Influence of intercrops/trap crops on the preference of major pests of cotton in different IPM modules under rainfed condition

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ABSTRACT

In the present study, the influence of intercrops on the incidence of major pests of cotton was studied in different IPM modules. In Dharwad module, *Amrasca devastans*, *Bemisia tabaci* and *Aphis gossypii* recorded preference ratios of 1.60, 0.82 and 1.29, respectively towards bhendi. *A. devastans* and *A. gossypii* showed preference ratios of 1.51 and 1.17 respectively, towards bhendi, in TNAU IPM module whereas they did not prefer any intercrop in Guntur IPM module. *B. tabaci* recorded preference ratios less than one in TNAU, Guntur IPM modules and farmers' practice towards the intercrops. *Earias* spp. showed more preference on bhendi and registered 2.69 and 2.08 as preference ratios in Dharwad and TNAU IPM modules whereas it showed no preference to intercrops / trap crops in Guntur module and in farmers' practice. The preference ratios of *Helicoverpa armigera* were 1.08 and 1.13 on bhendi in Dharwad and TNAU IPM modules while in Guntur IPM module and farmers' practice the intercrops were less preferred compared to cotton. The leaf eating caterpillar *Spodoptera litura* preferred castor, sunflower and bhendi more than that of cotton in TNAU IPM module whereas the preference was more towards castor and groundnut in Guntur IPM module. The cotton semiloopers *Anomis flava, Xanthodes graellsi* and *Tarache nitidula* recorded 0.93, 2.54 and 0.05 in Dharwad module and 1.95, 3.91 and 0.22 in TNAU module as preference ratios on bhendi, respectively. *Thrips tabaci*, pink boll worm *Pectinophora gossypiella* and stem weevil *Pempherulus affinis* showed no preference to the intercrops/trap crops in all the modules.

Key words: *Amrasca devastans*, *Bemisia tabaci*, *Aphis gossypii*, crop pest

INTRODUCTION

Cotton (*Gossypium* spp.), considered as 'King of fibre' and 'white gold', is one of the most important commercial crops. In India cotton is cultivated over an area of 9.13 million ha with a production of 243 lakh bales and productivity of 463 kgha^{-1} in 2004-05 (AICCIP, 2007) which is very low compared to some of the cotton growing countries and the world average of 590 kgha^{-1}. Despite the recent setbacks, cotton continues to remain the backbone of the rural economy, particularly in the dry land areas. The important key pests *viz*., leafhopper (*Amrasca devastans* Distant), aphids (*Aphis gossypii* Glover), whitefly (*Bemisia tabaci* Gennadius), thrips (*Thrips tabaci* Lind.), spotted bollworm (*Earias insulana* Boisd. and *Earias vittella* Fab.), American bollworm (*Helicoverpa armigera* Hubner), pink bollworm (*Pectinophora gossypiella* Saund.), cotton leaf worm (*Spodoptera litura* Fab.) and stem weevil (*Pempherulus affinis* Faust.) which cause severe yield losses (Dhawan, 2000).

The increasing problems due to continued usage of pesticides and failure of any individual component to check the pest population in cotton have made the adoption of IPM (Integrated Pest Management), an imperative and have given urgency to the need to develop ecologically viable and economically feasible alternative technologies (Raheja, 1995; Gautam, 1998). Insecticides valued at US$660 million are used annually on all crops in India, of which about half are used on cotton alone (Manjunath, 2004; Rai *et al*., 2009). Today, the main aim is to bring down the ETL rather than eradication, for which IPM is well suited rather than any one individual component. In recent years, IPM has gained increased attention as a potential means of reducing reliance on chemical pest control and therefore fostering the long term sustainability of agricultural systems. In most of the crop ecosystems, intercropping/trap cropping plays a pivotal role as one of the important components of IPM in diverting the pests from main crop to inter/trap crop and reducing the loss to the main crop (Shelton and Badenes-Perez, 2006). Though intercropping or trap cropping is an age old practice of pest management, it has its own scientific back ground to deter the insects or to reduce the attraction towards the main crop. Hence an attempt

was tried to evaluate the preference of major pests of cotton to the intercrops in different IPM modules *viz.*, Dharwad, TNAU (Tamil Nadu Agricultural University), Guntur and farmers practice under rainfed condition.

MATERIALS AND METHODS

Three different IPM modules *viz*., Dharwad, TNAU, Guntur and farmers' practice were evaluated for the preference of major pests of cotton to the intercrops/trap crops under rainfed condition in two seasons, one at Sengappadai, Madurai district and another at Regional Research Station, Aruppukottai, Virudhunagar district using cotton variety SVPR 2. An area of 1600 m^2 was allotted to each IPM module and observations were taken in five demarcated plots (10 x 8 m^2) in each field, considering each as one replicate. The IPM modules were laid in such a way that they were 100 m apart to reduce the movement of pests and natural enemies from one module to another. Ten plants per replication were randomly selected and tagged for assessing the pest and natural enemy populations. The seed rate used was 15 $kgha^{-1}$ (fuzzy seeds) with a spacing of 45 x 30 cm. In case of TNAU IPM module, paired row system was followed *i.e.*, 60 cm between the paired rows and 30 cm within paired row. Between paired rows and along the boundary, the intercrops/trap crops were raised. The fertilizer dose of 40: 20: 0 kg NPK ha^{-1} was applied. Half the dose of N in the form of urea and full P in the form of super phosphate was applied basally and half the dose of N was applied 45 days after dibbling of seeds, coinciding with monsoon rain. Based on the need the intercrops were applied with fertilizers.

In Dharwad IPM module bhendi was sown as intercrop @ 10:1, whereas in TNAU IPM module cowpea, sunflower, blackgram, greengram, cumbu and bhendi as intercrops in the cotton paired row system and two rows of maize as border crop and castor was raised in the border with a spacing of 6 m as trap crop. In Guntur IPM module, blackgram, greengram, cowpea, clusterbean and groundnut @ 8:2 ratios, sorghum and maize as border crops and castor was raised as trap crop. Sucking pests, nymphs and adults of jassids (*A. devastans)*, whiteflies (*B. tabaci*) aphids (*A. gossypii*) and thrips (*T. tabaci*) were recorded from ten randomly selected tagged plants in each replication. In each plant, three leaves (top, middle and bottom) were considered for observation (Singh *et al.*, 1995). The selected plants and shed parts beneath the plants were observed for larval population of bollworms. Stem weevil incidence was accounted during 30, 60, 90 and 120 DAS by observing the presence of galls in 100 plants in each replication. The percent germination, root rot and wilt incidence were observed in each replicate, in different IPM modules. The preference ratio of pests was calculated by the following formula:

$$PR = \frac{\text{Population of pests on intercrop / trap crop}}{\text{Population of pests on cotton}}$$

RESULTS AND DISCUSSION

The influence of intercrops on the preference of major pests was worked out for mean pest population over two seasons. The data indicate that *A. devastans* recorded the highest preference ratio of 1.60 times towards bhendi than that of cotton in Dharwad module (Table 1) while *B. tabaci* and *A. gossypii* recorded preference ratios of 0.82 and 1.29, respectively. In TNAU module, A. *devastans* showed preference ratios of 1.51 and 0.52 on bhendi and sunflower, respectively. *B. tabaci* displayed preference ratios of 0.35, 0.33, 0.30, 0.28 and 0.27 on sunflower, bhendi, greengram, black gram and cowpea, respectively (Table 1). *A. gossypii* showed its preference only to bhendi intercrop and registered 1.17 as preference ratio. *A. devastans* and *A. gossypii* did not prefer any intercrop in Guntur module. *B. tabaci* recorded preference ratios of 0.33, 0.29 and 0.28 on greengram, cowpea and black gram. In farmers' practice a preference ratio of 0.23 was noted on black gram by *B. tabaci*. *T. tabaci* did not prefer any intercrop in all the modules.

Though there are much informations on the influence of intercrops on the incidence of major pests of cotton, there were no reports about the preference ratio. The population of sucking pests *viz*., whitefly, aphid and thrips was high and leafhopper population was maximum in TNAU IPM module, when compared to other modules. The population reduction in TNAU module is due to the influence of intercropping on the enrichment of natural enemies, which in turn checked the pest population. In addition, the presence of intercrops (bhendi and sunflower) in cotton attracted a proportionate population of pests from cotton as well explained by Singh *et al*. (1993) and Simwat (1994). Lower aphid population was noted on cotton + cowpea (Vieira and Santos, 1983; Natarajan and Sheshadri, 1988), cotton + greengram (Venkatesan *et al.,* 1987) than sole cotton. Simwat (1994) also opined that there was a decrease in sucking pests when cotton intercropped with cowpea, black gram and greengram. In intercropping, the modification of the microenvironment and differences in the nutrient uptake by the intercrops may influence plant infestation and the development and movement of insect pests (Rao and Reddy, 1999; Choudhary and Laroia, 2001).

The incidence of *B. tabaci* indicates lower level in TNAU module on cotton. In the TNAU IPM module, bhendi was highly preferred by leafhopper, followed by sunflower. The preference of *B. tabaci* was in the order of sunflower

Table 1. Influence of intercrops on the preference of sucking pests of cotton in different IPM modules

Module	Crops	*A. devastans*		*B. tabaci*		*A. gossypii*		*T. tabaci*	
		P	PR	P	PR	P	PR	P	PR
Dharwad	Cotton	16.17	-	29.32	-	46.93	-	42.78	-
	Bhendi	29.44(18.40)	1.60	28.40(34.47)	0.82	68.91(53.44)	1.29	0.00	0.00
TNAU	Cotton	18.16	-	22.90	-	40.52	-	32.49	-
	Bhendi	31.43(20.77)	1.51	9.25(27.79)	0.33	55.91(47.83)	1.17	0.00	0.00
	Greengram	0.00	0.00	7.84(25.80)	0.30	0.00	0.00	0.00	0.00
	Blackgram	0.00	0.00	7.33(25.80)	0.28	0.00	0.00	0.00	0.00
	Cowpea	0.00	0.00	7.00(25.80)	0.27	0.00	0.00	0.00	0.00
	Sunflower	11.60(22.40)	0.52	9.08(25.80)	0.35	0.00	0.00	0.00	0.00
	Cumbu	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Maize	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Castor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Guntur	Cotton	16.26	-	30.34	-	42.72	-	40.42	-
	Greengram	0.00	0.00	8.62(25.80)	0.33	0.00	0.00	0.00	0.00
	Blackgram	0.00	0.00	7.20(25.80)	0.28	0.00	0.00	0.00	0.00
	Cowpea	0.00	0.00	7.38(25.80)	0.29	0.00	0.00	0.00	0.00
	Groundnut	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Cluster bean	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Maize	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Sorghum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Castor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Farmers' practice	Cotton	23.02	-	34.34	-	52.99	-	46.17	-
	Blackgram	0.00	0.00	6.18(26.36)	0.23	0.00	0.00	0.00	0.00

Mean of two seasons data; P-Population / 10 plants; PR-Preference Ratio ; Figures in parentheses indicate the population number of particular pest in cotton corresponding to the duration / same period of intercrop / trap crop.

> bhendi > greengram > black gram > cowpea among the intercrops. *A. gossypii* preferred bhendi more than that of cotton. *T. tabaci* did not show any preference to the intercrop/trap crops. The incidence of *A. gossypii* and *T. tabaci* also was less in TNAU module on cotton because of the higher activity of natural enemies. *E. vittella* showed more preference on bhendi and registered 2.69 and 2.08 as preference ratios in Dharwad and TNAU modules, respectively, while it showed no preference to intercrops or trap crops in the remaining modules (Table 2). *Helicoverpa armigera* recorded 1.08 as preference ratio on bhendi in Dharwad module. In TNAU module it preferred the intercrops in the order of bhendi > sunflower > cowpea > maize > greengram > blackgram > cumbu and recorded 1.13 > 0.94 > 0.84 > 0.80 > 0.76 > 0.73 > 0.42 as preference ratios. The preference ratios were 0.52 > 0.49 > 0.47 > 0.44 > 0.37 > 0.35 towards maize, cowpea, groundnut, greengram, sorghum and blackgram, respectively for Guntur module (Table 2). In farmers' practice it registered 0.17 as preference ratio on blackgram. *P. gossypiella* showed no preference to the intercrops/trap crops raised in all the modules.

The population of bollworms and damage caused by them in cotton was low in TNAU module which may be because of the influence of intercrops. Insect was unable to locate host plants in polyculture as the visual and chemical stimuli got manipulated or altered and due to disruption of host finding behaviour through aromatic odours of other plants. Thus, host plants are protected from insects. Intercropping can interfere with the population development and survival of insect pests because the companion crops block their dispersal across the field and it may be more difficult for them to locate and remain in microhabitats, which favour their rapid development (Altieri, 1987). The reduction in the incidence and damage of *H. zea* in cotton intercropped with sorghum/maize (Burleigh, 1973) and *H. armigera* in common beans intercropped with maize (Karel, 1993) could have been due to the restricted movement of adult moths and increase in population of natural enemies in that system. Increased humidity and reduced temperature created by intercropping with maize favours the incidence of natural enemy populations (Karel, 1990). Increased degree of parasitism on cotton bollworm in the zones intercropped

Table 2. Influence of intercrops on the preference of cotton bollworms in different IPM modules

Module	Crops	*Earias* spp.		*H. armigera*		*P. gossypiella*	
		P	PR	P	PR	*P	PR
Dharwad	Cotton	4.31	-	7.09	-	4.20	-
	Bhendi	10.23(3.81)	2.69	8.18(7.58)	1.08	0.00	0.00
TNAU	Cotton	4.66	-	5.20	-	2.95	-
	Bhendi	10.31(4.95)	2.08	6.67(5.90)	1.13	0.00	0.00
	Greengram	0.00	0.00	3.88(5.10)	0.76	0.00	0.00
	Blackgram	0.00	0.00	3.72(5.10)	0.73	0.00	0.00
	Cowpea	0.00	0.00	4.71(5.60)	0.84	0.00	0.00
	Sunflower	0.00	0.00	5.26(5.60)	0.94	0.00	0.00
	Cumbu	0.00	0.00	2.63(6.30)	0.42	0.00	0.00
	Maize	0.00	0.00	3.80(4.73)	0.80	0.00	0.00
	Castor	0.00	0.00	0.00	0.00	0.00	0.00
Guntur	Cotton	5.13	-	6.74	-	3.63	-
	Greengram	0.00	0.00	3.01(6.80)	0.44	0.00	0.00
	Blackgram	0.00	0.00	2.39(6.80)	0.35	0.00	0.00
	Cowpea	0.00	0.00	3.33(6.80)	0.49	0.00	0.00
	Groundnut	0.00	0.00	3.57(7.63)	0.47	0.00	0.00
	Clusterbean	0.00	0.00	0.003.86(7.40)	0.00	0.00	0.00
	Maize	0.00	0.00		0.52	0.00	0.00
	Sorghum	0.00	0.00	2.84(7.64)	0.37	0.00	0.00
	Castor	0.00	0.00	0.00	0.00	0.00	0.00
Farmers' practice	Cotton	7.50	-	15.09	-	6.33	-
	Blackgram	0.00	0.00	2.20(13.20)	0.17	0.00	0.00

Mean of two seasons data; P-Population / 10 plants; *P-Nos./50 bolls; PR-Preference Ratio ; Figures in parentheses indicate the population number of particular pest in cotton corresponding to the duration / same period of intercrop / trap crop.

with cowpea, alfalfa and sesame have been reported earlier (Baliddawa, 1985).

The larval population of *H. armigera* was high in TNAU module on cotton. The development of *H. armigera* or any other pests on various crops in a multicrop / polycrop ecosystem varies. *H. armigera* on sorghum / cumbu earhead takes a longer time to develop because of poor nutritional factors compared to other crops and become vulnerable to natural enemies attack. Thus, indirectly increasing the population of natural enemies and this may encounter the pests on cotton leading to least damage. Manjunath *et al*. (1985) revealed that eggs and larvae of *H. armigera* are common on sorghum earheads and are heavily parasitised by hymenopterans notably by *T. chilonis* and *Campoletis chlorideae*. The incidence of *E. vittella* was low in Dharwad module followed by TNAU module on cotton because of bhendi as intercrop. Bhendi was more preferred by *E. vittella* than the cotton. The preference of *H. armigera* was in the order of bhendi > sunflower > cowpea > maize > greengram > black gram > cumbu. The incidence of *P. gossypiella* was less in TNAU module and showed no preference to the intercrops. Thimmaiah and Raju (1991) reported bhendi was the preferred host plant of cotton jassid, spotted bollworms and American bollworm and the population of above pests could be reduced by periodical removal and destruction of infested fruits. Hiremath (1984) was also in the opinion that bhendi was mostly preferred by *Earias* spp. for feeding and oviposition and recommended bhendi as trap crop in cotton fields to reduce *Earias* spp. attack. Ratnadass *et al.* (2009) proposed sorghum and physic nut (*Jatropha curcas*) for management of plant bugs (Hemiptera: Miridae) and cotton bollworm (*Helicoverpa armigera*) on cotton.

The leaf-eating caterpillar *S. litura* preferred bhendi 0.63 times compared to cotton in Dharwad module. Likewise in TNAU module its preference ratios were 5.95, 1.95, 1.25, 0.80, 0.75 and 0.53 on castor, sunflower, bhendi, greengram, cowpea and blackgram, respectively. In Guntur module it registered 4.92, 1.81, 0.76, 0.71 and 0.50 as preference ratios on castor, groundnut, cowpea, greengram and blackgram. In farmers' practice it displayed 0.15 as preference ratio on black gram intercrop. The cotton semiloppers *A. flava*,

Table 3. Influence of intercrops on the preference of cotton defoliators and stem weevil in different IPM modules

Module	Crops	Defoliators								*P. affinis*	
		S. litura		Semiloopers							
				A. flava		*X. graellsi*		*T. nitidula*			
		P	PR	P	PR	P	PR	P	PR	*P	PR
Dharwad	Cotton	6.94	-	5.63	-	3.76	-	0.78	-	8.03	-
	Bhendi	6.07(9.65)	0.63	5.25(5.63)	0.93	9.56(3.76)	2.54	0.04(0.78)	0.05	0.00	0.00
TNAU	Cotton	2.91	-	2.97	-	2.57	-	0.60	-	2.70	-
	Bhendi	3.63(2.91)	1.25	5.80(2.97)	1.95	10.04(2.57)	3.91	0.13(0.60)	0.22	0.00	0.00
	Greengram	3.93(4.93)	0.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Blackgram	2.63(4.93)	0.53	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Cowpea	3.70(4.93)	0.75	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Sunflower	5.68(2.91)	1.95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Cumbu	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Maize	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Castor	17.31(2.91)	5.95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Guntur	Cotton	3.77	-	6.39	-	6.05	-	0.68	-	7.65	-
	Greengram	4.31(6.03)	0.71	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Blackgram	3.00(6.03)	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Cowpea	4.40(5.80)	0.76	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Groundnut	9.45(5.23)	1.81	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Clusterbean	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Maize	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Sorghum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Castor	18.55(3.77)	4.92	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Farmers' practice	Cotton	10.21	-	9.94	-	8.61	-	1.02	-	10.60	-
	Blackgram	2.20 (15.03)	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Mean of two seasons data; P-Population / 10 plants; *P – Per cent incidence; PR-Preference Ratio; Figures in parentheses indicate the population number of particular pest in cotton corresponding to the duration / same period of intercrop / trap crop.

X. graellsi and *T. nitidula* registered preference ratios as 0.93, 2.54 and 0.05 on bhendi in Dharwad module and 1.95, 3.91 and 0.22 on bhendi in TNAU module, respectively. Cotton stem weevil *P. affinis* showed no preference to all intercrops raised in all the modules (Table 3). Spodoptera litura, the leaf worm, is mainly a foliage feeder but it also damages cotton bolls.

TNAU module recorded minimum population of defoliators. It is possible because of bhendi as intercrop which is most attractive to defoliators than cotton. Castor acted as trap crop which effectively reduced the population of *S. litura* on cotton. This is in consonance with the opinion of Dhawan (1999). *P. affinis* incidence was low in TNAU module compared to others. It is because of basal application of neem cake @ 250 kgha^{-1}, which deterred the stem weevil from egg laying on collar portion of plants. No other modules followed this operation. The population and activity of natural enemies, coccinellids, chrysopids, syrphids, spiders, braconids, reduviids, and trichogrammatids were high in TNAU module because of the polycrop ecosystem. It can be concluded that inclusion of intercrops/trap crops in the IPM schedule will reduce the infestation by major pests on cotton by diverting them to the intercrops/trap crops.

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