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Impact of Host Plants on Development and Reproduction of *Acrida exaltata* (Walker) (Orthoptera : Acrididae)

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Post ingestive effect of seven host plants on the developmental and breeding performances of the grasshopper, *Acrida exaltata* was studied. *Eleusine coracana* and *Coix lachryma* were identified as the most suitable host plants while *Cyperus rotundus* was least suitable. *A. exaltata* performed better on *E. coracana* and *C. lachryma* considering their life history traits such as nymphal development, longevity, fecundity and egg hatchability.

Key Words : *Acrida exaltata*, **Host plant, Life history traits**

Introduction

All plants are known to contain the basic nutrients that are required by insects. Dadd (1985) has emphasised the importance of qualitative food requirements for proper growth and development. In evaluating the effects of host quality on acridid biology, the parameters considered were : (a) duration of postembyronic development, (b) percentage of adult emergence, (c) gain in body weight and (d) fecundity and sex ratio (Bailey & Mukerji 1976, Ananthakrishnan et al. 1985, Meera Muralirangan & Muralirangan 1990). In response to the variation in the nutritional quality of the host plants, acridids generally undertake compensatory adaptations to optimize its life cycle traits (Scriber & Slansky 1985). The present work examines these aspects in the context of the influence of selected host plants in regulating the developmental and reproductive programmes in *Acrida exaltata*.

Materials and Methods

Seven host plants namely *Sorghum vulgare* (Sorghum), *Zea mays* (Maize), *Eleusine coracana* (Ragi), *Pennisetum americana (P. typhoidem)* (Pearl millet), *Oryza sativa* (Paddy), *Coix lacryma* (Job's tears) and *Cyperus rotundus* (Common sedge) were chosen for ascertaining host suitability based on food consumption preferences by the insect (Suresh 1993). Surveys, conducted periodically have also indicated the abundance of this acridid in the fields of crops mentioned above, in addition *C. rotundus*, growing in the bunds of these fields was found to support the early instars. Hence, based on our field observations, the above plants were chosen for the present study.

Newly hatched nymphs (derived from insects caught in the wild roughly 4-5 months back and pedigreed from parents fed on the same host plants) obtained from laboratory cultures were reared separately on fresh mature leaves kept in Knop's solution (Potassium nitrate = 1g, Magnesium sulphate = 1g, Calcium nitrate = 4g, Acidopotassium sulphate = 1g, Ferric chloride solution = trace, Dist. water = 1000 cc) and replenished daily. Rearing of the insects was carried out in wooden cages measuring 25 × 25 × 30 cm. The duration of nymphal instars (based on the successive molting), mortality, adult emergence and sex ratio were recorded for insects raised on each host plant and the adults were continued on their respective diets. Moist soil, in wax coated cups, were provided in the cages for oviposition and data on the first oviposition, total number of eggs laids and percentage of egg hatchability were also recorded. In addition, the total lifespan of these insects held on the different experimental regimes was also calculated.

Results

Postembryonic Development

Developmental period, an important parameter in the study of insect dietetics, appears to be a major factor in determining the suitability of a diet since in a suitable diet the postembryonic development is shorter. The data collected on these aspects indicate *E. coracana* and *C. lachryma* to be the most suitable hosts in contrast to other hosts (table 1). In *S. vulgare* nymphal development spanned through 48.61 ± 2.36 days for males and 60.22 ± 3.73 days for females. The final instar stage for both male and female had the longest developmental period. In *Z. mays*, the male nymphs took 53.3 ± 1.96 days and female nymphs 73.17 ± 2.07 days, to moult into adults. The male nymphal period lasted for 43.52 ± 1.43 days and that of females for 59.46 ± 0.26 days when fed on *E. coracana*. Here the final instars of both sexes had the maximum nymphal period. In *P. americana* and *O. sativa*, the fourth instar males the fifth instar females had a longer duration of development. When fed on *C. lachryma* for both the male and female nymphal instars, nymphal period lasted for 45.41 ± 1.43 days and 64.82 ± 1.87 days respectively. The final instars of both males and females had the longest duration on. When *A. exaltata* nymphs were fed with *C. rotundus*, females took 86.11 ± 2.31 days to complete their nymphal development. Fifth instar nymphs of both sexes the males and females had the maximum developmental period.

Nymphal Mortality

The impact of hosts on the percentage mortality during the postembryonic development of *A. exaltata* was also assessed (table 2). Maximum mortality was observed among nymphs reared on *C. rotundus* (86.15%). The nymphs survived to adult stage with least mortality when fed on *E. coracana* (28.81%). Maximum mortality was recorded during the first instar stage of the development in all host plants and the mortality rate getting reduced with progression of development. However, in the case of *C. rotundus*, even the final instar had a relatively high mortality of

Table 1 *Impact of host plants on the duration of postembryonic development of A. exaltata*

Host plant	Sex	I	II	III	IV	V	VI	Total duration (days)
S. vulgare	M	7.03±0.81	6.12±2.32	9.31±0.83	12.01±1.31	14.13±0.76	-	48.61±2.38
	F	7.61±0.96	8.13±0.87	10.23±1.08	10.14±0.90	12.02±0.58	12.12±1.23	60.22±3.73
Z. mays	M	7.34±1.01	9.01±1.03	10.60±1.30	11.21±1.31	15.13±0.94	-	53.30±1.96
	F	8.12±0.80	10.24±1.01	12.01±1.21	16.17±1.67	13.08±1.03	14.35±1.02	73.17±2.07
E. coracana	M	7.01±0.41	8.22±0.64	6.13±0.76	10.11±0.73	12.16±1.07	-	43.52±1.43
	F	7.41±0.83	8.13±0.82	7.16±0.81	10.31±1.01	12.27±0.96	13.62±1.31	59.46±2.06
P. americana	M	7.16±0.61	8.30±1.03	9.21±0.93	12.23±1.23	11.91±0.76	-	48.73±1.08
	F	8.25±0.73	9.31±0.97	10.23±1.01	12.16±1.12	13.73±0.87	13.19±0.92	67.51±1.63
O. sativa	M	9.02±1.02	10.46±1.12	10.26±0.87	13.42±1.63	11.34±0.96	-	54.32±2.01
	F	10.21±1.05	11.03±1.41	11.16±1.04	12.75±1.27	13.63±1.02	13.29±1.07	73.37±2.63
C. lachryma	M	7.42±0.73	8.32±0.67	8.04±0.83	10.14±0.87	11.37±1.06	-	45.41±1.43
	F	7.93±0.64	9.07±0.83	10.23±1.11	11.78±0.93	12.62±0.83	13.13±0.87	64.82±1.87
C. rotundus	M	11.31±1.31	11.17±1.21	10.12±1.01	12.21±1.03	14.35±0.94	-	59.37±1.93
	F	12.52±1.07	12.12±1.08	11.07±1.21	14.12±0.87	18.71±1.02	17.61±1.04	86.12±2.31

M = Male; F-Female
Values in mean ± S.D; n = 6

Table 2 *Impact of host on the mortality (%) of nymphs of A. exaltata*

Host plant	I	II	III	IV	V	VI	Total mortality (%)
S. vulgare	13.10	7.43	5.20	4.93	4.76	8.30	43.82
Z. mays	20.20	10.53	8.33	7.24	4.85	11.55	62.05
E. coracana	7.43	3.48	4.15	4.52	4.11	5.12	28.80
P. americana	10.49	7.50	6.24	4.90	4.69	7.30	41.38
O. sativa	13.56	8.30	5.17	7.73	5.24	10.26	50.28
C. lachryma	10.42	8.51	5.45	5.38	5.39	6.33	41.48
C. rotundus	23.80	12.00	11.29	6.98	9.68	22.40	81.15

n = 7

22.4%. There was no sex difference in the mortality.

Impact of Hosts on the Adult Emergence and Sex Ratio

Adult emergence was highest in individuals fed on *E. coracana* (71.2%). The least value was recorded on *C. rotudus* (18.85%). At emergence, males were invariably more in number than females and this trend was not altered as a result of change in host plants. The percentage of emergence for males ranged between 47.6 and 61.3% and for females 39.2 and 57.6%.

Longevity

The total lifespan of females was always longer than those of the males (table 3). Females. Reared on *C. lachryma* had the maximum lifespan of 134.42 ± 5.76 days compared to those reared on other hosts. Among males, the longest life span was recorded for individuals raised on *O. sativa* diet viz., 101.82 ± 3.57 days. Though the total life span of the females fed on *C. rotundus* was 128. 22 ± 4.71 days, the major portion of this duration was spent on postembryonic development. Consequently the adult life span for females was higher on

Table 3 *Impact of host plants on various life history traits of* ***A. exaltata***

Host plant	Sex	Hopper period (days)	Adult lifespan (days)	Total lifespan (days)	Preoviposition period (days)	Fecundity	Egg-hatchability (%)
S. vulgare	M	48.61±2.38	50.6±2.32	99.21±2.72	-	-	-
	F	60.22±3.73	57.3±1.67	117.52±3.93	33.7±5.86	61.22±12.12	65.93±3.07
Z. mays	M	53.30±1.96%	36.9±2.61	90.20±2.66	-	-	-
	F	73.17±2.07	47.3±3.84	120.47±4.27	34.7±3.21	53.40 ± 04.90	61.08±2.67
E. coracana	M	43.52±1.43	50.2±2.94	93.72±3.19	-	-	-
	F	59.46±2.06	71.9±2.16	131.36±3.84	20.7±2.65	144.87±18.69	83.72±4.01
P. americana	M	48.73±1.08	49.7±1.87	98.43±2.97	-	-	-
	F	67.50±1.63	60.2±2.31	127.70±4.63	29.9±3.69	102.70±10.50	69.32±4.87
O. sativa	M	54.32±2.01	47.5±1.09	101.82±3.57	-	-	-
	F	73.37±2.63	51.3±1.47	124.67±4.08	30.4±2.41	45.57±11.84	64.46±3.34
C. lachryma	M	45.41±1.43	46.5±0.97	91.91±2.17	-	-	-
	F	64.82±3.73	69.6±1.24	134.42±5.76	26.4±3.55	107.50±13.26	77.45±3.89
C. rotundus	M	59.37±1.93	27.7±0.87	87.07±2.86	-	-	-
	F	86.12±2.31	42.1±1.04	128.22±4.71	37.4±2.76	21.41±5.50	59.30±2.71

F- Female; M - Male
Mean with ± SD; n = 5

E. coracana diet, while adult males survived longer in *S. vulgare* and *E. coracana* diet. Males had shorter life span on *C. rotundus* (87.07 ± 2.86 days) and *Z. mays* (90.20 ± 2.66 days), while females survived shorter on *S. vulgare* (117.52 ± 3.93 days) and *Z. mays* (120.47 ± 4.27 days).

Preoviposition Period, Fecundity and Egg Hatchability

The fecundity of the insects fed on *E. coracana* was the highest (144.87 ± 18.67 eggs per female) and their preoviposition period, was also the shortest (20.7 ± 2.65 days) (table 3). In addition this plant species also favoured the maximum egg hatchability (83.72 ± 4.01). When fed on *C. rotundus* least fecundity, longest preoviposition period and minimum egg hatchability were recorded.

Discussion

In the present study, influence of host plants on the postembryonic development of *A. exaltata* showed no variation in the number of instar whithin a sex, although the duration of the nymphal development varied considerably. The number of larval instars is generally fixed either by genetic and/or by the influence of environmental conditions (Setal 185). In this study, *A. exaltata* had a longer nymphal duration on the least preferred hosts also without any additional moult.

Generally, survivorship in grasshoppers is very much the same as in many other insects, with percentage mortality being higher during the early stages of nymphal development. The results obtained in the present study were in accordance with this generalization. Egg mortality may be quite high which is influenced by moisture and temperature, though other factors like host quality, egg predation and attack of fungal pathogens may also be important (Hewitt 1985). In *A. exaltata*, egg mortality varied with respect to the host plants; highest being in *C. rotundus* which was the least preferred host (Suresh, 1993). Similarly in *M. bivittatus* a 100% nymphal mortality was reported when reared on the least preferred host viz., Alfalfa (Bailey and Mukerji, 1976). The maximum mortality observed in *A. exaltata* was 81.15% when reared on *C. rotundus*. In addition to higher mortality and longer postembryonic development, lower feeding rate was also observed in *A. exaltata* when reared on *C. rotundus*.

In *A. exaltat* the fecundity was higher when fed on the preferred hosts like, *C. lachryma* and *E. coracana*, and their nymphs developed faster and had a longer adult life span. When fed on the least preferred hosts like *C. rotundus* and *Z mays* resulted in a longer preoviposition period indicating a possible delayed ovarian development.

The long term bioassay provides an indication that host plants influences the vital life history traits in *A. exaltata*. The results follow a distinct pattern from the earlier study (Suresh 1993), wherein the most preferred host influences the life cycle pattern. The insect possibly distinguishes the hosts correctly during the initial process and ably categorise the hosts on their nutritional basis. The host in which nymphal development was faster, with longer life span and higher fecundity alone were regarded categorised as the most preferred host plants, since their nutritive value and consumption rate were higher (Suresh 1993).

Host shift, as recorded in *O. nitidula* (Meera 1982) and *E. a. alacris* (Pushkala 1994) in their nymphal and adult food preference was not observed in *A. exaltata*. Both nymphs and adults of *A. exaltata* exhibited a similar selection pattern on consumption of all the plants tested.

This diversity of influence of host on various life history traits of *A exaltata* showed a level of variation in quality within the selected plants.

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