THE METABOLIC EFFECT OF THE JUVENILE HORMONE AND PRECOCENE II, ON ADULT SCHISTOCERCA GREGARIA FORSK .

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(Manuscript received 9 October, 1996)

Abstract

Newly moulted fourth and fifth instar nymphs of *Schistocerca gregaria* Forskal were exposed to Precocene II and Juvenile Hormone III (40 µg per live body weight).

The effects of Precocene treatment might be attributed to the lack of JH release, which caused reduction in the haemolymph protein and lipid of male and female adults emerging from treated 5th instar nymphs.

Also, JH III inhibited both of protein and lipid in the adult female haemolymph when treated on 4th instar nymphs.

The inhibition of protein synthesis and the substantial suppression of lipids by JH III and PII in gregarious locusts could probably suppress long-distance migratory flights; thus, JH III and PII could conceivably be used to prevent migration of *S.gregaria* from their recession areas into farmland, which would allow an alternative strategy in locust control.

INTRODUCTION

Recently, the main objective in locust control is to suppress the outbreak of their mobile swarms by preventing the metamorphosis of their nymphal instars in the breeding sites.

Bowers (1976) reported anti-juvenile hormone activity in two chemicals extracted from the plant Ageratum hostonianum. Both compounds produced premature metamorphosis in some Hemiptera and Orthoptera, and induced degeneration in corpora allata, which decreased or removed endogenous juvenile hormone. Such compound may be more appropriate for using as pest control agent.

Juvenile hormone III was the only known JH homologue to be detected either in the whole body extract (Trautmann *et al.*, 1974) or in the haemolymph (Blight and Wenham, 1976) of the repoductively active females of the desert locust Schistocerca gregaria Forskal when bred in crowds.

The present investigation is a study on the effect of anti-allatotropins (PII) and Juvenile Hormone III treatment on newly moulted 4th and 5th instar nymphs on the haemolymph main metabolite of the resulting adults.

It is extremely difficult to carry out such studies on field locusts; therefore, laboratory reared insects were used.

MATERIALS AND METHODS

The newly-moulted nymphs of 4th and 5th instar were segregated from the gregarious stock of S.gregaria which had been maintained under the crowded conditions of Hunter-Jones (1961) for several years in the Locust Research Station, Agricultural Research Centre, Dokki, Egypt.

Hoppers were kept in wooden cages with glass sides (30x30x30 cm) at a rate of 100 per cage. All cages were incubated at 32 ± 2°C and 65±5% R.H. The leguminous plant Sesbania aegyptiaca, was daily provided as feeding material.

A dose of 40 µg per live body weight (4th or 5th newly instar nymphs) from either Precocene II (6,7 - dimethoxy - 2,2 - dimethyl - chromene) or Juvenile Hormone III (cis 10, 11 - epoxy - 3,7, 11-tris methyl trans, trans - 2,6 dodecadienoic acid methyl ester), was applied.

The hormone was dissolved in pure arachis oil and nymphs were injected with 5 µl solution; Precocene II was applied topically to the 2nd intersegmental membrane of the 1st and 2nd abdominal segments using 5µl of acetone and the control received 5 µl of the solvents alone.

The haemolymph main metabolites were quantitatively estimated as total protein and lipids in treated and untreated adults. Three pools for each group were used, each consisted of 10 adults. The haemolymph was collected for chemical analysis from 6-day old adults.

The metabolites were colourimetrically determined according to the tech-

niques outlined by Gornal *et al.* (1949) for protein extraction (0.1 ml haemolymph sample), Folch et al. (1957) for lipid extraction, Knight *et al.* (1972) for lipid estimation (0.05 ml haemolymph sample).

The growth rate estimation was expressed in average of daily weights of the developing nymphs and their resulting adults for each treated group and the control insects. The nymphal durations were calculated by Dembester's equation (1957).

RESULTS AND DISCUSSION

Effect of JHIII and PII on body weight of gregarious phase

JH appears as an ideal coordinator, we therefore studied the impact of exogenous (JHIII and anti - hormone (PII) on growth and main metabolic rate.

The most effective dose (40 µg per live body weight) against the nymphal instar of this pest was used. In the present study treated S.gregaria, treatment with chemicals used was found increasing during both the 4th and 5th stadia at a higher rate than control, but unexpectantly, this was followed by a rapid weight decline in adults, whose body weight in both adultoids and precocoius (PII treatment) were lower than that in JH treatment and control, Fig. 1.

These findings with nymphs are in agreement with those of Baehr *et al.* (1979) who showed that ecdysteroids and JH are never present in high concentrations during the last two larval instars of L.migartoria. Results in adults go in line with those of Slama (1978), who pointed out that PII treatment suppressed growth in adult delay of somatic growth. In a study made by Mandal *et al.* (1983), who found that allatectomy resulted in a significant reduction in the amount of protease, lipase and trypsin enzyme activity. Furthermore, Schneider *et al.* (1995) demonstrated that JH III inhibited fat body development and suppressed the adipokinetic reaction, thus they may suppress migratory flights.

Effects of chemicals on larval duration, precocious and mortality during metamorphosis

1. The duration of the 5th instar treatment of newly 5th stadium with JH III decreased, to 7 and 9.6 days, in contrast treated newly 4th instar nymphs showed increased duration to 18 and 17 days; However, PII treatment at 4th instar showed

the same trend exhibited in its counterparts JH III treatment decreased the duration to 7 and 6 days compared with untreated control which was 13.2 and 14 days for male and female, respectively (Table 1).

Table 1. Effect of Juvenile Hormone III and Precocene II on larval duration and mortality during metamorphosis from teated 4th and 5th instar nymphs.

Material	Nymphal application												
	4th									5th			
	% Precocious	% Mortality during metamorphosis				Duration in days				% Mortality		Duration in days	
		4 th		5 th		4 th		5 th					
		Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
JH III	0	33.3	33.3	66.6	50.0	10.2	11.9	18.0	17.0	85.7	83.3	7.0	9.6
PII	35.3	45.5	45.5	0	0	9.5	9.6	7.0	6.0	20.0	23.1	14.9	14.3
Control	0	0	0	0	0	7.1	9.5	13.2	14.0	0	0	13.2	14.0

In view of the foregoing results obtained, it seems that the nymphal duration depends on the instar stadium treatment. However, these differences might rather be due to the metabolic changes that take place through the course of the hopper development in correlation with the C.A. hormone activity. This might be due to the high titre of JH in 5th instar nymphs resulting from earlier instars treatment (Injeyan and Tobe, 1981).

The duration of the 4th instar was prolonged with JH III treatment to 10.2 and 11.9 days and with PII treatment to 9.5 and 9.6 days compared with untreated control which was 7.1 and 9.5 days for male and female, respectively, this might be due to the prothoracicotropic effect of the corpus allatum hormone (JH) (Cymborowski and Stocard, 1979).

2. Precocious metamorphosis took place in 35.3 % of the treated insects at the subsequent moult from the 4th instar treated with PII Table 1 and did not develop the colouration characteristics of sexually mature adults. Examination of the ovaries revealed that most of the terminal oocytes were arrested in the previtellogenic stage, since JH is essential for vitellogenesis. Unnithan and Nair (1979) stated that PII led to precocious metamorphosis at the subsequent moult, the resulting adults were sterile and corpora allata (CA) of these adults had atrophied.

3. Mortality as recorded in Table 1 occurred during stadium treatment and subsequent development showed that JH III exerted the strongest effect at 5th instar nymphs treatment than PII which the percent mortalities were 85.7 and 83.3 compared with PII treatment which were 20 and 23.1 for male and female, respec-

tively.

Percent mortalities for 4th instar after treatment with JHIII were 33.1 and 33 compared with PII which were 45.5 and 65.3 for male and female, respectively. On the other hand, during subsequent development of 5th instar percent mortality for JHIII treatment were 66.6 and 50.0 for male and female, in contrast there was no mortality during 5th instar treated during 4th instar with PII. It must stressed here that all adult died within a week after emergence.

Effect on the main metabolites of adults

The haemolymph of the treated and untreated adults were collected on day 6 of their life for chemical analysis (vitellogenesis day) to determine total protein and lipid.

Table 2 shows that the haemolymph total protein and lipid were decreased significantly ($P<0.05$) adults treated at 4th instar with JH III, it was 1.6 ± 0.016 mg/ml for protein and 2.9 ± 0.02 mg/ml for lipid compared with control 13.4 ± 0.31 mg/ml and 15.4 ± 0.1 mg/ml respectively. Unexpectedly, there was no significant difference between precocious adult and control in the haemolymph total protein and lipid. In contrast, the concentration of haencolysph total protein was increased in adult male treated with PII at 4 th instar. It was 35.3 ± 0.07 mg/ml compared with control (25.8 ± 0.09 mg/ml). Also, lipids increased in adult female to 23.2 ± 0.89 mg/ml compared with control (15.4 ± 0.10 mg/ml).

Similarly, adults treatment with PII on 5 instar nymphs, induced significant decrease ($P<0.05$) for haemolymph total protein, (1.6 ± 0.18 and 1.4 ± 0.023 mg/ml compared with control (25.8 ± 0.09 and 13.4 ± 0.31 mg/ml) for male and female, respectively.

In this respect, Cassier and Delmorme (1976) stated that cholesterol in insects serve as a precursor for ecdysone hormone which stimulate protein biosynthesis in L.migratoria. So, the low level of protein in the haemolymph would result from a low level of cholesterol as indicated by the low level of ecdysone hormones of the treated adults in the present study.

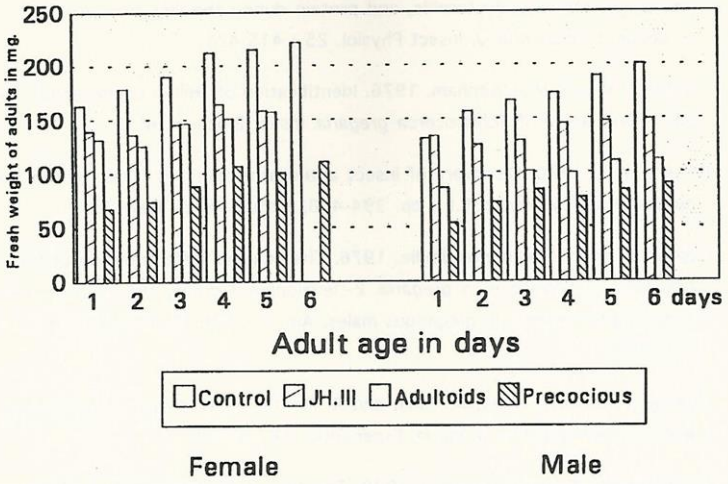
Metathetelic adultoids were encountered frequently in S.gregaria after larval treatment with JH III. This phenomenon could, as readily recognized from table 2 be connected with consumption of more lipids. Hill and Izzat (1973) suggested that JH III might have a dual effect on fat body metabolism in the adult female S.gregaria,

that JH might suppress lipid synthesis. The dual response of CA after exposure to PII, showed that the remaining tissue fragments may become active and secrete JH (Tobe and Stay, 1980).

In conclusion, and as revealed from the findings of the present study, the pattern of total protein and lipids indicates that our present investigations are consistent with the proposed hypothesis that the JH has been implicated in the control of the synthesis of haemolymph protein and lipids. The results of our present investigations are consistent with those of Schneider (1995) who showed that females treated with JH III were very poor fliers.

Table 2. Metabolic effect of 40 µg per live body weight of Precocene II or Juvenile Hormone III on the main metabolites of *S.gregaria adults* analysed on day 6 of their life after application on newly moulted nymphs.

Sex	Larval	Haemolymph total protein (mg/ml)				Haemolymph total protein (mg/ml)			
		Precocene II				Precocene II			
	application	Precocious	Adultiform	JH-III	Control	Precocious	Adultiform	JH-III	Control
Male	4th instar	18.9±0.15	35.3±0.06	20.4±0.03	25.8	--	19.8±0.05	21.8±0.31	19.9
	5th instar	--	1.6±0.018	-	±0.09	--	2.4±1.91	-	±0.33
Female	4th instar	14.6±0.09	13.2±0.31	1.6±0.06	13.4	14.1±0.76	23.2±0.89	2.9±0.87	15.4
	5th instar	--	1.4±0.03	12.4±0.02	±0.31	--	5.2±0.12	14.1±0.2	±0.10



- The adults used in this study resulted from treated newly 4th instar nymphs.
- Each group consists of equal number of 20 insects from both sexes.

Fig. 1. Fresh body weight of non-treated gregarious (control), compared with Hormone (JH) and Precocene II (Adultoids, Precocious).

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دور هرمون الشباب ومضاده فى التحول الغذائى للحشرات الكاملة للجراد الصحراوى شيستوسركا جريجاريا (مستقيمات الأجنحة: أكريديدى)

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تم دراسة تأثير هرمون الشباب ومضاده على التمثيل الغذائى للحشرات الكاملة بالجراد الصحراوى وكذلك عملية التشكل والتطور بعد معاملتها فى طور الحورية (بداية العمر الرابع والخامس) بجرعة ٤٠ ميكروجرام لكل حشرة وتأثير ذلك على تركيز البروتين والليبيدات فى الدم ونسبة الابادة والتحول الى المظهر الانفرادى.

كان هناك علاقة ايجابية بين التطبيق الهرمونى وانخفاض مستوى البروتين والليبيدات بالمظهر التجمعى خاصة عند المعاملة فى بداية العمر اليرقى الخامس حيث انخفض تركيز البروتين الى ١٨,٠ ± ١,٦ و ٢٣,٠ ± ١,٤ ملليجرام / ملليلتر بالمقارنة بالكنترول (٠,٠٩ ± ٢٥,٨ و ٠,٣١ ± ١٣,٤ ملليجرام/ملليلتر) وكذلك تركيز الدهون الى (١,٨١ ± ٢,٤ و ٠,١٢ ± ٥,٢ ملليجرام / ملليلتر بالمقارنة بالكنترول ١٩,٩ ± ٠,٣٣ و ١٥,٤ ± ٠,١ ملليجرام/ملليلتر) للذكور والاناث على التعاقب. ووصلت نسبة الابادة الى ١٠٠٪ تقريبا عند وصول الحشرات الى الطور الكامل خلال أسبوع من الانسلاخ.

يتضح من النتائج ان التطبيق الهرمونى على عدم قدرة الحشرة على الهجرة والطيران كان ايجابيا والذى يعتبر العامل الأساسى فى عمل استراتيجيات المكافحة المتكاملة ضد آفة الجراد الصحراوى فى مناطق التربية والتكاثر.