DOI : 10.5958/0974-0112.2016.00051.7

Indian J. Hort. 73(2), June 2016: 219-223

Impact of intercrops and border crops on pest incidence in okra

G.K. Sujayanand*, R.K. Sharma and K. Shankarganesh

Division of Entomology, ICAR-Indian Agricultural Research Institute, New Delhi 110 012

ABSTRACT

The okra intercropping trial was conducted for management of leafhopper (*Amrasca biguttula biguttula*), whitefly (*Bemisia tabaci*) and fruit borer (*Earias vittella*). The results revealed that lowest leafhopper population (5.49 & 2.95/3 leaves/plant) was recorded from the treatment having coriander and maize as intercrop and border crop, respectively during *kharif* 2010 and 2011. Similarly, whitefly population was lowest (5.89 and 9.07/3 leaves/plant) in marigold intercrop treatment. The pooled average per cent fruit infestation by fruit borer was lowest in the marigold intercrop treatment (9.69) followed by coriander intercropping (12.40) on weight basis. While the sole crop (32.14) recorded the highest per cent fruit infestation. The treatments having maize as border crop and coriander/ marigold/ mint as intercrop recorded the highest population of natural enemies. The coccinellids per plant was highest in the coriander intercrop treatment (2010:0.67 & 2011:0.76). Higher Shannon-wiener index was found in the same treatment, while sole crop recorded lowest.

Key words: Cultural control, ecological engineering, fruit borer, IPM, okra.

INTRODUCTION

Okra, *Abelmoschus escullentus* L. Moench (Malvaceae) is an important vegetable cultivated for domestic consumption and for export. The major constraint in increasing the productivity of okra is insect pests, *viz.*, leafhopper (*Amrasca biguttula biguttula* Ishida), whitefly, *Bemisia tabaci* Gennadius and fruit borers, *Earias vittella* (Fabricius), *Earias insulana* (Boisduval) and *Helicoverpa armigera* (Hubner) are known to cause severe damage (Srinivasa Rao and Rajendran, 14). Farmers rely on synthetic broad spectrum insecticides to manage these insect pests. The dependence on synthetic insecticides results in pesticide residue problems in green fruits and their export value is getting reduced and even sometimes get rejected on the grounds of Maximum Residue Limit (MRL). In order to prevent the farmers from falling into pesticide treadmill, the usage of intercropping and border cropping as an IPM strategy was envisaged. The resource concentration hypothesis elucidates that in monocropping the host plants are concentrated in time and space, whereas in intercropping the intercrops increases the diversity in the crop field and acts as impediments for colonization and movements of insect pest (Andow, 3). To have a sustainable ecofriendly IPM, the effectiveness of three intercrops and two border crops with okra was appraised in this study.

MATERIALS AND METHODS

The experiment was conducted during *kharif* 2010 and 2011 in the experimental farm of Division of Entomology, IARI, New Delhi. It was laid out in randomized block design (RBD). After germination, the seedlings were thinned out to have a spacing of 65 cm × 45 cm. Concurrently, the marigold and mint transplanting was also done. The plot size was 5 m × 5 m. The coriander variety Pusa Harit was used for sowing, while for marigold, the selection, AF/SR/12-1 was sown on a raised nursery bed. Healthy seedlings were transplanted to the main field. The border crops, *viz.*, maize hybrid, PEMH-2 and cowpea variety Pusa Komal was sown on the same day of okra sowing. The treatment T_1 comprises of okra + coriander with maize as borer crop, T_2 comprises of okra + coriander with cowpea as borer crop, T_3 comprises of okra + marigold with maize as borer crop, T_4 comprises of okra + marigold with cowpea as borer crop, T_5 comprises of okra + mint with maize as borer crop, T_6 comprises of okra + mint with cowpea as borer crop and T_7 comprises of okra alone.

In each treatment, five plants were randomly selected and tagged for observation on insect pest and coccinellid population on weekly basis. The number of leafhoppers and whiteflies were observed from top, middle and bottom leaves of each plant. The population of leafhopper and whitefly was recorded from 4th week to 12th week and 5th week to 12th week after sowing, respectively. The fruits were harvested at regular intervals. The healthy and damaged fruits were sorted out and per cent fruit infestation on number and weight basis was calculated for each treatment. The data was transformed and analysed using ANOVA and DMRT in SAS 9.2 (PROC GLM procedure) software. After 55-60 days of sowing, the

*Corresponding author's present address: Division of Crop Protection, IIPR, Kanpur 208 024, U.P.; E-mail: shankarento@gmail.com

number of taxa of natural enemies present on okra in each treatment was recorded and collected for identification. The total number of individuals present in a specific species and total number of individuals in all species in different treatments were used for diversity analysis through Shannon-Wiener index. This index combines both the species richness and evenness in a habitat. Generally, for a sample size with more than five species, the index range from 0 to 4.5. A value near zero indicates that the treatment is dominated by a single species and a value near 4.6 indicates the number of individuals are evenly distributed in all species.

RESULTS AND DISCUSSION

Leafhopper population from treatments, T_1 to T_3 was significantly lower than the sole crop in both the years (Table 1). The lowest mean leafhopper population in okra was recorded from treatment having coriander as intercrop and maize as border crop (T_1: 5.49 and 2.95 / 3 leaves / plant). The second best treatment in both the years was treatment having marigold as intercrop and maize as border crop (T_3: 7.56 and 5.02 / 3 leaves / plant). The intercropped treatments, T_1 to T_5 recorded the lower population of leafhopper than sole crop (T_7: 11.82 and 9.44/ 3 leaves / plant). Maize as border crop reduced the incidence of leafhopper than cowpea. Hence the treatments comprising maize and coriander (T_1: 5.49 and 2.95), maize and marigold (T_3: 7.56 and 5.02) and maize and mint (T_5: 8.47 and 5.87) recorded lower leafhopper population than corresponding cowpea treatments during both the years. The treatment T_1 had recorded the lowest leaf hopper population during the years 2010 and 2011 in which coriander was used as an intercrop and maize as border crop. The natural enemies attracted by maize might have helped in lowering the insect pest population. The maize terminal bud was infested by *Rophalosiphum maydis* (Fitch), its honeydew, β farnesene (Al Abassi *et al.*, 1) and herbivore induced plant volatiles (HIPV) (Powell *et al.*, 10) might have attracted coccinellids and other aphidophagous predators and parasitoids, as reported by Ninkovic *et al.* (9). The results convey that the maize as a border crop and coriander as intercrop lowered the leafhopper population in okra in both the years. The present results are in corroboration with Saxena and Basit (12). Treatment having coriander as intercrop along with maize as border crop suppressed the leafhopper population. Maize + cowpea and *Setaria* in between rows reduced insect pest in cotton (Bhosle *et al.*, 5).

The lowest mean whitefly population in okra was recorded from treatment having marigold as intercrop and maize as border crop (T_3: 5.89 and 9.07 /3 leaves / plant) (Table 1). During *kharif* 2010, the mean whitefly population was lowest in the treatment T_3 (5.89 / 3 leaves / plant) and T_1 (6.40 / 3 leaves / plant) than sole crop T_7 (12.71/ 3 leaves / plant). Similar, trend was also observed in *kharif* 2011, T_3 (9.07/ 3 leaves / plant) and T_1 (9.53/ 3 leaves / plant), while T_7 (15.77/ 3 leaves / plant) recorded the highest. Thus, marigold as intercrop and maize as border crop proved best in lowering the whitefly population in okra. Marigold intercropping in tomato reduced number of aphids, whiteflies and also resulted in lower levels of virus incidence in tomato (Zavaleta-Mejia and Gomez, 15). The results clearly

Table 1. Effect of intercrop and border crops on leaf hopper, whitefly, and coccinellid predator incidence in okra during *kharif* 2010 and 2011.

Treatment	Mean insect population per three leaves per plant for 10 weeks					
	A. bigutula biguttula		*B. tabaci*		Coccinellid predator	
	2010	2011	2010	2011	2010	2011
T1	5.49 (2.43)[a]	2.95 (1.86)[a]	6.40 (2.62)[a]	9.53 (3.17)[a]	0.67 (1.08)[a]	0.76 (1.12)[a]
T2	8.96 (3.08)[c]	4.70 (2.27)[b]	9.66 (3.19)[c]	11.88 (3.51)[b,c]	0.31 (0.90)[c]	0.35 (0.92)[c]
T3	7.56 (2.84)[b]	5.02 (2.35)[b]	5.89 (2.53)[a]	9.07 (3.09)[a]	0.60 (1.05)[a]	0.63 (1.06)[b]
T4	9.61 (3.18)[c,d]	6.36 (2.62)[c]	7.85 (2.89)[b]	11.16 (3.41)[b]	0.27 (0.88)[c,d]	0.24 (0.86)[d]
T5	8.47 (2.99)[b,c]	5.87 (2.52)[c]	8.39 (2.98)[b]	11.64 (3.48)[b,c]	0.49 (0.99)[b]	0.53 (1.02)[b]
T6	10.70 (3.34)[d,e]	7.34 (2.80)[d]	10.53 (3.32)[c]	13.00 (3.67)[c]	0.25 (0.87)[c,d]	0.21 (0.84)[d]
T7	11.82 (3.51)[e]	9.44 (3.15)[e]	12.71 (3.63)[d]	15.77 (4.03)[d]	0.22 (0.85)[d]	0.21 (0.84)[d]
CV	3.62	3.72	2.53	3.66	2.62	2.93
CD (p<0.05)	0.20	0.17	0.14	0.23	0.04	0.05

Figures in parenthesis are square root transformed. In a column means followed by same letter(s) are not significantly different from each other (P ≤ 0.05) elucidates that the marigold as an intercrop and maize as border crop lowers the whitefly population in okra. The present findings support the reports of Altieri and Liebman (2) and Gangwar *et al*. (6), strong odour from the intercrops hinder the mechanism of orientation to the host plants by insect pests. Thus, all the intercropping treatments helped in lowering the whitefly incidence than sole crop. Intercropping was found reduce the insect pests of cotton (Mensah and Sequeira, 8).

The highest mean per cent fruit infestation (Table 2) was recorded from the sole crop T_7 in both number and weight basis (32.14 and 32.14). The highest percent reduction in infestation over control was also from T_3 (66.28 & 66.40 and 67.82 and 73.02) in both number and weight basis during 2010 and 2011, respectively. The highest per cent increase in yield over control in both number and weight basis was recorded from T_1 (42.44 and 80.22) followed by T_3 (32.68 and 58.5) (Fig. 1). The treatment having marigold as intercrop and maize as border crop had recorded the lowest fruit borer infestation. All intercropped treatments (T_1 to T_6) recorded significantly lower per cent fruit infestation than the sole crop (T_7). The highest reduction in percent fruit borer infestation was reported from the treatment using marigold as intercrop with okra. These finding corroborates with Prasad and Prasad (11), they reported highest per cent reduction of fruit damage and shoot damage in okra intercropped with marigold by *E. vitella* than other treatments. The T_1 and T_3 had coriander and marigold as intercrop, respectively and also maize as border crop in both the treatments. Treatment T_3 recorded the highest reduction in fruit borer infestation. Thus maize played a pivotal role in reducing the *E. vittella* infestation by hindering its adult movement and then oviposition.

Table 2. Mean fruit borer, *E. vittella* infestation in okra during *kharif* 2010 and 2011 in different treatments.

Treatment	Per cent fruit infestation	
	No. basis	Weight basis
T1	12.85 (20.97)^{b}	12.40 (20.62)^{b}
T2	20.57 (26.95)^{d}	20.57 (26.97)^{d}
T3	10.57 (18.95)^{a}	9.69 (18.12)^{a}
T4	16.76 (24.08)^{c}	16.53 (23.94)^{c}
T5	12.39 (20.53)^{a,b}	12.45 (20.65)^{b}
T6	18.87 (25.71)^{c,d}	19.09 (25.90)^{d}
T7	32.14 (34.51)^{e}	32.14 (34.53)^{e}
CV	6.53	4.09
CD ($p \leq 0.05$)	1.90	1.18

Figures in parenthesis are Arc sine transformed. In a column means followed by same letter(s) are not significantly different from each other ($P \leq 0.05$).

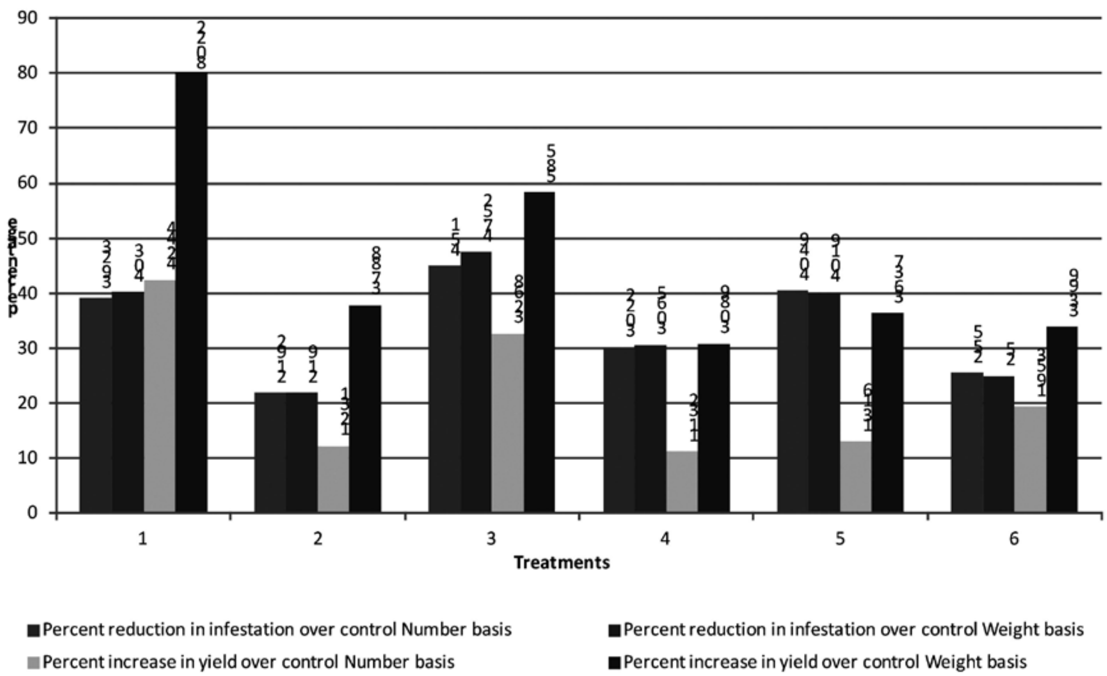

Fig. 1. Mean percentage reduction in infestation over control treatment *vis-a-vis* percentage increase in marketable yield over control in okra during *kharif* 2010 and 2011.

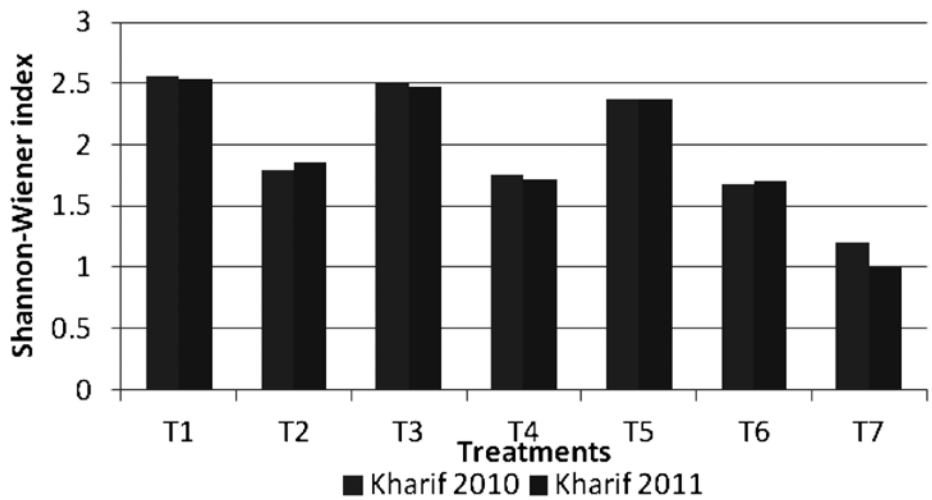

Fig. 2. Shannon-Weiner diversity index for natural enemies recorded from different treatments.

The results are in agreement with Sharma and Sinha (13), where they had concluded that okra insect pests can be effectively managed by growing baby corn as a border crop.

In the years 2010 and 2011 (Table 1), the coccinellid population was highest in the treatments T_1 and T_3, while the sole crop recorded the lowest coccinellid population among the seven treatments. The pooled mean of *kharif* 2010 showed that T_1 (0.67 per plant) and T_3 (0.60 per plant) were on par with each other followed by T_5 (0.49 per plant), T_2 (0.31 per plant), T_4 (0.27 per plant), T_6 (0.25 per plant) and T_7 (0.22 per plant). During *kharif* 2011, the mean coccinellid population was highest in T_1 (0.76 per plant) followed by T_3 (0.63 per plant), T_5 (0.53 per plant), T_2 (0.35 per plant), T_6 (0.21 per plant) and T_7 (0.21 per plant). The results indicated that the treatment using maize as border crop has recorded more natural enemies in okra than cowpea as border crop. Apart from coccinellids other natural enemies like syrphids, rove beetles, *Brachymeria* sp. and green lacewings were also recorded maize border cropped treatment but not in cowpea border crop. It appears that maize had conserved more natural enemy diversity than cowpea. Some special predators like reduvids and *Geocoris tricolor* F. were also recorded apart from many diverse coccinellids. The treatments using maize as a border crop has recorded more natural enemies than the cowpea as border crop. The Shannon-Wiener diversity index for natural enemies is highest for the intercropped treatment (1.6-2.5) and lowest for the sole crop treatment (1.0). To conclude, the diversity in agro-ecosystem increased natural enemy population concurrently lowers insect pest, which is a valuable ecosystem service (Gurr *et al.*, 7).

The Shannon-Wiener index for species richeness in different treatments varied from 2.561 to 1.202 and 2.540 to 1.003 during 2010 and 2011, respectively (Fig. 2). The total number of individuals varied from 73 to 17 and species 15 to 4 during 2010 in different treatments. Similarly, in 2011, the total number of individuals and species 78 to 17 and 15 to 3 recorded respectively in different treatments. The highest number of species, individual and Shannon-Wiener index was recorded from the treatment T_1, while it is lowest for the sole crop treatment T_7.

The fruit borer, *E. vitella* was managed effectively with the help of crop diversification using marigold as an intercrop and maize as border crop. Same treatment was also best in managing the whitefly, *B. tabaci* efficiently The treatment using maize as border crop and coriander as intercrop also proved effective in reducing the leafhopper population than all other treatments. All the treatments except sole crop treatment recorded higher coccinellid population. The results clearly indicated that crop diversification increased the natural enemy population and also helped in reducing the insect pest population in okra. Thus, the crop pest diversionary approach could help in a sustainable insect pest management in okra.

ACKNOWLEDGEMENTS

The author acknowledge Dr V.V. Ramamurthy and National Pusa Collection for identification of predators and parasitoids. The study was supported by financial assistance from DST, INSPIRE programme of GoI.

REFERENCES

1. Al Abassi, S., Birkett, M., Pettersson, J., Pickett, J., Wadhams, L. and Woodcock, C. 2000.

Response of the seven-spot ladybird to an aphid alarm pheromone and an alarm pheromone inhibitor is mediated by paired olfactory cells. *J. Chem. Ecol.* **26**: 1765-71.

2. Altieri, M.A. and Liebman, M.1986. Insect, weed and plant disease management in multiple cropping systems. **In**: *Multiple Cropping Systems*, Francis, C.A. (Ed.). Macmillan Publishing Company, New York, pp. 183-217.
3. Andow, D.A. 1991. Vegetational diversity and arthropod population response. *Ann. Rev. Entom.* **36**: 561-86.
4. Anonymous. 2010. *Indian Horticultural Database 2009*. Bijay Kumar (Ed.). National Horticulture Board. Aristo Printing Press, New Delhi, 262 pp.
5. Bhosle, B.B., More, D.G., Bambawale, O.M., Sharma, O.P. and Patange, N.R. 2007. Effectiveness of cotton IPM module in rainfed Maharashtra region. *Ann. Pl. Protec. Sci.* **15**: 21-25.
6. Gangwar, S.K., Singh, Y.P. and Patel, C.S. 1994. Influence of intercropping infestation by insect pests of crops at medium high altitude of Meghalaya. *Indian J. Agric. Sci.* **64**: 137-40.
7. Gurr, G.M., Wratten, S.D. and Luna, J.M. 2003. Multifunction agricultural biodiversity: pest management and other benefits. *Basic Appl. Ecol.* **4**: 107-16.
8. Mensah, R.K. and Sequeira, R.V. 2004. Habitat manipulation for insect pest management in cotton cropping systems. **In**: *Ecological Engineering for Pest management: Advances in Habitat Manipulation for Arthropods*, Gurr, G.M., Wratten, S.D. and Altieri, M.A. (Eds.), Cornell University Press, New York, pp. 187-97.
9. Ninkovic, V., Al Abassi, S. and Petersson, J. 2001. The influence of aphid-induced plant volatiles on ladybird beetle searching behaviour. *Biol. Control.* **21**: 191-95.
10. Powell, W., Pennacchio, F., Poppy, G.M. and Tremblay, E. 1998. Strategies involved in the location of host by the parasitoid *Aphidius ervi* Haliday (Hymenoptera: Braconidae: Aphidiinae). *Biol. Control.* **11**: 104-12.
11. Prasad, R. and Prasad, D. 2002. Effect of crop association and insecticides on the incidence of shoot and fruit borer of okra (*Abelmoschus esculentus*). *J. Res. (BAU)*, **14**: 255-56.
12. Saxena, K.N. and Basit, A. 1982. Inhibition of oviposition by volatiles of certain plants and chemicals in the leafhopper, *Amrasca devastans* (Distant). *J. Chem. Ecol.* **8**: 329-38.
13. Sharma, R.K. and Sinha, S.R. 2009. Insect pest management in okra with babycorn as border crop and ecofriendly insecticides. *J. Insect Sci*. **22**: 254-58.
14. Srinivasa Rao, N. and Rajendran, R. 2002. Joint action potential of neem with other plant extracts against the leaf hoppers, *Amrasca devastans* (Distant) on okra. *Pest Manag. Econ. Zool.* **10**: 131-36.
15. Zavaleta-Mejia, E. and Gomez, R.O. 1995. Effect of *Tagetes erecta* L. tomato (*Lycopersicon esculentum* Mill.) intercropping on some tomato pests. *Fitopatologia Brasileira*, **30**: 35-46.

Received : September, 2015; Revised : May, 2016;
Accepted : May, 2016