EFFECT OF THREE IGRS ON DEVELOPMENT TIME, MORTALITY AND REPRODUCTION OF *APHIS GOSSYPII* GLOVER (APHIDIDAE : HEMIPTERA)

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Abstract

The effect of three IGR compounds flufenoxuron, PH 70-23 and chlorfluazuron was tested against *Aphis gossypii* Glover in the laboratory. Aphids fed on cotton leaves dipped into solutions of the three IGR compounds at the concentration 25 ppm showed a prolongation of the nymphal stage of the different instars. Reduction in the number of produced nymphs and significant higher mortality than the control were observed. A number of individuals did not reach the adult stage or did not produce offspring. The three IGR compounds were less effective if aphids were transferred 24 or 48h after dipping. At 50 and 100 ppm concentrations of the three IGR compounds, individuals did not moult or produce offspring within 72 h, and mortality was significantly higher than the control for adults, first and second instars.

INTRODUCTION

Cotton aphid, *Aphis gossypii* Glover has been recognized as a pest damaging cotton, especially late in the season. High infestation with aphids at this stage of cotton growth usually cause honey dew which result in sticky cotton at harvest. Cotton aphids are highly mobile, polyphagous and are characterized by high reproductive potential . The pest is able to adapt itself on several hosts, migrates to summer vegetables growing near cotton, and damaging summer cucurbits by transmitting viral diseases.

Many insecticides used against aphids curtailed from aphid contral program

due to the development of resistance and pollution of the enviromment.

Insect growth regulators (IGRs) have shown good potential as control agents or inhibitors of chitin synthesis in epidermal cells. Previous studies have indicated the effectiveness of these compounds in decreasing growth rate and reducing repoductive capacity of insects and mites. Different compounds acting with the same mode of action were evaluated on different stages of various insects and mites (El-Guindy *et al.,* 1977; Moore *et al.,* 1978; Hoying and Riedl, 1980; Madore *et al.,* 1983; El-Sayed, 1984-85, El-Atrouzy et al., 1989; Iskander et al., 1990; Darvas *et al.,* 1992; Berry *et al.,* 1993 and Haynes and Smith, 1993).

MATERIALS AND METHODS

Compounds used

a. Flufenoxuron (Cascade 5% EC): ((1-4-2 chloro-4 (trifluoromethyl) phenoxy-2-fluorophenyl 1-3-(2,6-difluorobenzoyl) urea).

b. Ph 70-23 (Andalin 5% EC) : 1-(oc-(4-chloro-oc-cydoprophyl benzylidene-amino-oxy)-p-toyl)-3-(2,6-difluorobenzoyl) urea.

c. Chlorfluazuron (Atabron 5% SE) : N- (4-(3-chloro-5trifluoromethyl-2-pyridyloxy)-3,5-dichlorophenyl) -N- (2,6-difluorobenzoyl) urea.

Laboratory tests

Aphis gossypii strain used in the present study was reared on cotton seedlings grown in plastic pots (20 cm diameter). Other cotton seedlimgs were kept aphid-free in cages (60 x 60x 40 cm). The seedlings were used as discs dipped with the tested compounds. Three IGR compounds were tested at 25 ppm aqueous concentration by dipping cotton leaves for 10 seconds, then kept to dry and cut into small discs (2cm diameter). Control was made by using water only. Discs were placed on moistened cotton wool in Petri dishes. Single aphid (newly born or moulted) was transferred either immediately or after 24h and 48h on the treated disc. Five individuals were tested in each aphid instar and were replicated three times. Each tested instar was allowed to complete its development on treated discs and the duration of each instar as well as the number of dead individuals were recorded. When nymphs reached the adult stage, newly born nymphs were counted for two days.

The effect of the two concentrations of the three IGRs (50 and 100 ppm) on the percentage of mortality of the first and second instars and adult aphids was investigated. Treatment means were calculated and standard deviation was obtained for all means derived from the three replicates. Treatments were compared using analysis of variance (P = 0.01).

The experiments were conducted under the controlled conditions of 25 ± 2oC and 65 ± 5% R.H.

RESULTS AND DISCUSSION

The tested IGRs against A.gossypii caused a prolongation of nymphal development as well as a reduction in offspring whether in newly born nymphs or other instars used.

When aphids were ransferred immediately on treated cotton leaves, the duration of the different instars was longer than the untreated ones. The newly born nymphs treated had devloped in a longer time with a percentage of mortality after each moult . The duration of the first instar was the longest for PH 70-23 (2.08 day compared with 1.46 in the control). The lowest number of survivals which produced nymphs was for PH 70-23 treatment (5 individuals). Treated individuals produced fewer nymphs than the control (1.87, 2.6 and 1.77 nymphs per individual for flufenoxuron, PH 70-23 and chlorfulazuron, respectively) versus 4.58 nymphs per individual for the control.

When the second instar was treated, the duration of the third instar was the longest 2.20 days for individuals treated with PH 70-23 (1.6 days for the control). This was accompanied by a lower number of nymphs (1.77 nymphs/individual). Treated third instar individuals produced more nymphs than the other treated instars (5.46, 5.18 and 5.44 individuals compared with 9.92 for the control). Flufenoxuror produced a higher percentage of mortality (40%) at the end of the 4th instar with the longest period of development (2.00 days).

When aphids were transferred after 24 h on treated cotton leaves with 25 ppm of the three IGRs (Table 2) , the treated individuals were less affected than those transferred immediately. The longest period was 1.72 days for the second in-

Table 1. Effect of IGRs on nymphal development time (day ± SD), percentage of mortality of different instars and offspring of *A. gossypii* transferred immediately on treated cotton leaves.

Compound	Stage	Developmental stages and percentage of mortality									
		% Mortality	1st instar	% Mortality	2nd instar	% Mortality	3rd instar	% Mortality	4th instar	% Mortality	Offspring/ individuals
Flufenoxuron	1st instar	26.66	1.60±0.51	6.66	1.50±0.53	6.66	1.12±0.35	0.00	1.50±0.35	6.66	15/8=1.87
PH 70-23		0.00	2.08±0.99	6.66	1.50±0.70	13.33	1.50±0.54	0.00	1.00±0.00	33.33	13/5=2.60
Chlorfluazuron		0.00	1.46±0.51	0.00	1.75.0.70	0.00	1.22±0.44	0.00	1.22±0.44	6.66	16/9=1.77
Control		0.00	1.46±0.51	0.00	1.21±0.42	6.66	1.00±0.00	6.66	1.16±0.38	0.00	55/12=4.58
Flufenoxuron	2nd instar			0.00	1.66±0.65	13.33	2.00±0.66	6.66	1.75±0.70	26.66	33/8=4.12
PH 70-23				6.66	1.66±0.77	6.66	2.20±0.78	6.66	1.57±0.53	33.33	12/7=1.74
Chlorfluazuron				0.00	1.64±0.63	0.00	1.78±0.69	6.66	2.08±0.66	13.33	34/11=3.09
Control				0.00	1.40±0.50	0.00	1.60±0.69	0.00	1.42±0.51	6.66	117/14=8.36
Flufenoxuron	3rd instar					0.00	1.64±0.63	0.00	1.64±0.63	6.66	71/13=5.46
PH 70-23						0.00	1.71±0.46	0.00	1.75±0.62	13.33	57/11=5.18
Chlorfluazuron						0.00	1.93±0.25	0.00	1.63±0.67	26.66	49/9=5.44
Control						0.00	1.57±0.64	6.66	1.42±0.52	0.00	139/14=9.92
Flufenoxuron	4th instar							6.66	2.00±0.81	40.00	20/7=2.86
PH 70-23								0.00	1.60±0.69	26.66	20/7=2.86
Chlorfluazuron								6.66	1.66±0.88	40.00	24/8=3.00
Control								0.00	1.46±0.51	6.66	119/13=9.15

Table 2. Effect of IGRs on nymphal development time (day ± SD), percentage of mortality of different instars and offspring of *A. gossypii* transferred after 24h. on treated cotton leaves.

Compound	Stage	Developmental stages and percentage of mortality									
		% Mort-ality	1st instar	% Mort-ality	2nd instar	% Mort-ality	3rd instar	% Mort-ality	4th instar	% Mort-ality	Offspring/ individuals
Flufenoxuron	1st instar	20.00	1.63±0.67	6.66	1.18±0.40	6.66	1.22±0.44	0.00	1.22±0.44	0.00	38/9=4.22
PH 70-23		0.00	1.53±0.50	6.66	1.72±0.78	0.00	1.33±0.70	20.00	1.33±0.50	20.00	33/9=3.67
Chlorfluazuron		6.66	1.53±0.66	6.66	1.38±0.49	0.00	1.25±0.46	13.33	1.25±0.46	0.00	36/8=4.50
Control		6.66	1.14±0.36	0.00	1.20±0.46	0.00	1.23±0.43	0.00	1.20±0.43	6.66	77/13=5.92
Flufenoxuron	2nd instar			0.00	1.38±0.65	20.00	1.54±0.52	6.66	1.80±0.62	0.00	41/10=4.10
PH 70-23				0.00	1.33±0.48	6.66	1.66±0.49	6.66	1.50±0.67	0.00	41/10=4.10
Chlorfluazuron				13.33	1.45±0.68	6.66	2.00±0.63	0.00	1.22±0.42	0.00	45/9=5.00
Control				0.00	1.26±0.45	0.00	1.28±0.46	6.66	1.42±0.57	0.00	100/14=4.14
Flufenoxuron	3rd instar					0.00	1.50±0.65	0.00	1.71±0.61	6.66	50/13=3.84
PH 70-23						6.66	1.20±0.42	6.66	1.58±0.66	0.00	39/12=5.25
Chlorfluazuron						0.00	1.20±0.42	6.66	1.75±0.75	13.33	55/12=4.58
Control						0.00	1.42±0.51	0.00	1.28±0.46	6.66	113/14=8.07
Flufenoxuron	4th instar							0.00	1.26±0.45	20.00	83/14=5.92
PH 70-23								0.00	1.60±0.58	6.66	55/13=4.23
Chlorfluazuron								0.00	1.66±0.72	13.33	77/13=5.92
Control								0.00	1.33±0.40	13.33	135/13=10.38

star if newly born nymphs were treated withPH 70-23, 2.00 days for the third instar when the second-instar was treated with cholrfluzauron, and 1.75 days for the 4th instar when the third-instar was treated with chlorfluazuron giving the lowest number of produced nymphs (3.25 nymphs/individual).

Durations of the different instars were less prolonged, and the percentages of mortality had decreased when aphids were transferred after 48 h on treated cotton leaves with the IGRs (Table 3). The number of survivors increased producing more nymphs/individual. The nymphal stage for survivors was insignificantly longer for treated individuals than in the control (Table 4).

Other treated nymphs that faild to moult to the succeeding instar had died before being able to shed the old exuvia. Some adults did not produce offspring. Prolongation as well as reduction of offspring were more pronounced when the individuals were transferred immediately on treated leaves than those transferred after 24h or 48h. Survivors produced significant fewer nymphs than those of the control (Table 4).

From the data summarized in Table 5, it could be seen that the highest percentage of mortality was recorded for PH 70-23 (50 ppm) when it was applied on the first andsecond instars and adult aphids (83.33 , 60.00 and 86.66%, respectively). The corresponding values for the concentration 100 ppm were 88.6 , 73.3 and 86.6%, respectively. Chlorfluazuron was effective against the first and second instars, and adult aphids. Flufenoxuron however had the lowest effect. Mortality percentages were significantly higher than the control 13.33%. Within the 72h of exposure no moulting or offspring occurred.

From the previous results, it could be concluded that the three IGRs can successfully reduce aphid offspring when the pest is immediately in direct contact with the treated leaves. However, the development of aphids was shightly affected during the first 3days of treatments. A more pronounced effect was observed when the newly born nymphs or newly emerged adults were treated. On the other hand, the second and third instars were more tolerant to the action of the IGRs.

Darves *et al.*, (1992) tested ecdysteroids against different insect orders. They indicated low effectiveness on Acyrthosiphon pisum (Homoptera) in comparison with lepidopteran or coleopteran individuals and this was related to differences in

Table 3. Effect of IGRs on nymphal development time (day ± SD), percentage of mortality of different instars and offspring of *A. gossypii* transferred after 48h. on treated cotton leaves.

Compound	Stage	Developmental stages and percentage of mortality										
		% Mort-ality	1st instar	% Mort-ality	2nd instar	% Mort-ality	3rd instar	% Mort-ality	4th instar	% Mort-ality	Offspring/ individualsa
Flufenoxuron	1st instar	0.00	1.46±0.50	0.00	1.46±0.63	0.00	1.41±0.51	0.00	1.41±0.51	20.00	44/12=3.66
PH 70-23		0.00	1.35±0.49	0.00	1.42±0.75	0.00	1.46±0.51	0.00	1.30±0.48	6.66	45/13=3.46
Chlorfluazuron		0.00	1.46±0.50	0.00	1.46±0.63	0.00	1.41±0.51	0.00	1.41±0.51	20.00	44/12=3.66
Control		0.00	1.28±0.46	0.00	1.28±0.46	0.00	1.35±0.49	0.00	1.14±0.36	0.00	82/13=5.85
Flufenoxuron	2nd instar			0.00	1.23±0.43	6.66	1.38±0.50	6.66	1.53±0.66	0.00	75/13=5.76
PH 70-23				0.00	1.51±0.51	0.00	1.21±0.42	0.00	1.35±0.49	6.66	58/14=4.14
Chlorfluazuron				0.00	1.51±0.75	0.00	1.23±0.43	0.00	1.38±0.50	0.00	67/13=5.15
Control				6.66	1.35±0.49	6.66	1.21±0.42	0.00	1.50±0.51	0.00	108/14=7.71
Flufenoxuron	3rd instar					0.00	1.26±0.45	0.00	1.64±0.49	6.66	101/13=7.21
PH 70-23						0.00	1.38±0.50	0.00	1.46±0.66	6.66	72/13=5.53
Chlorfluazuron						0.00	1.42±0.51	6.66	1.57±0.69	0.00	97/14=6.92
Control						0.00	1.14±0.36	0.00	1.28±0.46	0.00	127/14=9.07
Flufenoxuron	4th instar							6.66	1.64±0.63	6.66	117/13=9.00
PH 70-23								0.00	1.53±0.66	20.00	118/12=9.83
Chlorfluazuron								6.66	1.76±0.83	6.66	121/13=9.30
Control								0.00	1.33±0.48	13.33	149/13=11.49

Table 4. Duration of nymphal stage and offspring (means) of newly emerged nymphs of *A. gossypii* surviving the three IGRs when transferred immediately, after 24h or 48h on treated cotton leaves.

Treatments	Flufenoxuron PH 70-23	Chlorfluzauron	Control	LSD
	Nymphal stage			
Immediately	5.61 (8 ind.)	5.00 (6 ind.)	5.47 (9 ind.)	4.83 (12 ind.) -
After24 hr.	5.66 (9 ind.)	5.55 (9 ind.)	5.33 (8 ind.)	4.85 (13 ind.) -
After 48 hr.	5.83 (12 ind.)	5.46 (13 ind.)	5.33 (12 ind.)	5.90 (14 ind.) -
	Offspring			
Immediately	1.87 (8 ind.)	2.60 (5 ind.)	1.77 (9 ind.)	4.58 (12 ind.) 2.20
After24 hr.	4.22 (9 ind.)	3.67 (9 ind.)	4.51 (8 ind.)	5.92 (13 ind.) 1.95
After 48 hr.	3.66 (12 ind.)	3.46 (13 ind.)	3.66 (12 ind.)	5.85 (14 ind.) 1.00

Table 5. Mortality response of first instar, second instar and adults of *A. gossypii* fed on IGRs-treated cotton leaves.

Treatments	Percentage of mortality			
	Flufenoxuron PH 70-23	Chlorfluzauron	Control	LSD
50 ppm				
1 *st* instar	56.66	83.33	83.33	13.33 13.33
2 *nd* instar	36.66	60.00	60.00	13.33 22.51
Adults	66.66	86.66	86.66	13.33 14.23
100 ppm				
1 *st* instar	63.33	86.66	86.66	13.33 16.69
2 *nd* instar	53.33	73.33	73.33	13.33 19.49
Adults	66.66	86.66	86.66	13.33 17.43

cytochrome inhibitors between insects species. Acute mortality of aphids at the highest dose (5 ug/larva) was however observed although the survivors were fertile. Berry et al. (1993) showed that ecdysis was prevented in gypsy moth and the insect died within the old cuticle, or was initiated but not completed. The individuals died or were completed but some deformations prevented nymphs from feeding. Prolongation of development time in the field affects the nutritional suitability of the host plant which escapes the pest infestation. Sterilization of aphid adults, as suggested by Kim et al., (1992), may be due to the inhibition of ovarian development caused by blocking the necessary endocrine secretion.

It seems therefore that the residues persisting on treated cotton leaves could affect development time and fecundity of aphids, thus revealing decay over time. It is likely that IGRs could affect the population density in the field, especially when it is overcrowding and migrating from one host to another.

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دراسة تأثير ثلاث مركبات من منظمات النمو الحشرية على النمو والتكاثر ونسبة الموت على من القطن *Aphis gossypii*

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معهد بحوث وقاية النباتات - مركز البحوث الزراعية - الدقى .

تم فى هذا البحث دراسة تأثير ثلاث مركبات من منظمات النمو الحشرية (Flufenoxuron Chlorfluazuron , PH 70-23) ضد من القطن تحت ظروف معملية ٢٥ ± ٢م ورطوبة نسبية ٦٥ ± ٥٪. تمت تغذية أطوار المن المختلفة على أوراق قطن غمرت فى محالى المركبات السابق ذكرها بتركيز ٢٥ جزء فى المليون.

أظهرت النتائج إطالة فترة حياة الحوريات للأعمار المختلفة وانخفاض فى أعداد الولادات الناتجة من الأطوار الكاملة و أيضا كانت النسبة المئوية للموت أعلى معنويا بمقارنتها بالأفراد الغير معاملة ، ووجد أن هناك أعداد من الحوريات لم تصل الى الطور الكامل أو لم تنتج ولادات.

ولوحظ أن هذه المركبات كانت أقل فاعلية اذا تم تغذية الأفراد على أوراق قطن معاملة بعد ٢٤ أو ٤٨ ساعة من غمرها ، ولوحظ أيضا أن الأفراد لم تنسلخ أو تنتج ولادات خلال ٧٢ ساعة بتركيزى ٥٠ ، ١٠٠ جزء فى المليون من مركبات السابق ذكرها ، وكانت النسبة المئوية للموت أعلى معنويا للأعمار الأولى والثانية والأطوار الكاملة بمقارنتها بالأطوار الأخرى.