 bc	3.167bc	3.667 bc	3.000 bc	3.26 bc

Figures in the same column accompanied the same letter (s) are not significantly different at 5% level as per DMRT.

Table 2. Effect of intercropping on fruit infestation in brinjal by brinjal shoot and fruit borer

Crop combinations	Number of infested fruits by brinjal shoot and fruit borer recorded from 8 plants								Mean of infested fruit during crop season
	15th March	23rd March	31st March	7th April	14th April	21st April	28th April	5th April	
Brinjal	24.00 a	20.33 a	18.67 a	21.67 a	20.33 a	20.00 a	19.00 a	20.33 a	20.54 a
Brinjal + coriander	12.67 c	9.000 c	10.67 b	12.33 b	11.33 b	10.00 b	9.667 b	10.67 b	10.79 c
Brinjal + fenugreek	20.00 ab	20.33 a	19.00 a	9.67 a	19.67 a	19.33 a	15.00 ab	18.00 a	18.87 ab
Brinjal + chilli	18.00 bc	14.00 b	12.67 b	13.67 b	10.67 b	12.33 b	11.33 b	12.67 b	13.16 b
Brinjal + radhuni	14.33 c	12.33 bc	10.67 b	11.67 b	11.00 b	9.000 b	11.00 b	11.67 b	11.45 bc

Figures in the same column accompanied by the same letter (s) are not significantly different at 1% level as per DMRT.

Statistical analysis

Data were statistically analyzed by a MSTATC program. The treatment means were separated by Duncan's Multiple Range Tests (DMRT) at $P \leq 0.05$.

RESULTS AND DISCUSSION

Infestations of brinjal shoot by brinjal shoot and fruit borer

Significantly the lowest number of shoot infestation (2.75) from six plants in brinjal by brinjal shoot and fruit borer was recorded in brinjal + coriander system (Table 1). On the other hand, the highest number of shot infestation (5.73) by brinjal shoot and fruit borer was recorded during this period when brinjal grown alone which was also significantly higher than that recorded from intercrop combinations of brinjal + radhuni, brinjal + chili, brinjal + fenugreek.

Infestation of brinjal fruit by brinjal shoot and fruit borer

Generally, the lowest fruit infestation (10.79) by brinjal shoot and fruit borer was recorded in brinjal + coriander system which differed significantly from brinjal sole, brinjal + radhuni. Brinjal + chili, brinjal + fenugreek intercrop combination (Table 2). However the highest fruit infestation (20.54) was almost always observed in brinjal when grown as sole crop. Result of the current study is general conformity with that reported by Amin (2004) found that infestation of brinjal shoot by brinjal shoot and fruit borer was higher in case of monoculture of sole brinjal than brinjal + onion, brinjal + garlic, brinjal + chili, brinjal + coriander intercrop combination. The lowest infestation was found in brinjal + coriander combination. In case of fruit infestation in brinjal by brinjal shoot and fruit borer, Amin (2004) also found that lower fruit infestation in intercropping of brinjal + coriander, brinjal + chili, brinjal +onion, brinjal + garlic in comparison to that of brinjal alone.

Incidence of sucking pest of brinj1al

The mean numbers of aphid, jassid, and whitefly recorded on 10 leaves of brinjal during January to February 2007 under different crop combinations are presented in Table 3. Brinjal + coriander, brinjal + radhuni, and brinjal + chili systems were found to show significant effect in reducing aphid incidence. The lowest number of aphid was recorded in brinjal + coriander (4.990) followed by brinjal + radhuni (6.995) whereas the

Table 3. Influence of polyculture on the incidence of sucking pests of brinjal during January to March 2007

Crop combination	Number of insects recorded from 10 leaves/plant		
	Aphid	Jassid	White fly
Brinjal	7.89 b	6.533 a	6.801 a
Brinjal + coriander	4.990 e	4.353 b	4.107 d
Brinjal + fenugreek	19.75 a	5.960 a	4.877 c
Brinjal + chilli	14.75 c	6.567 a	6.043 b
Brinjal + radhuni	6.995 d	4.577 b	3.193 e

Figures in the same column accompanied by the same letter (s) are not significantly different at 1% level as per DMRT.

Table 4. Effect of polyculture on the yield performance of brinjal by number.

Crop combinations	Number of fruits/plot ($6m^2$)/8 plants			Number of fruits decreased over brinjal sole (%)	Reduction of fruits infestation over brinjal sole (%)	Percentage of healthy fruits
	Healthy	Infested	Total			
Brinjal	125.33 a	246.70 a	372.03 a			33.75
Brinjal + coriander	100.70 c	124.30 e	225.00 e	39.40	49.59	44.73
Brinjal + fenugreek	120.70 b	200.54 b	321.24 b	13.48	18.69	37.57
Brinjal + chilli	106.70 d	172.30 c	279.00 c	24.84	30.13	38.23
Brinjal + radhuni	98.67 e	154.30 d	252.97 d	31.86	37.43	38.99

Figures in the same column accompanied by the same letter (s) are not significantly different at 1% level as per DMRT.

Table 5. Effect of polyculture on the yield performance of brinjal by weight during.

Crop combinations	Weight of fruits kg/plot ($6m^2$)/8 plants			Yield decreased over brinjal sole (%)	Reduction of infestation over brinjal sole (%)
	Healthy	Infested	Total		
Brinjal	7.230 a	12.95 a	20.18 a		
Brinjal + coriander	6.130 c	7.740 d	13.87 d	31.26	40.23
Brinjal + fenugreek	7.067 a	11.197 b	18.264 a	9.49	13.53
Brinjal + chilli	6.807 b	9.993 c	16.8 b	16.50	23.84
Brinjal + radhuni	6.027 c	8.153 d	14.18c	29.72	37.06

Figures in the same column accompanied by the same letter (s) are not significantly different at 1% level as per DMRT.

highest was in sole brinjal (19.75). However the lowest number of jassid was recorded in brinjal + coriander (4.35) followed by brinjal + radhuni (4.577). Brinjal + radhuni also had significantly the lowest incidence of whitefly (3.193) which was, however, statistically similar to that found from brinjal + coriander (4.107).

Effect of polyculture on the yield performance of brinjal

Effect of polyculture treatments against the brinjal shoot and fruit borer infestation in brinjal and its subsequent impact on the yield performance by number of fruits and its weight are presented in Table 4 and 5, respectively. The highest number of infested fruit was recorded in sole brinjal (246.7) followed by brinjal + fenugreek (184.3) mentioned in Table 4. The result showed a significant variation among the treatments. Significantly the lowest (124.3) fruit infestation was found from brinjal + coriander system. Fruit infestation by weight ranged from 12.95 kg to7.740 kg and followed a similar trend with that of infestation by number (Table 5). The percent reduction of infestation by weight over sole brinjal was the highest in brinjal + coriander (40.23) followed by brinjal + radhuni (37.06) and the lowest was recorded from brinjal + fenugreek (13.53). The incidence of insect pest in intercropping under different crop combination, in the present study is in conformity with the findings of several studies conducted elsewhere. Andow (1991) and Risch *et al.* (1983) found that intercropping had lower pest infestation than monocultures. In the tropical low lands of Mexico, Letourneau (1986) was found the similar result in maize + cowpea + squash intercropping. In a maize + bean intercropping system, Van Huis (1981) and Francis *et al*. (1978) claimed lower attack rates of *spodoptera frugiperda* in this system compared to a maize

Table 6. Total edible yield, relative yield and land equivalent ratio of sole and intercropping systems.

Crop combinations	Total edible yield ton/ha	Relative ayield					LER
		Brinjal	Coriander	Radhuni	Chilli	Fenugreek	
Brinjal + coriander	23.54	0.75	0.29				1.04
Brinjal + Fenugreek	31.04	0.95				0.26	1.21
Brinjal + chilli	25.35	0.82			0.17		0.99
Brinjal + Radhuni	24.02	0.77		0.24			1.01
Brinjal	30.63	1					1
Coriander	1.52		1				1
Radhuni	1.67			1			1
Chilli	5.5				1		1
Fenugreek	1.72					1	1

Table 7. Equivalent yield and gross return in intercropping of brinjal under different crop combinations.

Crop combinations	Equivalent yield (t ha^{-1})					Gross return (BDT ha^{-1})					
	Brinjal	Coriander	Fenu greek	Chilli	Radhuni	Brinjal	Coriander	Fenu greek	Chilli	Radhuni	Total
Brinjal + coriander	25.21	5.12				151500	102400				253900
Brinjal + fenugreek	32.02		32.02			192120		124200			316320
Brinjal + chilli	26.23			6.25		157380			93750		251130
Brinjal + radhuni	25.04				5.2	150240				104000	254240
Brinjal	30.63					183780					183780
Coriander		1.52									30400
Fenugreek			1.61								32200
Chilli				3.5							52500
Radhuni					1.67						30060

Price of commodities (BDT kg $^{-1}$): brinjal: 6.00, coriander: 20.00, fenugreek 18.00, chilli: 15.00, radhuni: 20.00; 1 BDT = 0.0125 USD (1USD = 80.00 BDT).

monoculture. Dempster and Coaker (1974) found that the colonization of cabbages by *Erioschia brassicae* and *pieris rapae* was greatly interfered with when the cabbages were sown with white and red clover.

Yield and economics

In the studied intercropping systems, brinjal + coriander and brinjal+ radhuni were more compatible than brinjal + chili and brinjal + fenugreek intercropping.

LER is the most frequently used index to determine the effectiveness of intercropping system relative to growing crop separately. LER indicates the land advantage and measures the biological efficiency of land use by intercrops in comparison to sole crops. In the present study, LER was more than 1 in brinjal + coriander, brinjal + fenugreek, and brinjal + radhuni systems indicating greater biological efficiency and yield advantage over the monoculture (Table 6). In the present study the highest LER (1.21) was obtained from brinjal + fenugreek indicated the most compatible intercropping system. The highest brinjal equivalent yield (32.02 t ha^{-1}) was obtained from brinjal + fenugreek combination followed by brinjal + chilli (26.23 ton^{-1}ha) and the lowest in brinjal + radhuni (25.04) intercropping system (Table 7). Equivalent yield for coriander, fenugreek, radhuni, and chilli in all intercropping was higher than sole crops. Lower equivalent yield of brinjal in brinjal + coriander, brinjal +

radhuni and brinjal + chilli than brinjal sole indicated that brinjal yield was suppressed when it was grown in association with other crops. Yield advantage or yield reduction of intercropping system depends on complimentary or competitive behavior of component crops (Spitters, 1983). In the present study, brinjal have failed to get any complementary effects from coriander, chilli, fenugreek and radhuni and reduced the equivalent yield. From the economic point of view, it was observed that intercropping of different combinations provided higher economic return than monoculture (Table 7). The results agreed well with the finding of Haque and *et al.* (2001) and Shah *et al*. (1991) where they found a higher gross return from intercropping than their corresponding sole crops. The highest gross return (BDT 316320 ha^{-1}) was recorded from the brinjal + fenugreek intercropping system followed by brinjal + radhuni (BDT 254240 ha^{-1}). Fenugreek based intercropping system provided better return than other intercropping systems. Higher yield of fenugreek than other intercrops contributed the increment of gross return in the intercropping system. In sole cropping, the highest gross return (BDT 183780 ha^{-1}) was recorded from brinjal followed by fenugreek and the lowest (BDT 30400 ha^{-1}) from coriander.

CONCLUSION

The results revealed that polyculture had a lower pest population with more abundance of natural enemies as compared to mono crop. The maximum per cent reduction of fruit infestation of brinjal by brinjal shoot and fruit borer in weight over sole brinjal was found in brinjal + coriander (40.23%) followed by brinjal + radhuni (37.06%) combination.

REFERENCES

Aiyer, A.K.Y.M. (1949). Mixed cropping in India. *Indian J. Agric. Sci.* 19: 439-443

Alam, M.Z. (1969). Insect pests of vegetables and their control in East Pakistan. Agric, Inform. Serv. Dept. of Agric. Dhaka, p.146.

Amin, S.R. (2004). Effect of intercropping on the diversity and management of the insect pests and their natural enemies in brinjal. M.S. thesis, IPSA, Salna, Gajipur.

Andow, D.A. (1991). Yield loss to arthropods in vegetationally diverse agro ecosystems. *Environ. Entornol.* 20 (5): 122S-1235.

Anonymous. (2002). Statistical Pocket book of Bangladesh2002. Bangladesh Bureau of Statistics. Government of the people Republic of Bangladesh, Dhaka, Bangladesh, pp.184.

Chattopadhyay, P. (1987). Entomology of Pest control and Crop protection. West Bengal State Board, Arjo Mansion (9^{lh} floor), 6A Raja Skubodh Mollick Square, Calcutta 700013, India, p. 304.

Chowdhury, P.C. (1988). Intercropping short-duration summer crops with ginger in Darjeeling hills. *Indian Farming* .37 (11): 4-5.

David, P.M.M. and Kumaraswami, T.L (1989). Influence of synthetic pyrethroids on the population of red spider mite *Tetranchus dnnabarinus* Boisduval in bhendi. *J, Tamilnadu Agril.Univ.*17 (2): 271-274

Dempster, J.P. and Coaker, T.H. (1974). Diversification of crop ecosystems as a means of controlling pests, pp.106-114.In: price Jones, D. and M. E. Solomon (eels.) Biology in pest and disease control. Blackwell Scientific, Oxford.

Dhaliwal, G.S. and Dilawari, V.K. (1993). Advances in Host Plant Resistance to Insects. Kalyani Publishers, New Delhi - Ludhiana - Noidia (U.P) - Hyderabad-Madras - Calcutta - Cuttack, p.443.

Dhanker, B.S. (1988). Progress in resistance studies in eggplant (Solanum melongena L.) against shoot and fruit borer (*Leucinodes orbanalis* Guenee) infestation. *Tropical pest management* 34: 343-345.

Francis, C.A., Flor, C.A. and Pragner, M. (1978). Effects of bean association on yield and yield components of maize. *Crop Sci.* 18:760-4.

Haque, M.M., Hamid, A. and Bhuiyan, N.T. (2001). Nitrogen uptake and productivity as affected by nitrogen and potassium application, levels in maize/sweet potato intercropping system. *Korean J. Crop Sci.* 46:1-5

Letourneau, D.K. (1986).Associational resistance in squash monocultures and polycultures in tropical Mexico. *Environ. Entomol.* 15:285-292.

Nayer, K.K., Ananthakrishnan, T.N. and David, B.V. (1995). General and Applied Entomology. Eleventh edn. Tata McGraw- Hill publ. Co. Ltd. 4/12 Asaf Ali Road, New Delhi-110002, p.557.

Risch, S.J. Andow, D. and Alteiri, M.A. (1983), Agro ecosystem diversity and pest control: data tentative conclusions and new research directions. Environ. Entomol. 12: 625-629.

Shah, M.H., Koul, P.K., Chowdhury, B.A. and Kachroo, D. (1991). Production potential and monitary advantage index of maize intercropped with different grain legumes. *Indian J. Agron.* 36: 23-28.

Singh, R.N. and Singh, K.M.. (1978). Influence of intercropping on succession and population build up of insect pests in early variety of red gram. *Indian. Ecol.*7 (2):22-26.

Spitters, C.J.T. (1983). An alternative approach to analysis of mixed experiments: Estimation of competition effects. *Neth. J. Agric. Sci.* 31: 1-11.

Tewari, G.C. and Sandana, H.R. (1990). An unusual heavy parasitization of brinjal shoot and fruit borer, *Leucinodes orbonalis* Guen., by a new braconid parasite. *Indian J. Entomol.* 52 (2): 338-341.

Tewari, G.C.and Moorthy, P.N.K. (1985). Selective toxicity of some Synthetic pyrethroids and conventional insecticides to aphid predator, *Menochilus sexmaculatus* Fabricius. *Indian J. Agric. Sci.* 55 (1): 40-43.

van Huis, A. (1981). Integrated pest management in the small farmers maize crop in Nicaragua. Mededelingen Landbouwhoge School, wageningen. p. 221