Kasetsart J. (Nat. Sci.) 43 : 662 - 668 (2009)

Influence of Trap Crop on Yield and Cotton Leafhopper Population and Its Oviposition Preference on Leaves of Different Cotton Varieties/Lines

Praparat Hormchan[1,*], Arunee Wongpiyasatid[2] and Wiriya Prajimpun[1]

ABSTRACT

The experiment was set up as a split plot design, with four replications. White and naturally colored cotton of 4 varieties/lines, each was cultivated in monoculture, and with perimeter trap cropping and row intercropping with okra and castor bean at Thong Pha Phom, Kanchanaburi and with okra , and sunflower and castor bean at Nakhon Ratchasima Field Crop Research Center during the dry and late rainy seasons of the year 2008 respectively. The populations of leafhopper (*Amrasca biguttula* Ishida) were recorded from top and bottom leaves 30, 60 and 75 DAP (days after planting) and expressed as an average number / 2 leaves. The plots with trap crops were found to decrease in a number of leafhopper while yields increased comparing to the sole cotton in every variety/line. Choice test on oviposition preference was undertaken in the nylon cages holding 10 plants of each cotton variety/line exposed together to 20 leafhopper females for 2 weeks. The results from 20 leaves of each showed more egg numbers in the lateral vein than in the mid vein with no significant differences among test varieties/lines.

Key words: trap crop, cotton leafhopper, cotton

INTRODUCTION

Cotton crop is subjected to attack by a number of insect pests. It constitutes a major limiting factor in cotton production. Predominant loss is caused by the bollworms, and sucking pests like leafhopper and white-fly. The cotton leafhopper, *Amrasca biguttula biguttula* (Ishida) (Hom., Cicadellidae) is an important pest of several field crops including cotton, okra, egg plant, potato, tomato, sunflower, cluster bean, castor, cowpea and wild plants including country mallow. The characteristic symptom of leafhopper attack is phytotoxemia (hopperburn) caused by desapping of leaves by nymphs and adults (Hooda *et al*., 1997). In severe attacks, plants are stunted and unable to produce flowers and fruits. The number of practical trials of trap cropping has increased rapidly in recent years. Trap crops are composed of one or more plant species grown to attract insects in order to protect the cash crop from the pests (Hokkanen,1991). There are two types of planting the trap crops; perimeter trap cropping (border trap cropping) and row intercropping. Perimeter trap cropping is the planting of trap crop completely surrounding the main cash crop. Row

1 Department of Entomology, Faculty of Agriculture , Kasetsart University, Bangkok 10900, Thailand.

2 Department of Applied Radiation and Radioisotopes, Faculty of Science, Kasetsart University, Bangkok 10900, Thailand.

* Corresponding author, agrprh@ku.ac.ht

Received date : 02/07/09 Accepted date : 18/09/09

intercropping is the planting of the trap crop in alternating rows within the main crop. Trap crops give considerable advantage over sole cropping. These have ranged from single rows of early-planted trap crop potatoes between current and previous year fields for Colorado potato beetle control (Michanec, 2003) to border trap cropping against pepper and cucurbit pests (Boucher, 2003; Boucher and Durgy, 2003). Corn or tobacco planted in every 20 rows of cotton are found to attract cotton bollworm (Hasse, 1986; 1987). Sunflower or cowpea sown in every 5 rows of cotton attracts moths when planted as trap crops. Castor attracts caterpillars (CIKS, 2000) and okra also attracts cotton flower weevils when planted as border crops. In determination of yield and resistance to leafhopper and shoot/fruit borers of selected egg plant entries, okra was grown around the test plots to serve as the trap crop to leafhopper (http://www.oired.vt.edu/ipmcrsp/communications/annrepts/annrep02/Philippines/phil_topic4.pdf). Row intercropping with marigold in two rows in between cotton rows and incorporating it on 30 DAS (days after sowing) had contributed ultimately less incidence of pests and more kapas and lint yield of cotton securing higher yield advantage in both summer and winter crops of sunhemp and sesamum having moderate and low effects, respectively on pest management (Vaiyapuri *et al.*, 2007). Intercropping cotton (*Gossypium hirsutum* L.) and cowpea (*Vigna unguiculata* (L.) Walp) is one of the ways to improve food security and soil fertility whilst generating cash income of the rural poor. However, the timing of planting of trap crops as intercrops or border crops should be properly observed because these crops must flower at the same time with cotton. The objective was to investigate the effect of trap crops on cotton in the amount of cotton leafhopper as well as yield of white and naturally colored cotton. Oviposition preference of this insect pest in choice test was also studied.

MATERIALS AND METHODS

Field study

The studies were conducted under irrigated conditions of the farmer's field at Thong Pha Phum, Kanchanaburi, and Nakhon Ratchasima Field Crop Research Center, Nakhon Ratchasima starting March and August, 2008, respectively. Each experiment was laid out in split plot design with four replications. White and naturally colored cotton varieties/lines, AP2, SR60, PM1 and PM4 were bordered and intercropped with okra and castor bean respectively in the following treatments at Thong Pha Phum:

S_1: Sole cotton: 3 rows at 1×1 m spacing of row x plant

S_2: Perimeter trap cropping: 3 rows of cotton bordered with 2 rows of okra; spacing between row × plant of cotton = 1×1m, between rows of cotton and okra = 1 m and between okra plant = 50 cm

S_3: Row intercropping: 2 rows of cotton alternating with 1 row of castor bean; spacing between row × plant of cotton = 1×1 m, between rows of cotton and castor bean =1 m and between castor bean = 1.00 m

For the following planting at Nakhon Ratchasima Field Crop Research Center, intercropping of cotton with sunflower was added and the spacing of all crops between row and plant was 1×1 m.

S_4: Row intercropping: 2 rows of cotton alternating with 1 row of sunflower; spacing between row × plant of cotton = 1×1m, between rows of cotton and sunflower =1 m and between sunflower = 1m

Fertilizer of formula 15-15-15 was applied at the rate of 25 kg/rai for 2 times. Water application and weed eradication were given as needed. The seed cotton yields were harvested in 2 pickings. The populations of leafhopper (*Amrasca biguttula* Ishida) were recorded on top

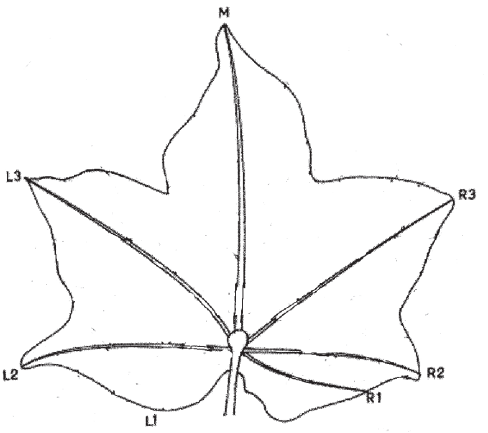

Figure 1 Diagram of cotton leaf showing pattern and name of leaf veins.

and bottom leaves 30, 60 and 75 DAP (days after planting) and expressed as an average number / 2 leaves.

Laboratory test

The cotton plants belonging to 2 white (AP2 and SR60) and 2 naturally colored lines (PM1 and PM4), were grown at the Department of Entomology, Bangkhen. Under choice test, all varieties/lines, 10 plants for each in a pot size of 10 inches in diameter, were exposed together for oviposition by the 20 leafhopper females in cages covered with nylon cloth for 2 weeks. Twenty leaves of each variety/line were then were dissected under microscope to recover the numbers of egg deposited in different leaf veins (main, lateral and subveins) of cotton on the pattern as suggested by Singh and Agarwal (1988). The ruptured cells of the veins by oviposition were also counted in case of untraceable eggs. The experiment was repeated three times.

RESULTS

Field study

Cotton leafhopper population were counted on each 20 cotton plants (2 leaves/plant) of all test varieties/lines (from 4 replicates) in each subplot (sole, boardered and intercropped with 2 plants) and the average incidences were shown. On the average, all leafhoppers had significantly lower incidences due to intercropping and bordering of castor bean, and okra respectively as compared to cotton without intercropped and bordered plants (Table 1). Similarly in Table 2, the results were in the same track as those in Table

Table 1 Average amount of leafhopper, *A.biguttula* on the test varities/lines of white and naturally colored cotton, sole, and bordered and intercropped with castor bean and okra respectively in 2008 dry season at Thong Pha Phum, Kanchanaburi.

Variety/Line	Numbers of leahopper		
	S_1	S_2	S_3
SR60	8.8 a	2.3 b	3.6 b
AP2	11.0 a	4.3 b	8.0 c
PM1	11.2 a	5.1 b	6.5 b
PM4	10.7a	4.8 b	6.5 b

Means followed by the same letters in the same row are not significantly different as determined by DMRT at p=0.05

Table 2 Average amount of leafhopper, *A. biguttula* on the test varities/lines of white and naturally colored cotton, sole, bordered with okra and intercropped with castor bean and sun flower in 2008 late rainy season at Nakhon Ratchasima Field Crop Research Center

Variety/Line	Numbers of leahopper			
	S_1	S_2	S_3	S_4
SR60	6.0 a	1.4 b	1.6 b	1.5 b
AP2	4.5 a	1.6 b	2.7ab	3.9 a
PM1	8.2 a	4.0 b	4.1 b	3.8 b
PM4	5.7a	1.9 b	2.5 b	2.9 b

Means followed by the same letters in the same row are not significantly different as determined by DMRT at p=0.05

Table 3 Seed weights of 10 plants of each test variety/line, white and naturally colored cotton, sole, bordered with okra and intercropped with castor bean and sun flower in 2008 late rainy season at Nakhon Ratchasima Field Crop Research Center.

Variety/Line	Seed weight (g)			
	S_1	S_2	S_3	S_4
SR60	299.0 a	289.8 a	254.9 b	226.8 b
AP2	181.8 a	235.0 b	270.9 bc	296.0 c
PM1	211.7 a	300.2 b	356.1 b	310.6 b
PM4	93.1a	224.0 b	258.3 b	236.0 b

Means followed by the same letters in the same row are not significantly different as determined by DMRT at p=0.05

1 which included the amount of leafhopper in the intercropping plots with sunflowers.

In Table 3, the positive effect of intercropping and bordering attributes reflected on yield, thus, having higher yield than the sole cotton. All varieties/lines of the bordered plot with okra and intercropped plots with castor bean and sunflower except for SR60 were found to have significantly different seed weights from those of the sole cotton plots.

Laboratory test

The choice test on preference of egg oviposition did not show significant difference among the test varieties/lines, SR60 , AP2 , PM1, PM4 (Table4). However, the leafhoppers seemed to prefer lateral vein L_3 over the others of most variety/lines except AP2 for egg laying. It could also be noticed that the females did not prefer to lay eggs on the first and second lateral veins on the left- sided leaves (L_1 and L_2) in AP2 while on PM1 leaves, no egg/egg traces were noticed in R_2 and R_3.

DISCUSSION

The cotton leafhopper, *Amrasca biguttula biguttula* (Ishida) (Hom., Cicadellidae) is an important pest of several field crops including cotton, okra, egg plant, potato, tomato, sunflower, castor (Deshmukh *et al*., 1979), cowpea (Sagar and Mehta, 1982)and green gram (Yein, 1982). According to the mentioned references, okra, castor bean and sunflower were then chosen as the trap crops in this experiment partly due to their approximately equal life periods to cotton and useful production. Hammond and Jeffers (1990) found that soybean-wheat with row intercropping exhibited substantially reduced density of the potato leafhopper, *Empoasca fabae* (Harris), an

Table 4 Average numbers of eggs/ovipositional punctures of *A.biguttula* per 20 leaves of the test varieties/lines of white and naturally colored cotton under choice test of preference in the cage condition.

Variety/Line	Mid vein	Lateral vein (leafhopper no.)						Total
	(leafhopper no.)	L_1	L_2	L_3	R_1	R_2	R_3	
SR60	1	0	1	8	1	7	1	19 a
AP2	2	0	0	3	1	7	2	15 a
PM1	4	2	1	7	2	0	0	16 a
PM4	3	1	1	8	3	2	1	19 a

Means followed by the same letters in the same column are not significantly different as determined by DMRT at p=0.05

insect pest of soybean, relative to soybean monocultures. Bullas-Appleton *et al*.(2005) showed that if a very susceptible *Phasiolus vulgaris* cultivar , Berna Dutch brown planted as the early-sown border row with the good leafhopper management in the trap crop, could consequently protect an edible bean main crop. This study also found significant levels of suppression of cotton leafhopper population density in trap crop system compared with the cotton monoculture

During the 2008 dry season at Thong Pha Phum, the perimeter trap cropping and row intercropping of cotton with okra and castor bean respectively was undertaken to compare cotton growing without the border and intercrop plants in terms of a number of leafhopper and yield. However, the early rain of 2008 year (started to rain since April 2008) caused damage to yield (both seed and lint), hence, no yield from all test plots were obtained. Only the amount of leafhopper was then reported.

Similar experiment to the one at Thong Pha Phum was conducted at Nakhon Ratchasima Field Crop Research Center in the late rainy season of the same year. Row intercropping with sunflower was added. The results showed less a number of leafhopper and greater seed weight of all varieties bordered with okra, and intercropped with castor bean and sunflower than those from sole crop of both white and naturally colored cotton of all varieties/lines. This agreed with Dhawan *et al*. (2008) who reported the effect of castor bean, a trap crop in cotton agroecosystem in relation to major insect pests that the Bt cotton intercropped with castor bean registered lower incidence of jassids, *Amrasca bigutulla* Ishida (0.76 nymphs/3 leaves) than that in the sole crop. Okra was noticed to receive the maximum number of eggs in the oviposition preference test over castor bean, cotton, cowpea, egg plant and country mallow as reported by Shamar and Singh (2002). Double row intersowing/interplanting of green manures in cotton also had more control on pest as leafhopper, thrips, whitefly and bollworm in the early stages of plant growth (Vaiyapuri *et al*., 2007), and the yields also increased as compared to the sole cotton. Since there have been little work concerning trap crop of cotton, with this study, the knowledge obtained would be useful as the basis for advanced researches.

As for the leafhopper oviposition, the females deposit eggs inside leaf veins (Agarwal *et al*., 1978) and it has been found in cotton and okra that a larger number of thicker leaf veins (diameter > 1 mm) increases the oviposition response of leafhopper (Singh and Agarwal, 1988). Shamar and Singh (2002) found the lateral veins of castor bean, cotton, cowpea, egg plant and country mallow leaves to receive more eggs in comparison with the main vein and subveins. The oviposition preference test on 4 white/naturally colored cotton varieties/lines which revealed the higher number of eggs on lateral veins than those

in the main vein (M) of all varieties/lines in the laboratory, was similar to the results of the above authors. The leafhopper also showed no particular preference over any varieties/line. From the investigation of Shamar and Singh (2002), it indicated leaf-vein thickness and length to be crucial factors in influencing the oviposition of cotton leafhopper. These characters are then having great potential in developing cultivars resistant to the leafhopper through enhancement of the oviposition preference mechanism, the study which will be further carried out.

CONCLUSION

Perimeter trap cropping and row intercropping of okra, and castor bean and sunflower respectively in the cotton plots gave lower numbers of cotton leafhopper and higher yields than those in the sole cotton. Leafhoppers preferred to lay eggs in the sub vein to the mid vein with no significant difference in preference among all test cotton varieties/lines.

LITERATURE CITED

Agarwal, R.A., S.K. Banerjee and K.N. Katiyar. 1978. Resistance to insects in cotton to *Amrasca devastans* (Dist.). **Cott. Fib. Trop.** 33(4): 409-414.

Boucher, T. J. 2003. Insect management update for peppers and eggplant. Proceedings, 2003 New England Vegetable and Berry Conference**.** http://www.newenglandvfc.org/2003_conference/proceedings2003.html

Boucher, T. J. and R. Durgy. 2003. Perimeter trap cropping for summer squash and cucumbers. Proceedings, 2003 New England Vegetable and Berry Conference. http://www.newenglandvfc.org/2003_conference/proceedings2003.html

Bullas-Appleton, E. S., C. Gillard and A.W. Schaafsma. 2005. Aggregation of potato leafhoppers, *Empoasca fabae* (Harris) (Homoptera: Cicadellidae), on a trap crop in an edible bean, *Phaseolus vulgaris* L., intercropping system. **Canadian J. of Plant Science.** 85: 237-242.

CIKS. 2000. Bollworm control in cotton. Center for Indian Knowledge Systems. Chennai, India. **Pesticide Post.** Vol 8, No. 6

Deshmukh, S. D., M. D. Akharl and M.N. Borle. 1979. Insecticidal control of the insect pest of castor. **Indian. J. Plant Prot**. 7: 66–68.

Dhawan, A.K., M. Bharathi and K. Singh. 2008. Impact of castor as a trap crop in relation to major insect pests in cotton agroecosystem. **Indian J. Ecol**. 35(1): 70-72.

Hammond, R. B. and D. L. Jeffers. 1990. Potato leafhopper (Homoptera: Cicadellidae) populations on soybean intercropped into winter wheat. **Environ. Entomol.** 19: 1810–1819.

Hasse, V. 1986. Introducing plant protection to cotton farmers. The Philippines. Second International Conference on Plant Protection in the Tropics. Malaysian Plant Protection Society, Kuala Lumpur. http://www.oista.org/control_methods/cultural_practices/trap_cropping.html

Hasse, V. 1987. Cotton. Philippine-German Cotton Project, Department of Agriculture. Manila, Philippines. No 1-2. http://www.oista.org/control_methods/cultural_practices/trap_cropping.html

Hooda, V. S., B.S. Dhankhar and R. Singh. 1997. Evaluation of okra cultivars for field resistance to the leafhopper *Amrasca biguttula biguttula* (Ishida). **Insect Sci. Applic.** 17: 323–327.

Hokkanen, H. 1991. Trap cropping in pest management. **Annu. Rev. Entomol.** 36: 119-138.

Michanec, J. 2003. Successful trap cropping for colorado potato beetle. **Proceedings, 2003 New Vegetable Conference**.

Sagar, P. and S.K. Mehta. 1982. Field screening

of exotic cowpea cultivars against *Amrasca biguttula biguttula* (Ishida) (Cicadellidae: Homoptera) in Punjab**. J. Res. Punjab Agric. Univ**. 19: 222–223.

Sharmar, A. and R. Singh. 2002. Oviposition preference of cotton leafhopper in relation to leaf vein morphology. **J. of Applied Entomology**. 126 (10): 538-544.

Singh, R. and R.A. Agarwal. 1988. Influence of leaf-veins on ovipositional behaviour of jassid, *Amrasca biguttula biguttula* (Ishida). **J. Cotton Res. Dev.** 2: 41– 48.

Vaiyapuri, K., M. Mohemmed Amanulluk, S. Pazhanivelan, E.Somasundaram and K. Sathyamoorthi. 2007. Influence of intercropping unconventional green manures on pest incidence and yield of cotton. **J. of Appl. Sci. Res.** 3(12): 1717-1716.

Yein, B. R. 1982. Effect of carbofuran and fertilizers on the incidence of insect pests and on growth and yield of green gram. **J. Res. Assam Agric. Univ**. 3: 197–203.