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Do Egg Pods in the Desert Locust *Schistocerca gregaria* Display as Oogenesis Limiting Factor? II- Effects of Females Treated During the Ovipositing Period

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Abstract: When oviposited solitaries and gregarious females of desert locust, *Schistocerca gregaria* were exposed to hexane and ethanol extracts of froth or eggs during oviposition period, they showed significant reduction in the number of egg pods per female. The number of eggs per pod was significantly reduced. The injurious effect on fecundity and fertility of 'pod factors' was higher by using hexane extract compared by ethanol. The reproductive potential of the females treated by 'pod factors' never exceeds 50% of the control except in three cases out of 16.

Key words: Desert locust, froth, egg pods, fecundity, fertility, reproductive potential

INTRODUCTION

Temporal and spatial aggregation of egg pods is characteristic of almost all locusts and many grasshoppers of economic importance. This phenomenon occurs through maturation synchronization of the adults and group oviposition at common sites[1-9]. In common with other locusts, female desert locust, *S. gregaria*, oviposit at common sites suggesting that oviposition is pheromone mediated[10]. Saini *et al.*[11] verifies this hypothesis and showed that semiochemicals from froth of egg pods attract ovipositing female *S. gregaria.* Rai *et al.*[12] identified acetopheromone and veratrole as two major electrophysiological actives compounds from the froth volatile.

MATERIALS AND METHODS

Stock colony and rearing conditions: The stock colony of *S. gregaria* was initiated and has been maintained for several years at the Locust and Grasshoppers Research Department, Plant Protection Research Institute Dokki, Giza, Egypt. This colony was initiated using progenitors of wild strains indigenous to Aswan. The insects have been reared and handled to satisfy the crowded breeding conditions described by Hunter-Jones[15]. Experimental gregarious locusts were segregated from the general stock colony at the beginning of the first instar nymph and held up in-groups, each of 15 hoppers per cage.

Hoppers of solitary phase were reared individually in cylindrical glasses and kept away from each other for several generations for more than 3 years.Hoppers were fed on *Sesbania aegyptiace* in spring and summer and *Alexandranium trifolum* in autumn and winter. All cages were incubated at 32±2°C and 60± 5% RH.

Extraction of pod factors: The egg pods of *S. gregaria* as other *Acrididae* are consisted of two essential parts, the eggs and froth plug above the buried egg mass. Froth and egg extracts were obtained by single solvent extractions (hexane and ethanol) according to the method carried out by Saini *et al.*[11].

Ovipositing bioassays: The present study was carried out to follow up the effect of hexane and ethanol extracts of the two parts of egg pods (froth and eggs) on the reproductive potential and other related parameters of the ovipositing females. Oviposited solitaries and gregarious females (after laying first egg pod) were exposed to contaminated sand (egg laying sites) of their extracts or of each other. The number of egg pods, eggs per pod, hatched eggs, total eggs per females, fertility and ovariol percentages and reproductive potential were calculated according to the method of Elsayed[13].

RESULTS AND DISCUSSION

Effect on egg pods: Egg pods are undoubtedly the output of the ovarian function. Froth as well as eggs, each has its production line and its processing tissues. When a treatment arise a disorder in the segments of the whole work of the egg production, it must be considered a

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serious one. Thus, if the same hits to the reproductive potential, shown in the first paper, of this series are consistent here, the factors in the extracts may be of prospective value as control agent. These effects may correspond to those shown by Kalpana *et al.*[14]. They concluded that sublethal injection of enosulfan caused sever damage to fat bodies which consequently stopped vitellogenin synthesis, adversely affected oocyte development (Table 1).

The number of egg pods in treatments of hexane or ethanol extracts, of froth or egg and of solitary or gregary laying females; was significantly reduced than control. A trend, which persists here again, showing the similarity of action in the females two conditions. This trend of action of the extracted factors introduces these factors as a promising agent of biological control.

Despite absence of significance, the extracts of froth were more effective in reducing egg pods than those of eggs, especially in case of hexane extracts.

The gregary females, control as well as treated, produced lower number of egg pods than sloitary females. However, by ethanol extracts the differences between gregary and solitary females were slight as compared with hexane solvent.

Effect on number of eggs per pod: The same trends of the treatments which occurred by treating females during pre-oviposition period persisted here with females treated during the oviposition period . The number of eggs per pod was significantly reduced than control in all treatments. The differences among treatments were mostly non significant (Table 1).

Although the number of eggs per pod were higher in solitary females of control than their gregary counterparts, yet such surpass was slight and in gregary females the number of eggs per pod approximated those of sloitary females. This tendency may be a reflect of higher sensitivity to affecting factors in solitary females than gregary ones. It may be also an outgrowth of plasticity in the physiological potency in gregary females rather than solitary ones. This may be explained by the findings of Moehrlin and Juliano[16], working on grasshopper *Rumalea guttata* during an oviposition cycle, they reported that placticity in reproductive tactis appears to be controlled by hormone in a manner similar to the hormonal control placticity of metamorphosis.

The differences between the action of the two extracts were slight.

Effect on hatchability: The hachability as a qualitative measure for the effect of treatments may introduce a situation of special bearing. The results presented in Table 1 verify that the qualitative effect of pod factors is absent here in comparison with the treatment during the pre-oviposition period. This may be detailed through the following trends:

It is striking to reveal that the treatments did not lead to the prospective role of extracts in diminishing hatchability of treated than control. On the contrary, the differences among all treatments including control treatment in both phases and both solvents, were not significant. More and above, these differences were slight.

Here again, the hatching percentages of gregary females tended to be higher than solitary ones. No difference between the performance of the extracts of the two solvents or the two sources, froth or eggs.

Conclusively, although the effect of the extract factors persisted on the quantitative parameters (number of egg pods and number of eggs per pod), yet the hatchability as a qualitative criterion was not affected remarkably as in the females treated during the preovipostion period. Thus, this achievement related to pod factors is unreliable with respect to hatchability in females treated during the oviposition period.

Effect on fecundity: Evaluation of the data presented in Table 2 show that the fecundity of all treatments compared with control were drastically reduced, parallel to the treatment in the preoviposition period. The differences among treatmenrs were not significant, but the difference between treated solitaries and control were highly significant. The same result was found in gregary females.

The fecundity in solitaries, as expected, were higher than gregaries. The hexane extracts were slightly higher in their effect than ethanol and froth than that of eggs. The same results were reached with treatment of the females during the preoviposition period.

In conclusion, the treatment of females with pod factors during the oviposition period reduced the fecundity of these females. This reduction exceeded in some cases, 60% when related to the untreated control. The fecundity as a physiological function of ovaries is controlled by the acteivities of JHs in haemolymph and the factors which inhibit its function show adverse effect on fecundity and plays limiting role on oocyte development. It was shown, on the other side, by Rennucci *et al.*[18] that: when mating was associated with ovipositing, juvenile hormone biosynthesis and haemolymph titers increased and oocyte development and fecundity were stimulated, haemolymph JH titers and JH estrases activities were related to ovarian development.

Table 1: Effect on egg pods, eggs per pod and percentages hatched eggs of female treated during the oviposition period

	Solitary phase					
	Hexane			Ethanol		
Treated phase	No. of egg	No. of egg	% of hatched	No. of egg	No. of egg	% of hatched
Extract of	pods ±S.D.	per pods ±S.D.	eggs ±S.D.	pods ±S.D.	per pods ±S.D.	egg ±S.D.
Solitary froth	2.3±0.70b	70.0±3.50c	79.8 9.0b	2.0±0.0c	69.50±3.4b	77.5±6.2c
Solitary eggs	2.3±0.70b	66.0±3.04c	74.8 4.01b	3.0±0.0b	68.50 ±3.2b	75.3±5.3c
Gregary froth	2.3±0.70b	75.0±3.12b	79.4 4.7b	2.3±0.7	71.50±1.0b	88.4±8.2a
Gregary eggs	2.3±0.70b	68.9±1.50c	83.6 1.4b	3.0±0.0b	67.33±1.8b	81.8±2.1b
Solitary control	5.0±0.00a	95.6±0.70a	91.2 1.9a	5.0±0.00a	95.6±0.70a	91.2±1.9a
L.S.D. 0.05	0.85	4.1	7.9	0.5	3.62	3.2
Treated phase	Gregary phase					
Extract of						
Solitary froth	2.0±0.0b	65.0±2.17b	81.8±5.5b	2.0±0.0b	71.32±2.4b	84.5±3.9a
Solitary eggs	1.7±0.5b	64.3±4.30b	79.3±3.2b	2.0±0.0b	65.00±2.0b	81.5±5.0a
Gregary froth	1.9±0.1b	64.7±3.80b	76.2±4.2b	2.0±0.0b	66.50±4.8b	77.0±6.5a
Gregary eggs	1.7±0.4b	70.0±3.80b	87.5±3.7a	1.7±0.5c	67.20±4.0b	82.1±2.6a
Gregary control	3.0±0.0a	81.8±9.10a	89.0±4.5a	3.0±0.0a	81.8±9.10a	89.0±4.5a
L.S.D. 0.05	0.46	8.1	5.1	0.35	8.07	6.8

(The means with the same letter are not significantly different)

Table 2: Effect on fecundity, fertility, ovariole yield and decrease in the reproductive potential of females treated during the ovipositing period

	Solitary phase							
	Hexane				Ethanol			
Treated phase	Fecundity	%	% Ovariole	% Decrease in	Fecundity	%	% Ovariole	% Decrease in
Extract of	±S.D	Fertility	yield	reproductive potential	±S.D	Fertility	yield	reproductive potential
Solitary froth	187.0±31.0b	79	78.7	47.7	137.00±62.0b	84.2	53.3	52.2
Solitary eggs	153.3±33.0b	74.8	55	57.2	159.60±39.0b	75.3	57.3	64.5
Gregary froth	175.7±39.0b	79.5	62.5	41.2	166.30±32.0b	80.1	59.6	40.4
Gregary eggs	161.3±46.0b	83.6	54.42	49.2	202.0±4.30b	81.9	56.11	50.84
Solitary control	478.0±10.4a	91.2	80	-	478.0±10.4b	91.2	80	-
L.S.D. 0.05	57.26				56.8			
Treated phase	Gregary phase							
Extract of								
Solitary froth	130±2.6b	81.8	72.2	41.8	143.00±16b	84.6	74.2	27.1
Solitary eggs	106±31b	79.3	71.4	44.72	131.70±4.6b	81.5	72.5	42
Gregary froth	106±7.7b	76.2	72	41.17	133.00±33b	77	74	42.33
Gregary eggs	117±57b	87.5	77.7	27.8	110.70±3.4b	82.1	74.7	37.6
Gregary control	245±7.5a	95	88.1	-	245.0±7.5a	95	88.1	-
L.S.D. 0.05	47.92				26.71			

(The means with the same letter are not significantly different)

Effect on fertility: The fertility as a parameters involving the previous one (hatchability) may be an outward expression of the effects of treatment on the function of ovaries in the females treated post the preoviposition period after practicing the pod production (Table 2). It could be deduced that:

If the quantitative effects of applicating pod extracts to females during the preovipositing period are considered as an account; these effects of the oviposition period are drawing from this account. In the former case, the hatchability and fertility were reduced by pod factors than in the latter.

Fertility as shown in Table 2 joined the hatchability and these qualitative characters escaped the hits of "pod factors" and showed normal performance without remarkable reduction than control.

This parameter, like hatchability, was higher in gregary phase than solitary phase opposite to quantitative characters (number of egg pod, eggs per pod and fecundity).

The injurious effect of pod factors was higher by using hexane extract compared by ethanol, because the fertility were higher in the latter than in the formers. In other words, hexane extracts compared with ethanol were more effective in reducing the fertility.

Ovariole yield: In Table 2 it is apparent that ovariole yield were higher in gregaries than solitaries and by hexane extracts than by ethanol. The ovariole yield was remarkably lowered by ethanol extract especially with solitaries (Table 2). Although the differences among treatments were slight, it were excessively expressed. However, by using another procedure in evaluating ovariole productivity, Antipanova and Kopanova[17], studied the structure of the ovarioles of the locust *Calliptamus italicus* and its potential fecundity. They

found the panoistic ovaries having each an ovary of 20 ovarioles. There were 5 stages in the maturation of the oocytes. It is suggested that counting the eggs ready for deposition give a better estimate of potential fertility than counting the egg in egg-cases.

Decrease in reproductive potential: As shown in Table 2, the reproductive potential of the females treated by pod factors never exceed 50% of the control except in three cases out of 16 (57.2, 52.2 and 64.5 for solitary froth with hexane extract, solitary froth with ethanol extract, and solitary eggs with ethanol extract, respectively). The production of egg pods by locust females; under the posed effects of pod factors ; is controlled by an interplay of two major events: one limiting quantity and second limiting quality. It must be focused in this respect that the current results are in line only, with the view of Saini *et al.*[11] in that a chemical signal, originating from the froth of egg pods attracts gravid female *S. gregaria* to common egg laying sites, froth volatiles elicited the strongest egg laying response. Their results with froth extracts obtained by sequential extraction with solvents of increasing polarity suggest that both non-polar and polar components are involved in the attraction of gravid females. Electroantennogram recordings with extracts and volatiles collected from the froth confirmed the presence of olfactory receptors on the antennae that are responsive to compounds in the extracts and volatile collections. However, further research is needed to be done to investigate the possibilities.

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