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Impact of Natural Hosts and Artificial Adult Diets on Some Quality Parameters of the Melon Fly, *Bactrocera cucurbitae* (Coquillett) (Diptera: Tephritidae)

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Abstract: Experiments were conducted to evaluate the impact of different natural hosts and artificial adult diets on the pupal quality, adult emergence, ovariole number and longevity of the melon fly, *Bactrocera cucurbitae* (Coquillett) for two generations under laboratory condition. Pupal quality and percentage adult emergence was slightly higher in F_2 generation than F_1 generation from all tested hosts. *B. cucurbitae* fed on proteose-peptone sugar (1:4) produced twice as many as eggs when fed on yeast:sugar (1:3). The differences in fecundity can be explained by the higher number of ovarioles and source of protein ingested. Highly significant interaction between adult diets and natural hosts was observed in terms of ovariole number of *B. cucurbitae*. Experimental results indicated the importance of understanding the genetic traits in the variation of ovariole number among natural populations of the fly spp.

Key words: Melon fly, *Bactrocera cucurbitae*, natural hosts, adult diets, quality parameters

INTRODUCTION

The oviposition behaviour in herbivorous and frugivorous insects and parasitoids is dynamic at the level of the individual, responding to the variation in the quality and availability of host (Papaj, 2000). Conditions favouring host effects on ovarian development include trade-off between egg production and their survival or dispersal. A correlation in host conditions between the time that oogenesis is initiated and the time that eggs are laid is also considered.

The larval feeding is known to have significant influence in ovariole number of adult flies. The total egg production of the oriental fruit fly, *Bactrocera dorsalis* (Hendel) basically depends on two interdependent variables: the number of ovarioles present in the ovaries and the quality of nutrients taken by the larvae and adults (Khan *et al*., 2000). The ingestion of protein has already been reported to increase the egg production of different insects by different authors (Clift and Mcdonald, 1976; Cangussu and Zucoloto, 1995; Khan *et al*., 1999; Nakamori and Kakinohana, 1980; Saha *et al*., 1996).

The melon fly, *Bactrocera cucurbitae* (Coq.) (Diptera: Tephritidae) is considered as economically most important pest of fruits and vegetables in tropical and subtropical countries of the world. In Hawaii it has a host range of 125 plant species (Metcalf and Metcalf, 1992), while 42 hosts in South-east Asia have been reported (Allwood *et al*., 1999). In Bangladesh *B. cucurbitae* represents 74.5% of the total number of flies infesting different vegetable growing areas (Akhtaruzzaman *et al*., 1999). In Sterile Insect Release Method (SIRM) of this pest it is a pre-requisite to ensure biological quality parameters in terms of mass rearing with local ingredients to obtained competitive adults to bring about a successful suppression in the field population.

The objectives of the present research were to evaluate the quality of pupae and percentage of adult emergence of *Bactrocera cucurbitae* from the natural hosts tested; to determine the ovariole number and egg production reared in seven different natural hosts and fed on two different adult diets and to observe the longevity of adults from those eggs were collected (egging) and not collected (non-egging).

MATERIALS AND METHODS

The flies used in the present study originated from a population collected from infested bitter gourd in 1993 and rearing continued for several generations (F-130) for better laboratory adaptation. About 1500-2000 adult flies were maintained in a wooden cage (60×50×45 cm) covered with nylon net.

The natural hosts used for the experimental purposes were: Sweet gourd, *Cucurbita maxima* (D.), Bitter gourd, *Momordica charantia* (L.), Snake gourd, *Trichosanthus cucumerina* (L.), Ribbed gourd, *Luffa acutungula* (L.),

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Sponge gourd *Luffa cyclindsica* (L.), Ash gourd, *Benincasa hispida* (Thumb) and Cucumber, *Cucumis sativus* (L.).

Two different adult diets used were: Proteose-peptone:sugar (1:4) and Yeast:sugar (1:3). Water was supplied as common drinking source via cotton wicks in conical flask to the flies.

Pupal quality and adult emergence: Seven different natural hosts measuring 500 g from each type were exposed at a time for 30 min in a cage (44×30×36 cm) filled with 200 gravid adults (F-130) from the laboratory adapted stock culture for egg laying. The flies used for egg laying termed as parental generation. They were then kept separately in small plastic container for pupation. Freshly emerged (24 h) pupae were then counted, weighted and subsequent adult emergence against each host was recorded. Emerged adults from each host were termed as F_1 generation and kept in similar type of cages (44×30×36 cm). The same experiment was also conducted to measure pupal quality and adult emergence for F_2 generation.

Effect of natural host and adult diet on ovariole number, egg production and longevity: Twenty (10♀x10♂) newly emerged adults (F_2) from respective hosts were separated into small cages (15×12×15 cm) and were fed on two different adult diets mentioned above. After 14 days mature females were anesthetized in chloroform vapour and were dissected in saline water. The number of ovarioles was counted under Nikon sterio-microscope. To determine the influence of natural host and adult diets on fecundity, newly emerged 5 pair adults (5♀x5♂) against each host were placed in small cages in two groups and fed on proteose-peptone:sugar (1:4) and yeast:sugar (1:3) separately. At the age of 14 days plastic vials perforated with holes (1.5 mm diameter and containing 30-40 holes) lined internally with respective host paste were used as egging receptacles for egg laying twice in a weak and continued until their death. Due to scarcity of snake-gourd, egg collection was not possible using the corresponding host paste.

Longevity of the egging insects was also recorded against each host and adult diet. To record the longevity of non-egging insects the rest of the adults (F_2) were also separated in two cages against the respective host and also fed on two types of artificial adult diets. All experiments were conducted in controlled laboratory condition at 28±2°C and 85±5% RH and repeated three times.

Statistical analysis: All data obtained were statistically analysed using computer package Minitab, version-13.1. DMRT, one-way and two-way Analysis of Variance (ANOVA) were performed.

RESULTS

Table 1 showed the pupal quality and subsequent percentage adult emergence of *B. cucurbitae* reared in seven different natural hosts. The mean pupal weight were 20.9±2.0, 16.5±1.6, 15.5±1.7, 15.0±2.1, 14.8±1.4, 14.4±1.3 and 14.0±2.9 mg for sweet gourd, bitter gourd, ribbed gourd, cucumber, ash gourd, snake gourd and sponge gourd, respectively. Sweet gourd ranked the highest in terms of pupal weight and adult emergence, although maximum number of pupae was collected from ash gourd (466±5.5 and 535±4.0 at F_1 and F_2 generation, respectively). Mean pupal weight and the percentage adult emergence from all the natural hosts were slightly higher at F_2 generation than F_1 generation.

Significant ($p<0.05$) differences were observed among ovariole numbers of flies reared on seven different natural hosts and two different adult diets (Fig. 1). Interaction between adult diets and natural hosts in terms of ovariole number was also significant (Table 2). Higher ovariole number (67.33±8.50) and egg production (199.02±5.0) were observed in flies reared on sweet gourd and fed on proteose-peptone:sugar at 1:4 ratio. Mean ovariole number (24.66±4.6) and egg production (32.40±5.0) was significantly lower in case of flies reared on sponge gourd and fed on yeast: sugar (1:3), respectively (Fig. 2).

Table 1: Quality of pupae and adult emergence of melon fly *B. cucurbitae* reared in seven different natural hosts at F_1 and F_2 generations

	F_1 generation			F_2 generation		
Hosts	No. of pupae	Weight (mg) Mean±SD	Adult emergence (%)	No. of pupae	Weight (mg) Mean±SD	Adult emergence (%)
Sweet gourd	355	20.90±2.09^{a}	88.00	429	21.17±2.54^{a}	98.00
Bitter gourd	330	16.58±1.68^{ab}	82.00	379	18.86±2.67^{a}	87.00
Ash gourd	466	14.89±1.43^{b}	64.00	535	15.17±1.79^{bc}	77.00
Cucumber	292	15.09±2.12^{b}	78.00	339	18.74±3.49^{a}	79.00
Ribbed gourd	242	15.52±1.73^{b}	74.00	324	16.90±1.71^{b}	74.55
Snake gourd	235	14.48±1.33^{bc}	74.00	305	16.29±1.83^{b}	72.35
Sponge gourd	219	14.07±2.09^{bc}	54.00	287	14.73±2.84^{bc}	64.33

Figures in a column having same letter(s) do not differ significantly at 0.05% (DMRT)

Table 2: Interaction between adult diets and natural hosts on the ovariole number of *B. cucurbitae*

Factors and interaction	df	F	p-value
Adult diets	1	909.48	0.000***
Natural hosts	5	257.85	0.000***
Interaction	5	31.08	0.000***
Error	24		
Total	35		

*** Highly significant (p<0.001, two-way ANOVA) df = Degree of freedom, F = Frequency, P = Probability

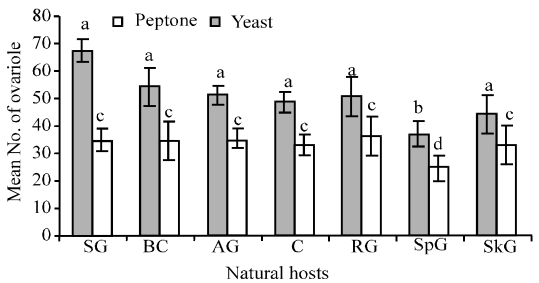

Fig. 1: Mean (±SE) ovariole number of *B. cucurbitae* reared in seven different natural hosts and fed on two different adult diets. Bars among same treatment group with different letters differ significantly (p<0.05, Tukey's pairwise comparison test). SG = Sweet gourd, BC = Bitter gourd, AG = Ash gourd, C = Cucumber, RG = Ribbed gourd, SpG = Sponge gourd, SkG = Snake gourd

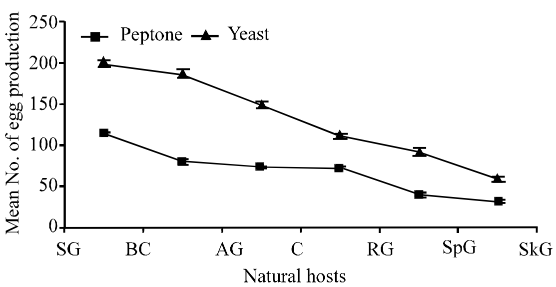

Fig. 2: Mean (±SE) egg production of *B. cucurbitae* reared in six different natural hosts and fed on two different adult diets. SG = Sweet gourd, BC = Bitter gourd, AG = Ash gourd, C = Cucumber, RG = Ribbed gourd, SpG = Sponge gourd

Mean longevity (Fig. 3) of non-egging adult (88.77±4.0 and 76.33±4.0 days) was comparatively higher than the egging adults (56.47±2.0 and 50.73±4.0 days) when fed on proteose-peptone:sugar and yeast: Sugar, respectively (Fig. 4).

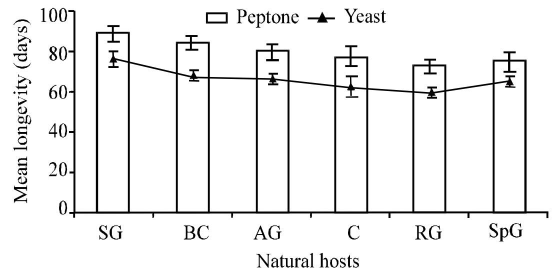

Fig. 3: Mean (±SE) longevity of *B. cucurbitae* from those egg was not collected, reared in six natural hosts and fed on two adult diets. SG = Sweet gourd, BC=Bitter gourd, AG = Ash gourd, C = Cucumber, RG = Ribbed gourd, SpG = Sponge gourd

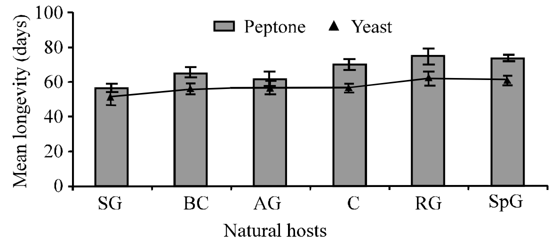

Fig. 4: Mean (±SE) longevity of *B. cucurbitae* from those egg was collected, reared in six natural hosts and fed on two adult diets. SG = Sweet gourd, BC = Bitter gourd, AG= Ash gourd, C = Cucumber, RG = Ribbed gourd, SpG = Sponge gourd

DISCUSSION

The present experimental results are in agreement with the previous findings of Saha *et al*. (1996) confirming that sweet gourd is the best natural host for *B. cucurbitae* both in terms of pupal quality and adult emergence (Table 1).

Partially similar to the present experiment, a broad positive relationship between natural host range and ovariole number in 14 different species from the genus *Dacus* has been reported by Fitt (1990a). The author suggested that the observed relationship between ovariole number and host range were tentative. Highly poly phagaous *Dacus* species had 35 to 40 ovarioles per ovary while the specialist species ranged from 8 to 20 ovariole. In fruit fly usually each ovariole give rise to one mature egg at a time. Fitt (1990b) recorded the higher number of ovarioles in *Dacus tryoni* (Froggatt) (38 ovarioles per ovary) compared to *D. jarvisi* (Tryon) (27 ovarioles per ovary) which also resulted in higher number of egg production. In the present experiment similar trends of more ovariole number and higher egg production of mature female reared on sweet gourd at larval stage and fed on proteose-peptone:sugar (1:4) as adult diet were recorded compared to others adult reared on six different hosts and fed on yeast:sugar (1:3). The observation of Khan *et al.* (2000) on the effect of natural hosts and adult diets on the ovariole number of *B. dorsalis* also supports the present finding.

Higher egg production observed in the present experiment on proteose-peptone:sugar fed than yeast:sugar fed diet indicated the fact that not only the protein but also the sources of protein is important for higher egg production of *B. cucurbitae* (Fig. 2). The present finding is also in agreement with the previous observations reported by several authors (Huda *et al.*, 1983; Khan *et al.*, 2000; Nakamori and Kakinohana, 1980; Saha *et al.*, 1996). Moreover, Meats and Leighton (2004) noted that adult female of *B. tryoni* at 25°C required more than 0.1 mg of yeast autolysate per day to mature their oocytes to the vitellogenic stage and mate which indicate that the quantity of protein is also important.

Saha (2003) reported higher longevity of blow fly *Lucilia cuprina* (Wied) at different seasons (winter, autumn and summer) when supplied with additional protein than the normal feeding with sugar and water only. In the present experiment it is difficult to raise a simple explanation as to why longevity of adult access to similar sources of protein varied while egging and non-egging conditions were considered at the same temperature. The experimental results may be explained by the influence of both the intrinsic and extrinsic environmental condition (nutrition, soundness, etc).

However, the present experimental results suggested that sweet gourd is most suitable natural host for *B. cucurbitae* in terms of ovariole number, pupal quality and adult emergence. Proteose-peptone and sugar (1:4) can be recommended for the higher egg production of the fly species which will help to boost the mass rearing directed towards SIT. It needs further investigation on the relation between food and environmental condition on the development of oocytes and egg production and also the relation between protein ingestion and longevity of flies in egging and non-egging condition.

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