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Feasibility Study on Insect Pests Affecting the Growing of Naturally Colored Cotton Comparing with White Cotton in Thailand

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ABSTRACT

Feasibility study of growing naturally colored cotton, *Gossypium hirsutum*, PM1and PM4 and *Gossypium arboreum*, PM2 along with white cotton, *G.arboreum*, PM3 comparing with the standard white *G.hirsutum*, SR60 was conducted from 2003-2004 at the National Corn and Sorghum Research Center, Pak Chong, Nakhon Ratchasima. RCB was used with 4 replicates, each with 5 rows of each variety. Data of insects were biweekly collected in the three middle rows for four consecutive times. In both years, the kinds and mean numbers of key pest were mainly leafhopper, *Amrasca biguttula*, and the *plant bug*, *Megacoelum biseratense* while the bollworm, *Helicoverpa armigera* was found in 2004 only. The 2003 and 2004 similar results revealed that the leafhoppers on PM1 and SR60 and those on PM2 and PM3 were not significantly different while all were significantly different from PM4. The average amounts of plant bug on every variety in both years were also found not to be significantly different from one another. Comparing the numbers of leafhopper between 2003 and 2004, they were significantly different at all varieties except PM2, while those of the plant bug on every variety did not significantly differ. As for the fiber analysis and % gin turn out, PM1 was found to have the acceptable qualities compared with the standard ranges of fiber determination as well as the commercial variety, SR 60.

Key words: colored cotton, cotton insects

INTRODUCTION

Cultivation of colored cotton began around 2700 BC in Indo-Pakistan, Egypt and Peru. It was then common for growing cotton in a variety of natural colors: mocha, tan, gray and red-brown. A variety of sources indicated that colored cotton was produced for indigenous and commercial in many countries as Peru, China, Egypt, United States and Russia during 1800s and 1900s (Dabney, 1896). Sally Fox researched and experimented for decades to cultivate a naturally colored cotton seed capable of yielding a fiber long enough to be spun into yarns. Her colored cotton is naturally resistant to pests (Fox, 1987). The feasibility of production of cotton in Pennsylvania, USA, several types of cotton including naturally colored cotton ones were evaluated for five years to determine agronomic performance and cotton quality. The results revealed a few problems facing in growing cotton, with the exception of some insect pests including budworm, bollworm and Japanese beetle. The

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white natural and brown samples were found to give the best fiber characteristics and high yields (Leonhard, 1999). In 1905, cotton landrace varieties were grown by the USDA in a series of experiment for boll weevil resistance (Cook, 1906). Growing organic cotton, including naturally colored cotton which eliminates heavy chemical application, some methods as crop rotation, beneficial insects, insecticides, resistant varieties, etc., were used. However, information concerning pests of colored cotton have not been available in the literature. In order to reduce the need for chemical dye which resulted in less contamination of the environment, a study was, therefore, conducted to determine if naturally colored cotton with good quality could be grown in the country under the presence of white cotton and whether both types of cotton had the same kinds of pest and could tolerate the infestation.

MATERIALS AND METHODS

Two and one promising colored cotton varieties of *Gossypium hirsutum*, PM1 (dark brown) and PM4 (green), and *Gossypium arboreum*, PM2 (light brown), respectively, were compared with the white cotton varieties of *G.hirsutum*, SR60, and *G.arboreum*, PM3. The experiment was undertaken at the National Corn and Sorghum Research Center, Pak Chong, Nakhon Ratchasima in 2003 and 2004 during the growing seasons from August to December in Randomized Complete Block design with four replications. Rows of 20 meters long were 1 meter apart with plant spaced at 1 meter within rows, 5 rows for each variety. Four weeks after planting, plants were thinned to one plant per hole. The crop was partly rain fed and partly irrigated. Weed control and fertilizer applications were administered as needed. After 8 weeks of planting, the numbers of key insect pest were recorded at biweekly intervals for 4 consecutive times from the 3 middle rows. To note the populations of leafhopper, thrip and whitefly, observations were made from 10 leaves per variety per replicate. Hopperburn symptom was also used to indicate the leafhopper damage. Each set was randomly picked from the top and bottom portions of the plant. For the bollworm and plant bug, 10 squares of each variety from each replicate were checked. Data were analyzed according to Duncan (1970) and Student's t test. Fiber testing was performed using the high volume instrument (HVI) by The Thai Textile Institute and Agronomy Research Center at Nakorn Sawan.

RESULTS AND DISCUSSION

Climatic conditions

Monthly rainfalls and monthly means maximum and minimum air temperatures during the growing seasons (August-December) of the years 2003 and 2004 at the experimental site were recorded. Temperatures were similar in both years with the averages of 25 and 25.5 C, in 2003 and 2004 respectively. The total amounts of rainfall were 1264mm in 2003 and 969 mm in 2004 with the greatest rainfalls in September of both years. The unusual dryness was encountered from September 2004 till the end of growing year. The climatic condition in each year had an impact on insect infestation.

Insect pests

Table 1 shows the types and mean numbers of key pest found in the year 2003 and 2004 experiments to be mainly leafhopper, *Amrasca biguttula* and plant bug, *Megacoelum biseratense* while the bollworm, *Helicoverpa armigera* was noticed in the year 2004 only .

The 2003 and 2004 similar results revealed leafhopper on SR60 and PM1 not to be significantly different in number from each other while significantly higher than on PM2, PM3 and PM4. The numbers on PM2 and PM3 significantly differ from that of PM4 as well. It was also found that there were no significant differences among the amounts of plant bug in all varieties. In 2004, the cotton bollworm was encountered in every G. *hirsutum* variety with no significantly different from one another. It was then presumed that G. *arboreum* either white or colored with natural resistance was not favored by the bollworm. The cause(s) of resistance has to be further investigated.

Mean numbers of leafhopper and plant bug in the year 2003 were compared with those of 2004 (Table 2). Significant differences in the amounts of leafhopper were found between 2003 and 2004 of all varieties except PM2 as analysed by Student's t-test. As for the plant bug, the numbers of every variety in each year did not significantly differ from each other.

The other usual cotton pests as whiteflies, aphids, thrips, spiny bollworms, leaf rollers,cotton stainers and pink bollworms were of small amounts to be noticed and did not distinctly contribute to the plant damages. It was also found that the insects attacking the naturally colored cotton in the experiments (dark brown, light brown, green) were the same kinds as the ones causing injuries to the white cotton, SR60. There are at least one or two key pests in every cotton production region. The key pests have been reported to vary among cotton growing area. In Egypt, the egyptian cotton leafworm and the pink bollworm were the key pests; in USA the boll weevil, *Lygus spp* ; in Africa and Australia, *H. armigera*, mites. thrips and aphids ; in Thailand, *A. biguttula*, *H. armigera, M. biseratense* (Frisbie, 1983; Sterling *et al.*, 1989. Fitt, 1994, Leonhard, 1999; Hormchan and Wongpiyasatid, 1999; Khaing et al, 2002). Obviously, the cotton leafhopper, *A. biguttula* is becoming the most devastating pest at present, while the bollworm reduced it's role in most cotton growing fields.

Table 1 Average amounts of key pest on naturally colored cotton compared with the commercial white cotton in 2003 and 2004.

Variety	2003		2004		
	Leafhopper	Plantbug	Leafhopper	Plantbug	Bollworm
SR60	3.5 c	0.3 a	21.6 c	0.4 a	1.3 a
PM1	3.1 c	0.2 a	22.6 c	0.1 a	0.6 a
PM2	0.3 a	0.5 a	0.25 a	0.1 a	0
PM3	0.2 a	0.6 a	2.5 a	0.5 a	0
PM4	2.6 b	0.8 a	14.9 b	0.1 a	1.2 a

Means followed by the same letters in the same columns are not significantly different at p=.05 as determined by DNMRT

Table 2 Comparison of average numbers of leafhopper and plant bug between those in the years 2003 and 2004.

Variety	Leafhopper		t-test	Plant bug		t-test
	2003	2004		2003	2004	
SR60	3.5	21.6	*	0.3	0.4	ns
PM1	3.1	22.6	*	0.2	0.1	ns
PM2	0.3	0.3	ns	0.5	0.1	ns
PM3	0.2	2.5	*	0.6	0.5	ns
PM4	2.6	14.9	*	0.8	0.1	ns

Mean differences determined by Student's t-test

Leafhopper, *Amrasca biguttula*

At present, in many cotton growing areas, the leafhopper is considered to be the most harmful to the successful cultivation of cotton crop. The losses occur on different cultivars may range from slight reduction in yield to the total failure of the crop depending on their resistance capacity (Tidke and Sane, 1962). In this experiment, there were no differences in leafhopper infestation between white and colored cotton or between *G. hirsutum* and *G.arboreum*. During the first year, the quantities and qualities of all varieties were affectecd by the infestation. The characteristic symptom of leafhopper attack in phytoxemia (hopperburn) was noticed to be caused by nymph and adult. The red and yellow coloration of leaves resulted from changes in the photosynthesis following interruption or stoppages of the vascular tissue, which resulted from insect feeding. In severe attacks, plants were stunted and unable to produce flowers and bolls as similarly stated by (Hooda *et al*.,1997). However, the potential of leafhopper to inflict damage depends on its oviposition preference and subsequent population build up on different host plants (Singh and Agarwal. 1988). Mature bolls and yields of lint and seed of both white and colored varieties were reduced to the point that only small amount of yields could be harvested in both growing seasons. It could be seen that the number of leafhopper in the wetter 2003 was less than that in the drier 2004 resulting in higher leafhopper population in 2004 as suggested by Mabbet *et al*. (1984) that the reduction of jassid nymph could be caused by the heavy rain and the favorable dry weather increased the insect number.

American bollworm, *Helicoverpa armigera*

As in white cotton, the american bollworm larvae were found to be destructive causing damages to boll, square, flower and bud leaf of the tested naturally colored cotton. The two reasons that they were not found in the 2003 experimental plots might be as followed: First, there were other suitable plant hosts grown nearby such as corn, soybean and second, the rainfall. As reported by Wangboonkong (1981), early infestations of cotton field in Thailand were associated with the movement of the adult moths from early sown maize. However, since the bollworm preferred maize to cotton and at the experiment location maizes were grown at all time, only some of the insect moved into the cotton plots. Rainfall also influenced seasonal abundance by affecting the density and suitability of the host plants (Choosang, 1994), the higher rainfalls in 2002 and 2003, therefore, could affect the bollworm population for it was known that the larvae were susceptible to high humidity. In 2004, the rain stopped after September onwards leaving the dry condition everywhere including at the growing area. This should then favor the increasing of the bollworm.

Plant bug, *Megacoelum biseratense*

Hormchan and Wongpiyasatid (1999) stated the becoming of the plant bug, *M.biseratense* as the potential key pest of cotton. Since the insect, mostly nymphs and some adults, were found to spend most time hiding between bracts and squares (flower buds) and the adults between bracts and bolls, they were hardly noticed. Similarly reported by Wilson *et al.*(1984) most nymphs of *Lygus hesperus*, a pest of cotton in California's San Joaquin Valley, were located on squares while the majority of adults were found on bolls. If plants in bloom are attacked, lygus feeding may results in flower dropping. However, nymphs and adults of *M. biseratense* were not in a large amount to cause distinct infestation on both white and colored of both cotton varieties during the two-year experiments. In Thailand, this plant bug is not well known for the mentioned reason plus its damage may be confused with the one caused by other sucking insect as the cotton fleahopper.

Agronomic quality and fiber analysis of white and colored cotton

Table 3 presents some agronomic performance and fiber determination using high volume instrument (HVI) of colored as well as white cotton comparing to the standards of each character. It was found that micronaires of PM1 was in Premium Range, SR60 and PM3 the Base Range while PM2 and PM4 the Discount Range according to Raghavendra *et al.* (2004). Micronaire values of Fox Fiber cottons were around 2.5 to 3 for green and 3 to 4 for brown (http://www.spinnyspinny.com/articles/coloredcotton.html). Although the results could not be really comparable because of different growing time and location, Fox still gave the idea of what micronaire ranges of colored cotton should be and this experiment yielded the brown PM1 and the green PM4 of closely similar values.

As for the fiber length, SR60 was designated as long, PM1 as medium and the rest as short. Vreeland (1996) reported fiber length for the colored cotton perennial tree form to range from 0.48-1.69 inch. Compared with such lengths, the dark brown PM1, the light brown PM2 and the green PM4 were within normal ranges of colored cotton. Lint percentages of the tested variety comparing with the standard SR60, those of PM1 and PM3 were similar and fell in the normal ranges of 30-45% whereas % lints of PM2 and PM4 were low and well below the minimum range. The analysis also indicated fiber strength of all varieties to be designated in degree of strength as very weak, as the standard variety, SR60.

The report stated that a premium quality of cotton fiber was placed on environmentally and culturally sensitive production techniques by minimizing or eliminating the use of pesticides, fertilizers while exclusively utilizing hand harvesting methods (Vreeland, 1996). Therefore, in order to improve the fiber qualities, further experiments should be conducted in different locations and followed such method mentioned.

Based on fiber evaluation, PM1, the dark brown variety appeared to be competitive compared with the standard SR60 in every aspect or even better.

Leonhard (1999) studied feasibility of cotton as a crop for Pennsylvania and found that it was potentially feasible to produce cotton, both naturally colored and white, with suitable fiber qualities in the northern area of the state. In this study, although PM1had good fiber qualities, it still needed further improvement in terms of insect resistance. Whereas PM2, PM3 and PM4 had less insect infestation compared with SR60, they still lacked of other qualities either long fiber or

Table 3 Agronomic characteristics and fiber determination of colored and white cotton of *G.hirsutum* and *G.arboreum* compared with the standard performances.

Variety	Micronaire	Fiber Length[1/] (inch)	Fiber Strength[2/] (g/tex)	% Lint[3/]
SR60	4.7	1.26	18.0	33
PM1	3.8	0.98	15.6	32
PM2	5.6	0.70	13.6	28
PM3	4.9	0.73	17.5	36
PM4	3.1	0.91	17.3	20

[1/] Micronaire: Values of 3.7-4.2=Premium Range, 4.3-4.9 = Base Range and more than 5 = Discount Range

[2/] Fiber length: 0.96 inch or less = short
0.97-1.10 inch = medium
1.11-1.28 inch = long

[3/] Fiber strength: less than 18 g/tex = very weak desirable micronaire value or normal % lint. PM2 and PM3 also had the extended growing period of over 5 months before they could be harvested. Since the growing was executed in a small scale, the yields were then not executed in this investigation.

CONCLUSION

There was potential in producing naturally colored cotton in Thailand with more or less same problems especially insect infestation as the white cotton, both *G.hirsutum* and *G.arboreum* . All tested samples had the same kinds of insect infested. PM1, the dark brown color of *G.hirsutum*, had the best qualities in every aspect compared with the standard variety SR60. Further improvement of most materials in insect resistance, fiber qualities and yield are needed in order to produce cotton economically.

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