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Effect of growth regulators on sucking insect pest population in *Bt* cotton

TABASSUM*, N. SUSHILA, A.G. SREENIVAS, A.C.HOSAMANI AND R. V. BELDHADI

Department of Agricultural Entomology, College of Agriculture, University of Agricultural Sciences,Raichur-584 104

**E-mail: nikhat151tabu@gmail.com*

ABSTRACT : The changes that occur in the physiology of plant by the application of growth regulators and nutrients affect the insect plant interactions. The present experiment was conducted to study the effect of growth regulators jasmonic and salicylic acid on the population of cotton leaf hopper, *Amrasca biguttula bigutulla* (Ishida), cotton aphid, *Aphis gossypii* (Glover) and cotton thrips, *Thrips tabaci* (Lindeman) in *Bt* cotton under glasshouse and field conditions. *Gossypium hirsutum* L plants in the early growth stage were pretreated with 1 mM solution of JA and SA to study the effect of the growth regulators on these sucking pests. The results indicated that there was decrease in the population of these pests in the plants pretreated with JA and SA under glasshouse and field conditions indicating that these growth regulators had a negative effect on these sucking pests population as compared to the nutrient sprays except potassium nitrate that also had a negative impact on the sucking pests. It was found that these plant growth regulators have offered tolerance to the sucking pests which lowered their infestation in the treated plants.

Key words : *Bt* cotton, jasmonic acid, salicylic acid, sucking insect pests

Cotton, *Gossypium hirsutum* L. (Family: Malvaceae), is one of the most commercially important fiber crops in the world. It is a perennial semi shrub grown as an annual crop in both tropical and warm temperate regions. In addition to textile manufacturing, it produces seeds with a potential multi product base such as hulls, oil, lint and food for animals (Ozyigit *et al.,* 2007).

Production of cotton is limited by biotic and abiotic stresses. Biotic factors like insect pests are bottleneck. As many as 1326 insect pests have been reported to attack cotton at various stages of crop growth across the globe. However, in India the number is limited to 130 species. No doubt *Bt* cotton is a wonderful tool against bollworms, but due to *Bt* cotton cultivation sucking pests problem has increased.

With the increase in these sucking insect pests, the usage of insecticides has also increased. *Bt* cotton has developed high levels of resistance to several commonly used insecticides. Therefore, there is a need for alternative methods of pest control to reduce the over dependence on insecticides and to conserve biodiversity. It is in this context host plant resistance, which is economic and environmental friendly, assumes a central role in integrated pest management. In this view, studies on effect of different growth regulators and nutrients in inducing tolerance to sucking pests in *Bt* cotton were conducted in glass house and field conditions.

Plants have developed an elegant defense system against insect herbivory. The defense systems employed by plants against insects can be constitutive or induced (Wasternack, 2007; Chitra *et al.,* 2008; Kawazu *et al.,* 2012). Although many plant hormones act as elicitors of induced resistance, the most important and widely used

phytohormones are jasmonic acid (JA) and salicylic acid (SA). The use of these phytohormones in inducing plant resistance against insect pests has raised the possibility of their implications for insect pest management (War *et al.,* 2011).

Studies on the effect of growth regulators and nutrients against sucking insect pests of *Bt* cotton was made both under glass house and field conditions. The methodology followed in both the conditions is detailed below.

Glass house condition

Maintenance of pure culture : Field collected final instar nymphs of *Amrasca biguttula bigutulla* , *Aphis gossypii* and *Thrips tabaci* were used for initiating the pure culture in the laboratory. Such collected nymphs were released in potted cotton plants covered with cages. Such final instar nymphs were maintained in rearing cages till they moulted finally to reach adult stage. The pure culture of leafhoppers, aphids and thrips were maintained in the glasshouse conditions by transferring the nymphs to fresh plants. Once sufficient population of these insects was developed, they were used for further experimental purposes.

Raising of plants : The untreated seeds of *Bt* cotton hybrid (MRC 7351) were obtained from Mahyco research laboratory, Jalgoan, Maharashtra. The seeds were sown in cement pots of size 42 × 32 sq cm containing mixture of farm yard manure, vermi compost and soil in the ratio of 1:1:2. Thirty such pots were maintained representing three replications for each treatment and watered regularly. Once the seedlings were 10 days old each pot was covered with nylon cages (mesh size 0.15 × 0.15 sq.cm). Two pairs of final instar nymphs of leafhopper, aphids and thrips were released/leaf and the pots were covered with cages.

Preparation of treatments

Growth regulators : 1 mM solution of jasmonic acid (JA) was prepared from jasmonic acid methyl ester. The other treatments were weighed accordingly and the treatment solution was prepared. These chemicals were mixed thoroughly and sprayed separately using a hand sprayer.

Imposition of treatments and release of sucking pest population : In glasshouse, the treatments were imposed on 15 and 30 days old plants. The imposition of treatments was done as per the details given in Table 1. The first spray was made when the plants were 15 days old. The first spray with the growth regulators and nutrients was made to induce the tolerance in the *Bt* cotton. Then, the next spray was made on 30 days old crop. On the next day after spray, two pairs of last instar nymphs of leafhopper, aphids and thrips were released on the pre treated *Bt* cotton plants to study the effect of the growth regulators and nutrients on these sucking pests.

Field conditions

Raising of plants : The untreated seeds of *Bt* cotton hybrid (MRC 7351) were obtained from Mahyco Research Laboratory. Two seeds/ hill were dibbled with a spacing of 90 cm between rows and 60 cm between plants. Randomized block design was used with three replications and eleven treatments for carrying out the experiment.

Imposition of treatments : The first spray was made on 15 days old plants in the field and the imposition of treatments was done as per the details given in Table 1. Similarly, the imposition of the treatments was

made on 30 days old plants to further induce the tolerance against these pests in *Bt* cotton. Before the imposition of the first spray, the pre count on the number of leafhoppers, aphids and thrips was recorded.

Observations recorded : Observations on leafhoppers, aphids and thrips/leaf were recorded on 15 and 30 days after second spray both in glasshouse and field conditions.

Results obtained from the present investigations on inducing tolerance against sucking insect pests of *Bt* cotton using growth regulators and nutrients both in glass house and field conducted at Main Agricultural Research Station, Raichur during *kharif,* 2014-2015 conditions are presented.

Leafhoppers : At fifteen days after release the population of leafhopper ranged from 3.77 to 5.40 per plant among different treatments (Table 1). The lowest population of leafhoppers was recorded in the treatment jasmonic acid (3.77/ plant) which was followed by salicylic acid (3.93/ plant). The highest population of leafhopper was recorded in the untreated plants (5.40/ plant). At 30 days after release, the lowest population of leafhoppers/plant (3.33/ plant) was recorded in jasmonic acid and was *at par* with salicylic acid (3.87/ plant). This may be due to the fact that these growth regulators being systemic may induce the defense responses when applied repeatedly and help the plant to defend itself against the herbivores. The reports of Zarate *et al.,* (2007), Sengottayan *et al.,* (2009) and Walkeil *et al.,* (2010) substantiate the results

Table 1. Effect of growth regulators and nutrients on sucking pests population of *Bt* cotton under glass house condition

Treatments	Dosage/l	Number of sucking pests / leaf					
		Leafhopper		Aphids		Thrips	
		15 DAR	30 DAR	15 DAR	30 DAR	15 DAR	30 DAR
T1: N:P:K	4 g	4.47 (2.23)^{ab}	4.03 (2.33)^{bc}	4.47 (2.15)^{bc}	4.13 (2.23)^{bc}	4.33 (2.19)^{cd}	4.07 (2.14)^{bc}
T2: Jasmonic acid	1 mM	3.77 (2.06)^{a}	3.33 (1.95)^{a}	3.5 (2.00)^{a}	3 (1.86)^{a}	3.27 (1.94)^{a}	3.1 (1.89)^{a}
T3: Salicylic acid	1 mM	3.93 (2.09)^{ab}	3.87 (2.09)^{ab}	3.67 (2.03)^{ab}	3.5 (1.99)^{ab}	3.47 (1.98)^{ab}	3.37 (1.96)^{ab}
T4: KNO_3	4 g	4.9 (2.32)^{ab}	4.2 (2.17)^{bc}	4.53 (2.24)^{bc}	4.23 (2.17)^{bc}	4.13 (2.15)^{bc}	4.1 (2.14)^{bc}
T5: $CaNO_3$	15 g	5.1 (2.37)^{ab}	4.33 (2.20)^{c}	4.6 (2.25)^{bc}	4.47 (2.23)^{c}	4.37 (2.20)^{cd}	4.33 (2.20)^{c}
T6: Bio 20	5 ml	5.17 (2.38)^{ab}	4.4 (2.21)^{c}	4.77 (2.29)^{c}	4.87 (2.31)^{c}	4.47 (2.23)^{cd}	4.47 (2.23)^{c}
T7: Vermi wash	1:10	5.33 (2.40)^{bc}	4.77 (2.29)^{c}	4.9 (2.32)^{c}	4.57 (2.25)^{c}	4.73 (2.29)^{cd}	4.57 (2.25)^{c}
T8: *P.fluorescens*	4 g	5.3 (2.41)^{bc}	4.57 (2.25)^{c}	4.97 (2.26)^{c}	4.63 (2.34)^{c}	4.63 (2.26)^{cd}	4.53 (2.24)^{c}
T9: Untreated Control	-	5.4 (2.43)^{c}	5.47 (2.44)^{c}	5.2 (2.97)^{c}	5.17 (2.36)^{c}	5.07 (2.35)^{d}	5.13 (2.36)^{c}
CV (%)		5.29	6.8	6.67	5.86	6.49	6.35
S.Em(±)		0.06	0.09	0.08	0.07	0.08	0.08
CD (p=0.05)		0.2	0.27	0.25	0.21	0.24	0.24

Table 2. Effect of growth regulators and nutrients on sucking pests population of *Bt* cotton under field condition

Treatments	Dosage/l	Number of sucking pests / leaf								
		Leafhopper			Aphids			Thrips		
		1 DBS	15 DAS	30 DAS	1 DBS	15 DAS	30 DAS	1 DBS	15 DAS	30 DAS
T1: N:P:K	4 g	5.4	4.9	4.57	4.83	4.57	4.33	5.07	4.93	4.67
		-2.42	(2.32)^{b}	(2.24)^{bc}	-2.31	(2.25)^{ab}	(2.20)^{b}	-2.33	(2.32)^{a}	(2.26)^{bc}
T2: Jasmonic acid	1 mM	5	4.4	3.65	4.33	3.77	2.83	5	4.57	3.11
		-2.33	(2.21)^{a}	(2.04)^{a}	-2.2	(2.04)^{a}	(1.82)^{a}	-2.35	(2.25)^{a}	(1.89)^{a}
T3: Salicylic acid	1 mM	5.3	4.77	3.68	4.13	3.97	3.37	5.09	4.67	3.52
		-2.4	(2.29)^{a}	(2.03)^{a}	-2.15	(2.10)^{ab}	(1.96)^{a}	-2.36	(2.27)^{a}	(2.00)^{ab}
T4: KNO_3	4 g	5.17	5.1	4.11	4.87	4.67	4.5	5.17	5.1	4.7
		-2.37	(2.37)^{b}	(2.14)^{ab}	-2.31	(2.25)^{ab}	(2.20)^{b}	-2.38	(2.37)^{a}	(2.28)^{bc}
T5: $CaNO_3$	15 g	5.5	5.4	5.3	5	4.73	4.57	5.57	5.43	5.33
		-2.43	(2.42)^{c}	(2.41)^{bc}	-2.32	(2.28)^{bc}	(2.21)^{b}	-2.46	(2.43)^{a}	(2.41)^{cd}
T6: Bio 20	5 ml	5.33	5.53	5.33	5.33	5.1	4.77	5.3	5.2	5.67
		-2.4	(2.45)^{c}	(2.41)^{bc}	-2.41	(2.41)^{bc}	(2.28)^{bc}	-2.41	(2.37)^{a}	(2.34)^{bc}
T7: Vermi wash	1:10	5.67	5.5	5.57	5.53	5	4.67	5.5	5.37	5.73
		-2.67	(2.46)^{c}	(2.46)^{bc}	-2.45	(2.42)^{ab}	(2.27)^{bc}	-2.45	(2.42)^{a}	(2.41)^{c}
T8: *P.fluorescens*	4 g	5.33	5.83	5.67	5.4	5.27	4.93	5.8	5.63	5.03
		-2.41	(2.52)^{c}	(2.48)^{cd}	-2.42	(2.42)^{bc}	(2.32)^{bc}	-2.51	(2.47)^{ab}	(2.39)^{cd}
T9: Untreated Control	-	6.17	7.33	7.77	6.17	6.83	7.07	6.6	7.67	7
		-2.57	(2.79)^{c}	(2.80)^{d}	-2.58	(2.73)^{c}	(2.74)^{c}	-2.67	(2.83)^{b}	(2.73)^{d}
CV (%)		11.4	11.07	12.38	15.27	12.74	11.42	11.31	11.88	13.69
S.Em(±)		0.1	0.1	0.11	0.13	0.11	0.09	0.1	0.1	0.12
CD (p=0.05)		NS	0.3	0.33	NS	0.33	0.29	NS	0.32	0.36

of the present studies. Jasmonic acid and salicylic acid are known to induce defense responses when the plant is attacked by the herbivore, this may be the reason for the induction of tolerance against the leafhoppers.

Aphids : The observations recorded at 15 days after release indicated that jasmonic acid and salicylic acid showed their superiority by having lowest aphid population of 3.50 and 3.67 per plant respectively (Table 1). The next best treatment was potassium nitrate (4.53/ plant). The untreated control registered higher number of aphids (5.20/ plant). At 30 days after release, jasmonic acid recorded the lowest population (3/ plant) which was *on par* with salicylic acid (3.50/ plant). Similarly, the results obtained at 30 days after release indicate that the growth regulators proved to be superior by recording low population of aphids/plant.

These results were in line with the findings of Omer *et al.,* (2010) who reported that preference and performance of herbivores are reduced on induced plants under field condition; treatment with JA may reduce pest infestations and thereby reduce crop damage. Induction detected in the leaves indicates that JA treatment may exhibit long-term negative effects on herbivores. They also reported that the sustained induction may have important implications for seedling damage by herbivores. Early season induction may protect plants at a particularly vulnerable stage and slow population build up of multivoltine pests.

Thrips : At 15 days after release the population of thrips varied from 3.27 to 5.07/ plant among various treatments (Table 1).

Jasmonic acid recorded the lowest population of thrips (3.27/ plant) which was *on par* with salicylic acid (3.47/ plant). The plants in untreated control (5.07/ plant) recorded higher population of thrips (Table 1). Similarly, at 30 days after release plants treated with jasmonic acid registered lowest incidence of thrips (3.10/plant) which was *on par* with salicylic acid (3.37/plant) followed by the treatments potassium nitrate (4.10/ plant) and N:P:K (4.07/ plant). The plants in untreated control (5.13/ plant) recorded higher population of thrips. These results were in line with the findings of Omer *et al.,* (2010).

The same trend was noticed in the field condition which is depicted in Table 2. Here the pre count on the number of leafhoppers, aphids and thrips was taken into account.

CONCLUSION

- The growth regulators jasmonic acid and salicylic acid had an adverse impact on the population of the sucking insect pests.
- The results of the present studies reveal that there was an increase in the biochemical components of cotton leaves in the plants treated with JA and SA.

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