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Influence of Food Plants on Growth and Development of *Chrotogonus trachypterus* Blanchard

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Laboratory experiments were conducted with the surface grasshopper, *Chrotogonus trachypterus*, to evaluate the effect of food plants on its growth and development. As indicated by a growth index for hoppers, in descending order of effectiveness were; lucerne, wheat, barley, mixed food, oats, chickpea, bermuda grass, spinach, nut grass and pigweed. On lucerne, hoppers took the shortest period (17.40 days) to develop into a fledglings, while on pigweed, development took the longest (25.25 days). Hoppers had 100 per cent survival on lucerne, wheat and barley; survival was lowest when reared on pigweed: 82.50, 72.50 and 67.50 per cent for hopper survival of the IVth, Vth and VIth instars respectively). However, irrespective of the food plant, the sixth instar hoppers developed into fledglings, showing a cent (emergence the 100 per cent adult) per cent survival. The effect of different food plants on food utilization indices evinced that efficiency of conversion of ingested food (ECI) was high when the hoppers were reared either on wheat (36.53%) or mixed food (35.20%), but pigweed (16.21%) followed by nut grass (19.28) had lowest ECI. The approximate digestibility (AD) was high when the hoppers were reared on lucerne (45.20%) and significantly low in gram (38.39%). The efficacy of conversion of digested food (ECD) into body substances was significantly the maximum for hoppers raised on wheat (89.50%) and was significantly the lowest for hoppers on pigweed (42.14%).

Key words: Surface grasshopper, *Chrotogonus trachypterus*, food plants, growth and development.

Surface grasshoppers (*Chrotogonus trachypterus* and *C. oxypterus*) are widely distributed in the Orient and Africa. In India, *Chrotogonus trachypterus* is more common in the north, whereas *C. oxypterus* occurs in the southern regions. The surface grasshopper is a pest of pastures throughout the year. The common desert representative of the genus (Kevan, 1959) collected from western Rajasthan appeared to belong to *Chrotogonus trachypterus trachypterus*, being widely distributed on the ground (their habitat is the surface of the soil) and more frequently collected from nurseries, gardens and wheat fields. It is distributed throughout the plains in India including Orissa, South Arcot, Madura, Coimbatore, Bellary, Madhya Pradesh and Rajasthan. Akhtar (1971) examined nymphs and adults feeding on leaves by cutting germinating plants of cotton, wheat, and others, particularly in areas adjoining wastelands. Such damaged fields often had to be resown. Surface grasshoppers are polyphagous and feed on a number of cultivated crops. The occurrence and abundance of the surface grasshopper, *C. trachypterus* on paddy was monitored by Lanjar *et al.* (2002) in Dokri, Pakistan.

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Asad *et al*. (2001) reported that when adults of *C. trachypterus* were provided leaves of 41 plant species belonging to 25 families as food, 36 were accepted and 5 rejected. It was found that the grasshopper preferred, the seedlings of wheat, millet (*Pennisetum glaucum*) and cotton (*Gossypium hirsutum*). The most preferred food plants were berseem (Egyptian clover, *Trifolium alexandrianum*), cotton, mustard (*Brassica campestris*), lucerne, potato, and tomato. An estimated 6 to 12 percent of the available forage is consumed by them in U.S.A. (Cowan, 1958). Anderson (1961) reported 25.9 % to 62.1 % loss of forage due to grasshopper in Montana range lands of U.S.A.

Materials and Methods

Field-collected adults of the surface grass hopper, maintained in the laboratory were provided different food, including weeds and field crops, on weight basis (wet basis). The live culture was maintained at 32 ± 2°C and 65 ± 5 % relative humidity in aluminum frame wire-gauge cages kept on steel racks protected from ants. The adults were sexed and put into the wire-gauge cages (30 x 30 x 30 cm). The cages had four 6-inch egg laying tubes with

sand or soil filled almost up to the rim and moistened with distilled water for oviposition by the females. For food plant studies, newly hatched hopper nymphs were maintained on leaves of wheat, until they molted three times. Healthy IVth instar hoppers, starved for 6 h were transferred singly into individual wooden wire-gauge cages (15 x 7.5 x 7.5 cm) containing small dry twigs to facilitate molting. Four replicates of 10 hoppers each were maintained on fresh leaves from 10 different treatments: 9 food plants (5 from cultivated crops and 4 from uncultivated pasture grasses and weeds), with the tenth treatment comprising mixed food. The experiment was laid out in a complete randomized design or one way ANOVA (CRD) with four replications. The per cent value was changed to the angular transformed for statistical analysis.

Observations were made daily for each subsequent hopper instar. The sixth instar hopper was weighed and per cent hopper survival on each food plant computed. Times required for adult development on each food plant and survivals of adults were recorded. To compare the relative growth of hoppers on different food plants, a growth index was calculated using the following formula:

$$\text{Growth index} = \frac{\text{Percent hoppers attaining VI instar}}{\text{Duration (IV to VI instar) of hoppers (in days)}}$$

Food utilization indices were calculated on dry weight basis for newly enclosed VIth instar hoppers. The hoppers were reared on maize from hatching, starved overnight, and then provided with the different food plants until they developed into adults. Fresh, tender green parts of the different food plants were divided into two equal portions. One portion was weighed wet and fed to newly developed and starved VI instar hoppers, while the other portion taken as an aliquot. The aliquot food was weighed wet first, then dried at 80^{o} C in an oven and the dry weight was recorded. Left over food and faeces were removed every 24 h and dried to a constant weight at 80^{o} C. At the end of the experiment the newly formed adults were starved to devoid their guts of residual faecal material. Faeces for the period of starvation were also collected every 24 h. After starvation, the newly formed adults were killed and dried to a constant weight at 80^{o} C in an oven.

Calculation of food utilization indices

Having recorded dry weight of leftover food and faeces, the quantity of ingested food was calculated by subtracting it from the weight of the food introduced. The approximate weight of digested food was calculated by subtracting the weight of faeces from the weight of the ingested food. From these values, on a dry-weight basis, utilization indices were computed (Waldbauer, 1968):

$$\text{Efficiency of conversion of ingested food [ECI]} = \frac{\text{Weight gained}}{\text{Weight of food ingested}} \times 100$$

$$\text{Approximate digestibility [AD]} = \frac{\text{Wt. of food ingested} - \text{Wt. of faeces}}{\text{Weight of food ingested}} \times 100$$

$$\text{Efficiency of conversion of digested food [ECD]} = \frac{\text{Weight gained}}{\text{Wt. of food ingested} - \text{Wt. of faeces}} \times 100$$

Results and Discussion

Food preference studies indicate that the growth index for hoppers was maximum on lucerne, *Medicago sativa* L. (5.76) followed by wheat, *Triticum sativum* L. (5.37) were statistically significant with the value of mixed food (4.24); oats, *Avena sativa* L. (4.14); chickpea, *Cicer arietinum* L. (4.02); nut grass, *Cynodon dactylon* (L) Pers. (3.59) and spinach, *Spinacea oleracea* L. (3.37). By contrast, nut grass, *Cyperus rotundus* L. (2.74) and pigweed, *Chenopodium album* L. (2.48), had significantly lowest growth index (Table 1). Hopper development was shortest when they were fed lucerne; the IVth, Vth and VIth instar hoppers took 5.75, 5.13 and 6.50 days, respectively, totaling 17.38 days, to attain the fledgling stage.

A comparison among the different food plants showed that on lucerne hoppers took the shortest period (17.38 days) to develop into a fledgling, while on pigweed development took the longest (25.25 days). Hopper survival on lucerne, wheat and barley was 100 % while survival was 100, 90 and 90 % on mixed food for all the three instars. On oats, survival was 100, 92.50 and 90% for all three instars. The lowest survival was observed on pigweed, with 82.50, 72.50 and 67.50% for the IV, V and VI instars, respectively. However, irrespective of the food plant, the sixth instar hoppers developed into fledglings, showing 100 % survival.

The effect of different food plants on food utilization indices (Table 2) evinced that efficiency of conversion of ingested food (ECI) was high when the hoppers were reared either on wheat (36.53%) or mixed food (35.20%), which significantly differed with the values for spinach (26.41%) and bermuda grass (25.06 %). Pigweed (16.21 %) followed by nut grass (19.28 %) had significantly the lowest ECI. The approximate digestibility (AD) was equally high, when the hoppers were reared on lucerne (45.20%), and differed significantly with that for wheat (40.82%), spinach (40.80%), bermuda grass (40.79%) and oat (40.18%). The statistically lowest AD was found in gram (38.39 %) followed by pigweed

Table 1. Comparative Effect of Food Plants on the Developmental Potential of the Surface Grasshopper, *C. trachypterus*

Food plant	2005-06								2006-07								
	Average hopper duration (days)				Hopper survival (%)			Growth index	Average hopper duration (days)				Hopper survival (%)			Growth index	Rank
Wheat	6.000	5.625	7.000	18.625	100	100	100	5.37	6.125	5.750	7.125	19.000	100	100	100	5.26	I I
Lucerne	5.750	5.125	6.500	17.375	100	100	100	5.76	5.875	5.250	6.625	17.750	100	100	100	5.63	I
Barley	6.375	6.250	7.750	20.375	100	100	100	4.91	6.500	6.375	7.875	20.750	100	100	97.50	4.70	I I I
Oat	6.875	6.875	8.000	21.750	100	92.50	90.00	4.14	7.000	6.875	8.125	22.000	100	95.00	90.00	4.09	V
Gram	6.500	6.250	7.750	20.500	100	92.50	82.50	4.02	6.625	6.375	7.875	20.875	100	95.00	85.00	4.07	VI
Nut grass	8.250	8.000	8.375	24.625	90	75.00	67.50	2.74	8.375	8.125	8.500	25.000	90.00	75.00	67.50	2.70	IX
Spinach	7.750	7.250	8.750	23.750	97.50	90.00	80.00	3.37	7.850	7.375	8.875	24.100	97.50	92.50	82.50	3.42	VIII
Pig weed	8.000	7.750	9.50	25.250	82.50	72.50	62.50	2.48	8.125	7.875	9.875	25.875	82.50	75.00	62.50	2.42	X
Mixed	6.750	6.125	8.375	21.250	100	90.00	90.00	4.24	6.875	6.250	8.500	21.625	100	92.50	90.00	4.16	IV
Bermuda grass	7.500	7.250	8.250	23.000	97.50	92.50	82.50	3.59	7.625	7.375	8.375	23.375	100	95.00	85.00	3.63	VII
CD at5%	-	-	-	-	-	-	-	**0.938**	-	-	-	-	-	-	-	**0.995**	-
CV (%)	-	-	-	-	-	-	-	**3.636**	-	-	-	-	-	-	-	**3.105**	-

(38.46%). The efficacy of conversion of digested (ECD) food into body substances was maximum for hoppers raised on wheat (89.50%), followed by mixed food (84.66%). These values significantly differed with those for gram (72.61%), lucerne (71.01%), barley (70.33%), oats (67.61%) and spinach (64.74%). The ECD was lowest for hoppers reared on pigweed (42.14%), followed by nut grass (44.91%).

Similar studies conducted during 2006-07 showed that the growth index for hoppers was the maximum on lucerne (5.63) followed by that on wheat (5.26) were statistically significant with the value of mixed food (4.16), oats (4.09), gram (4.07), bermuda grass (3.63) and spinach (3.42). For pigweed (2.42) and nut grass (2.70) the growth index was significantly lowest (Table-1). The growth index for hoppers on the food plants were in descending order: lucerne > wheat > barley > mixed food > oats > gram > bermuda grass > spinach > nut grass > pigweed. Comparison among the different food plants showed that on lucerne, hoppers took the shortest period (17.75 days), while on pigweed the hoppers required the longest period (25.88 days) to develop into fledglings from the IV instar onwards. The development period of hoppers from the IV instar onwards on the other food plants ranged from 17.75 to 25.88 days. Hopper survival on lucerne and wheat was 100% and the survival was 100, 92.50 and 90% on mixed food for all the three instars. Lowest survival was observed for hoppers reared on pigweed with 82.50, 75 and 62.50% for the IV, V and VI instars, respectively. However, irrespective of the food plants, the sixth instar hoppers developed into fledglings (showing a 100% survival). However, no valid reasons can be ascribed to such a phenomenon, as it is basically a natural process.

The effect of different food plants on food utilization indices (Table 2) in 2006-07 evinced that efficiency of conversion of ingested food (ECI) was equally high irrespective of the fact that hoppers were reared on wheat (36.83 %) or mixed food (35.13 %). Feeding on pigweed (15.49 %) followed by nut grass (19.17 %) had the lowest ECI. Similarly, approximate digestibility (AD) was high when reared on lucerne (45.21 %), which significantly differed for wheat (41.98 %), spinach (40.38 %), bermuda grass (40.30 %) and oats (40.51 %). The lowest AD was for gram (38.36 %) followed by pigweed (38.59 %). The efficacy of conversion of digested food into body substances was maximum for hoppers raised on wheat (87.75 %) followed by mixed food (83.54 %), which both significantly differed from that for gram (71.97 %), lucerne (70.56 %), barley (70.79 %), oats (67.43 %) and spinach (63.95 %). The ECD was lowest for hoppers on pigweed (40.14 %) followed by nut grass (44.58 %).

C. trachypterus is known to feed on a variety of food plants (Singh, 1961). Of the 112 plant species evaluated, only *Melia azedarach* and *Azadirachta indica* were refused (Latif and Haq, 1951). Yousuf and Gour (1993) recorded *P. pictus* feeding on *Acacia senegal*, *Prosopis juliflora* and *Tecomella undulata*. Verma (1998) reported that *Plumeria alba*, *Tabernaemontana* (Apocynaceae) and *Chrysanthemum maximum* (Compositae) were preferred for feeding, while *Moringa oleifera* for congregation, besides *Acacia senegal*, *Prosopis juliflora* and *Tecomella undulata*. Earlier, Haldar *et al.* (1995) observed that of 51 plant species belonging to 23 families, 5 were always rejected, with the remaining 46 either sampled briefly or eaten as food by the grasshopper *Acrida exaltata*. Only 15 were regularly accepted as food. Plants of the family Poaceae were most preferred by *A. exaltata*.

Olfert *et a*l. (1994) reported that the mean dry weight of grasshoppers was significantly higher ($P<0.05$) on Western wheat grass (cv. S-8580) than

Table 2. Effect of Food Plants on Food Utilization indices for Surface Grasshopper, *C. trachypterus*

Food plant	2005-06			2006-07		
	ECI (%)	AD (%)	ECD (%)	ECI (%)	AD (%)	ECD (%)
Wheat	37.18**	39.71	71.09	37.36	40.38	69.51
	(36.53)*	(40.82)	(89.50)	(36.83)	(41.98)	(87.75)
Lucerne	34.51	42.24	57.43	34.39	42.25	57.14
	(32.09)	(45.20)	(71.01)	(31.90)	(45.21)	(70.56)
Barley	32.85	40.30	56.99	32.86	40.15	57.28
	(29.42)	(41.84)	(70.33)	(29.44)	(41.58)	(70.79)
Oat	31.42	39.34	55.31	31.51	39.53	55.20
	(27.17)	(40.18)	(67.61)	(27.32)	(40.51)	(67.43)
Gram	31.87	38.28	58.44	31.93	38.56	58.04
	(27.87)	(38.39)	(72.61	(27.97)	(38.36)	(71.97)
Nut grass	26.04	40.94	42.08	25.97	40.98	41.89
	(19.28)	(42.93)	(44.91)	(19.17)	(43.01)	(44.58)
Spinach	30.93	39.70	53.57	30.54	39.45	53.10
	(26.41)	(40.80	(64.74)	(25.82)	(40.38)	(63.95)
Pig weed	23.74	38.33	40.48	23.18	38.40	39.31
	(16.21)	(38.46)	(42.14)	(15.49)	(38.59)	(40.14)
Mixed	36.39	40.15	66.94	36.35	40.43	66.06
	(35.20)	(41.58)	(84.66)	(35.13)	(42.05)	(83.54)
Bermuda grass	30.04	39.69	51.62	30.08	39.41	51.70
	(25.06)	(40.79)	(61.44)	(25.12)	(40.30)	(61.59)
S.Em ±	1.820	1.133	2.922	1.804	1.135	2.899
CD at 5%	3.720	2.314	5.966	3.704	2.318	5.921
CV (%)	4.760	1.858	4.572	4.864	2.017	4.651

* Original pre cent value

** Angular transformed value

any other grass, and lowest on smooth brome grass (cv. Carlton and Signal). Development of grasshoppers was significantly more rapid ($P < 0.05$) when feeding on Western wheat grass (cv. 8580) and Intermediate wheat grass (cv. 9051) than any other grass. Smooth brome grass had the greatest negative impact on grasshopper development. Mortality among grasshoppers fed these grasses was not significantly different over the 21 day.

The duration of post- embryonic development and food utilization indices such as consumption, growth rate, approximate digestibility, efficiency of conversion of ingested and digested food, were evaluated to assess adaptability by *Oxya nitidula* reared on four monocotyledonous food plants, viz. *Oryza sativa*, *Panicum maximum*, *Pennisetum glaucum* and *Zea mays*. The duration of post-embryonic development of both sexes of *O*. *nitidula* were least on *P*. *maximum* while the consumption index and growth rate were the highest, when fed on *P*. *maximum* in comparison to the other three food plants. The consumption index and growth rates of nymphs varied on the different foods. The approximate digestibility ranged between 72 to 91 percent in nymphs and adults on the various food plants with the mean value being maximal when fed on *P*. *maximum*. The efficiency of conversion of digested and ingested food into the body tissues varied, viz., ECD ranged between 3 to 9 percent among the different food plants with the highest mean of 8 percent on *P*. *maximum*. ECI ranged between 2 to 8 percent with the highest mean of 6.8 percent on *P*. *maximum*. The data suggests that *O*. *nitidula* is more adapted to *P*. *maximum* followed by *O. sativa*, *P*. *glaucum* and *Z*. *mays* (Priscilla Fanny *et al.*, 1999).

References

Akhtar, M. 1971. Laboratory feeding tests with *Chrotogonus trachypterus* Blanchard (Orthoptera: Acrididae). *Pakistan J. Zoo*. **3**: 163-167.

Anderson, N.L. 1961. Seasonal losses in rangland vegetation due to grasshopper. *J. Eco. Entomol*. **54:** 369-378.

Asad, R., Awan, M.S., Abro, G.H. and Shah, A.A. 2001. Studies on feeding, copulation, oviposition and defense behaviour of *Chrotogonus trachypterus* Blanchard (Orthoptera: Pyrgomorphidae) under laboratory conditions. *Pakistan J. Zoo.* **33**: 85-91.

Cowan, F.T. 1958. Trends in grasshopper research in the United states. *10th Internat. Cong. Entomol.*, Monstreal 1956. **3**: 55-58.

Haldar, P., Bhandari, K.P. and Nath, S. 1995. Observations on food preferences of an Indian grasshopper, *Acrida exaltata* (Walker) (Orthoptera: Acrididae: Acridnae). *J. Ortho. Res.* **4**: 21-24.

Kevan, D.K.Mc.E. 1959. A study of genus *Chrotogonus* Audinet servile 1839 (Orthoptera: Acridoidea: Pyrgomorphidae) V. A. revisional monograph to the *Chrotogoniai*. *Public. Cult. Coms. Diam. Angola*. 43: 11-299.

Lanjar, A.G., Talpur, M.A., Khuhro, R.D. and Qureshi, K.H. 2002. Occurrence and abundance of grasshopper species on rice. *Pakistan J. Appl. Sci.* 2: 763-767.

Latif, A. and Haq, A. 1951. Influence of temperature and food on the growth in hopper of *Chrotogonus robertsi* (Kirby). *Pro. III Pakistan Sc. Conf., Dacca.* **3**: 50.

Olfert, O., Hinks, C.F., Weiss, R.M. and Wright, S.B.M. 1994. The effect of perennial grasses on growth, development and survival of grasshopper nymphs (Orthoptera: Acrididae): Implications for population management in roadsides. *J. Ortho. Res.* **2**: 1-3.

Priscilla Fanny, I., Ravikumar, T., Muralirangan, M.C. and Sanjayan, K.P. 1999. Influence of host plants on the duration of post-embryonic development and food utilisation of *Oxya nitidula* (Walker) (Orthoptera: Acrididae). *J. Ortho. Res.* **8**: 153-161

Singh, A. 1961. The food preference of *Chrotogonus trachypterus* (Blanchard) [Orthoptera: Acridoidea: Pyrgomorphidae]. *Pro. Roy. Entomol. Soc., London*. **36**: 1-4.

Verma, S.K. 1998. Incidence of *Poekilocerus pictus* (Orthoptera: Pyrgomorphidae) on some new hosts in arid western Rajasthan. *Entomon*. **23**: 233-234.

Waldbauer, G.P. 1968. The consumption and utilization of food by insect. *Adv. in Insect Physio.* **5**: 229-288.

Yousuf, M. and Gur, M. 1993. Some noteworthy insect pests of *Prosopis juliflora* (Swartz) of Rajasthan, India. Paper presented at the seminar on "*Potentials of Prosopis* species" at Central Arid Zone Research Institute, Jodhpur. 21-23.

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