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Biology and host suitability of cucurbit fruit fly, *Bactrocera cucurbitae* (Coq.): a comparative study on five different cucurbit species

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Abstract: Five different cucurbits namely; squash (*Cucurbita pepo*), bottle gourd (*Lagenaria siceraria*), sweet gourd (*Curcurbita moschata*), bitter gourd (*Momordica charantia*) and snake gourd (*Trichosanthes anguina*) were tested under laboratory condition for the host suitability and comparative biology of cucurbit fruit fly, is a major pest of cucurbitaceous vegetables. Fecundity, oviposition and incubation period was high on squash, sweet gourd and bottle gourd compared to bitter gourd and snake gourd. The mean larval period was longest (8.67 days) on bitter gourd and shortest on squash (7.00 days).The duration of pupal period differed significantly among the hosts and it was highest in squash (8.33 days). Both male and female longevity was highest on squash (45.62 days for male and 48.33 days for female) where as shortest longevity was recorded on bitter gourd (25.33 days for male and 26.00 days for female). The duration of life cycle of fruit fly was almost double on sweet gourd, bottle gourd or squash compared to other two hosts irrespective of sex. Based on most of the biological attributes, the suitability of five host species for cucurbit fruit fly was ranked as squash > sweet gourd >bottle gourd > snake gourd > bitter gourd.

Key words: Suitability, biology, cucurbit, *Bactrocera cucurbitae.*

Introduction

Tephritidae consists of over 4000 species, of which nearly 250 species are of economic importance, and are distributed widely in temperate, sub-tropical and tropical regions of the world (Christenson and Foote, 1960). Amongst them, the cucurbit fruit fly, *Bactrocera cucurbitae* (Coq.) is one of the destructive tephritid of cucurbitaceous vegetables (Dhillon *et al.*, 2005a; Biswas *et al*., 2007). *B. cucurbitae* has a wide range of host plants. Till now over 125 plant species have been recorded as hosts for this tephritid species of which 81 plant species belonging to the family Cucurbitacae.

Host suitability indicates how closely or appropriately an insect colonized with its host for its safe life cycle, biological development as well as feeding that's obviously regulates by nutritional and physiological condition of the host. Host suitability always positively correlates with extent of damage of particular insect and it is well reported that some cucurbits but not all are very much suitable for fruit flies feeding and life cycle and extent of damage of those cucurbits were very high (Dhillon *et al*., 2005a).

Different cucurbit species respond differentially to cucurbit fruit fly in respect of host preference as well as biological parameters. A group of scientists conducted a series of experiments to solve these issues on the basis of morphological features of the hosts, biochemical contents and role of secondary compounds (Cucurbitacins) in regulating ecdysteroid receptors at the cellular level (Dinan *et al*., 1999; Dhillon *et al*., 2005b). Although many investigations were done till now on the biology of cucurbit fruit fly on different hosts but we made our effort to find out a detailed comparative biology of *B. cucurbitae* on five top most commercial cucurbits in Bangladesh because pest biology provides important information about their nature of damage and appropriate control measures.

Materials and Methods

This study was conducted in the laboratory of the Department of Entomology, Bangladesh Agricultural University, Mymensingh during the period from September 2006 to June 2007 on the host suitability and biology of cucurbit fruit fly, *Bactrocera cucurbitae* on five different cucurbits. Squash (*Cucurbita pepo*), bottle gourd (*Lagenaria siceraria*), sweet gourd (*Cucurbita moschata*), bitter gourd (*Momordica charantia*) and snake gourd (*Trichosanthes anguina*) were taken as hosts for the study.

B. cucurbitae was reared on artificial diet, composed of sugar, yeast hydrolysate and water. The diet was prepared by properly mixing of yeast and sugar with 1:3 ratios. 25-35^{0}C temperature and 60-85% humidity were recorded during rearing period.

To keep a ready supply of fruit flies to meet our experimental aim, infested bottle gourd were collected from local market and kept in a plastic container for adult emergence. After getting adult, they were stocked in a wooden frame cage (60x50x45cm.) covered with nylon net and were carefully supplied with prepared artificial diet and water soaked in cotton. Rearing was continued up to five generations with bottle gourd. Experiments were started with generation five and continued with later generations.

Fifty adult fruit flies (male and female, 1: 1) were released for oviposition on each host after a period of 24 hours to get the next stages. Plastic bottles (10 x 13cm) with 1800-2000 holes (0.5), internally lined with a sheet of 50-mesh nylon net, inside the wooden cage for egg collection. The net was initially soaked with water to avoid water desiccation. The vegetables containing eggs were taken out and kept separately in plastic container to get larvae. Similarly, mature larvae were kept in a plastic container with sawdust for pupae collection and emergence of adults later. The adults were kept separately and maintained in a similar way as in the stock culture until death.

Data were collected on fecundity, oviposition and incubation period of eggs, larval and pupal durations, longevity of male and female adult three times a day and finally the total life span *B. cucurbitae* on five selected hosts. Based on these biological attributes, the suitability of five host species for cucurbit fruit fly was

ranked. All the data were analyzed statistically following one factor Completely Randomized Design (CRD) and the mean differences were adjudged with Duncan's Multiple Range Test (DMRT).

Results

Fecundity, oviposition and incubation period of the eggs of *B. cucurbitae*

Fecundity

Host variation had a significant effect on the fecundity (total number of eggs laid per female) of *B. cucurbitae* (Table1). Squash showed the most suitable host for egg laying (237.53 ± 17.87) among five different hosts. The flies reared on sweet gourd had the second highest fecundity (201.35 ± 9.72) which was followed by bottle gourd (167.24 ± 10.34). The lowest numbers of eggs were laid by the flies reared on bitter gourd (126.59 ± 2.37) which was closely followed by the snake gourd (143.70 ± 7.40). The difference among different hosts with respect to the fecundity of the adults were statistically significant (P<0.01) where bitter gourd and snake gourd showed the insignificant difference.

Table 1. Fecundity, oviposition and incubation period of the eggs of *B. cucurbitae* reared on five different hosts

Hosts	Total number of eggs laid per female (mean ± SD)	Oviposition period (days) (mean ± SD)	Incubation period (days) (mean ± SD)
Squash	237.53 ± 17.87a	35.33 ± 2.08a	24.25 ± 0.82b
Bottle gourd	167.24 ± 10.34c	26.67 ± 1.53b	25.25 ± 0.82b
Sweet gourd	201.35 ± 9.72b	35.00 ± 1.00a	25.50 ± 0.50b
Bitter gourd	126.59 ± 2.37d	21.31 ± 0.58c	28.00 ± 1.26a
Snake gourd	143.70 ± 7.40d	24.62 ± 1.53bc	27.25 ± 0.82a

* In a column, means followed by the same letter (s) are not significantly different.

Oviposition period

Oviposition period of *B. cucurbitae* was significantly influenced by different hosts (P<0.01) (Table 1). A profound variation was observed among the flies reared on different host. The highest oviposition period was found in the flies reared on squash (35.33 ± 2.08 days) which was followed by sweet gourd (35.00 ± 1.00 days) and the differences between these were insignificant. The lowest oviposition period (21.31 ± 0.58 days) was found in case of the flies reared on bitter gourd. Bottle gourd and snake gourd had the oviposition period of 26.67 ± 1.53 days and 24.62 ± 1.53 days respectively.

Incubation period

The incubation period of the eggs (Table 1) varied significantly among different hosts (P<0.01). The highest 28.00 ± 1.26 days of incubation period was found on bitter gourd which was followed by snake gourd (27.25 ± 0.82 days). The lowest incubation period of 24.25 ± 0.82 days was observed on squash followed by sweet gourd (25.50 ± 0.50 days) and bottle gourd (25.25 ± 0.82 days).

Larval period of *B. cucurbitae*

The mean larval duration varied significantly among five different hosts (Table 2, P<0.01). The highest duration was recorded on bitter gourd (8.67 ± 0.58 days) which was closely followed by snake gourd (8.33 ± 0.66 days) and sweet gourd (7.67 ± 0.58 days) and showed the significant difference among the hosts.

Table 2. Larval and pupal period of *B. cucurbitae* reared on five different hosts

Hosts	Larval period (days) (mean ± SD)	Pupal period (days) (mean ± SD)
Squash	7.00 ± 0.58c	8.33 ± 2.50a
Bottle gourd	7.33 ± 0.12bc	6.33 ± 0.58b
Sweet gourd	7.67 ± 0.58bc	7.00 ± 0.33b
Bitter gourd	8.67 ± 0.58a	5.33 ± 0.12c
Snake gourd	8.33 ± 0.66b	6.67 ± 0.58b

*In a column, means followed by the same letter (s) are not significantly different.

Moreover, larval duration was the lowest on squash (7.00 ± 0.58 days) and then on bottle gourd (7.33 ± 0.12 days). Similarly, the larval period on squash, bottle gourd and sweet gourd were found to be a par statistically.

Pupal period of *B. cucurbitae*

Different cucurbit hosts had significant effect on the duration of mean pupal period (Table 2). The mean pupal period was the shortest on bitter gourd (5.33 ± 0.12 days) and appeared to be the highest on squash (8.33 ± 2.50), compared to others. The bottle gourd, sweet gourd and snake gourd showed the almost same mean pupal duration.

Longevity of male and female adult

The cucurbit hosts were found to have a significant effect on the longevity of the flies (Table 3). The

highest longevity of male was found on squash (45.62 ± 1.51 days) followed by sweet gourd (45.00 ± 2.52 days) and they differed significantly from the rests of the hosts. Table 3 also indicated that bitter gourd was the most unsuitable host for the survival of male *B. cucurbitae* (25.33 ± 2.00 days) which was closely followed by snake gourd (28.62 ± 1.00 days) and they differed insignificantly from each other. Like as male, female also showed the highest longevity on squash followed by sweet gourd and bottle gourd. The lowest female longevity was recorded on bitter gourd (26.00 ± 1.53 days) and then on snake gourd (29.33 ± 0.58 days) and they showed insignificant differences.

Table 3. Longevity of adults of *B. cucurbitae* reared on five different hosts

Hosts	Adult longevity (days) (mean ± SD)	
	Male	Female
Squash	45.62 ± 1.51a	48.33 ± 0.58a
Bottle gourd	35.67 ± 3.00b	37.00 ± 1.53b
Sweet gourd	45.00± 2.52a	48.00 ± 0.66a
Bitter gourd	25.33 ± 2.00c	26.00 ± 1.53c
Snake gourd	28.62 ±1.00c	29.33 ± 0.58c

In a column, means followed by the same letter (s) are not significantly different.

Total life span of male and female flies

Figure1 showed that the duration of life span of female was the highest on sweet gourd (62.13 days) which was almost identical to the squash (58.03 days) and the lowest on bitter gourd (28.43 days) which was statistically identical to the snake gourd (31.33 days). The bottle gourd showed an intermediate duration (53.13 days) compared to rest of the four. The female flies lived longer than the males. Life span of male was the highest on sweet gourd (60.13 days) which was statistically identical to squash (58.7 days). Total life span of cucurbit fruit fly was much shorter on bitter gourd which was identical to the snake gourd.

Discussion

In this experiment, we studied the biology and host suitability using five different cucurbit species e.g. squash, bottle gourd, sweet gourd, snake gourd and bitter gourd. Till recently, a series of experiments were done on the biology and host suitability of *B. cucurbitae* on different cucurbit species and they reported almost a similar result but some cases yielded controversial results and explanation.

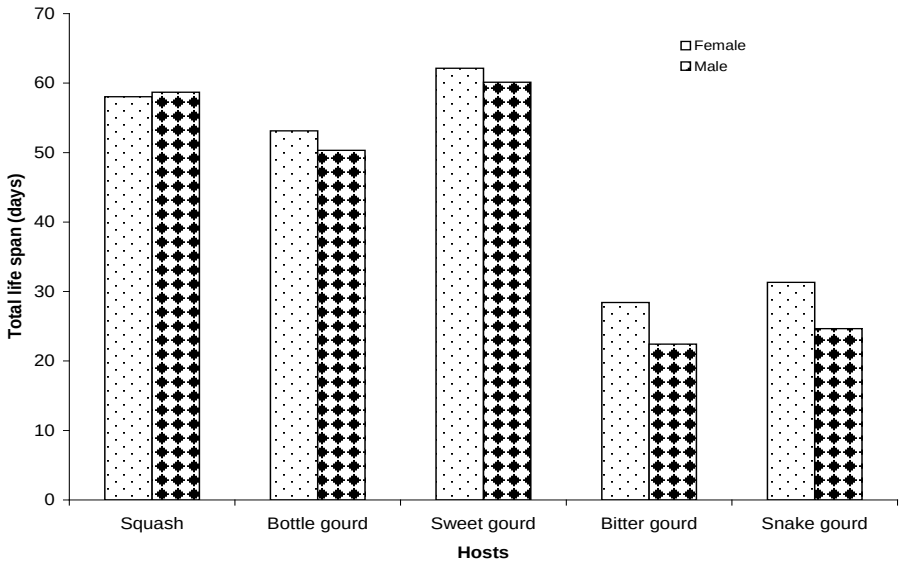

Fig. 1. Total life span of male and female cucurbit fruit fly, *B. cucurbitae* reared on five different cucurbit species

For these controversial results and explanations, different factors may be responsible here e.g. experimental zone, environmental conditions, host selections, methodological differences, etc. Along with these factors, morphological features of the hosts, nutritional variations and role of secondary compounds (cucurbitacins) in regulating insect ecdysteroid receptors in cellular level might be underlying factors also.

Table1 clearly indicated that there had no significant differences among the hosts squash, bottle gourd and sweet gourd regarding the fecundity as well as oviposition period where bitter gourd and snake gourd showed a significant difference with those three hosts. Yang *et al.*, (1994) also found almost the same results in their study. But unexpectedly insignificant differences were observed regarding incubation period among five different hosts.

It was also evident that both larval and pupal period, longevity and total life span of male and female adults were even high when flies were reared on squash, bottle gourd and sweet gourd compared to bitter and snake gourd (Table 3 and Figure 1). These results made a close agreement with the findings of Koul and Bhagat (1994) and Dhillon *et al.*, (2005a) but Samalo *et al.*, (1991) reported different result. It is still a controversial issue why different cucurbit species

respond differentially to cucurbit fruit fly in respect of host preference as well as biological parameters.

Boller and Prokopy (1976) reported that host preference of cucurbit fruit fly potentially regulated by different morphological factors of the host plants e.g. hairiness, color, smell, fruit structure etc. Hairiness, color and smell of the host plants interfere with feeding and oviposition by the insects. Fruit length, fruit diameter, roughness of the fruit surface, flesh thickness, number of ribs per fruit, and depth of fruits also positively correlated egg laying, oviposition, incubation, larval and pupal duration and total life span of test insect. Chelliah and Sambandam (2001) recently reported that egg laying by the fruit fly was 17.77% in fruit having rough surface or tough rind in *Cucumis callosus* when compared with smooth surface (87.33%).

Biochemical traits of the host plants keep a potential role in ranging of host-fly interaction as well as host suitability as Chelliah and Sambandam (2001) suggested that perception of chemical stimuli is well developed in *B. cucurbitae*. Very recently Dhillon *et al* (2005b) reported that ascorbic acid, nitrogen, phosphorus, potassium, protein, reducing, non-reducing and total sugars are the vital bio-chemical factors keep role in regulating different biological parameters as well as host suitability.

Dinan *et al*., (1997) recently conducted a series of experiments on cellular interaction of ecdysteroid receptors and the cucurbitacins. They mentioned that when carbon-carbon double bond cannot be hydrogenated, cucurbitacins may become antagonist at ecdysteroid receptors i.e. structure of the ecdysteroid receptors become change and as a result hormone can not bind with its specific receptor. The interruption of hormone-receptor binding, negatively affect insect growth, development, total life span as well as host preferences. In the present study we have found that adult flies had the lowest life span on bitter and snake gourd suggesting that the cucurbitacins in these two species acted might have as the antagonist of ecdysteroid receptors which may be absent in rest of the three species.

Pareek and Jakhar (2003), Bhagat and Koul (1999) and Yang *et al*., (1994) also reported that some environmental factors e.g. temperature, humidity, day length, sunshine might also the regulating factors which plays vital role in variation with preference of hosts. As per the present findings and the previous explanation, it raises the possibility that the morphological features and bio-chemical contents of each host, environmental factors as well as cucurbitacins invariably regulate the biology and host suitability of *B. cucurbitae*.

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