International Journal of Agricultural Science Research Vol. 1(2), pp. 16-23, November 2012
Available online at http://academeresearchjournals.org/journal/ijasr
ISSN 2327-3321 ©2012 Academe Research Journals

Full Length Research Paper

Food preference and consumption by adults of black blister beetle *Meloe proscarabaeus* (Coleoptera: Meloidae) on different host plants

Ghoneim K. S.[1]*, Abdel-Khaliq A. A.[2], Bream A. S.[1], Emam D. M.[1]

[1]Faculty of Science, Al-Azhar University, Cairo, Egypt.
[2]Desert Research Institute, Cairo, Egypt.

Accepted 14 November, 2012

The black blister beetle *Meloe proscarabaeus* was firstly recorded in Egypt in (1976). It has attracted very little attention in spite of its status as an agricultural pest. The present study was conducted to investigate the food preference and consumption by adults of this beetle on four different host plants (viz., faba bean *Vicia faba*, Egyptian clover *Trifolium alexandrinum*, lettuce *Lactuca sativa*, and pea *Pisum sativum*) under laboratory conditions. Along a time interval of 12 h through 3 successive days, under the multiple-choice condition, two arenas of females and males were observed to determine the relative choice and preference % on each of the host plants. Relatively to *V. faba*, the feeding interest of adult females was estimated in 1.04 for *T. alexandrinum*, 2.26 for *L. sativa*, and 0.15 for *P. sativum*. These data indirectly indicate the highest consumption rate of female beetles on *L. sativa* and lowest rate on *P. sativum*. A similar trend of food preference was easily appreciated for male congeners. Under no-choice condition, the food intake, faeces output, and the relative consumption rate had been determined every day throughout the adult longevity. The mean food intake by adult females from *V. faba* was 1.35±0.39 mg/ . Comparatively, non-significantly smaller quantity from *T. alexandrinum* and the smallest ingested quantity from *P. sativum* were ingested. On the contrary, female adult beetles ingested considerably large amount of *L. sativa*. Generally, adult females discharged faeces comparable to the ingested food. For the male congeners, a similar feeding response could be recorded.

Key words: *Meloe proscarabaeus*, food preference, food consumption, multiple-choice, no-choice, *Vicia faba*, *Trifolium alexandrinum*, *Lactuca sativa*, *Pisum sativum*.

INTRODUCTION

Host selection by phytophagous insects can be considered as “choice behaviour” with two extremes (Browne, 1977). The first extreme is that insects “choose” solely after contact with the plant such that the frequency with which different plants, hosts and non-hosts, are visited depends only on their relative abundance. The other extreme implies that insects perceive plant characteristics at a distance and “choose” according to these impressions (Visser, 1988). Acceptance or rejection of any host plant by an insect may be ascribed to the presence of attractants which stimulate feeding and support growth or repellents inhibit feeding (Thorsteinson, 1960).

Host plant selection behavior or feeding preferences are largely mediated by the presence and distribution of secondary metabolites in plants (Lin et al., 1998). Plant odours can attract or repel insects, in either case the volatile plant constituent affects the orientation of the insect with respect to the plant (Dethier et al., 1960). Also, the acceptability of plants to herbivorous insects to a considerable degree is influenced by the secondary chemicals. Unpalatability of secondary chemicals is not

*Corresponding author. E-mail: kar_ghoneim@yahoo.com.

necessarily associated with detrimental effects, but their presence influence meal size and duration of feeding (Chapman, 1990). Undoubtedly, these compounds play an important role in limiting defoliation and consequently reducing food consumption by insect herbivores (Hinks et al., 1993). Food preference and consumption studies, when properly interpreted, can help to develop control strategies that are based on different degrees of plant susceptibility and/or nutritional quality for pest development and survival (Panizzi and Parra, 1991).

As reported few years ago, blister beetles (family Meloidae) contains more than 3000 species in 120 genera. They are distributed throughout the world except for New Zealand and the Antarctic and their diversity is greatest in arid or semi-arid regions (Dettner et al., 1997; Arnett et al., 2002). The black blister (oil) beetle *Meloe proscarabaeus* Linnaeus in Europe has attracted the attention of some researchers. Klausnitzer and Rauch (2000) observed large numbers of *M. proscarabaeus* larvae on a small *Buddleja* shrub in a garden at Innsbruck, Austria. Also, triungulins of *M. proscarabaeus*, *Meloe brevicollis* and *Meloe rugosus* had been studied in certain localities in Germany (Luckmann and Kuhlmann, 1997). In Asia, *M. proscarabaeus* and the violet oil beetle *Meloe violaceus* were discovered with bees as a new record in India and adults of them were collected from Himalayan region (Anand, 1978). In Egypt, Alfieri (1976) recorded the *M. proscarabaeus* among some other species of Meloidae and other families of Coleoptera. The first reference reporting this beetle as an agricultural pest attacking faba bean, peas, alfalfa, onion and wild weeds was Ali et al. (2005a). Ali et al. (2005b) carried out a field study on this species in El-Al-farafra oasis (in western desert of Egypt) including biology, feeding behaviour and sexual behaviour. This paper is part of an extended study on this beetle in Egypt. The objective of the present paper was to investigate the food preference and consumption by the adults on faba bean *Vicia faba*, Egyptian clover *Trifolium alexandrinum*, lettuce *Lactuca sativa*, and pea *Pisum sativum*.

MATERIALS AND METHODS

Experimental beetle

Newly emerged adults (1-day old) of the black blister beetle, *Meloe proscarabaeus* Linnaeus had been collected using pit-fall traps in faba bean and Egyptian clover fields in El-Farfra oasis (in western desert of Egypt at 580 km from Cairo) in order to maintain a continuous culture of the beetle under the laboratory conditions (23±2°C, 46±10% RH, 12L:12D photoperiod). Adult females and males were allowed to mate in cylindrical jars (20 cm height and 20 cm diameter) and the laid egg-masses were kept at bottom of jars until hatching. The first instar larvae (triungulins) were provided with a diet of honey and wax combs containing clutches of honeybee, *Apis mellifera* (Hymenoptera: Apidae). Unfortunately, these triungulins did not feed on the food and aggregated in clusters until death. Another trial of culturing had been carried out using some egg-pods of the desert locust, *Schistocerca gregaria* (Orthoptera: Acrididae), and the same behaviour of triungulins had been observed until death. Therefore, 1-day old adult beetles of both sexes were collected from the field and directly transferred to the laboratory of Plant Protection Department, Desert Research Center, Egypt. Under the previously mentioned laboratory conditions, these adults were kept and fed on different host plants: faba bean, Egyptian clover, pea and lettuce, separately.

Multiple-choice test

Food preference of the present experimental beetle was determined by the multiple-choice test as the following procedure: two square arenas (90x90 cm x50 cm height) were prepared with sandy bottoms and without cover as the beetle usually does not fly under the laboratory conditions. An amount of 40 g of each of a month-old host plants (faba bean, Egyptian clover peas, and lettuce) was placed at the corners of the arena forming X-shape.

The 1-day old adult beetles collected from the fields were starved for 24 h in order to estimate the effect of hunger on the food choice. They had been released, as mixed sexes, at the center of the arena containing the four host plants. Males (with knee-shaped antennae) were observed searching for females (with straight antennae) in trials to mate, i.e. their sexual behaviour competitively overcomes their feeding behaviour. Therefore, males were segregated and released in an arena other than the arena of females. Ten adult females were released at the center of one arena and ten adult males were released at the center of the other. All adult beetles in each arena were allowed to freely select and feed on the host plants. Each arena was checked every hour during a period of 12 hours to count the number of beetles on each host plant and to determine the weight of the food remains. The test was repeated 3 times through 3 successive days.

The eaten plant material was corrected considering the water loss of control plants and the true consumed plant material was calculated by the difference between the corrected weight of the remains and the initial weight. The degree of preference (C) for each host plant was determined by two indices as follows:

1) Average number of beetles of the same sex/host plant.
2) Mean weight of consumed host plant by the formula of Kogan and Goeden (1970): $C = 2A/(M+A)$, where A represents the material weight consumed from the test plant, M represents the material weight consumed from the faba bean as standard host plant.

Table 1. Food preference of the adult females of black blister beetle, *Meloe proscarabaeus*, in the Multiple-choice test.

Host plants	*Vicia faba*	*Trifolium alexandrinum*	*Lactuca sativa*	*Pisum sativum*
Mean ± SD.	2.25 ± 0.62	2.33 ± 0.49[a]	5.08 ±1.24[d]	0.33 ± 0.65[d]
%	22.5	23.3	50.8	3.3
R C	—	1.04	2.26	0.15

The test was carried out by 10 adult females. %: percentage of aggregating beetles on the host plant. R C: relative choice indicates the food choice relatively compared to the beetle preference to the faba bean (*Vicia faba*) as a standard host plant. Mean ± SD followed with the letter (a): non-significantly different (P>0.05), (b): significantly different (P<0.05), (c): highly significantly different (P<0.01), (d): very highly significantly different (P<0.001).

No-choice test

The food consumption parameters were estimated for each individual along its longevity including daily weighing of beetle body, fresh food before feeding, food remains (after 24 h feeding) discharged faeces and beetle body (after 24 h). Concerning the body weighing after feeding, the beetle was deprived from food for 3 h in order to avoid the food remains in the alimentary tract. For calculations, known weights of fresh food were left under the same laboratory conditions for 24 h without beetles, and the food was re-weighed at the end of this time interval. The amount of water lost by evaporation could then be calculated.

Feeding rate represents the amount of food consumed during the feeding period of adults, generally expressed on "per day basis" (consumption rate, CR) or on a "per day per unit body mass basis" (relative consumption rate, RCR). RCR can be calculated according to Slansky and Scriber (1985): RCR = mg consumed food / g mean fresh body weight / day.

Statistical analysis of data

Data obtained were calculated as mean ± SD and analyzed using the Student *t*-distribution and were refined by Bessel's correction (Moroney, 1956) for testing the significance of difference between means at probability 0.05, 0.01 and 0.001.

RESULTS

Multiple-choice test

Table 1 contains the data of food preference of females expressed in mean±SD. Preference percentage on each plant among all beetles and the relative choice (RC) by using *V. faba*, as a base or standard plant for the comparison purposes, were recorded. As obviously shown in the table, the most preferred plant by females was *L. sativa* (5.08±1.24 beetles, P<0.001) while the lowest preferred plant was *P. sativum* (0.33±0.65 beetles, P<0.001). The female beetles' interest to the tested host plants, relatively to *V. faba*, was estimated in 1.04 for *T. alexandrinum*, 2.26 for *L. sativa*, and 0.15 for *P. sativum*. These data indirectly indicate the highest consumption rate of female beetles on *L. sativa* and lowest one on *P. sativum*.

The same multiple-choice test was carried out for the adult male beetles using the second arena and the observations resulted in data assorted in Table 2. As easily seen, a similar trend of food preference was observed because the largest mean number of beetles was observed on *L. sativa* (4.33±1.16, P<0.001) but the smallest mean number was found on *P. sativum* (0.42±0.67, P<0.001). Calculated % of aggregating males beetles were 24.2, 28.3, 43.3 and 4.2 on *V. faba*, *T. alexandrinum*, *L. sativa* and *P. sativum*, respectively. Relatively compared to the beetle consumption of *V. faba*, as a standard host plant in the present study, adult males preferred *T. alexandrinum* in 1.16 more than *V. faba* and *L. sativa* in 1.79 more than *V. faba*, but their preference was estimated on *P. sativum* in 0.17 less than *V. faba*.

As an extension to the multiple-choice test, another experiment was conducted to detect the beetle preference for, and consumption of the present host plants expressed in weights. The experiment was repeated three times (12 h of each) through three successive days on the same beetle groups. Data of consumed food and the degree of host preference are arranged in Tables (3-5) for the three replicates.

At the first day, adult females and males consumed 4.09 and 4.65 g/10 beetles from *V. faba* (Table 3). Meanwhile, the largest consumed quantity was determined for *L. sativa* (9.73 and 7.65 g/10 beetles, by females and males, respectively) but the smallest quantity was determined for *P. sativum* (1.51 and 1.26 g/10 beetles, by females and males, respectively). On comparing with *V. faba*, females consumed 0.77 *T. alexandrinum*, 1.41 *L.sativa* and only 0.54 *P. sativum*. Also, males consumed 0.83 *T. alexandrinum*, 1.24 *L. sativa* and only 0.43 *P. sativum*. A similar trend of food preference and consumption can be undoubtedly observed for both females and male beetles in the second replicate (Table 4) and the third one (Table 5).

Depending on the data given in Table (6), the mean degree of food preference and consumption of the tested

Table 2. Food preference of the adult males of black blister beetle, *Meloe proscarabaeus*, in the Multiple-choice Test.

Host plants	*Vicia faba*	*Trifolium alexandrinum*	*Lactuca sativa*	*Pisum sativum*
Mean ± SD.	2.42 ±0.90	2.83 ±0.72[a]	4.33 ±1.16[d]	0.42 ±0.67[d]
%	24.2	28.3	43.3	4.2
R C	—	1.16	1.79	0.17

The test was carried out by 10 adult females. %: percentage of aggregating beetles on the host plant. R C: relative choice indicates the food choice relatively compared to the beetle preference to the faba bean (*Vicia faba*) as a standard host plant. Mean ± SD followed with the letter (a): non-significantly different (P>0.05), (b): significantly different (P<0.05), (c): highly significantly different (P<0.01), (d): very highly significantly different (P<0.001).

plants, compared to the preferred and consumed *V. faba*, was highest on *L. sativa* (1.21 and 1.47 by females and males, respectively) while females preferred and consumed *P. sativum* in only 0.44 relatively to their preference and consumption of *V. faba*. However, the male preference or consumption was not affected.

No-choice test

In the light of data distributed in Table (7), it is easily seen that the adult females' mean food intake from *V. faba* was 1.35±0.39 mg/ ♂. Comparatively, non-significantly smaller quantity from *T. alexandrinum* (P>0.05) was ingested and moreover the smallest ingested quantity (0.47±0.36 mg/ ♀, P<0.05) from *P. sativum* was estimated. On the contrary, females adult beetles ingested considerably large amount of *L. sativa* (1.81±0.74 mg/ ♂, P<0.001, compared to 1.35±0.39 mg/ ♂ *V. faba*). Generally, adult females discharged faeces (frass) in amounts comparable to the ingested food (For more details, see Table 7).

According to data presented in the same Table (7), the food consumption rate of adult females on *V. faba* was determined in 97.25±81.29. Relatively to *V. faba*, RCR of food was increasing on T. alexandrinum, *L. sativa* and *P. sativum*, respectively, viz. the highest RCR (711.62±42.98) was measured for females on *P. sativum* while the lowest RCR (88.88±55.57) was measured for females on *T. alexandrinum*. It may be important to note that the RCR run in an inverse interrelationship with the food intake.

In respect to the daily food consumption rate of adult males, data of Table (8) evidently show a similar feeding response of female congeners. Although the adult females consumed 0.89±0.23 g/ ♂from *V. faba*, their male congeners consumed larger quantities from *T. alexandrinum* and *L. sativa* (0.99±0.30 and 1.23±0.58 g/ ♀, respectively). From *P. sativum*, the adult females consumed significantly smaller quantity (0.41±0.096 g/ ♂, P<0.001). Data given in the same table obviously revealed a direct correlation between the faeces discharge and the food intake, i.e., the greater food amount resulted in greater faeces output. Because the smallest quantity from *P. sativum* was accompanied with the highest RCR (633.88±52.36 vs.117.07±63.29 after feeding on *V. faba*), an inverse correlation between the food intake and RCR was easily observed.

DISCUSSION

Behavioral and physiological studies of nutrition have repeatedly shown that insect herbivores can readily discriminate among food sources of different quality (Simpson and Abisgold, 1985; Simpson and Simpson, 1990; Behmer and Joern, 1993, 1994; Joern and Behmer, 1997). In addition, many insect species can compensate for imbalances in their diets by choosing food that provides missing nutrients (Simpson and Simpson, 1990; Simpson et al., 1990; Waldbauer and Friedman, 1991).

Feeding activity of some blister beetles (Meloidae) species had been studied in different parts of the world (Shukla and Upadhyaya, 1972; Shukla and Upadhyaya 1973; Ali et al., 2005a,b; Kundu et al., 1971, 2006). Moreover, the food preference of blister beetles was investigated on different parts of the same host plant, such as the beetle *Rhabdopalpa atripennis* F. for which Shukla and Singh (1982) recorded its preference to certain parts of *Luffa cylindrical*. In the present study, food preference and consumption of the adult females and males of the black blister beetle *Meloe proscarabaeus* to four host plants (*Vicia faba*, *Trifolium alexandrinum*, *Lactuca sativa*, and *Pisum sativum*) had been investigated. Two modes of choice, multiple-choice test and no-choice test were applied under laboratory conditions.

Multiple-choice of *M. proscarabaeus* to host plants

The available literature contains several works on the food preference of different beetle species because the adult chrysomelid beetle *Diabrotica balteata*, under multiple-choice conditions, preferred to feed on bean instead of potato leaflets (Teng et al., 1984) and the adults on another chrysomelid beetle *Diabrotica speciosa* preferred to feed on bean leaves instead of soybean and corn leaves (Avila and Parra, 2003). Also, the host preference of the red pumpkin beetle *Aulacophora*

Table 3. Degree of preference of black blister beetle, to different plant hosts as indicated by food eaten (in g) during the 1st day.

Host plants	Initial weight		Water loss (%)	Corrected remain weight		Consumed food/10 beetles		Degree of preference	
	Females	Males		Females	Males	Females	Males	Females	Males
Vicia faba	40.19	40.35	25.05	36.10	35.70	4.09	4.65	–	–
Trifolium alexandrinum	40.25	40.35	16.21	37.68	36.94	2.57	3.31	0.77	0.83
Lactuca sativa	40.44	40.08	30.91	30.71	32.43	9.73	7.65	1.41	1.24
Pisum sativum	40.37	40.11	18.11	38.86	38.85	1.51	1.26	0.54	0.43

Table 4. Degree of preference of black blister beetle, to different plant hosts as indicated by food eaten (in g) during the 2nd day.

Host plants	Initial weight		Water loss (%)	Corrected remain weight		Consumed food/10 beetles		Degree of preference	
	Females	Males		Females	Males	Females	Males	Females	Males
Vicia faba	40.87	40.51	25.05	34.10	37.93	6.77	2.58	–	–
Trifolium alexandrinum	40.91	40.10	16.21	36.07	38.52	4.84	2.39	0.86	0.96
Lactuca sativa	40.11	40.72	30.91	31.56	32.82	8.55	7.29	1.12	1.48
Pisum sativum	40.29	40.55	18.11	39.93	36.50	0.36	3.79	0.10	1.19

Table 5. Degree of preference of black blister beetle, to different plant hosts as indicated by food eaten (in g) during the 3rd day.

Host plants	Initial weight		Water loss (%)	Corrected remain weight		Consumed food/10 beetles		Degree of preference	
	Females	Males		Females	Males	Females	Males	Females	Males
Vicia faba	40.23	40.51	25.05	32.88	38.78	7.35	1.73	–	–
Trifolium alexandrinum	40.15	40.10	16.21	35.50	37.56	4.65	2.59	0.78	1.20
Lactuca sativa	40.44	40.72	30.91	31.30	31.56	9.14	9.16	1.11	1.68
Pisum sativum	40.37	40.55	18.11	36.63	36.60	3.74	3.95	0.68	1.39

Table 6. Mean degree of preference of black blister beetle, Meloe to different plant hosts.

Host plants	*Vicia faba*	*Trifolium alexandrinum*	*Lactuca sativa*	*Pisum sativum*
Females	–	0.74	1.21	0.44
Males	–	1.00	1.47	1.00

Faba bean (*Vicia faba*) was used as a standard host plant for the comparison purpose.

Table 7. Daily food consumption (mg ±SD) of adult females black blister beetle, *Meloe proscarabaeus*, feeding on different plant hosts.

Host plants	Food intake	Faeces output	RCR	Change (%)
Vicia faba	1.35 ± 0.39	1.04 ± 0.24	97.25 ± 81.29	-
Trifolium alexandrinum	1.25 ± 0.40[a]	0.93 ± 0.22[a]	88.88 ± 55.57[a]	-8.61
Lactuca sativa	1.81 ± 0.74[c]	1.500 ± 0.53[d]	120.08 ± 76.35[a]	+23.48
Pisum sativum	0.47 ± 0.36[d]	0.42 ± 0.031[d]	71.16 ± 42.98[d]	+26.83

RCR: relative consumption rate of food (= mg consumed food / g mean fresh body weight / day). Faba bean (*Vicia faba*) was used as standard host plant for the comparison purpose. No. of adult ♀♀ = 10. Mean ± SD followed with the letter (a): non-significantly different (P>0.05), (b): significantly different (P<0.05), (c): highly significantly different (P<0.01), (d): very highly significantly different (P<0.001).

Table 8. Daily food consumption (mg ± SD) of adult males black blister beetle, *Meloe proscarabaeus*, feeding on different plant hosts.

Host plants	Food intake	Faeces output	RCR	Change (%)
Vicia faba	0.89 ± 0.23	0.73 ± 0.17	117.07 ± 63.29	——
Trifolium alexandrinum	0.99 ± 0.30[a]	0.82 ± 0.21[a]	158.85 ± 117.85[a]	+35.69
Lactuca sativa	1.23 ± 0.58[c]	1.01 ± 0.43[c]	176.84 ± 100.36[b]	+51.05
Pisum sativum	0.41 ± 0.096[d]	0.36 ± 0.041[d]	63.38 ± 52.36[d]	-45.86

RCR: relative consumption rate of food (= mg consumed food / g mean fresh body weight / day). Faba bean (*Vicia faba*) was used as a standard host plant for the comparison purpose. No. of adult ♂♂ = 10. Mean ± SD followed with the letter (a): non-significantly different (P>0.05), (b): significantly different (P<0.05), (c): highly significantly different (P<0.01), (d): very highly significantly different (P<0.001).

foveicollis ranked bitter gourd (*Momordica charantia*) was least preferred, but cucumber, musk melon, bottle gourd (*Lagenaria siceraria*) and pumpkin as medium in preference, but round gourd (*Citrullus lanatus*) and long melon (*Cucumis utilissimus*) as highly preferred and watermelon as the favorite host (Singh et al., 2000). The cigarette beetle *Lasioderma serricorne* (Anobiidae) exhibited the highest interest to oriental tobacco and flue cured Virginia tobacco while the other tobacco cultivars were least preferred (Rao et al., 2002). The epilachna beetle *Epilachna dodecastigma* (Coccinellidae) adults consumed the highest quantity from teaselgourd (*Momordica dioica*) but the lowest from yardlong bean (*Vigna sesquipedalis*) (Hossain et al., 2009). The attractivity and feeding preference of adults of the blister beetle *Epicauta atomaria* for leaves of passion fruit species *Passiflora* spp. were evaluated under laboratory conditions. In consumption tests (free and no choice), using leaf disks, *P. setacea* was the most consumed, confirming to be susceptible, *P. giberti* and *P. nitida*, were the least consumed expressing feeding non-preference (Baldin and Lara, 2002). When *V. faba* was used as a base, for comparison in the present study, the most interesting plant to females of *M. proscarabaeus* was *L. sativa* while the lowest was *P. sativum*. As clearly shown, *M. proscarabaeus* adult females and males preferred the tested host plants ranked as *L. sativa*, *V. faba*, *T. alexandrinum* and *P. sativum*. Also, they consumed plant quantities in a similar rank.

Although some authors reported sexual difference in the food preference (Lauprasert et al., 2006), no obvious difference between adult females and males of *M. proscarabaeus* was observed in the current study. However, the most preferred host plant was *L. sativa* from which adult beetles consumed the largest quantity among other tested plants. This may be due to compensate the inadequate nutritional requirements or to some other chemical stimuli and physiological factors influencing the food preference and consumption (Jones et al., 1981) since Richard and Filewood (1990) stated that food preference of the epilachna beetle *Epilachna vigintioctopunctata* was influenced by odour, taste, and age of host plant and also by thickness of leaves, proportion of crude fibers, parenchymatous tissue and water content.

No-choice food consumption of *M. proscarabaeus* on host plants

The consumption capability of adult beetles, in the present study, had been influenced by continuous feeding on each of the tested host plants. Comparatively to the mean food intake of adult females from *V. faba*, insignificantly smaller quantity from *T. alexandrinum*

(P>0.05) was ingested but the smallest ingested quantity (P<0.01) from *P. sativum* was estimated. On the contrary, adult female beetles ingested considerably large amount for *L. sativa* (P<0.001). On comparing with *V. faba*, the relative consumption rate (RCR) of food increased gradually by feeding on *T. alexandrinum, L. sativa* and *P. sativum*, respectively. In other words, the highest RCR was observed on *P. sativum* while the lowest RCR on *T. alexandrinum.* With regard to male beetles, the feeding responses to a great extent resemble those of their female congeners. In spite of the similarity appeared by the current results, Nagy (1952) and Gangwere (1959) reported that adult male grasshoppers may eat up to twice as much as adult females, while Holmberg and Hardman (1984) reported that the females proportionately eat more than males. The most likely explanation for this controversy is the variation in feeding rates during the egg-laying cycle of females and the mating condition of males. Moreover, Holmberg and Hardman's result was based on newly emerged adults but Nagy and Gangwere's results used adults on unknown ages.

The present results, again, show that the adult beetles of both sexes ingested remarkably large quantity from *L. sativa* and medium quantity from *V. faba* but smaller quantity from *T. alexandrinum* and smallest quantity from *P. sativum*. These results, however, do not reflect the nutritional values of the tested plants. This may be explained by the beetles' compensation of the low nutrients of a host plant by ingesting large quantity (Avila and Parra, 2003) or may be attributed to difference in nitrogen concentration in these plants (Avila and Parra, 2002).

In conclusion, the adult beetles of both sexes exhibited the highest preference for *L. sativa* but the lowest preference for *P. sativum*, under the multiple-choice condition. Also, the food intake was determined in a similar trend. Under no-choice condition, the highest relative consumption rate was estimated on *P. sativum* while the lowest rate on *T. alexandrinum*, regardless of the sex. Adult beetles of both sexes had no significant difference between the consumed food quantities under multiple-choice condition and those consumed quantities under no-choice condition.

REFERENCES

Alfieri A (1976). The Coleoptera of Egypt. Memories de la Societe Entomologique d'Egypte, 5: 361.

Ali MA, Abdel-Rhaman GA, Ibrahim IL, El-sheikh WEA (2005a). The blister beetle *Meloe proscarabaeus* L., a new insect pest threatens legume crops in El-Farafra oasis-Egypt. J. Agric. Res., 83(3): 1187-1200.

Ali MA, Abdel-Rhaman GA, Ibrahim IL, El-sheikh WEA (2005b). Field observations on the blister beetle *Meloe proscarabaeus* L., (Coleoptera: Meloidae), a threat to faba bean in El-Farafra oasis western desert of Egypt. Bull. Ent. Soc. Egypt, 82(109): 110-114.

Anand RK (1978). First record of *Meloe proscarabaeus* Linnaeus and *M. violaceus* Marsham (Coleoptera: Meloidae) from India, along with further description and a key to the Indian species. J. Entomol. Res., 2(1): 40-42.

Arnett RH, Thomas MC, Skelley PE, Frank JH (2002). American Beetles. CRC Press.Boca Raton, Florida. P. 861.

Ávila CJ, Parra JRP (2002). Desenvolvimento de *Diabrotica speciosa* (Germar) (Coleoptera: Chrysomelidae) em diferentes hospedeiros. Revista Ciência Rural, 32: 739-743.

Ávila, CJ, Parra JRP (2003). Leaf consumption by *Diabrotica speciosa* (Coleoptera: Chrysomelidae) adults on different host plants. Scientia Agricola, 60(4): 789-792.

Baldin ELL, Lara FM (2002). Attractivity and feeding preference of adults of *Epicauta atomaria* (Germ., 1821) (Col.: Meloidae) in passion fruit (*Passiflora* spp.), under lab conditions. Revista Brasileira de Fruticultura, 24(1): 68-71.

Behmer ST, Joern A (1994). The influence of proline on diet selection: sex-specific feeding preferences by the grasshoppers *Ageneotettix deorum* and *Phoetaliotes nebrascensis* (Orthoptera: Acrididae) based on the need for phenylalanine. Oecologia, 98: 76-82.

Behmer ST, Joern A (1993): Dietary selection by the generalist Grasshopper *Phoetaliotes nebrascensis* (Orthoptera: Acrididae). Funct. Ecol., 7:522-527.

Browne BL (1977). Host-related responses and their suppression: some behavioral considerations. In: (Shorey HH, McKelvey JJ Jr, eds) "Chemical Control of Insect Behaviour: Theory and Application". pp. 117-127. Wiley, New York.

Chapman RF (1990). Food selection. In: (Chapman, R.E. and John, A., eds)"Biology of Grasshoppers". pp: 39-72 John Wiley and Sons, New York.

Dethier VG, Brown BL, Smith CN (1960). The designation of chemicals in terms of responses they elicit from insects. J. Econ. Ent., 53: 134-136.

Dettner K, Bauer G, Völkl W (1997**)**. Vertical Food Web Interactions. Springer Verlag. Berlin. 390 pp.

Gangwere SK (1959). Experiments upon the feeding consumption of the grasshopper *Melanoplus scudderi* (Uhler). Mich.Acad.Sci., Arts. Lett., 44: 93-96.

Hinks CF, Hpka D, Olfert O (1993). Nutrition and the protein economy in grasshoppers and locusts. Comp.Biochem.Physiol., 104(A): 133-142.

Holmberg RG, Hardman JM (1984). Relative feeding rates to sex and size in six species of grasshoppers (Orthoptera: Acrididae). Can.Ent., 116: 597-606.

Hossain MS, Khan AB, Haque MA, Mannan MA, Dash CK (2009). Effect of different host plants on growth and development of epilachna beetle. Bangladesh J. Agril. Res., 34(3): 403-410.

Joern A, Behmer ST (1997). Importance of dietary nitrogen and carbohydrates to survival, growth, and

reproduction in adults of the grasshopper *Ageneotettix deorum* (Orthoptera: Acrididae). Oecologia , 112: 201-208.

Jones CG, Hoggard MP, Blum MS (1981). Pattern and process in insect feeding behaviour: a quantitative analysis of the Mexican bean beetle, *Epilachna varivestis*. Ent. Expt. Appl., 30(3): 254-264.

Klausnitzer B, Rauch R (2000). Observations of triungulin larvae of *Meloe proscarabaeus* Linnaeus, 1758 in the warm spring of 2000 (Col., Meloidae). Entomologische Nachrichten und Berichte, 44(3):207-208.

Kogan M, Goeden RD (1970). The host-plant range of *Lema trilineata daturaphila* (Coleoptera: Chrysomelidae). Ann. Entomol. Soc. Amer., 63: 1175-1180.

Kundu GG, Kishore P, Sukhani TR (1971). Occurrence of blister beetles, *Mylabris pustulata* Thunb. and *Lytta tenuicollis* (Pallas) as serious pests of sorghum in Rajasthan. In: (Pradhan S, ed.) "Invest On Insect Pests Of Sorghum & Millets". 1965/70 (Pub. Feb. 1971).

Kundu M, Chattopadhyay RN, Bhattacharya T (2006). Food preference of Chinese blister beetle, *Mylabris phalerata* (Pallas) (Meloidae, Coleoptera, Insecta). Science and Culture, 72(9/10): 321-322.

Lauprasert P, Sitthicharoenchai D, Thirakhupt K, Pradatsudarasar A-O (2006). Food Preference and Feeding Behavior of the German Cockroach, *Blattella germanica* (Linnaeus). J. Sci. Res. Chula. Univ., 31(2): 121-126.

Luckmann J, Kuhlmann M (1997). The triungulins of *Meloe brevicollis* Pans. and *Meloe rugosus* Marsh. with notes on the biology and ecology of the larvae (Col., Meloidae). Entomologische Nachrichten und Berichte, 41(3)183-189.

Moroney MJ (1956). Facts from figures (3rd ed.). Penguin Books Ltd., Harmondsworth. Middle Sex.

Nagy B (1952). Food consumption of *Dociostaurus erucigerus* Eversm. and *Oedipoda coerulescens* L. (Orthoptera: Acrididae). Acta Biol., Budabest, 3: 41-52.

Panizzi AR, Parra JRP (1991). A ecologia nutricional e o manejo integrado de pragas. In: (Panizzi AR, Parra JRP, eds.)"Ecologia nutricional de insetos e suas implicações no manejo de pragas". Piracicaba: Manole,. pp.313-336.

Rao CVN, Rao BN, Babu TR (2002). Feeding response of cigarette beetle, *Lasioderma serricorne* Fabricius (Coleoptera: Anobiidae) on different types and varieties (grades) of tobacco. J. Entomol. Res., 26 (1): 1-9.

Richard AM, Filewood LW (1990). Feeding behaviour and food preferences of the pest species comprising the *Epilachna vigintioctopunctata* Fab. Complex (Coleoptera: Coccinellidae). J. Appi. Ent. Univ. New South Wales, Kensington, Australia, 110(5): 501-515.

Shukla GS, Singh GC (1982). Feeding activity of *Rhabdopalpa atripennis* F. on host plant *Luffa cylindrica* (Col. Meloidae). Deutsche Entomologische Zeitschrift, 29(1-3): 111-115.

Shukla GS, Upadhyaya VK (1972). Feeding activity of *Mylabris pustulata* Thunb. (Coleoptera: Meloidae). Cell. Molec. Life Sci., 28(11): 1383.

Shukla GS, Upadhyaya VK (1973). Studies on the food preference of *Mylabris pustulata* Thunb. (Coleoptera: Meloidae). Zoologische Beitrage, 19: 18-24.

Simpson SJ, Abisgold JD (1985). Compensation by locusts for changes in dietary nutrients: behavioral mechanisms. Physiol. Entomol., 10:443±452 Simpson SJ, Simpson CL (1990). The mechanisms of nutritional compensation by phytophagous insects. In: (Bernays, E.A., ed) "Insect-plant interactions", vol 2. CRC, Boca Raton, F1a, pp 111-160.

Simpson SJ, Simmonds SS, Blaney WM, Hones JP (1990). Compensatory dietary selection occurs in larval *Locusta migratoria* but not *Spodoptera littoralis* after a single deficient meal during ad libitum feeding. Physiol. Entomol., 15:235-242.

Singh SV, Mishra A. , Bisen RS, Malik YP (2000). Host preference of red pumpkin beetle, *Aulacophora foveicollis* and melon fruit fly, *Dacus cucurbitae*. Indian J. Entomol., 62(3) 242-246.

Slansky F, Scriber JM (1985). Food consumption and utilization. In: (G.A. Kerkut and L.I. Gilbert, eds.)"Comprehensive Insect Physiology, Biochemistry and Pharmacology", Vol. 4. "Regulation: Digestion Nutrition Excretion", Pp. 87-163. Pergamon Press, N.Y.

Teng HJ, Waddill V, Slansky F, Strayer J (1984). Performance and host preference of adult banded cucumber beetles, *Diabrotica balteata* when offered several crops. J. Agric. Entomol., 1: 330-338.

Thorsteinson AJ (1960). Host selection in phytophagous insects. Annu.Rev.Entomol., 5: 193-216.

Visser JH (1988). Host-plant finding by insects: orientation, sensory input and search patterns. J. Insect Physiol., 34(3): 259-268.

Waldbauer GP, Friedman S (1991). Self-selection of optimal diets by insects. Annu. Rev. Entomol., 36:43-63.