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Effect of Feeding on Seeds of Five Species of Umbelliferae on the Rate of Development and Fecundity of *Graphosoma lineatum* (L.) (Heteroptera: Scutelleridae)

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Abstract: Rate of development and biological features of *Graphosoma lineatum* was studied under laboratory conditions of 28±2°C, 60±5% R.H. and a photoperiod of 16:8 (L:D) feeding the individual insects upon seeds of 5 umbelliferous species namely parsley, fennel, dill, celery and carrot. The results indicated no significant differences regarding the duration of embryonic development in rearings on 5 already mentioned food regimes. The lowest mean larval developmental time, from egg to egg and from egg to adult stages in rearings on dill seeds was estimated as 19.73, 36.30 and 25.47 days, respectively with the highest mean records being as 26.89, 45.3 and 32.39 days in rearings on celery seeds. Regarding the percentage egg hatches, there was no significant differences between 5 treatments. The mean survival rate from first instars larval stage into adult varied from 67.53-46.66% between 5 treatments. The mean number of eggs laid in the rearings on carrot was 99.1 with 79 being in rearings on celery. It was indicated that feeding on carrot seeds resulted in highest survival rate, lowest larval developmental stages and lowest total life cycle. The number of eggs laid by adult females reared on carrot seeds appeared to be higher than on other seeds, lowering in rearing on dill, fennel, parsley and celery, respectively.

Key words: *Graphosoma lineatum*, biology, heteroptera, development, fecundity, umbelliferae

INTRODUCTION

The sunn pest Eurygaster integriceps Put (Heteroptera: Scutelleridae) is distributed in the Palearctic Region, which covers the Near and Middle East, Southern Asia, North Africa, Turkey and also Iran (Asghari, 1998; Kivan and Kilic, 2004; Yazdanian and Farshbaf, 2005; Yazdanian *et al*., 2006). These are serious pests of wheat and barley. Eggs of sunn pest and various pentatomids such as Dolycoris baccarum, Aneyrosoma leuagrammes, Nezara viridula, Aelia accuminata and *Graphosoma lineatum* are frequently parasitized by wasps of the genus Trissolcus (Kivan and Kilic, 2004). The egg parasitoid Trissolcus semistriatus Nees is one of the natural enemies of the sunn pest (Kivan and Kilic, 2005). Knowledge of host preferences of egg parasitoids and their development in these hosts is important in mass rearing and in using them as biological control agents. Pentatomids have importance in the life cycle of egg parasitoids, because they are alternative hosts after E. integriceps migrates to overwintering areas. The sunn pest is a univoltine species and not suitable for use in mass production of egg parasitoids (Khlistovskii and Shirinyan, 1980). *G. lineatum* is a polyvoltine and gregarious insect (Candan and Suludere, 1999; Vesely *et al*., 2006). Kravchenkov (1974) working with 5 already mentioned species, found that the species *G. lineatum* was the best alternative host. In this study, the seeds of 5 umbelliferous species were used in determining the ideal food material for *G. lineatum* for production of the highest eggs and the least developmental time.

MATERIALS AND METHODS

All experiments were conducted under laboratory conditions of 28±2°C Temp., 60±5% R.H. and a photoperiod of 16:8 (L:D) (Nakamura *et al*., 1996; Yazdanian and Farshbaf, 2005; Yazdanian *et al*., 2006) at Dept. of Plant Protection of Tabriz, Faculty of Agriculture, Tabriz University. The bug, *Graphosoma lineatum*

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was reared on caraway seeds for successive generations (Karsavuran, 1992). The resultant eggs of the 5th generation were then transferred on parsley, fennel, dill, celery and carrot seeds. For each treatment, 140 g. of seeds of each species were used on which 140 eggs of the bug were added in petridishes being vovered tightly with terylene muslin. The experimental design was as CRD. To determine the developmental time of different nymphal stages, petridishes were used. In each petri, 1-day old larva was released on 1 g of food. There was 24 replicates for each treatment and weight of each resultant adult male and female were determined. To determine the fecundity of female adult females, an study was carried out with 48 males and 24 females encaging one virgin adult female with 2 unpaired adult males and number of eggs produced by each female was counted daily until they were died. More over, the pre-oviposition, oviposition and post-oviposition, longevity of adult males and females, number of eggs not produced but remained in ovarioles were also, studied, the hind tibial lengths of adult females as an indication of body size, was measured by means of calibrated micrometere mounted on a bionocular. Number of first instar larvae was determined upon hatching from the eggs and numbers of resultant adults were also determined upon their appearance. Survival rate from 1st instar larva into adult stage was calculated using the formula:

$$\text{Survival rate} = \frac{\text{No. of adults}}{\text{No. of neonate larva}} \times 100$$

RESULTS AND DISCUSSION

Embryonic development and larval development: The results indicated that the embryonic development lasted for 4-7 days and various food items had no any effect on it.

Duration of different larval stages: There were 5 larval stages in rearings on all feeding regims with no significant differences at the 1st and 2nd stages but regarding the 3rd, 4th and 5th larval stages there were significant differences. The longer duration of the 3rd, 4th and 5th larval stages led to longer larval developmental time, longer period from egg to egg stages, collapsing a longer period between the egg into adult stages hence, longer life cycles (Table 1). However, it is feasible that the 1st instar larvae usually feed on the egg skin upon hatching and consume water later on Musolin and Saulich (2001). This can justify the equal 1st instar larval durations on all provided food items with no significant differences. The 2nd instar larvae having small body size need no more food, thus no significant differences could be noticed between the 5 treatments. The developmental time of the 3rd instars was increased consequently the need for more food was also increased. Therefore, providing the better food item could result in faster development hence, accelerated moulting and shortened the larval duration.

The weight of adults: There were no significant differences between mean adult male and female weights in rearings on dill, carrot and fennel compared with rearings on fennel and carrot and parsley and celery. But there was significant differences once grouping were compared. Also, comparisons made between adult weights of individuals reared on carrot, dill and fennel with those reared on celery and parsley indicated no significant differences but significant differences was noticed when grouping comparisons were made.

Fecundity of adult females: The largest (99.1) and the smallest (71.03) eggs numbers were produced in individuals reared on carrot and celery and adult weights and hind tibial length as indices of individuals body size (Larson, 1989). Regarding number of eggs remaining in ovaries (eggs not laid), there was no significant difference between rearings in various food items used. The short duration of life cycle in rearings on dill, carrot and fennel was due to their nutritional status, compared with those in rearings on celery and parsley, which had caused increased rate of development and higher egg production. Asghari (1998) was rearing *G. Lineatum* on fennel and rampion seeds and a mixture of these two, obtained a mean number of eggs of 357.2 for natural populations and for 4 generations as 164.2, 98.1, 66.56 and 59.7 in laboratory rearings, respectively. Although, there were no significant differences in egg numbers in rearings on

Table 1: Effects of feeding on various foods on duration of larval stages, larval development, at time life cycles (egg to egg and egg to adult) in *Graphosoma lineatum* (L.) ($\bar{X}$ ±SE)

Food treatments	Duration of larval stages (days) 1st	2nd	3th	4th	5th	Larval developmental time (day)	Life cycles (days) Egg to egg	Egg into adult	Hind tibial length (m.m)
Carrot	3.03±0.09	3.62±0.29	4.74±0.32^{b}	4.79±0.35^{bc}	5.33±0.12^{bc}	21.33±1.26^{d}	36.59±1.64^{C}	26.80±1.56^{C}	3.78±0.02^{a}
Celery	3.08±0.13	3.66±0.30	6.12±0.36^{a}	6.41±0.40^{a}	7.62±0.29^{a}	26.89±1.50^{a}	45.03±1.56^{a}	32.39±1.25^{a}	3.67±0.04^{b}
Dill	2.95±0.14	3.24±0.28	4.04±0.25^{b}	4.41±0.33^{c}	5.58±0.33^{c}	19.73±1.50^{e}	36.60±1.88	25.47±1.51	3.80±0.02 ^{a}
Fennel	2.79±0.14	3.99±0.40	4.66±0.33^{b}	4.99±0.33^{bc}	5.66±0.24^{bc}	22.11±1.38^{c}	38.58±1.36^{c}	27.62±1.49^{c}	3.76±0.04^{a}
Parsley	3.24±0.13	3.41±0.29	5.14±0.12^{ab}	6.20±0.26^{ab}	5.95±0.24^{b}	24.28±1.57^{b}	41.55±1.54^{b}	29.01±1.88^{b}	3.69±0.04^{b}

Unsimilar letters indicate significant differences at p = 1% using Duncan's Multiple Range Test

Table 2: Effects of feeding on various foods on adult weight and longevity, number of eggs laid and number of eggs remaining in ovaries in *Graphosoma lineatum* (L.) ($\overline{x}$ ±SE)

Food treatments	Adult longevity (day)		Adult weight (mg)		No. of eggs laid	No. of eggs remaining in ovaries
	Females	Males	Females	Males		
Carrot	28.69±1.28^{ab}	27.69±0.05	84.36±0.27^{a}	74.96±0.82^{a}	99.10±1.88^{a}	7.14±0.96
Celery	27.15±0.32^{c}	26.99±0.74	76.37±0.48^{c}	68.41±0.27^{b}	79.03±1.33^{b}	7.92±1.20
Dill	29.47±0.30^{a}	27.18±0.57	86.20±1.11^{a}	74.36±0.37^{a}	93.75±0.37^{a}	9.45±1.10
Fennel	29.29±0.35^{a}	27.89±0.53	82.90±2.07^{ab}	73.33±0.48^{a}	91.60±1.68^{a}	8.95±1.13
Parsley	27.97±0.11^{bc}	26.66±0.29	77.79±0.58^{bc}	69.59±0.32^{b}	81.61±1.59^{b}	9.41±0.89

Unsimilar letters indicate significant differences at p = 1% using Duncan's Multiple Range Test

Table 3: Effects of feeding on various foods on duration of pre-oviposition and post- oviposition periods, embryonic development, percentage egg hatches and survival rate frm 1st instar larva into adult stage ($\overline{x}$ ±SE)

Food treatments	Postovipoition	Duration of ovipostion periods (days)	Postovipoition	Embryonic development(days)	Survival rate (%)	Percentage egg hatches
Carrot	9.79±0.89^{b}	16.95±0.32^{a}	2.33±0.19^{c}	5.38±0.23	67.53±1.89^{a}	73.93±1.53
Celery	12.64±0.43^{a}	10.20±0.40^{c}	4.87±0.69^{a}	5.50±0.29	46.66±0.12^{b}	75.1±1.73
Dill	10.83±0.81^{ab}	15.62±0.81^{b}	3.03±0.29^{b}	5.73±0.27	62.1±1.61^{b}	73.36±2.33
Fennel	10.967±0.85^{ab}	14.98±0.19^{b}	2.95±0.90^{bc}	5.51±0.17	60.8±1.59^{b}	75.16±0.90
Parsley	11.84±0.4^{a}	11.27±0.26^{c}	4.22±0.34^{ab}	5.42±0.43	51.43±2.92^{c}	74.43±2.86

Unsimilar letters indicate significant differences at p = 1% using Duncan's Multiple Range Test

various food items, but suitablefood, optimal conditions of temperature and humidity resulted in higher egg production.

Adult longevity: Regarding adult longevity, there were no differences between treatments (Table 2). But the effect of food on female longevity appeared to be significant at p = 1%. The mean adult life was 29.48 and 27.16 days in rearings on dill and celery seeds, respectively.

Percentage egg hatches: The percentage egg hatches appearing to be different varied from 73.27% in rearings on dill seeds to 75.17% in rearings on fennel but no significant difference was obtained between these two treatments. Asghari (1998) had found that the eggs laid within the earliest days of oviposition period, did not hatch despite occurrence of effective copulations.

Survival rate from 1st instar larva into adult stage: The lowest survival rate (46.67%) was obtained in rearings on celery seeds with the highest one (67.53%) in rearings on carrot. The lowest hind tibial length (3.67 mm) was measured in adult females reared on celery seeds with the highest (3.80 mm) in individuals reared on dill seeds (Table 3). These results justify the possible effects of nutritional status of the seeds on body size.

Duration of pre-oviposition and post-oviposition periods: The highest durations of each period was recorded for individuals reared on celery, carrot and celery seeds, respectively, with the least being in rearings on carrot, celery and carrot seeds, respectively. The lowest period of preoviposition and longer oviposition period was due to the feeding conditions wich had lead to individuals with higher ability for copulation and oviposition and the highest number of eggs were counted for individuals reared on carrot seeds (Table 3).

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