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EFFECT OF A JUVENILE HORMONE ANALOGUE ON THE DESERT LOCUST, *SCHISTOCERCA GREGARIA* (FORSKAL)

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Juvenile hormone activity of Stauffer R–20458 was assessed on fifth–instar nymphs of the desert locust, *Schistocerca gregaria* (Forsk.) by topical application and intra-haemocoelic injection. The maximum sensitivity to the test compound was observed during the first four days following the final nolt. The maximum number of intermediates were obtained when the compound was applied to the pronotal area at dosages varying from 2.5 to 20 µg. Morphogenetic effects included changes in pronotal pigmentation and wrinkling of both pairs of wings. The ED_{50} was 20 µg/g of body weight. Treated nymphs that survived, compared favourably with control insects in terms of oocyte maturation, gonadal size and fecundity.

INTRODUCTION

The effects of juvenile hormone analogues (JHa) have been reported by many workers[1–4] on several species of orthopterous insects. The discovery of several substances with juvenile hormone (JH) activity, namely terpenoids and their derivatives[5–12] has provided new methods for studying the hormonal control of insect development. Juvenile hormone analogues are known to result in mortality[12], inhibition of embryonic development[13], interference of sexual activity and maturation[14] and changes in colouration[4,15,16]. Nemec[17,18] tested several compounds of the farnesane type for JH activity in *Locusta migratoria* and *Schistocerca gregaria*. Yaragambli-math and Mathad[19] tested Stauffer R–20458 and two other JHa's (ZR 512 and ZR 777) on the cricket, *Gryllodes sigillatus* and reported changes in pigmentation and inhibition of adult emergence. The objectives of the present study were to evaluate the juvenile hormone activity of Stauffer R–20458 on fifth–instar nymphs of the desert locust, *Schistocerca gregaria* (Forsk.) and to assess its potential as control agent.

MATERIALS AND METHODS

Fifth–instar nymphs of the desert locust were selected from a colony maintained by PCSIR laboratories according to parameters recommended by Hunter–Jones[20]. The nymphs (25 for each replicate) were treated with Stauffer R–20458 (Stauffer Chemical Company, Moutain View, California) at concentrations ranging from 2.5 to 40 µg/g body weight. With respect to the prospective use of JH analogues in field, the compound was applied topically to nymphs of both sexes using a micrometer syringe at several sites including the pronotum and neck region. In addition, nymphs were also treated via injection through the membrane surrounding the hind coxa of the meta–thoracic legs. The dosages were calibrated for each locust individually on the basis of body weight as recommended by MacCuaig[21] for testing insecticidal formulations on locusts. Control nymphs were administered with a corresponding amount of acetone.

After application, the insects were housed in cages at ambient temperature (27 ± 2°) and humidity (62 ± 2%) under conditions described previously. Data on mortality and morphogenetic effects were collected during a period of three weeks post–treatment, while observation on their sexual activity, behaviour, oocyte development and longevity continued for three months after the administration of the compound.

RESULTS

The data collected have been summarized in Table 1. Topical application of the compound on the pronotal area of the 5th instar nymphs resulted in the maximum number of nymphal–adult intermediates. The compound caused morphogenetic changes to a varying degree at doses ranging from 2.5 to 40 µg/g body weight. These included the persistence of nymphal pattern of pigmentation on the adult pronotum and varying degrees of wrinkles in both pair of wings (Fig. 1). Maximum sensitivity to Stauffer R–20458 was observed during the first four days following the final molt. The ED_{50} or dosage required to produce morphogenetic effects in 50 % of the population was 20 ug/g body

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Table 1. Response of fifth-instar nymphs of *Shistocerca gregaria* to the juvenile hormone analogue, Stauffer R–20458.

Dosage (µg/g)	Post-treatment nymphal mortality			Mortality during developmental stage %			Intermediate production	Total mortality
	Week I	Week II	Week III	Nymphal	During moalt	Adult	(%)	(%)
0	6	12	–	5	–	12	0	19
2.5 (tp)	10	–	–	10	–	–	50	10
2.5 (tn)	26	5	8	27	3	5	5	39
2.5 (inj)	10	5	5	14	–	–	0	19
5.0(tp)	10	–	–	10	–	–	40	10
5.0(tn)	17	11	6	28	–	6	8	33
5.0(inj)	–	5	5	5	–	5	30	10
10.0(tp)	20	10	–	30	–	–	30	30
10.0(tn)	17	17	4	35	–	–	4*	39
20.0(tp)	20	10	–	20	–	20	60	30
20.0(tn)	10	15	–	15	5	5	20**	25
40.0(tp)	47	7	20	33	13	7	67	73
Control acetone 4ul(tp)	27	–	–	20	–	–	0	27
acetone 10ul(tp)	40	–	–	20	–	–	0	40

(tp – topical application on pronotum; (tn) – topical application on the neck region; (inj) – intra-haemocoelic injection; * – pronotum with nymphal pigmentation; ** – partial intermediates.

weight. Gross examination of the ovaries and testes in these individuals showed normal development and compared favourably with untreated locusts. The longevity of the topically applied locusts was not reduced at dosage below 20 µg/g.

DISCUSSION

The formation of nymphal–adult intermediates was the primary morphogenetic effect of treatment with Stauffer R–20458. Intermediate formation has also been reported by Nemec[17] and Slama[22] when fifth–instar nymphs of *Schistocerca gregaria* and *Locusta migratoria* were treated with other JHa via topical application. Intermediates produced by treatment with R–20458 retained nymphal morphology and pattern of the pronotal area. Other treated nymphs showed a wide variation in nymphal and adult pigmentation. In addition to the effect on the nymphal-adult transformation, the JH induced deformation in both pairs of wings (Fig. 1).

The pigmentation and colour pattern of the body region other than the pronotum remained unaffected by the treatment of the test compound. This is at variance with results obtained by Yaragamblimath and Mathdad[19] in tests on fifth–instar nymphs of the cricket, *Gryllodes signillatus*. They treated nymphs with R–20458, 48, 72 hr prior to the final moalt and recorded lighter pigmentation than control insects. Das and Gupta[23] on the other hand described excessive melanization in German cockroach, *Blatella germanica* when treated with other JHa. This variation may be related to the nature of the compound tested, the species tested and the age of the test insect. According to Sehnal[24], Joly and Joly[2] and Staal[4] the colour changes due to JHa's were variable and depended upon dosage and timing of the application.

In the present study, both treated and control locusts showed *solitaria* form of colouration. Some workers[4,15,16] have reported that JHa and their analogues

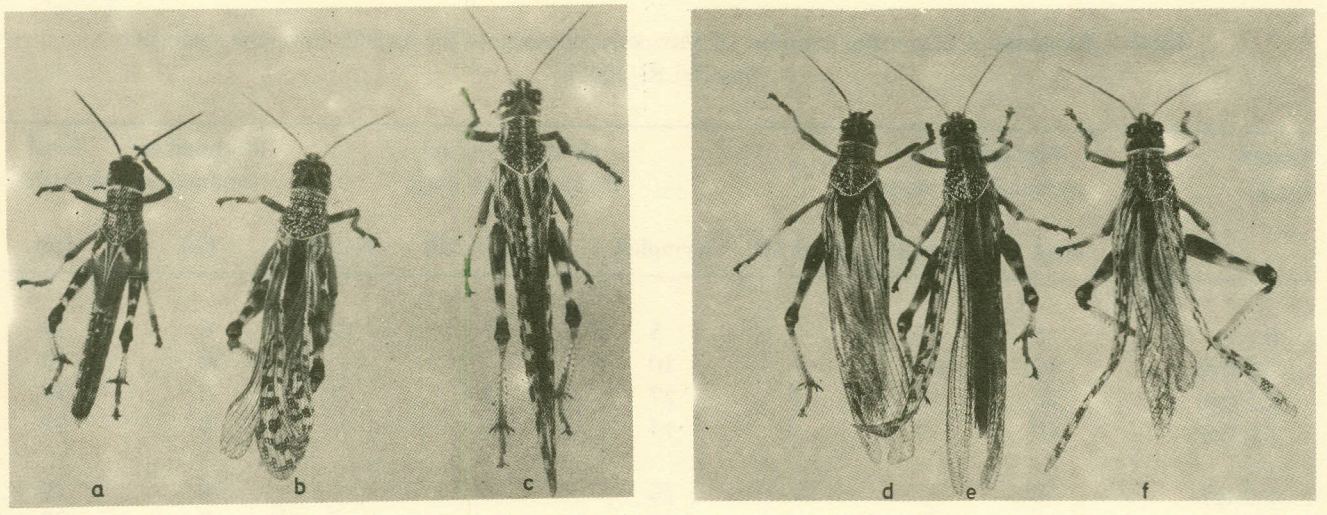

Fig. 1 (a) Normal fifth–instar nymph of *Shistocerca gregaria.* (b) Nymphal intermediate with malformed wings. (c) Normal adult locust. (d, e, f) Nymphal–adult intermediates showing various effects of treatment with Stauffer R–20458

could induce change from *gregaria* to *solitaria* phase in *Locusta* besides inducing nymphal-adult transformation. Nemec[17] observed two separate intervals of sensitivity to JH, one for morphogenesis and the other for pigmentation. Persistent compounds could evoke both the blocking of metamorphosis and phase change after a single administration on an early last–instar nymph of *Locusta migratoria* (L.). Metabolism studies with R–20458 in certain animals[25,26,27] have also demonstrated the extensive biotransformation of R–20458 *in vivo* and *in vitro,* and the ready elimination of residues of this chemical and its metabolites in urine and feces.

There was no observable effect on the development of gonads in treated nymphs and the treated females laid normal eggs and no ovarian abnormalities were noticed in dissected individuals. Treated males attained sexual maturation and exhibited normal sexual behaviour. Testicular examination of treated males revealed no structural abnormalities. Similar results were reported by Yaragamblimath *et al*[28] when R–20458 was administered to crickets.

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