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SKEWED DISTRIBUTION OF MELON FRUIT FLIES, *Bactrocera cucurbitae* (COQUILLETT) OWING TO COLOUR PREFERENCE

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ABSTRACT

Bactrocera cucurbitae **(Coquillett) is a melon fruit fly which is known to infest vegetables and fruits of plants that belong to family Cucurbitaceae. These flies are known to show their preferences to specific volatile chemical substances indicating the role of olfaction in selecting the host plant and site of oviposition. We tried to see the role of visual stimuli based on colour differences for the distribution of these flies. Flies were introduced in large plastic jars which were half coloured and half transparent, to see their distribution pattern in the two separate parts of jar. The experiments were conducted by using five different types of colour and the results obtained clearly indicate that significantly more number of flies settle in the area where the colour matches with their natural food materials. Based on the results, a strategy can be designed to trap and kill this pest fly by using colour specific flash lights.**

KEYWORDS: Colour Preference, Visual Stimuli, Integrated Pest Management, *Bactrocera cucurbitae*

Bactrocera cucurbitae, commonly called as melon fruit fly is one of the most destructive insect pests that belong to family Tephritidae of order Diptera. It infests on wide range of fruits and vegetables, mostly belonging to plants of Cucurbitaceae. This tephritid fly is evenly distributed throughout the India and attacks on wide range of cucurbit plants. From India itself, about 81 host species are reported which are infested by this species and causes profuse economic losses ranging from 30 to 100% (Dhillon et al, 2005). The larvae of this fly feed upon economically most important parts of fruits and vegetables and deter its quality completely. Farmers face problems in selling their produce if the infestation is noticed by the buyers. The adult female lays its egg below the hard covering of fruits/vegetables by penetrating its protruding ovipositor. The eggs hatch into larvae which feed upon fruit flesh. The adult in nature feed on sugary contents, resins released from fruits and plant parts. This fly due to its higher destructive nature has been considered as federal quartine pest in India and in many other countries (Mir et al, 2014). Other than degrading fruit quality, this pest also leads to decrease trade value and export due to strict regulations by importing countries (Chen et al, 2007).

In the present study, we observed the response of adult flies towards the different colour to check the host associated visual cue on its behavior. Host associated visual signal maybe one of the stimuli for adult flies to come over and sit and female lay eggs on the fruits or vegetables. Thus knowledge of colour preference by flies can be applied to control of this pest by providing coloured unprofitable crop as a trap or also can be utilized to lure the flies towards the coloured source of light and kill them right at the spot. This trap killing may be substantially enhanced by using certain olfactory stimuli to increase its efficacy under integrated pest management (IPM).

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MATERIALS AND METHODS

Fly Culture

Pumpkins infested by eggs and larvae of melon fly were collected from local fruit market, brought to laboratory and placed on moist soil in rearing jar (diameter 25cm, height 46 cm) for pupation. Newly emerged flies were collected and sexed within 24 hours and confined to new jar. The current study was performed on flies reared in laboratory condition for more than ten generations. Flies were fed on sucrose and yeast extract mixture in the ratio of 3:1 and additional water was provided to the flies through water soaked cotton ball. Fresh food and water was provided on every third day. Sexually mature flies of 8 to 10 days age were fed on fresh slice of pumpkin which they used for egg laying also. For experimental purpose, flies aged between 10 to 12 days were employed. These flies were maintained in the laboratory at 26±2°C temperature, 65±5% relative humidity and 12:12 light and dark cycle.

Experimental Setup

Five separate plastic jars, having a specific half colour and half transparent portions were used to see the distribution of flies. The coloured portion contained either yellow or green or black or brown or white colour. Thirty sexually mature virgin flies (aged for 10 to 12 days) of a particular sex were introduced into the jar and waited for 25 minutes to make them habitual to the surrounding. Before using flies for experiment, they were starved for 3 hours.

All experiments were performed between 11AM to 1PM. Counting of flies settled in coloured and transparent area of the jar commenced at the completion of twenty five minutes of habituation. Each experiment was repeated thrice by using fresh set of flies.

Statistical Analysis

Difference between number of flies distributed in coloured and transparent regions of the jar was checked by using χ^2 test. Based on the assumption that flies are not influenced by colour, equal number of flies in coloured and transparent areas would be present. Therefore the expected number was computed at 1:1 ratio for flies present in coloured and transparent portion of the jar. Significant difference between observation and expectation was considered to be statistically significant ($p<0.05$). The graphical representation was achieved by using Microsoft excel 2007.

RESULTS AND DISCUSSION

The number of flies of a specific sex, present in the coloured and transparent part of the plastic jar was counted. Table 1 depicts observed and expected numbers of male and female fruit flies present in five different colours and transparent regions of the jar. In case of male, significant difference in the distribution pattern was noticed for all the colour except for white. However, very high significant difference ($p<0.001$) was observed in case of yellow and green colour. It was distinctly seen that flies show high preference for these two colours. The number of male flies introduced in the jars with black and brown colours did not show their preference for these two colours and deviated towards transparent part and the difference in distribution pattern was found to be statistically significant. Females analyzed for same behavior also showed colour preference and were found to incline towards yellow, green and white colours. Black and brown colours made female flies to avoid the area and sat in significantly more number towards transparent part. Graph showing number of male and female flies in coloured and transparent regions is presented in figure1.

Results of the above experiments clearly show that melon fruit flies show their preference for colour mainly matching the host food materials. These flies (both sexes) are significantly attracted towards the yellow and green colours. In fact, these two colours mimic the fruit/vegetable colour of most cucurbits. In natural conditions, a female fly has to successfully search a host material to oviposit her eggs where their maximum survival could be ensured. To understand the natural instincts working in them for such preference, it can be said that visual as well as olfactory stimuli play important role. The present experiment clearly establishes the fact that in *B. cucurbitae* visual stimuli do contribute for the selection of food item for feeding as well as oviposition. On the other hand black and brown colours deter the flies from sitting over there. For white colour, females showed significant preference but males didn't show any significant attraction. When fruits and vegetables having dark colours like brinjal, black grapes etc are considered for their infestation with this insect fly, it is found that such items are not infested by them at all. Further, the specific odour stimulus of the chemicals that cucurbits possess, are lacking in brinjal and black grapes and therefore do not attract the flies.

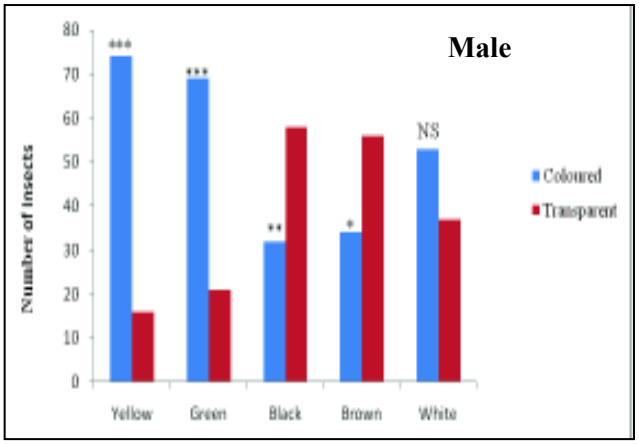
It has been reported in several studies performed on *Bactrocera dorsalis* and other phytophagous insects that the colour and odour of floral plant parts are primary cue for insect's attraction and foraging behaviour (Aluja and Prokopy, 1993; Prokopy and Vargas, 1996; Drew et al, 2003; Brevault and Quilici, 2007; Prokopy and Owens, 1978; Damodaram, 2014). Our study clearly shows that these flies have clear-cut colour vision. They are significantly attracted towards colours that mimic the fruit colour of most of their host plants. Our results are in consistency with the reports of Pinero et al, 2006, who also confirmed that these flies have colour attraction. Pinero also suggested that visual cue also stimulates sexually mature female to find host for egg laying. Studies conducted so far have involved only female flies to see their preference for colour (Pinero et al, 2006) and a positive response for colour preference in them were recorded. In this study, we considered both sexes separately to observe this phenomenon and found that males as well as females show almost similar behavior for colour choice. Therefore there is no sex specific attraction towards any colour. It is well known that the selection of host plant by an organism either for feeding or for egg laying or for mating purposes are primarily induced by visual cues which guide the insects to the host plants (Balagawi, 2005; Rattanapun 2009). It has been reported that the colour contrast of host plant against its background is most important in finding the host (Nakagawa et al, 1978; Prokopy and Owens, 1983). If one tries to know whether visual stimuli play primary role to attract the melon flies or the chemical odour that diffuse from the food source, then this finding has an answer. The jars did not contain any natural food material or synthetic

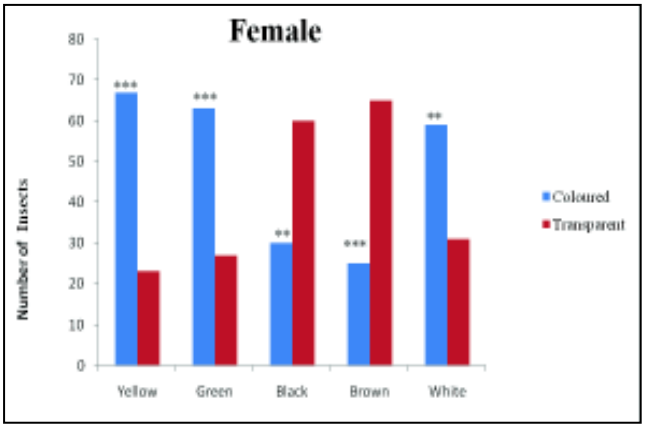
attractant and therefore their significant difference in distribution was only due to colour difference.

Knowledge of colour preference by this tephritid fly can be applied for control of this pest in the trap capture and kill method under integrated pest management (IPM). Associating appropriate visual stimuli with olfactory stimuli can maximize the efficacy of trap capture. Also it can be used to gather mass reared hymenopterans used as biological control agents against insect pest like some parasitoid like *Biosteres arisanus* are attracted to yellow colour (Vargas et al, 1991). In short, our results show that there is strong attraction of flies towards the yellow and green colour and deterred strongly from black and brown colours. Larvae of this pest fly prefer to stay in dark surroundings. Since the entire larval stage grows in the vegetable into which the female parent lays her eggs, it is quite natural for the larval form to feed the food available and remain protected in such covered shelter. Whereas the adults form have to lead a different sort of life, making efforts to find a suitable mate, selecting appropriate host plant or food material to lay her eggs. Therefore colour preference becomes inevitable for adults forms.

Table 1: Observed and expected (in parentheses) numbers of male and female melon fruit flies in different colour and transparent regions of the jar

	Male (N=90)	Female (N=90)
Yellow	74 (45)	67 (45)
Transparent	16 (45)	23 (45)
χ^2	37.4***	21.5***
Green	69 (45)	63 (45)
Transparent	21 (45)	27 (45)
χ^2	25.6***	14.4***
Black	32 (45)	30 (45)
Transparent	58 (45)	60 (45)
Chi-square	7.4**	10**
Brown	34 (45)	25 (45)
Transparent	56 (45)	65 (45)
χ^2	5.4*	17.8***
White	53(45)	59 (45)
Transparent	37 (45)	31 (45)
χ^2	2.8	8.8**





* p<0.05, **p<0.01, ***p<0.001

Figure 1: Graph showing number of male and female flies in coloured and transparent regions

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