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*Full Length Research Paper*

# Damage assessment and management of cucurbit fruit flies in spring-summer squash

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**Cucurbit fruit fly, *Bactrocera cucurbitae* (Coquillett), is one of the most important pests of cucurbits, and squash (*Cucurbita pepo* Lin.) is highly prone to damage by this pest in Nepal. Because of the difficulties associated with the control of this pest by chemical insecticides, farmers experienced great losses in cucurbits. Therefore, a participatory field experiment was conducted under farmer field conditions to assess losses and to measure the efficacy of different local and recommended management options to address the problem of it in squash var. Bulam House ($F_1$). The experiment consisted of six different treatments including untreated control, and there were four replications. All the treatments were applied 40 days after transplanting. Cucurbit fruit fly preferred young and immature fruits and resulted in a loss of 9.7% female flowers. Out of total fruits set, more than one-fourth (26%) fruits were dropped or damaged just after set and 14.04% fruits were damaged during harvesting stage, giving only 38.8% fruits of marketable quality. Application of locally made botanical pesticide 'Jholmal' was found superior in terms of fruit size (895 g), quality and yield (62.8 t/ha), and reduced fruit fly infestation in squash as compared to other treatments. Although, 'Jholmal' preparation is easy and its application is effective for the management of cucurbit fruit fly, it involves more labor cost and frequent application is a tedious process. Future efforts should be made to find the ways to reduce the cost of its application to make vegetable cultivation more profitable.**

**Key words:** *Bactrocera cucurbitae, Cucurbita pepo*, pesticide, melon fly, food baits.

## INTRODUCTION

The cucurbits such as cucumber, bitter gourd, sponge gourd, ridge gourd, bottle gourd, snake gourd, ash gourd, chayote, pointed gourd, and pumpkins are some of the major vegetables grown across Nepal. Several biotic factors limit the production and productivity of cucurbits, of which cucurbit fruit fly (*Bactrocera cucurbitae* Coquillett) has been the most prominent pest over the last several decades in Nepal (Manjunathan, 1997; GC and Mandal, 2000). Depending on the environmental conditions and susceptibility of the crop species, the extent of losses varies between 30 to 100% (Gupta and Verma, 1992; Dhillon et al., 2005a, b, c; Shooker et al., 2006). The field experiments on assessment of losses caused by cucurbit fruit fly in different cucurbits been reported 28.7 - 59.2, 24.7 - 40.0, 27.3 - 49.3, 19.4 - 22.1, and 0 - 26.2% yield losses in pumpkin, bitter gourd, bottle gourd, cucumber, and sponge gourd, respectively, in Nepal (Pradhan, 1976) . Considering previous facts and reports, it is apparent that >50% of the cucurbits are either partially or totally damaged by fruit flies and are unsuitable for human consumption. Although, several management options, such as hydrolyzed protein spray, para-pheromone trap, spraying of ailanthus and cashew leaf extract, neem products, bagging of fruits, field sanitation, food baits, and spray of chemical insecticides (Pawar et al., 1991; Zaman, 1995; Neupane, 1999, 2000; Akhtaruzzaman et al., 2000; GC and Mandal, 2000; Satpathy and Rai, 2002; Dhillon et al., 2005c; Palaniappan and Annadurai, 2006; Jacob et al., 2007) have been in use for the management of cucurbit fruit fly, some of them either fail to control the pest and/or are uneconomic and hazardous to non-target organisms and the environment (Manjunathan, 1997; Singh and Singh, 1998; Neupane, 2000; Dhillon et al., 2005c) . In mid hill district of Nepal, farmers attempted different methods of management, like indigenous (70%), chemical (32%),

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**Picture 1**. Adult female of cucurbit fruit fly.


**Picture 2.** Different stages of squash fruit damaged by cucurbit fruit fly. **A.** Pre-set damage, **B.** Post-set damage, **C.** Harvested damage.

mechanical (80%) and combination of two or more methods (68%) to combat the problems of fruit fly.

(Sapkota, 2009). Considering the hazardous impact of chemicals on non-target organisms and the environment, present studies were undertaken to assess the losses caused by *B. cucurbitae* and efficacy of different control measures aiming to develop an eco-friendly and sustainable pest management system in cucurbits (1).

**MATERIALS AND METHODS**

Pits of size 45 × 45 × 45 cm were dug at spacing of 1 × 1 m as per the recommendation of Rajan and Markose (2001). Then, twenty - eight days old seedlings of popular squash var. Bulam House ($F_1$) were transplanted on 25$^{th}$ January, 2008 in a pit with standard dose of manure and fertilizer 40 t FYM + 120:80:60 NPK kg/ha. Field experiment was arranged under six farmers' fields spaced at more than 500 m apart as adopted by Nasiruddin et al. (2002) in randomized complete block design (RCBD) with four replications. The treatments consisted of: 1) Cue-lure [5 drops of cue-lure (4-p-acetoxyphenyl - 2-butanone) and 10 drops of malathion treated cotton-wool wick, recharged at 15 days interval]; 2) Indigenous food bait (Fermented rice 200 g + 5 ml molasses + 4 g borax and 1 ml malathion, replaced at 4 days interval); 3) Dichlorvos (NUVAN® at 2 ml/lit water, sprayed at weekly interval); 4) Banana pulp bait (Over ripe banana 500 g + 10 ml molasses + 10 g borax and 2.5 ml malathion, replaced at 4 days interval); 5) Botanical pesticide 'Jholmal' - leaf extract with cow urine, fresh cow dung and selective spices [Half kg leaves of each: neem (*Azadirachta indica* A. Juss.), ashuro (*Adhatoda vasica* Vasaka), tulsi (*Osimum sanctum* Lin.), tomato (*Lycopersicon esculentum* Mill), titepati (*Artemisia vulgaris* Mugwort), bojho (*Acorus calamus* Calamus), marigold (*Tagetes* sp.), khirro (*Sapium insigne* Royle), chrysanthemum (C*hrysanthemum* sp.), simali (*Vitex negundo* Lin.), and 100 g of each garlic (*Allimum sativum* Lin.), chilli (*Capsucum annuum* Lin.), and ginger (*Zingiber officinale* Roscoe)]; and vi) Untreated control. Treatments were imposed on the same day just before the initiation of flowers that is 40 days after transplanting (DAT). Micronutrients (Multiplex® at 2.5 ml/litre water) were applied at 20, 40, and 60 DAT in all the experimental plots, and other management operations like irrigation, weeding, hoeing etc., were managed by the farmers as per recommendations. Sixteen interior plants (4 plants per treatment per replication) were tagged for observations in each treatment. The observations were recorded on pre-set damage or ovary damage, post-set damage (PSD), and harvested damage (HD) at three-day intervals starting from flowering till last harvest. Observations were also recorded on losses of squash fruits due to other factors than fruit fly. Total number of set fruits per plant was calculated by adding the total post-set damage and total harvested fruits per plant.

**Pre-set damage:** Unopened female flowers (ovary) damaged by cucurbit fruit fly.

**Post-set damage (PSD):** Just after set to immature fruits (<100 g) damaged by cucurbit fruit fly.

**Harvested damage (HD):** Unmarketable fruits ($\geq$100 g) damaged by cucurbit fruit fly recorded at harvest.

$$\text{Total marketable fruits (\%)} = \frac{\text{Number of harvested marketable fruits}}{\text{Total number fruits set}} \times 100$$

$$\text{HD\%} = \frac{\text{Number of harvested fruit fly damaged fruits}}{\text{Total number fruits set}} \times 100$$

$$\text{PSD\%} = \frac{\text{Number of PSD fruit fly damaged fruits}}{\text{Total number fruits set}} \times 100$$

$$\text{Harvested marketable fruit (\%)} = \frac{\text{Number of harvested marketable fruits}}{\text{Sum of total harvested fruit number}} \times 100$$

$$\text{Marketable fruit weight (\%)} = \frac{\text{Weight of harvested marketable fruits}}{\text{Sum of total harvested fruit weight}} \times 100$$

Similarly, percentage of unmarketable fruits and their weights were also calculated separately. The average weight of a marketable fruit/plant/treatment was calculated dividing the total marketable weight by the sum of the total marketable fruit number of the respective plant. Total yield per hectare (t/ha) was also computed considering the per plant yield (g/plant) as an output of 1 $m^2$ area.

The data were subjected to analysis of variance (ANOVA) using MSTATC statistical package (MSTATC, 1986), and the treatment means were compared using Duncan Multiple Range Test at P = 0.05.

## RESULTS AND DISCUSSION

### Cucurbit fruit fly damage at different stages

Average number of ovary (Pre-set) damage due to cucurbit fruit fly infestation per plant differed significantly (Table 1). Ovary damage was significantly lower in 'Jholmal', cue-lure, rice food bait and banana pulp bait treated plots than the control, however, ovary damage in control was at par with that of chemical treated plot. More than one (1.2) ovary of each plant was damaged by cucurbit fruit fly before anthesis. Out of total female flowers, 9.7% flowers did not open due to the infestation by cucurbit fruit fly. It notify that, besides genetic and environmental factors, significant variation in cucurbit fruit fly damage in the ovaries played an important role in fruit set, and yield of cucurbits.

Out of total set fruits, more than one-fourth (26%) fruits were dropped or damaged just after set, while 14.04% fruits were damaged during harvesting by the cucurbit fruit fly. Significantly higher numbers of fruits were damaged in control (32.5%) than 'Jholmal' (18.6%) and banana pulp bait (24.1%) treated plots. It was noted that the number of fruits damaged during harvesting was economically critical as compared to unopened flower damage and just after set damage. The cucurbit fruit fly favored early stages of fruits, and the infested fruits failed to develop properly and dropped-off from the plant. Earlier studies on fruit flies have also reported that the adult females preferred unopened flowers and young fruits for egg laying (Weems and Heppner, 2004; Dhillon et al., 2005a, b; Ronald and Kessing, 2007).

### Fruit set and damage

Out of total squash fruits set, 40% were damaged by cucurbit fruit fly, and 21.2% losses in fruiting bodies due to other biotic and abiotic factors, of which 66% were lost due to hailstorm and remaining 34% due to rotting, blossom end shrinkage, abnormal growth, caterpillar infestation etc. (Table 2). Remaining 38.8% fruits were of marketable size and quality. The fruit damage due to other factors than fruit fly in 'Jholmal' treated plots was significantly lower, and numbers of marketable fruits (59.7%) significantly higher than that in other treatment plots.

There were a total of 10 harvests in insecticide treated plots as compared to a total of 12 harvests in other treatments. The total fruit set was also significantly lower in insecticide treated plot (8.94) than that in other treatment plots, suggesting that the use of chemical

**Table 1.** Fruit fly damage in unopened flowers (ovary), and post set and harvested fruits of squash under farmers' field conditions during spring-summer, Lamjung, 2008.

| S.N. | Treatments | Cucurbit fruit fly damage | | |
|---|---|---|---|---|
| | | Ovary (No.) | Post-set (%) | Harvested (%) |
| 1 | Cue-lure | $0.70^{b}$ | $25.2^{abc}$ | $12.38^{bc}$ |
| 2 | Rice food bait | $1.02^{b}$ | $26.1^{abc}$ | $11.72^{bc}$ |
| 3 | Chemical treatment | $1.35^{ab}$ | $29.5^{ab}$ | $17.65^{ab}$ |
| 4 | Banana pulp bait | $1.22^{b}$ | $24.1^{bc}$ | $10.06^{c}$ |
| 5 | Leaf extract 'Jholmal' | $0.65^{b}$ | $18.6^{c}$ | $10.59^{bc}$ |
| 6 | Control | $2.27^{a}$ | $32.5^{a}$ | $21.82^{a}$ |
| Grand mean | | 1.20 | 26.0 | 14.04 |
| LSD at P = 0.05 | | 0.95 | 7.55 | 6.63 |

Values following different letters in a column are significant at P = 0.05.

**Table 2.** Total fruits set, marketable fruits and fruits damaged due to fruit fly and other factors in squash under farmers' field condition during spring - summer, Lamjung, 2008.

| S.N. | Treatments | Fruit damage (%) by | | Marketable fruits (%) | Total fruit set/plant (No.) |
|---|---|---|---|---|---|
| | | Cucurbit fruit fly | Other factors | | |
| 1 | Cue-lure | $37.6^{bc}$ | $26.8^{a}$ | $35.6^{b}$ | $12.38^{a}$ |
| 2 | Rice food bait | $37.8^{bc}$ | $23.5^{ab}$ | $38.7^{b}$ | $12.50^{a}$ |
| 3 | Chemical treatment | $47.2^{ab}$ | $23.0^{ab}$ | $29.8^{b}$ | $8.94^{b}$ |
| 4 | Banana pulp bait | $34.1^{c}$ | $29.1^{a}$ | $36.7^{b}$ | $11.50^{a}$ |
| 5 | Leaf extract 'Jholmal' | $29.2^{c}$ | $11.1^{c}$ | $59.7^{a}$ | $11.81^{a}$ |
| 6 | Control | $54.3^{a}$ | $13.8^{bc}$ | $31.9^{b}$ | $11.81^{a}$ |
| Grand mean | | 40 | 21.2 | 38.8 | 11.49 |
| LSD at P = 0.05 | | 10.28 | 10.09 | 8.83 | 2.302 |

Values following different letters in a column are significant at P = 0.05.

insecticides is inferior option in terms of fruit set and protection against cucurbit fruit fly damage in squash over the other control measures. Lower number of set fruit in chemically treated plot might be due to chemical sensitivity in flowers resulting in poor fruit set, early plant maturity, and less numbers of crop harvests as compared to other treatments. Since, the fruit fly maggots feed inside the fruiting bodies, it is difficult to control this pest with insecticides. Neupane (2000) also concluded that use of chemical pesticides to control fruit fly was only burden to the environment and increased cost of production. Similarly, Dhillon et al., (2005c) also pointed out difficulties to control this pest with insecticides.

## Damaged fruit yield

Out of total harvested fruits, over two-third (67.1%) were marketable, while the remaining 25.4% and 7.5% unmarketable fruits were damaged by cucurbit fruit fly, and other biotic and abiotic factors, respectively (Table 3).Unmarketable fruits due to cucurbit fruit fly damage in terms of numbers and weights were significantly lower in 'Jholmal', banana pulp bait, cue-lure, and rice food bait treated plot as compared to that in insecticide treated and untreated control plots.

The numbers of marketable fruits were significantly higher in 'Jholmal' treated plots (84.11%) as compared to that in other treatment plots. Furthermore, the 'Jholmal' contains nutrient enriched supplements for fruit growth and development, and the decomposed plant materials might have repelled or destroyed the successful life cycle of cucurbit fruit fly resulting in reduced fruit damage by this pest. Earlier studies have also reported that the application of 'Jholmal' increased the quality and yield of vegetables (Khatiwada and Pokhrel, 2004), neem derivatives repel insect pests of cucurbits (Budhathoki et al., 1993), and spraying of ailanthus and cashew leaf extract reduced cucurbit fruit fly attack (Jacob et al., 2007).

**Table 3.** Numbers and weights of harvested fruits of squash under different treatment conditions in the farmer's fields during spring-summer, Lamjung, 2008.

| S.N. | Treatments | Harvested fruits (%) | | | |
|---|---|---|---|---|---|
| | | Unmarketable by cucurbit fruit fly | | Marketable | |
| | | Number | Weight | Number | Weight |
| 1 | Cue-lure | 21.8[b] | 10.2[b] | 62.2[b] | 84.6[a] |
| 2 | Rice food bait | 20.3[b] | 8.7[b] | 67.6[b] | 88.4[a] |
| 3 | Chemical treatment | 36.8[a] | 16.2[b] | 63.2[b] | 83.8[ab] |
| 4 | Banana pulp bait | 19.2[b] | 8.3[b] | 69.7[b] | 88.7[a] |
| 5 | Leaf extract 'Jholmal' | 15.1[b] | 6.6[b] | 84.11[a] | 92.7[a] |
| 6 | Control | 38.9[a] | 25.3[a] | 55.9[b] | 73.5[b] |
| Grand mean | | 25.4 | 12.6 | 67.1 | 85.6 |
| LSD at P = 0.05 | | 11.69 | 8.77 | 12.96 | 9.46 |

Values following different letters in a column are significant at P = 0.05.

## Conclusion

The present studies conclude that the cucurbit fruit fly causes significant damage in squash preferably in young and immature stages. The cucurbit fruit fly causes about 50% (10% flower and 40% set fruits) losses in squash yield under farmers field conditions in uncontrolled situations. Application of locally made botanical pesticide "Jholmal" offers superior yield in terms of fruit size and quality, and reduced fruit fly infestation in squash. Although, 'Jholmal' is easy to prepare locally and is effective for the management of fruit fly, it requires more frequent applications owing to more labor cost. It is also concluded that spraying of chemical insecticide is worthless in fruit fly management options. Therefore, future efforts should be made to find ways to reduce the cost of application of bio-pesticides like 'Jholmal' to make vegetable cultivation a profitable business, and to protect environment and life.

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