

INDUCING RESISTANCE IN COTTON PLANTS, *GOSSYPIMUM BARBADENSE* L. AGAINST SOME INSECT PESTS BY PLANT GROWTH REGULATORS

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Abstract

Induced resistance in cotton plants *Gossypium barbadense* L. against some insect pests was studied by application of the plant growth regulators, Pix , Uniconazole and Amcoton in green house and field experiments during 2007 and 2008 seasons. The Pix and Uniconazole treatments reduced the entering of 1st larval instars of spiny bollworm (SBW) and pink bollworm (PBW) to bolls, significantly. The percentage of larval penetration and development in bolls were (35.0, 36.37 %) and (48.7, 53.89%) for SBW and PBW, respectively as a compared with control (56.57, 88.33 %) during 2007 season in green house experiment. The plant growth regulators, Pix and Uniconazole increased significantly some chemical constituents of cotton plants such as carotenoids and the total phenol content in both seasons.

In the field experiments, the plant growth regulators, Pix and Uniconazole caused earliness than control by 17.2, 10.96 % in the early planting date, and it was 12.59 and 10.37% in the late planting date. Pix and Uniconazole were the most effective treatments against cotton bollworms. The seasonal average bollworm infestation were (10.77, 11.47), and (13.5, 15.27) when applied in two planting dates, respectively, as compared with 16.07 and 19.33 in the control. The plant growth regulator, Amcoton produced the lowest and non significant effect against cotton bollworms. All treatments produced non significant effect against Jassids , Aphids and mature stage of white fly.

INTRODUCTION

Cotton is a crop of great economic importance in Egypt. This plant is susceptible to infestation by several insect pests. Low yield of cotton is mainly related to damage in bolls caused by the pink bollworm, *P. gossypiella* and the spiny bollworm, *E. insulana* which attacked the fruiting portions, squares, flowers and green bolls reducing both quantity and quality of the harvested lint and seeds during the late season. The main way for controlling these pests is still by using chemical insecticides. One of the most economically and ecologically suitable elements in pest management is host plant resistance. Mechanisms of resistance can be induced by cultural methods, soil fertilizers or plant growth regulators. Plant growth regulators are applied to control undesirable vegetative growth of crop plants, enhancing fruiting bodies and increasing yield. The

application of Pix has proved in controlling the excessive vegetative growth and enhancing the fruiting bodies of cotton which subsequently increased the yield. (Abdel-Al *et al.*, 1986, Reddy *et al.*, 1990 and 1992) and Abdel – Al (1998). However, Hodges *et al.*, (1991) reported the increased photosynthetic rate in Pix treated cotton. The changes occurred due to the action of growth regulators in plant may affect the insect plant interactions. Zummo *et al.* (1984) studied the effects of the plant growth regulator, Pix (mepiquate chloride) on bollworm *H. zea* growth, survival and damage to cotton fruit in Texas. They indicated that application of Pix to cotton induced resistance to *H. zea*. Zhang *et al.* (1996) showed that application of plant growth regulator Pix during the flower and boll period at 30- 45 gm / ha. induced resistance in cotton plants against bollworms. Kassem and Namich (2003) reported that Pix spraying increased significantly chlorophyll (a, b and total), carotenoids and phenolic compounds in treated cotton plants. The present work aimed to study the induced resistance in cotton plants against some insect pests by plant growth regulators to evaluate the bioactivity of some plant growth regulators against infestation with some insect pests.

MATERIALS AND METHODS

1. Induced resistance in cotton plants against cotton bollworms

1.1. Green house experiments

Seeds of cotton *Gossypium barbadense* L. Var. Giza 80 were planted in 24 pots during the 1st week of March inside green house. After establishment, seedlings were thinned to two plants / pot. Pots were watered weekly. No insecticides were applied to cotton plants. Each test was replicated 3 times in a randomized complete block design. These inducers were sprayed by hand sprayer on cotton plants, at two regimes with 1st flower and two weeks after 1st flower. Bolls formed 18-20 days after flowering were artificially infested with SBW and PBW (Laboratory reared). At least 2 - 4 green bolls / plant were infested with two 1st instar PBW and SBW larvae (2 larvae / boll). Infested bolls were marked with colored polyethylene strips and were harvested 7days later. Samples were kept in tightly closed tissue bags and transferred to the laboratory for examination. The numbers of larvae that entered and developed in bolls were determined.

In order to estimate the chemical changes in cotton plants, samples of three mature fresh leaves were taken from the middle part of plant 3 replicates were carried out in the end of experiments to determine the chemical constituents such as chlorophyll a , b and carotenoides. The photosynthetic pigments were extracted by pure acetone (85%) according to the method of A.O.A.C. (1985). The optical densities of pigments (chlorophylls a, b and carotenoids) were measured colorimetrically at the

wave length 662, 644 and 440 nm. respectively. The concentration of pigments were then expressed in mg / gm fresh weight of leaves.

Total soluble phenols were colorimetrically determined in fresh bolls using spectrophotometer at wave length 730 nm as described by A.O.A.C. (1985) and modified by Daniel and George (1972) using the standard curve of pyrogallol. The quantity of the total soluble phenols was determined as mg / gm fresh weight.

1.2. Field experiments

Field studies were carried out to evaluate some inducers in cotton plants against cotton bollworm from March until September during the two successive seasons, 2007 and 2008. Cotton variety Giza 80 was sown on March, 5th and 2nd April, respectively. The experimental design was randomized blocks into four replicates. The whole cultivated area was divided into 32 plots. Every plot was 1/100 fed.. The normal recommended agronomic practices were followed in all plots. The used inducers were the following plant growth regulators (PGR_s):

Pix: Mepiquat chloride (1,1-dimethyl piperidinium chloride) Produced by Basf company.

The rate of application was 250 cm³ /fed.

Uniconazole : **Company code name : S- 3307D** (E- 1 – (p- chlorophenyl) - 4, 4 - dimethyl- 2 – (1,2,4 - triazol-1- yl) – 1- penten-3-ol.) Produced by Sumitomo Chemical Co., The rate of application was 50 gm / fed.

Amcoton : It consists of 1-Naphthyl acetic acid 0.45 %, 1- Naphthyl acetamid 1.20% and Inert ingredients 98.35%. The rate of application was 60 gm / fed.

These inducers were sprayed at the previously mentioned recommended rates twice every 15 days on cotton plants, at two regimes with 1st flower and two weeks after 1st flower. The percent infestation of cotton bollworms were determined starting from the mid of June until the end of August. Four replicates of each treatment. Each 25 cotton bolls were collected and examined weekly. The infestation of sap – sucking pests was recorded at weekly interval from randomly selected 5 plants per replicate. Samples of 5 plants were taken in every replicates to determine the following parameters: plant length in cm, number of fruit branches, green bolls and open bolls.

RESULTS AND DISCUSSION

1. Green house experiments

Application of some plant growth regulators (PGR's)

One of the most ecological and biotechnical methods of controlling insect pests in cotton plants is the induced host resistance.

To evaluate the effect of the different plant growth regulators (PGR's) for controlling the cotton bollworms attacking cotton fruiting parts, an experiment was carried out in the green house at Sids region in Beni- Suef Governorate during the 2007 and 2008 cotton growing seasons.

Results in Table (1) shows the effect of some plant growth regulator, PGR,s on the artificially infested with SBW , PBW and some chemical constituents of Giza 80 cotton variety. The Pix and Uniconazole treatments reduced the entrance of 1st larval instar of SBW and PBW to bolls, significantly. The percentage of larval penetration and developed in bolls were (35.0 , 36.67 %) and (48.7 , 53.89%) for SBW and PBW , respectively as a compared with control (56.67 , 88.33 %) during 2007 season. The Amcoton treatment was non significantly differed as compared to untreated check. In 2008 season, the percentage of larval penetration and development were (43.33, 50.0) and (33.33, 56.67 %) for SBW and PBW as compared with control (73.33 and 76.67 %), respectively.

The plant growth regulators, Pix and Uniconazole increased significantly some chemical constituents of cotton plants such as carotenoids (0.88, 0.76) and (0.82, 0.57) mg / g fresh weight) in both season compared with untreated check (0.73, 0.67), respectively. The total phenol content (14.67, 13.40) and (14.63, 13.03) mg / g fresh weight compared with untreated check (11.53, 11.80), respectively. None of the treatments Pix and Uniconazole as well had significant effects on chlorophyll (a, b) content in both seasons.

Table 1. Effect of different inducers (PGR,S) on the artificially infested with SBW and PBW and some chemical constituents of Giza 80 cotton.

Seasons	Treatments	<i>E. insulana</i>			<i>P. gossypiella</i>			Some chemical constituents of cotton plants			
		No. of larvae		Av. % Larval penetration	No. of larvae		Av. % Larval penetration	Total phenols	Chlorophylls		Carotenoids
		Infest.	Penet.		Infest.	Penet.			a	b	
				mg / gm fresh weight							
2007	Pix	60	21	35.00 a	58	28	48.70 a	14.67	5.13 a	1.65	0.88 a
	Uniconazole	60	22	36.67 a	58	31	53.89 a	14.63	4.50 b	1.70	0.82 b
	Amcoton	60	30	50.00 b	60	47	78.33 b	12.41	4.60 b	1.60	0.75 c
	Control	60	34	56.67 b	58	48	83.33 b	11.53	4.33 b	1.63	0.73 c
F value		---	---	24.8	---	---	60.64	3.47	6.29	0.37	7.01
L.S.D at 5% level		---	---	7.24	---	---	7.66	2.8	0.49	n.s	0.09
2008	Pix	30	13	43.33 a	30	10	33.33 a	13.40 a	4.87	1.45	0.76
	Uniconazole	30	15	50.00 a	30	17	56.67 b	13.03 b	4.37	1.67	0.57
	Amcoton	30	20	66.67 b	30	22	73.33 c	11.60 c	4.93	1.58	0.68
	Control	30	22	73.33 b	30	23	76.67 c	11.80 c	4.40	1.47	0.67
F value		---	---	10.6	---	---	8.65	3.9	1.03	3.39	0.89
L.S.D at 5% level		---	---	14.84	---	---	23.2	1.56	n.s	n.s	n.s

* The values marked with the same letter are not significantly different according to the value to the L. S. D. test at 5% level.

These results agree with those outlined by Zummo *et al.* (1984) who showed that after Pix treatment a relatively condensed tannin concentration and astringency increased significantly in treated plants. Heliothis larvae developing on these plants weighed less, had lower survival rates and damaged less fruit than larvae on untreated plants. They indicated that application of Pix to cotton induced plant resistance to *H. zea* infestation. Also, Mansour *et al.* (1997) found a negative linear relationship between the concentration of tannins in two Egyptian varieties, Giza 70 and Giza 76 and the population density of piercing sucking insects. Zhang *et al.* (1996) mentioned that earliness, Okra leaf, lack of nectarines, smooth leaf and high gossypol content were found to be correlated with resistance to *Pectinophora gossypiella*, while dense leaf pubescence and low gossypol were correlated with susceptibility to the pest.

2. Field experiments

2.1. Effect of different plant growth regulators on vegetative and fruiting characters

It is obvious from the results presented in Table 2, which show the effect of different inducers on the average of some growth characters i.e. plant height, fruiting branches, bolls and open bolls in two sowing dates. The plant growth regulators Pix and Uniconazole decreased the average plant height significantly. The average plant heights were (123.9 , 129.8) in the early planting date and (124.8 , 128.5) cm / plant in the late planting date, respectively as compared with control (135.9 and 140.7 cm / plant), while the plant growth regulator Amcoton produced non significant height differences compared with the untreated plots in both planting dates.

The plant growth regulators, Pix and Uniconazole significantly increased the average number of fruiting branches. The average number of fruiting branches were (18.9, 17.6) and (19.7, 16.1) branch / plant, respectively as compared with control (16.7, 12.3 branch / plant) in both planting dates, respectively. The plant growth regulator Amcoton did not produce a significant different number of fruiting branches.

The plant growth regulators, Pix and Uniconazole increased the average number of green bolls and open bolls / plant significantly. The average number of green bolls and open bolls were (40.3, 31.3) and (39.0, 27.7) , respectively , as compared with (32.3 , 17.1) in untreated plants in the first planting date (5 March). They were (31.9, 21.7) and (29.3, 18.1) , respectively, in the second planting date. The plant growth regulator Amcoton did not significantly increase the average number of green bolls and open bolls.

Table 2. Effect of different inducers (PGR,S) on the average of some plant growth characters and percentage of earliness in bolls opening of Giza 80 cotton sowing in two dates .

Planting dates	Treatments	Vegetative and fruiting characters						
		Plant height (cm)	Av. No. / plant				Boll opening	
			Fruiting branches	bolls	Open bolls	% opened bolls	Period to 1 st boll in days	% earliness
5- March	Pix	123.9a	18.9 a	40.3a	31.3a	77.58	121	17.12
	Uniconazole	129.8b	19.7 a	39.0a	27.7a	71.05	130	10.96
	Amcoton	133.9b	17.4 b	35.0b	20.8b	59.33	142	2.74
	Control	135.9b	16.7 b	32.3b	17.1b	52.99	146	0.00
F value		8.77	8.55	5.9	19.04	---	---	---
L.S.D at 5% level		6.19	1.59	5.19	5.04	---	---	---
2 - April	Pix	124.8a	17.6 a	31.9a	21.7a	67.95	118	12.59
	Uniconazole	128.5a	16.1 b	29.3a	18.1a	61.96	121	10.37
	Amcoton	138.2b	13.9 b	24.3b	12.0b	49.59	133	1.48
	Control	140.7b	12.3 b	20.5b	10.0b	48.70	135	0.00
F value		12.99	44.47	14.15	21.26	---	---	---
L.S.D at 5% level		5.67	4.21	4.7	4.03	---	---	---

* The values marked with the same letter are not significantly different according to the value to the L. S. D. test at 5% level.

In both planting dates, a time required for opening the first boll, in different treatments were also shortened than that of the control. The plant growth regulators, Pix and Uniconazole caused earliness than control by 17.2 , 10.96 %) in the early planting date and by 12.59 and 10.37% in the late planting date. The results agree with the finding of Kassem and Namich (2003) reported that Pix spraying significantly increased carotenoids and phenolic compounds in treated cotton plants and also increased chlorophyll (a, b and total). Nobreqa *et al.* (1999) found that the application of pix (mepiquate chloride) has enhancing effects on fruiting bodies of cotton which increased yield. Thakar *et al.*, (1999) tested different growth regulators on cotton and found thiadiazuran increased harvestable bolls per plant , boll opening percentage , yield and decreased days to maturity.

2.2. Effect of some plant growth regulators (PGR's) on some insect pests of cotton

To evaluate the effect of the plant growth regulators Pix , Uniconazole and Amcoton, on the cotton bollworms attacking cotton fruiting parts and some sap sucking pests , an experiment was carried out at Sids region in Beni-Suef Governorate during the 2006 and 2007 cotton growing seasons.

The data in Table 3 shows the effects of different inducers applied at different planting dates on the average bollworm infestation cotton plants with the PBW and SBW. The plant growth regulators pix, Uniconazole, and Amcoton were the most effective treatments against cotton bollworms. The seasonal average rates of bollworm infestation were (10.77, 11.47), and (13.5, 15.27) when applied in two planting dates, respectively as compared with 16.07 and 19.33 in the control. The plant growth regulator, Amcoton, produced the lowest effect against cotton bollworms and not significant with control.

Population fluctuation of Jassid and aphids after application of these inducers in cotton were evaluated, the results indicated that there was no significant effect of plant growth regulator on the population of Jassid and aphids in the two planting dates.

The effect of the plant growth regulators on the population of *B. tabaci* (immature and mature stages) varied significantly between the treatments Table (3). The most effective treatments against *B. tabaci* (immature and mature stages) were Pix and Uniconazole treatments. The seasonal average immature and mature stages / leaf were (2.7 , 1.87) and (3.07, 1.9) in the first planting date, respectively, as compared with 3.87 and 2.27 in the control. These treatments gave good protection and it can be used as good agrochemical elements in cotton pest management strategies.

Table 3. Effect of different inducers (plant growth regulators) on insect pest infestation in cotton sowing in two dates in the field.

Sowing dates	Treatments	Av. bollworm infestation %	Seasonal X±S.D. pest population / cotton leaf)			
			Jassid	Whitefly		Aphis
				immature	mature	
5- March	Pix	10.77 ± 5.58 a	4.20 ± 1.49	2.70 ± 0.17 a	1.87 ± 0.32 a	9.93 + 1.00
	Uniconazole	11.47 ± 6.53 a	4.47 ± 1.54	3.07 ± 0.51 b	1.90 ± 0.26 a	11.03 + 2.49
	Amcoton	14.37 ± 6.50 b	5.13 ± 1.88	4.27 ± 0.58 c	2.13 ± 0.46 b	11.30 + 2.86
	Control	16.07 ± 8.09 b	4.57 ± 1.62	3.87 ± 0.55 c	2.27 ± 0.15 b	11.23 + 1.82
F value		5.11	1.17	8.59	5.56	3.13
L.S.D at 5% level		3.8	n.s	0.85	0.27	n.s
1%		5.7		1.28	0.42	
2-April	Pix	13.50 ± 8.86 a	3.63 ± 1.29	3.90 ± 0.66 a	4.28 ± 0.19	11.87 ± 1.35
	Uniconazole	15.27 ± 9.81 a	3.33 ± 1.21	5.20 ± 0.10 b	5.07 ± 0.10	13.00 ± 0.64
	Amcoton	18.87 ± 8.91 b	3.60 ± 1.22	6.57 ± 0.35 b	5.10 ± 0.98	13.60 ± 1.00
	Control	19.33 ± 9.35 b	3.57 ± 1.24	6.03 ± 0.74 b	5.23 ± 0.67	12.87 ± 0.95
F value		9.38	0.26	14.52	1.95	0.29
L.S.D at 5% level		3.2	n.s	1.04	n.s	n.s
1%		4.8		1.57		

- The values marked with the same letter are not significantly different according to the value to the L. S. D. test at 5% level.

These findings are in agreement with other investigations carried out by several authors. Wilson *et al.* (1992) showed that the growth regulating chemical ethephone (2-chloroethylphosphonic acid) caused bolls to open earlier and decreased the number larvae of *P. gossypiella* over wintering. Abdel – Al *et al.*, (1986) and Abdel- Al (1998) showed that application of Pix to cotton cause bolls to open earlier and enhance crop maturity, increased the cotton yield / plant and induced resistance in cotton plants against bollworms than untreated check. This plant resistance may be due to that pix treatment inhibits the synthesis of the plant hormone gibberilic acid that plays a major role in enhancing cell enlargement and general vegetative growth. Ashfaq *et al.*, (2001), Ahmed *et al.* (2003) and Abro *et al.* (2004) also, observed similar trend in the reduction of sucking pest and bollworm infestation treated with different doses of Pix.

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تحفيز مقاومة نباتات القطن ضد بعض آفات القطن الحشرية باستخدام منظمات النمو النباتية

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تم دراسة تحفيز مقاومة نباتات القطن *Gossypium barbadense* L. ضد بعض الآفات الحشرية التي تصيب محصول القطن وذلك عن طريق تطبيق بعض منظمات النمو النباتية وهي Pix و Uniconazole و Amcoton في رشتين مع أول زهرة وبعد 14 يوم من أول زهرة وذلك في تجارب معملية وحقلية . وأوضحت النتائج أن تطبيق منظم النمو النباتي Pix و Uniconazole أحدث تحفيزا لنباتات القطن حيث خفض معنويا نسبة دخول وتطور العمر الأول من يرقات دودة اللوز القرنفلية والشوكية بعد العدوى الصناعية في تجارب الصوب خلال موسمي الدراسة 2007 و 2008 م. وأوضحت النتائج أن التطبيق الحقلية بنفس التركيزات ونفس الوقت مع ميعاد زراعة مبكر واخر متأخر حيث أعطت معامليتي Pix و Uniconazole تبيكيرا للمحصول بمعدلات 17.12 % و 10.96 % بالنسبة لميعاد الزراعة الأول و 12.59 % و 10.37 % بالنسبة لميعاد الزراعة الثاني على التوالي. كذلك فان هذه المعاملات خفضت معنويا نسبة الإصابة بديدان اللوز. لم تؤثر هذه المعاملات معنويا على الحشرات ذات أجزاء الفم الثاقب الماص في كلا مواعي الزراعة عدا تأثيرها على الأطوار الغير كاملة للذبابة البيضاء حيث خفضت الإصابة معنويا في الميعاد المبكر. لذلك يجب الاهتمام بمنظمات النمو النباتية كعنصر من عناصر مكافحة المتكاملة في محصول القطن .