Kasetsart J. (Nat. Sci.) 35 : 378 - 385 (2001)

Effects of Cotton Growth Regulator on Jassid Infestation and Injury

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ABSTRACT

Six upland cotton cultivars with different morphological characters were tested during the cotton growing season of 1998 to determine the changes in leaf characters due to plant growth regulator. Mepiquat chloride (cotton growth regulator) sprayed at first flowering stage reduced mid vein and hair lengths on lamina as well as on mid vein but increased lamina thickness and hair density on mid vein. Cotton growth regulator did not show significant effect on jassid infestation. Jassid injuries were higher in treated plots but the results were not significant. No interaction between cultivar and growth regulator spray was observed. Cultivar differences on jassid infestation and injury were highly significant. The cotton growth regulator mainly reduced the number of jassid eggs laid per leaf. However, mid vein shortening seemed to be more responsible for lowering egg deposition than changes in leaf hairiness.

Key words : cotton, jassid, leaf characters, cotton growth regulator, mepiquat chloride

INTRODUCTION

In Southeast Asian countries, the jassid, *Amrasca biguttula biguttula* (Ishida), is one of the major pests of cotton. Even though efficient chemicals are available, growing resistant cottons remains the cheapest and the most harmless way to manage jassid infestation. Although, chemical and biochemical factors could be involved (Sharma and Agarwal, 1983; Singh and Agarwal, 1988), the most recognizable character link with jassid resistance was leaf hairiness (Krishnananda and Agarwal, 1979; Butler *et al*, 1991). Some cotton growth regulators were already known to affect plant and leaf growths (Stuart *et al*, 1984; Crozat and Kasemsap, 1997) as well as some pest infestations (Henneberry *et al*, 1988; Hollis *et al*, 1996). Preliminary studies conducted at National Corn and Sorghum Research Center, Kasetsart University, Suwan Research and Training Station (Nakhon Ratchasima Province, Thailand) suggested that mepiquat chloride (Pix®) induced an increase of hair density on mid vein and subsequently reduced jassid egg deposition (Renou and Chongrat-tanameteekul, 1997). Thus, further investigations were carried out in 1998 to study the effect of this active ingredient on jassid infestations and injuries in relation to changes in leaf characters.

MATERIALS AND METHODS

Six upland cotton cultivars with different morphological characters namely, F135J129 (Cameroon), V145 (Bangladesh), SRT1 (India), DORA11 (Thailand), REX Gless (USA) and IRMA BLT PF (Cameroon) were selected for this study. They were grown with pest control practice to study the changes induced by cotton growth regulator on

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leaf characters without pest control practice to study jassid infestations and jassid injuries.

Pest control practices

Two plots, each one with six cotton rows (one row per cultivar) of 5 meters long were grown. One plot was sprayed with mepiquat chloride at the rate of 1.5 liter per hectare when plants were at first flowering stage (60 days after planting). The other plot was left unsprayed. Plant spacing was 1 m x 0.25 m and after thinning plant population would be 40,000 plants per hectare. To avoid any leaf damage, various insecticides were applied three times per week. 5, 15 and 30 days after spraying cotton growth regulator, 15 main stem leaves were tagged at emergence from each row of each plot and collected 10 days later. In laboratory, after recording mid vein length, observations were carried out for each leaf on a small piece of lamina with mid vein cut from leaf at one third from leaf tip. Using a stereomicroscope with ocularmicrometer, thickness, hair density and maximum hair length were observed. All data were analyzed considering tagging dates as an additional factor of a completely randomized design.

Without pest control practice

Using a split plot design with 4 replications, effects of cotton growth regulator sprayed at first flowering (first factor) on jassid infestation and jassid injuries were investigated on six cotton cultivars (second factor) similar to the previous study. Plot unit was consisted of one two-meter-cotton-row with 0.25m spacing between hill. After spraying cotton growth regulator, two plants from each plot unit were selected for jassid observation. During 5 observation weeks, one newly emerged main stem leaf was tagged at the beginning of each week. Each tagged leaf was observed for jassid infestation twice weekly for 5 weeks while jassid injuries and mid vein length were recorded on a weekly basis during the same period. For jassid infestation, four instar groups were recorded separately as: adults, young nymphs (L1 and L2), medium aged nymphs (L3 and L4) and old nymphs (L5). Jassid injury on leaf was assessed using the following grade scale (Renou *et al*, 1998) : 0 = no leaf injury, 1 = beginning of yellowish margins, 2 = yellowish margins, 2.5 = beginning of reddening margins, 3 = spread of yellowish to lamina, 3.5 = spread of reddening to lamina, 4 = beginning of drying on margins, 4.5 = appearance of hopperburn symptom on margins, 5 = hopperburn symptom on all margins, 6 = spread of hopperburn symptom to lamina and 7 = all leaf dry or burnt. Means infestation and injury of each plot unit were analyzed for each week. Based on life table data of *Amrasca biguttula biguttula* (Ishida) (Chieuchan, 1976; Sharma and Sharma, 1996), ratios between old nymphs occurred on a week and young nymphs recorded one week earlier were calculated per plot unit during leaf life to assess jassid survivorship.

Moreover, within the first two replications, the sum of jassid adult infestations occurred on the 5^{th} main stem leaf from the top of 5 plants were recorded weekly for each plot unit. Finally, three times during the cotton-growing season, 40 leaves with a wide range of sizes assessed by mid vein length were collected from each cultivar within the remaining two replications. These leaves were kept individually inside plastic bag after removing all jassids. Subsequently, numbers of jassid occurred on each leaf were recorded daily for 12 consecutive days considering the same instar groups as mentioned earlier. The data were recorded according to the cultivar, the use of cotton growth regulator, collecting date, and emergence date of each group of instars. These data were analyzed according to a completely randomized design considering collecting dates as replications. Newman Keuls test at 5% was used for mean comparisons.

RESULTS

When no hair occurred on lamina or on mid vein, hair length could not be considered as equal to

zero. Therefore, data from some cultivars were removed from hair length analysis. However, it concerned only hair length on lamina since hairs always occurred on mid vein. The cotton cultivars of which data were removed were DORA11, V145 and REX Gless.

Except the results on lamina hair density and mid vein thickness, significant effects of cotton growth regulator were observed (Table 1). According to the calculated F-value, changes in lamina thickness and mid vein length were the most important effects of growth regulator i.e. lamina thickness increased while mid vein length decreased. Hair length on lamina and on mid vein reduced while hair density on mid vein increased after cotton growth regulator spray. However, the plant responses to cotton growth regulator spray sometimes varied according to the tagging dates and cotton cultivars.

According to the results from leaves kept in laboratory, the main effect of mepiquat chloride was significant reduction in the number of young nymphs per leaf (Table 2). The numbers of medium aged nymphs per leaf were also significantly lower while the numbers of old nymphs per leaf were not significantly different at 5%. No significant effect was observed in minimum or maximum mid vein length of leaves which produced young nymphs. Nevertheless, significant difference was noticed in mid vein length of leaves producing maximum number of young nymphs (P = 0.0143) which indicated that cotton growth regulator reduced mid vein length and subsequently reduced jassid egg deposition.

Table 1 Effects of cotton growth regulator (Pix®) on leaf morphology.

	No Pix®	Pix®	Calculated F	P
Mid vein length (cm)	10.26	9.45	59.43	0.01
Mid vein thickness (mm)	0.76	0.77	0.60	0.4434
Hair density on mid vein (per mm^2)	12.25	12.92	4.26	0.0373
Hair length on mid vein (mm)	1.03	0.96	8.24	0.0044
Lamina thickness (mm)	0.14	0.16	64.94	0.01
Hair density on lamina (per mm^2)	3.89	3.92	0.06	0.8083
Hair length on lamina (mm)	0.86	0.80	5.98	0.0145

Table 2 Effects of cotton growth regulator (Pix®) on jassid.

	No Pix®	Pix®	Calculated F	P
Average number of young nymphs / leaf	2.19	1.62	5.37	0.0280
Average number of medium aged nymphs / leaf	1.46	1.04	4.80	0.0366
Average number of old nymphs / leaf	0.59	0.43	3.63	0.0658
Minimum mid vein length of leaves that jassids emerged (cm)	4.15	4.27	0.68	0.4240
Maximum mid vein length of leaves that jassids emerged (cm)	10.38	9.61	3.06	0.0897
Mid vein length of leaves that produced maximum number of young nymphs (cm)	8.45	6.90	6.89	0.0143

Significant cultivar differences were observed on number of jassid per leaf (young, medium aged and old nymph) and in minimum or maximum mid vein length of leaves that jassid nymphs could be found (Table 3). The lowest number of nymphs per leaf occurred on SRT1 while the highest occurred on IRMA BLT PF.

Except on one observation date (November, 6) during the growing season, the numbers of adult jassid observed on the 5th main stem leaves from the top of cotton plant were not significantly affected by cotton growth regulator spray (Table 4). However, significant cultivar differences were found nearly every week.

Mepiquat chloride expressed its significant effect on survivorship of jassids by inducing the change of leaf morphology during the beginning of leaf life. The ratio between old nymphs recorded on a week and young nymphs occurring one week earlier was significantly different during the first week of leaf life but as the leaves aged, no significant results were found (Table 5).

During leaf life, leaf injury due to jassid increased (Table 6). Although jassid injury appeared more serious when mepiquat chloride was sprayed, no significant effect was noticed. However varietal differences were highly significant since the beginning of leaf life. The least injuring cotton variety, SRT1, was the least infesting cotton while the most injuring cotton, V145, was the most infesting one. Injuries noticed on F135J129 were in accordance with infestation records when compared to the other cotton varieties. However, greater serious injuries than it had been expected from infestation records were noticed on REX Gless. This last cotton variety probably could not withstand heavy jassid infestation.

DISCUSSION

Cotton growth regulator induced significant changes in leaf morphology by reducing the mid vein length and hair length on lamina as well as on mid vein but increasing the hair density on mid vein and lamina thickness. These results were in accordance with those previously reported in

Table 3 Jassid egg deposition on various cotton cultivars.
(observed from leaves collected from the field and maintained in laboratory)

	Number of nymphs per leaf*			Mid vein length of leaevs that produced maximum		Mid vein length of leaves that jassid emerged (cm)* number of young nymphs (cm)*
	Young	Medium aged	Old	Minimum	Maximum	
F135J129	2.44 b	1.69 b	0.58 bc	5.27 a	12.23 a	8.37
V145	2.13 b	1.38 b	0.58 bc	3.77 bc	9.82 bc	8.52
SRT1	0.38 a	0.23 a	0.03 a	5.10 a	8.27 c	6.65
DORA11	1.93 b	1.45 b	0.63 bc	3.73 bc	9.03 bc	7.38
REX Gless	0.89 a	0.58 a	0.35 b	3.18 c	10.03 bc	7.17
IRMA BLT	3.66 c	2.16 b	0.88 c	4.22 b	10.60 b	7.98
Calculated F	15.21	9.53	7.04	20.43	6.37	1.02
P	0.01	0.01	0.0004	0.01	0.0007	0.4261

* Means follow by the same letter in a column are not significantly different by Newman-Kuels test at a = 0.05.

Thailand about hair density on mid vein (Renou and Chongrattanameteekul, 1997). The increase of hair density on mid vein could be due to reduction of mid vein length. The increase of lamina thickness and the reduction of mid vein length were in accordance with the literatures (Hake *et al*, 1991; Crozat and Kasemsap, 1997). At last, hair shortening could be considered as a new result about effect of cotton growth regulator on leaf characters.

The two less infested and less injured cotton varieties in this study (SRT1 and F135J129) were the most hairy ones. However, based on the data of other cotton varieties it was difficult to conclude that leaf hairiness was the only factor involved in

Table 4 Effects of cotton growth regulator and cultivars on jassid adult dynamics during 1998, Nakhon Ratchasima province.
(Number o f adult s per 5 main stem leaves at node 5 from the top of plant)

	Dates								
	Sep,22	Oct,2*	Oct,9	Oct,16	Oct,23	Oct,30	Nov,6	Nov,13	Nov,20
F135J129	0.50	1.00 a	11.00 b	5.50ab	7.25ab	19.75 b	21.75bc	7.00	8.00 d
V145	0.00	3.50ab	18.25 b	12.25 b	17.75 c	22.75 b	35.00 c	3.00	1.50 b
SRT1	0.00	0.25 a	2.00 a	2.00 a	0.50 a	3.25 a	1.50 a	2.25	0.00 a
DORA11	1.50	4.50 b	12.75 b	13.25 b	13.00bc	23.00 b	25.25bc	6.75	4.00 c
REX Gless	0.50	3.25ab	11.00 b	9.00 b	5.25ab	14.00 b	8.75 b	0.50	0.25 a
IRMA BLT	0.25	4.75 b	16.75 b	13.50 b	13.25bc	25.25 b	18.25bc	3.25	3.50 c
Calculated F	1.14	5.76	9.09	4.93	8.37	7.08	17.82	2.36	27.41
P	0.4000	0.0100	0.0020	0.160	0.0030	0.0050	0	0.1160	0
No Pix	0.25	2.00	12.58	7.75	11.25	18.83	15.75	4.50	4.08
Pix	0.67	3.75	11.33	10.08	7.75	17.17	21.08	3.08	1.67
F pix	1.00	5.44	1.67	4.51	1.36	99.25	27704.3	0.21	9.45
P	0.5000	0.2660	0.4220	0.2870	0.4520	0.6360	0.0080	0.7180	0.2090
Transformation	log(x+1)		log(x+1)	log(x+1)			log(x+1)		log(x+1)

* Means followed by the same letter in a column are not significantly different by Newman-Kuels test at a = 0.05.

Table 5 Effect of cotton growth regulator (Pix,) on ratios between old nymphs occurred on a week and young nymphs accorded one week earlier according to leaf age after leaf emergence (WALE = Week After Leaf Emergence).

	Ratios between old nymphs occurred on a week and young nymphs recorded one week earlier			
	1 WALE	2 WALE	3 WALE	4 WALE
No Pix	0.29 a	0.29	0.40	0.96
Pix	0.56 b	0.28	0.47	0.69
F pix	59.53	0.41	0.62	0.28
P	0.01	0.56	0.49	0.63

Table 6 Jassid leaf injury according to cultivar and cotton growth regulator spray.

	Average injury off all tagged leaves according to leaf age in weeks after tagging date				
	1	2	3	4	5
F135J129	0.82 b*	1.17 b	1.56 b	2.18 b	2.82 c
V145	1.86	2.26	2.69	3.53	4.39 d
SRT1	0.05 a	0.00 a	0.00 a	0.0 a	0.00 a
DORA11	1.24 c	1.78 c	2.14 c	2.88 c	3.69 c
REX Gless	1.78	2.21	2.53	2.91 c	3.68 c
IRMA BLT	1.36 c	1.87 c	2.34 cd	2.91 c	3.77 c
Calculated F	74.84	101.17	112.48	95.92	131.74
P	0.01	0.01	0.01	0.01	0.01
No Pix®	1.17	1.50	1.82	2.34	3.01
Pix®	1.20	1.59	1.93	2.46	3.11
F Pix®	0.05	0.41	0.18	0.11	0.09
P	0.8330	0.5680	0.6970	0.7560	0.7760

* Means followed by the same letter in a column are not significantly different by Newman-Kuels test at a = 0.05.

jassid resistance. Thus, these results agreed with the most well known assertion that "If all jassid resistant cotton are hairy, not all hairy varieties are resistant to jassid" (Hussian and Lal, 1940; Joshi and Rao, 1959).

Among leaf morphology character imparting resistance to jassids on cotton crops, many research works concluded that leaf hairiness was the main responsible which reduced jassid egg deposition (Verma and Afzal, 1940; Sharma and Sharma, 1997a). However, research works sometimes differed about hairiness characters, on mid vein as on lamina, which were important resistance to jassids (Tidke and Sane, 1962; Sikka *et al*, 1966; Ambekar and Kalbhor, 1981). Some research reported that hair density could play an important role only if hairs were long enough (Parnell *et al*, 1949; Sikka *et al*, 1966). According to the effect of cotton growth regulator on hair length in the present experiment, it could be concluded that hair density played more important role than hair length in reducing jassid egg deposition. Jassid adult selected mid vein near petiole insertion to lay their eggs (Hughes, 1964; Evans, 1966; Sharma and Sharma, 1997b). Shortening of mid vein after Pix ® spray could reduce suitable locations for jassid egg deposition and the number of jassid egg laid per leaf.

For jassid injury to leaf, no effect of mepiquat chloride was noticed.The increase of lamina thickness due to mepiquat chloride spray might help in explaining the recoupment from jassid injury (Tidke and Sane, 1962) that could be due to thicker cuticle instead of the increase of palisade tissue.The reduction of jassid egg deposition due to cotton growth regulator spray could be balanced by higher jassid survivorship and longer time during which leaf characters were suitable for jassid egg deposition and jassid infestation per leaf area unit could increased due to the reduction of leaf area so that no effect of cotton growth regulator on jassid injury was noticed.

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Received date : 08/08/01
Accepted date : 28/09/01