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RESEARCH ARTICLE

EFFICACY OF DIFFERENT HOMEMADE AND COMMERCIAL BAITS IN MONITORING OF FRUIT FLIES AT MARANTHANA, PYUTHAN, NEPAL

Akash Gupta[a]*, Rajendra Regmi[b]

[a] Faculty of Agriculture, Agriculture and Forestry University (AFU), Rampur, Chitwan, Nepal
[b] Department of Entomology, Agriculture and Forestry University (AFU), Rampur, Chitwan
**Corresponding author email: agriculture.akash@gmail.com*

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ABSTRACT

Fruits & vegetable commodities incur huge loss in field & postharvest conditions due to infestation by Tephritid Fruit Flies. The adult female flies lay eggs inside near maturity fruits & vegetables. The eggs hatch into apodous larvae which feed on the pulp; making them unfit for human consumption and marketing. Using male pheromone lures like Cue Lure & Methyl Eugenol Lure is one of novel techniques for annihilating male fruit flies only. Female flies can still mate & keep ovipositing fruits. So, an experiment was carried at Maranthana, Pyuthan, Nepal with 3 replications & 7 treatments to devise techniques for female fruit flies management. The experiment comprised of commercially used pheromones like Cue Lure & Methyl Eugenol Lure and 5 home based baits viz. Apple Cider Vinegar, Yeast fermented sugar, Tulsi Lure, Local Liquor Lure & Pumpkin Lure; all poisoned with Malathion, soaked in cotton wick and assembled in Lynfield traps. The experiment was completed in two trappings; 2021/04/18 to 2021/05/09 and 2021/04/16 to 2021/07/07; with similar results in both trappings. The commercial were able to attract the highest number of flies; all of which were male. Local liquor lure & tulsi lure attracted least number of male fruit flies. The Apple Cider Vinegar Lure and Yeast Lure attracted both male & female flies while pumpkin lure attracted only female flies of genus *Zeugodacus*. Results revealed that female flies of genus *Zeugodacus tau* & *Z. cucurbitae* could be attracted efficiently by making use of Apple Cider vinegar and Pumpkin.

KEYWORDS

Malathion, Methyl Eugenol, Cue Lure, Apple Cider Vinegar, Pumpkin, Fruit Fly

1. INTRODUCTION

Fruit Flies attacking cucurbits are the insects that belong to class Insecta, order Diptera & family Tephritidae. These insects lay eggs inside the near mature fruits & vegetables via sharp ovipositors where they hatch into apodous larvae. The so hatched larvae feed on the pulp & inner fruit parts making it hub of secondary infections and eventually making them unfit for human consumption (Dhillon et al., 2005). Later on, they jump to soil for pupation where they form barrel shaped pupae which release adult forms at the end. Hence, their larval forms incur loss in field as well as postharvest conditions & stand as an economic insect pest of various fruits & vegetables. These insects may have some extent of host specificity like *Bactrocera dorsalis* mainly attack Mango & tropical fruits while *B. cucurbitae* (now *Zeugodacus cucurbitae*) mainly attacks vegetables like Cucurbits (Kwasi, 2008; Bhowmik et al., 2014).

In Nepal, seventeen species of fruit flies have been reported by Entomological Division, Nepal Agriculture Research Council (Adhikari et al., 2019). The fruit flies in Nepal mainly attack Cucurbit fruits (79%), fruits (14%) and solanaceous fruits (6%) (Adhikari et al., 2018). Their population varies with season & climatic conditions. Their management remains as a big challenge for farmers growing different horticultural crops; be it fruits or vegetables. Fruit Flies reduce the crop yield & marketability of fruits. In many countries, the fruit flies serve as quarantine pest, thus reducing scope for foreign export of Nepalese produce.

The fruit flies are one of the most destructive insects that cause huge loss to horticultural commodities. These insects are usually managed by chemical insecticide sprays, botanicals sprays, food lures like Cue lure (in cucurbits), Methyl eugenol lure (in fruits) or by cultural methods like deep summer tillage, soil solarization; Sanitary methods like destroying infested fruits and by manual methods like fruit bagging or using nets. Among all these methods, the food lure or para-pheromones are most effective & promising methods to control fruit flies as they leave no chemical residue on the environment & the fruits are free from insecticides poisoning, offering organic fruits & vegetables. In addition, they are less labor intensive than the cultural & manual methods. But the commercially available lures & pheromones are very expensive to be used by farmers of underdeveloped countries like Nepal and moreover, these lures attract male flies only which remains as secondary fruit fly control mechanism. As not all males can be lured & killed, the female flies can mate & keep ovipositing on near ripe fruit & vegetables as it will still be able to mate. Thus, making lures that are cost effective & kill both sexes of flies by using locally available resources can contribute largely to fruit flies monitoring & control programs at farmer's level in low-income countries like Nepal.

The volatile gases produced by products like Banana, Soybean hydrolysate, Apple Cider Vinegar, Locally Brewed Liquor, yeast sugar fermented products when poisoned with insecticides like Dimethoate, Fenthion, Spinosad, Deltamethrin, Malathion or Carbofuran can make a good trap for attracting fruit flies & their subsequent killing or knocking

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down (Bharathi et al., 2004; Mesquita et al., 2018; Hardy and Jessup, 2012; Bhowmik et al., 2014). Also, Methyl Eugenol is naturally present in many plants and can be extracted from e.g., holy basil (Tulsi). Extracts may contain as much as 80% Methyl Eugenol (Sumatra, 2012). These attractants are equipped in economical Lynfield traps made from used drinking water plastic bottles. Thus, a cost-effective trap from locally available resources can prove to be a sustainable solution for an economically threatening problem & this research can stand as a stepping stone for sustainable & local resource based fruit fly management & monitoring system.

The life cycle of fruit fly consists of stages viz. egg, maggots, pupa & adult. Its systematic position in animal kingdom is:

Domain: Eukaryota

Kingdom: Metazoa

Phylum: Arthropoda

Subphylum: Uniramia

Class: Insecta

Order: Diptera

Family: Tephritidae

B. dorsalis is said to develop well between temperatures 15-33°C. The eggs hatch in 1.46-4.31 days. The larval and pupal stages last for 7.14–25.67 days & 7.18–31.50 days respectively (Kenfak, et al., 2021).

B. zonata; known as peach fruit fly has its total life duration from egg to death of the adult male and female varied between 34.5-61.5 days and 35.5-65.0 days, respectively. The mean duration of prepupal and pupal stages last for 1.8 and 10.7 days. The mating period ranged between 4 and 6 hours (Mir et al., 2015).

In the pumpkin fruit fly (*Z. tau*) the female fly has a preovipositional period of 11.7 ± 4.49 days. Then the whitish, shiny, elliptical eggs are hatched inside fruits which gradually tur darker. The larval period is 1.2 ± 0.42, 1.7 ± 0.48 and 4.0 ± 0.94 days for first, second and third instars & pupation occurs inside soil/sand whose duration is 7.0 ± 0.47 days. Overall, the life cycle spans for 14.2 ± 1.69 days (Singh et al., 2010).

The *Zeugodacus cucurbitae* flies lay 80.0±20 eggs/life cycles beneath the skin of near ripe fruits which go on to hatch within 1.25±0.25 days. The apodous maggots feed on the pulp & fully fed within 5.93±1.41 days according to climate. The maggots pupate inside the soil by jumping off from infested fruits. The pupation takes place within 9.5±0.5days. The adult fly may live for 1-3 months; up to 12 months in cooler climate & begin mating after 8-12 days (Sohrab, 2018).

Different species of fruit flies have a huge number of host ranges. The flies damage different horticultural commodities at near ripe conditions when they are almost ready for marketing or at near marketing stages.

In Ghana, 60% farmers reported loss due to fruit flies in Mango orchards (Kwasi, 2008). In Nepal, the fly has damaged 20-50% of the fruit every year and resulted in a loss of millions of rupees in sweet orange. *Bactrocera dorsalis* causes damage to fruit crops like rainy season guava (up to 100%), mango (87%), peach (78%) and pear (61%) (Sharma et al., 2011; Sharma and Dahal, 2020). In Asia, *Z. tau* causes up to 90% loss in cucurbits & solanaceous crops like tomato (Sharma and Tiwari, 2020). *Bactrocera minax* is very serious insect in sweet oranges causing up to 97 % loss by the end of harvesting season (Sharma et al., 2015). Cucurbit fruit fly (*Z. cucurbitae*) infests flowers & fruits in Cucurbits and 9.7% loss of female flowers was seen. Cucurbit fruit fly resulted in more than one-fourth (26%) fruit drop or damaged just after set and 14.04% fruits were damaged during harvesting stage, giving only 38.8% fruits of marketable quality (Sapkota et al., 2010). So, a substantial loss in horticulture industry has been reported due to fruit fly.

In Nepal, different methods have been deployed for fruit fly management like chemical (32%), mechanical (80%), indigenous (70%) (Jholmol) and often a combination of these (68%) methods have been used too in mid hills of Nepal (Sapkota et al., 2010). The most effective chemical in reducing the fruit infestation by melon fruit fly have been identified as Spinosad in Cucurbits (Bhowmik et al., 2014). Cue lure and Methyl eugenol baited with Malathion were used for attracting & killing male fruit flies in Sweet orange orchards at Sindhuli using Steiner trap (Sharma et al., 2015).

Phytosanitary measures & botanicals sprays are suggested by agriculture technicians for fruit fly management in Nepal (Adhikari et al., 2020). Trimedlure (for *Ceratitis capitata, C. rosa*) was suggested for use in Sri-Lanka as para pheromone along with components like killing agent inside McPhail Trap by technicians there and the trapping system introduced there also made combined & solitary use of Torula Yeast Borax, Protein derivatives, Ammonium carbonate, Putrescine & Trimethylamine, Ammonium salts, Butyl hexanoate along with toxicants such as Dichlorvos, Malathion, Spinosad and Pyrethroids (such as Deltamethrin) along with 1.5 to 2 g of borax or 10% propylene glycol were added to preserve captured flies in liquid based killing traps (Jiajiao, 2019). The easy trap baited with Ammonium Acetate and Trimethylamine using Deltamethrin as killing agent was identified as the best trap against *C. capitata* in a mango orchard (Cohen, 2007).

In an experiment, Soybean hydrolysate, fishmeal, beef extract, banana/grapes, bread and dog biscuit along with vinegar and beer (to enhance their attractiveness) were used as food baits for managing melon fruit flies. Results revealed that, banana and soybean hydrolysate were 85–95% more attractive to adult *Zeugodacus cucurbitae* than other forth mentioned treatments. Similarly, among combined treatments, Grapes + beer + palm oil was found to be 37% more attractive than the other admixtures (Bharathi et al., 2004).

2. Material and Methods

2.1 Research Site

Pyuthan Municipality, Ward 9 & 10 was selected as the research site. The site was selected due to abundance of farmers growing cucurbitaceous vegetable crops like cucumber, bitter gourd, bottle gourd, sponge gourd along with occurrence of substantial amount of tropical & sub-tropical fruit tress like mango, sweet orange & mandarin. Thus, the baits could be used for trapping more species of fruit flies prevalent in Pyuthan & further efficiency & performance of such baits can be tested.

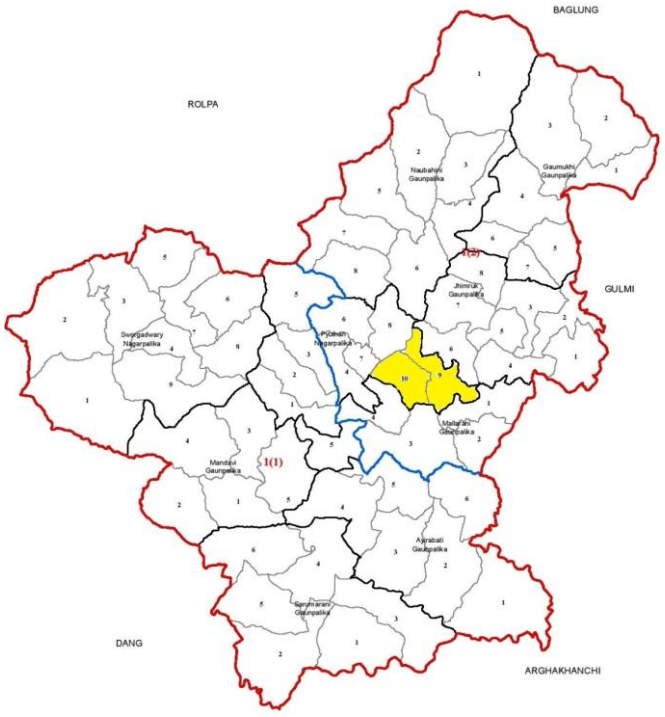

Figure 1: Research Location (Ward 9 & 10 of Pyuthan Municipality)

2.2 Treatments

Seven treatments were prepared with different ingredients as evident from the literature review. Among seven; 2 lures were commercially used lure namely Cue Lure & Methyl Eugenol Lure. The cue lure is used mainly for cucurbitaceous vegetable crops while the latter is used for fruit fly management in fruit orchards. The remaining 5 treatments were prepared from products that are used for human consumption. All the attractants made use of Malathion to make baits and for knocking down the flies that were attracted to the food component. All these treatments were installed in Cucumber fields (Ninja Variety) at fruiting height at fruiting initiation period. All treatments solutions were prepared, soaked in cotton wick for 24 hours & equipped in Lynfield trap. Lynfield like traps can be made locally by using abandoned packaged water bottles. After removing the

plastic label of such bottles, 4 holes of size 6-8 mm; just enough for entry of fruit flies only are pierced using hot GI wire. The holes are made towards the upper 5cm band of the label on plastic bottle. Then, they were further equipped using GI-wires for hanging. A prototype Lynfield trap model is shown in Figure 2.

Table 1: Different treatments & their ingredients to be used in the experiment

Treatment	Treatment Name	Treatment Composition/Ratio
T1	Cue Lure (Division, 2017a)	Cue Lure-4 ml Ethyl Alcohol-6 ml Malathion-2 ml
T2	Methyl Eugenol Lure (Division, 2017b)	Methyl Eugenol-4 ml Ethyl Alcohol-6 ml Malathion-2 ml
T3	Apple Cider Vinegar Lure (Maung et al., 2019)	Apple Cider Vinegar with mother-90ml Malathion-10ml
T4	Yeast Lure (Lloyd, 2003)	Baker's Yeast-2gm Sugar-8gm Water-90ml Malathion-10ml
T5	Tulsi Lure (Sumatra, 2012) (Mumford, 2006)	50gm Tulsi paste Jaggary-10gm Water-90ml Malathion-10ml
T6	Local Liquor Lure (Piñero et al., 2017)	Liquor-90ml Malathion-10ml
T7	Pumpkin Lure (Mumford, 2006)	Mashed Pulp-100gm Malathion-10ml

All treatments solutions were prepared, soaked in cotton wick for 24 hours & equipped in Lynfield trap. Lynfield like traps can be made locally by using abandoned packaged water bottles. After removing the plastic label of such bottles, 4 holes of size 6-8 mm; just enough for entry of fruit flies only are pierced using hot GI wire. The holes are made towards the upper 5cm band of the label on plastic bottle. Then, they were further equipped using GI-wires for hanging. A prototype Lynfield trap model is shown in Figure 2.

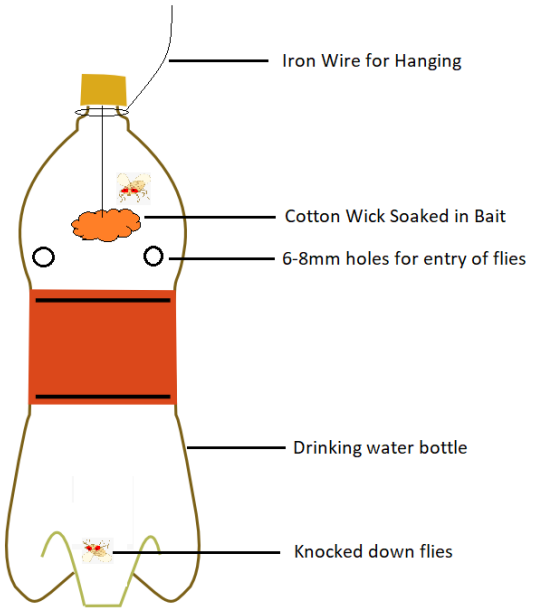

Figure 2: Lynfield trap model made from used plastic bottles equipped with lure-soaked cotton wick

2.3 Research Design

The experiment design was Randomized Complete Block Design (RCBD). Three locations within Pyuthan Municipality Ward 9 & 10 were used as three replications. The baits/lures were hanged at crop height (where fruiting occurs) using iron wires; usually 1.5m above ground level in Cucumber fields. The distance between each trap was 5m (Mesquita et al., 2018). Such spacing allowed the fruit flies to choose their favorite bait for feeding. While feeding, they were subsequently knocked out due to Malathion which disrupts the nerve impulse system & after death got collected at bottom of the Lynfield trap. After installation, the traps were left in the field for 3 weeks. The entire experiment was done twice in different durations to gain better confidence about the results.

Figure 3: Map showing replication sites R_1, R_2 and R_3 at Maranthana, Pyuthan, Nepal (Source: Google Maps)

2.4 Data Collection

The fruit flies collected in Lynfield trap were counted & categorized according to sex & species after three weeks of trap placement. The specimens were preserved by dry preservation techniques in insect collection box. The sexes were distinguished based on presence or absence of sharp ovipositor while species were distinguished by virtue of morphological features based on identification guidelines provided by:

- THE AUSTRALIAN HANDBOOK FOR THE IDENTIFICATION OF FRUIT FLIES Version 3.1 (Schutze et al., 2018)
- Field Guide for Identification of Fruit Fly Species of Genus *Bactrocera* Prevalent in and around Mango Orchards (Choudhary et al., 2014)
- Occurrences and field identities of fruit flies in sweet orange (*Citrus sinensis*) orchards in Sindhuli, Nepal (Adhikari and Joshi, 2018)

2.5 Data Analysis

The mean number of catches incurred by each trap were compared & categorized by using Duncan's multiple range tests. The number of male adult flies & female adult flies trapped in different lure were compared & categorized similarly. All these analyses were performed by using MS Excel & RStudio software.

3. Results and Discussion

3.1 Comparison of Number of Adult Fruit Flies Trapped in Different Baits at 2 Different Trappings

The comparison between all the treatments for total fruit flies trapped, total male fruit flies trapped, and total female fruit flies trapped was done using Duncan multiple range test. The results are presented in Table 2.

Table 2 shows that the maximum number of adult fruit flies were trapped in commercial baits i.e. Cue Lure & Methyl Eugenol Lure; compared to home based attractants poisoned with Malathion. The commercial lures showed statistically similar results in first trapping while during second trapping, the cue lure attracted maximum number of insects. During first trapping, least number of adult fruit flies was found attracted to Local Liquor Lure which was statistically similar to Tulsi Lure & Ripe Pumpkin Lure. During second trapping, the least fruit flies were found attracted to Local Liquor Lure again, which was statistically similar to Tulsi Lure only.

Table 2: Adult Fruit Flies trapped in the experiment on different trappings

Treatments	Number of Adult Fruit Flies Trapped					
	2078/01/05 to 2078/01/26			2078/03/02 to 2078/03/23		
	Total	Male	Female	Total	Male	Female
Cue Lure	264.67[a]	264.67[a]	0.00[c]	132.33[a]	132.33[a]	0.00
Methyl Eugenol Lure	226.67[a]	226.67[a]	0.00[c]	122.33[b]	122.33[b]	0.00
Apple Cider Vinegar Lure	146.67[b]	101.33[b]	45.33[a]	114.67[c]	86.67[c]	28.00[ab]
Yeast Lure	90.33[c]	51.67[c]	38.67[ab]	76.33[d]	50.33[d]	26.00[b]
Tulsi Lure	44.33[d]	44.33[c]	0.00[c]	11.00[f]	11.00[e]	0.00
Local Liquor Lure	19.33[d]	19.33[cd]	0.00[c]	8.33[f]	8.33[e]	0.00
Ripe Pumpkin Lure	32.00[d]	0.00[d]	32.00[b]	30.00[e]	0.00[f]	30.00[a]
SEm (±)	13.96	13.19	2.37	1.37	1.15	0.77
F-Probability	***	***	***	***	***	***
LSD (=0.05)	43.02	40.65	7.29	4.21	3.56	2.36
CV (%)	20.55	22.59	24.72	3.35	3.41	11.06
Grand Mean	117.71	101.14	16.57	70.71	58.71	12.00

Note: CV, Coefficient of variation; LSD, Least significant difference; SEm (±), Standard error of mean; Letters a, b, c, d, e, f represent the ranking of treatments according to DMRT at 0.05 level of significance; *, **, *** denote significance at p=0.05, p=0.01, p=0.001 respectively

In regard to male fruit flies, all the treatments attracted male fruit flies except the Pumpkin Lure. Highest number of male fruit flies were attracted to Cue Lure in both trappings. During first trapping, male fruit flies attracted to Cue Lure were statistically similar to Methyl Eugenol Lure. The pumpkin lure attracted only female fruit flies. In addition to pumpkin lure, Apple Cider Vinegar Lure & Yeast Lure also attracted female fruit flies viz. *Zeugodacus tau* & *Zeugodacus cucurbitae*. The highest number of female fruit flies during first trapping was found in Apple Cider Vinegar Lure which was statistically similar to Yeast Lure. During second trapping, the highest number of female fruit flies were found in Pumpkin Lure which was statistically similar to Apple Cider Vinegar Lure.

The number of insects trapped in second trapping were almost twice as lower compared to first trapping except in the case of pumpkin lure. The higher precipitation during the second trapping might be the possible reason behind it. The higher catch in pumpkin lure might be due to faster microbial rotting of pumpkin which makes it more suitable for the fruit flies infestation. This is evident from the weather characteristics derived from NASA power & shown in figure.4 below:

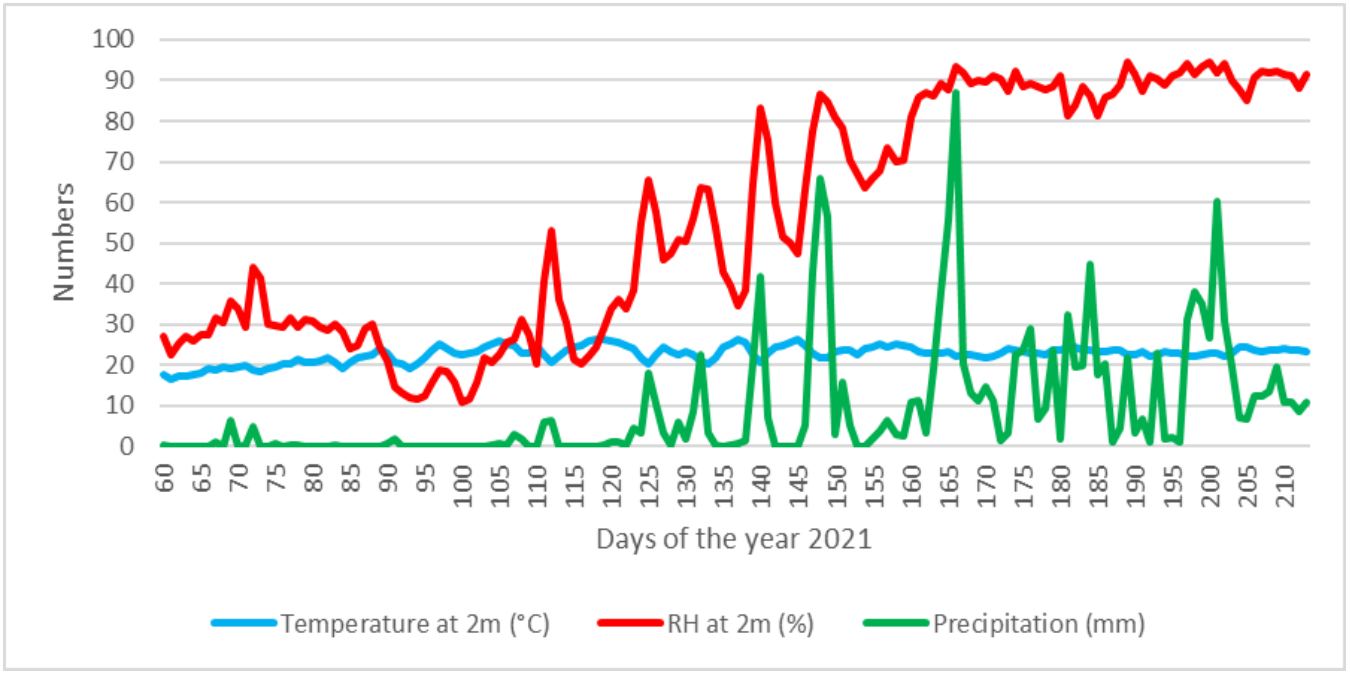

Figure 4: Weather data during research period at Maranthana, Pyuthan, Nepal (Source: NASA Power)

3.2 Fruit Fly Species Trapped by Different Lures

During experimentation, four species of fruit flies were seen in different traps viz.

- *Bactrocera dorsalis* (Hendel) – Oriental Fruit Fly
- *Bactrocera zonata* (Saunders) – Peach Fruit Fly
- *Zeugodacus tau* (Walker) – Pumpkin Fruit Fly
- *Zeugodacus cucurbitae* (Coquillet) – Melon Fruit Fly

3.2.1 Cue Lure

Cue Lure is extensively used for cucurbitaceous vegetable crop's fruit fly management on a commercial scale. The species attracted by this pheromone lure were *Zeugodacus tau* & *Zeugodacus cucurbitae*. The number of *Z. tau* caught was higher compared to *Z. cucurbitae* during both trappings as shown in figure.5. The flies caught during second trapping were lower as evident from weather characteristics at Maranthana as shown in figure.4. Only male adult flies were caught in this lure.

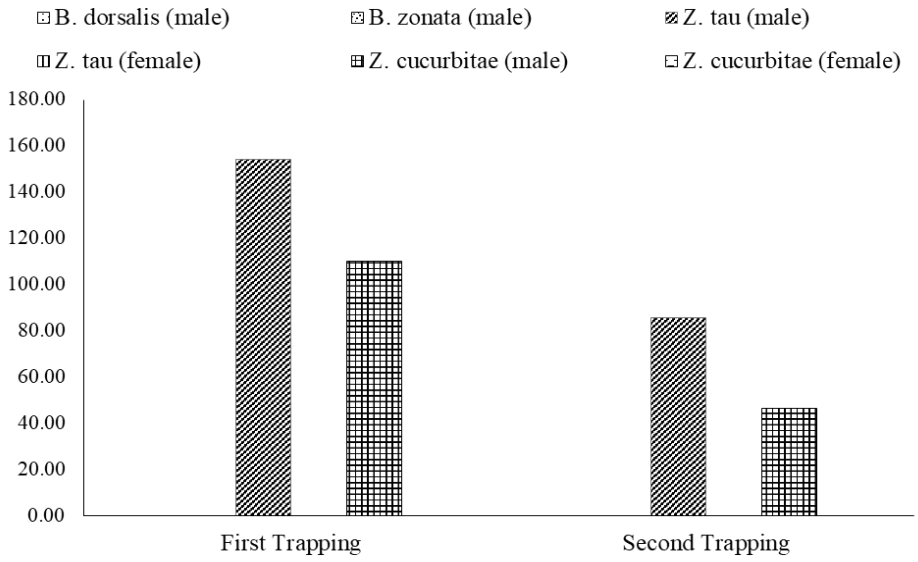

Figure 5: Different fruit fly species caught in cue lure

3.2.2 Methyl eugenol lure

Methyl eugenol is used for fruit fly management specifically in fruit orchards. In this experiment, the lure attracted mainly two male fruit fly species only viz. *B. dorsalis* & *B. zonata*. The number of *B. dorsalis* was higher than *B. zonata* in both trappings as shown in Figure 6. The number of flies caught during second trapping was again lower due to above stated reasons.

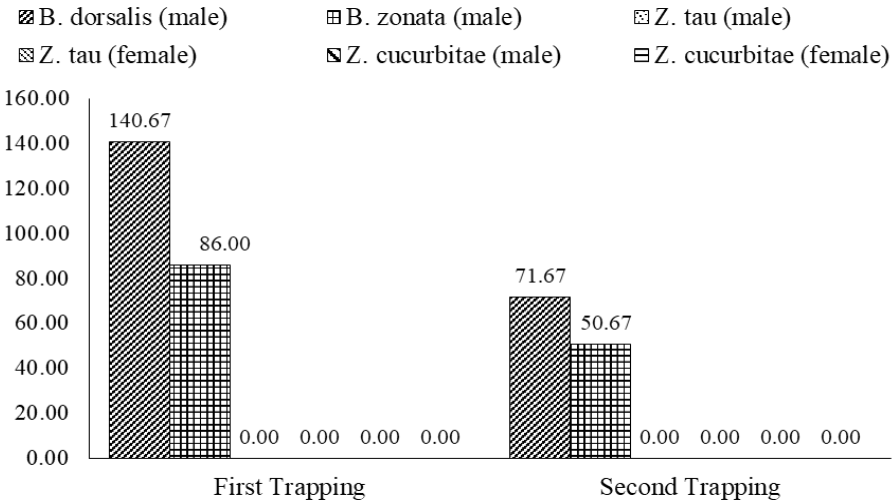

Figure 6: Different fruit fly species caught in methyl eugenol lure

3.2.3 Apple cider vinegar lure

The apple cider vinegar was able to attract all the four species of fruit flies encountered in this experiment. The lure was able to attract both male & female fruit fly species. ACV attracted female fruit fly species of *Z. tau* & *Z. cucurbitae*. The male fruit flies attracted in this experiment belonged to all four species stated above (Figure 7). The number of different flies caught in this lure is shown in bar diagram below:

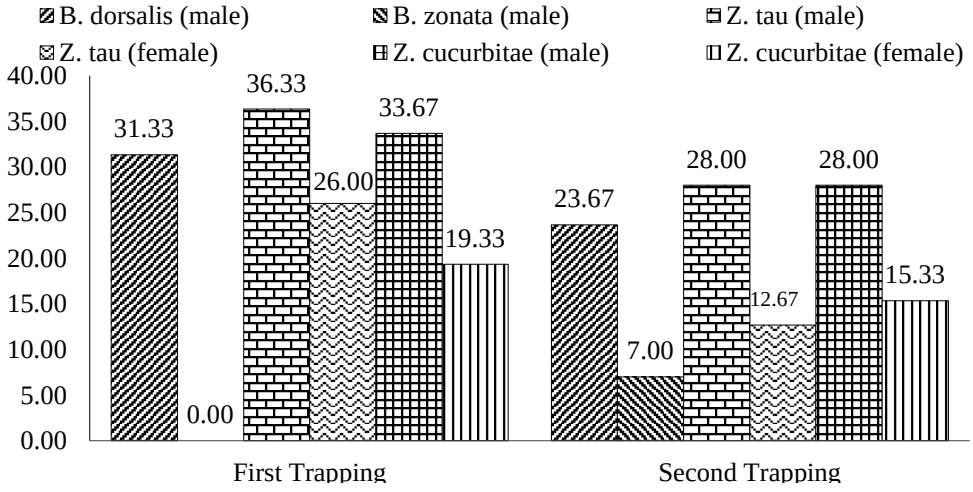

Figure 7: Different fruit fly species caught in apple cider vinegar lure

3.2.4 Yeast lure

The yeast lure attracted male & female fruit flies of species *Z. tau* & *Z. cucurbitae*. It didn't attract the fruit flies that are more evident in fruit orchards. However, the number of insects trapped in different trappings are almost similar as shown in Figure 8 which is unlike the results obtained in other traps and remains unaffected by weather characteristics during the research period.

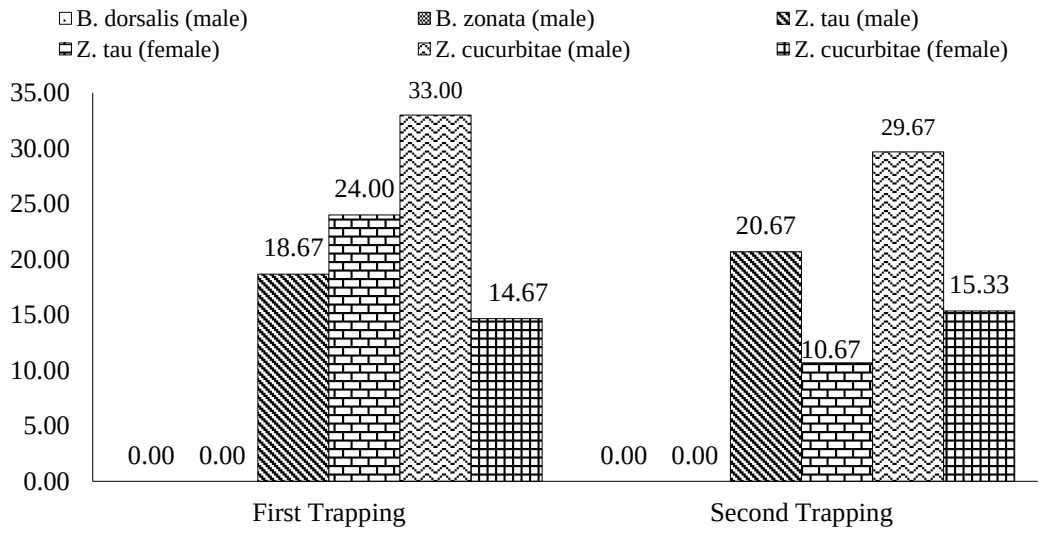

Figure 8: Different fruit fly species caught in yeast lure

3.2.5 Tulsi lure

Tulsi is said to be a prominent source of Methyl Eugenol. Proving it aright, it was able to attract only male flies of species *B. dorsalis* & *B. zonata* (figure.9) which were similar to that attracted in Methyl Eugenol Lure. However the numbers were almost 4 times lower compared to the latter.

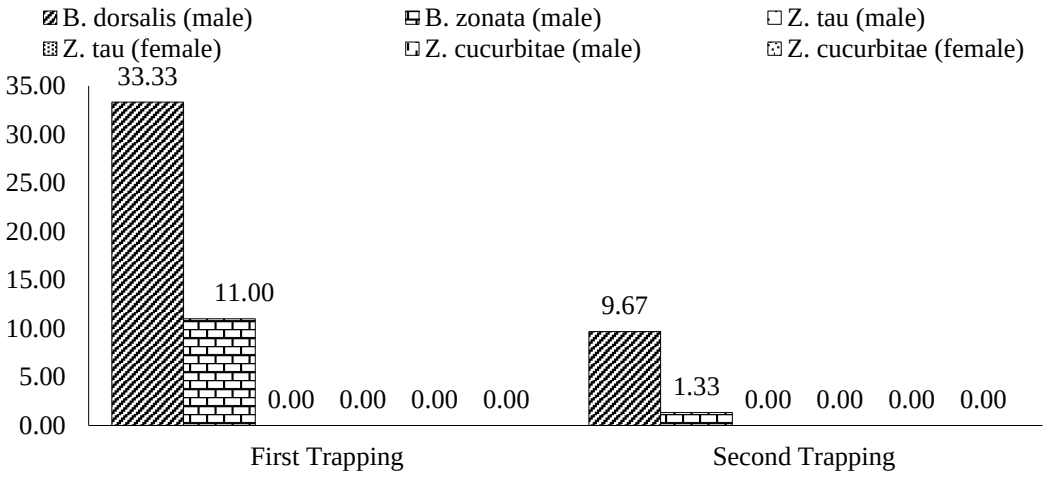

Figure 9: Different fruit fly species caught in tulsi lure

3.2.6 Local liquor lure

Local liquor also attracted fly species similar to that of Methyl Eugenol Lure. However, the number of flies attracted was least among all the lures used in the experiment which was almost 11 times lower than the numbers figured in Methyl Eugenol Lure (Figure 10).

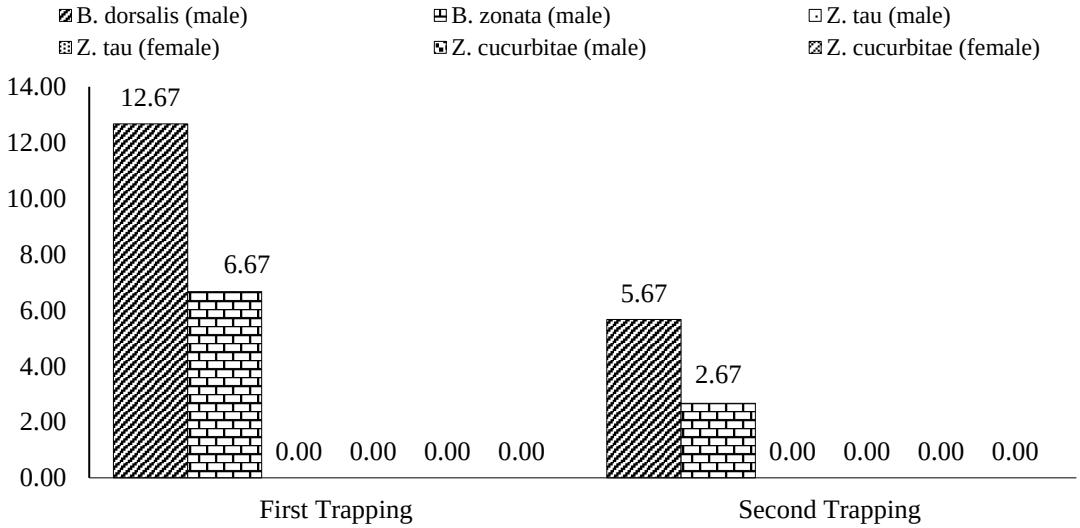

Figure 10: Different fruit fly species caught in local liquor lure

3.2.7 Pumpkin lure

The pumpkin lure attracted only female fruit flies in the experiment. The female fruit flies attracted were *Z. tau* & *Z. cucurbitae*. The numbers in both trappings were similar. During second trapping, number of *Z. tau* was higher (Figure 11).

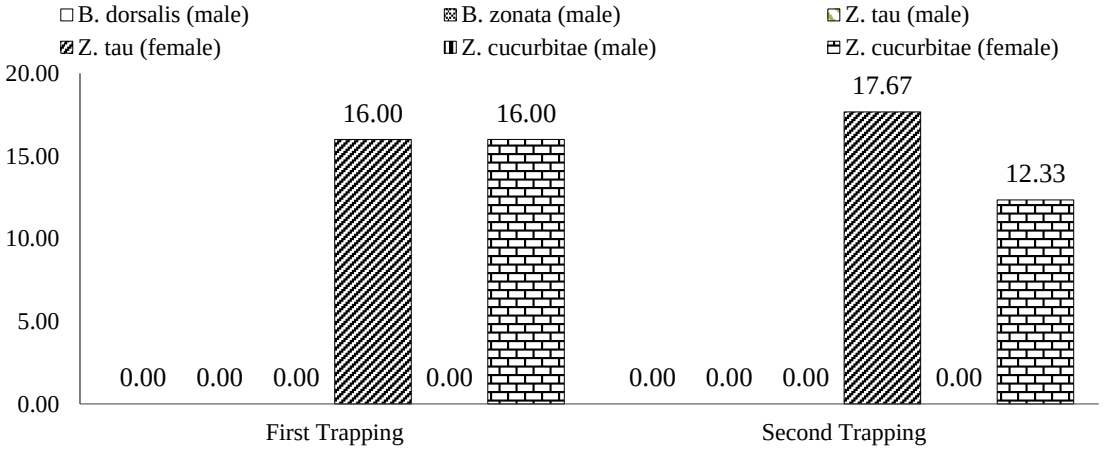

Figure 11: Different fruit fly species caught in yeast lure

The cue lure mainly caught *Z. cucurbitae* & *Z. tau* while the Methyl Eugenol caught *B. dorsalis* & *B. zonata* which is in line to what recommended by National Institute of Plant Health Management (Division, 2017a; Division, 2017b). Though Tulsi (*Ocimum sanctum*) is source of Methyl eugenol, the catch performed by commercial methyl eugenol was very high comparatively. The major reasons behind this was quoted by Jhala, et al., 2006 here he found that 1ml of Methyl Eugenol could be extracted from 46 gm of Black Tulsi (var. Krishna) while the same 1 ml was extracted from 417 gm of Green Tulsi. As, local green Tulsi paste of 90 gm was used in the experiment to prepare 3 traps; this makes the methyl eugenol content to just 0.071ml per trap & hence the catch obtained in Tulsi Lure might be low. However, usage of smaller amount of Black Tulsi paste could prove game changer for male fruit fly management.

The fruit flies management using male sex pheromone lures stand as an indirect method of fruit fly management. As being part of management approach and not the control approach; it doesn't kill all the male flies & hence the females still is able to mate & oviposit in the cucurbitaceous fruits and vegetables. The females have also show some extent of interspecific mating (Schutze et al., 2013). Thus, management of female fruit flies seems better approach for reducing fruit fly infestation & fruit fly management. Similarly, as evident from Table 2 the grand mean of female flies is 6 times lower compared to male flies during first trapping & this number stands 5 times during second trapping; showing the number of female flies is lower than males by many folds in the experiment & managing female flies could enhance the profitability of the cucurbitaceous vegetables.

The baits made from apple cider vinegar, yeast lure & pumpkin was able to attract female fruit flies which was also depicted in the texts (Mumford, 2006). About 13 volatile compounds were identified from yeast fermentation of minimal media to which the fruit flies prefer (Becher et al., 2012). Similarly, Dipterans of Drosophilidae family were found attractive to Apple Cider Vinegar while in this experiment at Maranthana, Pyuthan, Nepal; Dipterans of Tephritidae family were also found attractive (Kleiber, 2013). Overall, as the catch produced by the home based attractants is lower than the commercials ones, to match the latter's performance, more number of homebased traps could be installed to catch more number of flies; still making the approach economical compared to the commercial ones.

3.3 Economic Aspects of Building Different Traps Used in The Experiment

This experiment stresses on minimizing the cost of fruit fly management and hence an estimate for the cost of active ingredients used in the experiment was devised in accordance of the existing market scenario during experimentation. The result is presented in Table 3.

Table 3: Cost of active ingredients for making different lures used in the experiment

Trap Name	Ingredients	Estimated Cost (NRs)	Traps Made	Cost of ai/trap (NRs)
Cue Lure	Cue lure-4 ml Ethyl alcohol-6 ml Malathion-2 ml	80×4+0.8×6+1.54×2 =327.9	3	109.3
Methyl Eugenol Lure	Methyl eugenol-4 ml Ethyl alcohol-6 ml Malathion-2 ml	75×4+0.8×6+1.54×2 =307.9	3	102.6
Apple Cider Vinegar Lure	Apple cider vinegar-90ml Malathion-10ml	0.84×90+1.54×10 =91	10	9.1
Yeast Lure	Baker's yeast-2gm Sugar-8gm Water-90ml Malathion-10ml	0.56×2+0.09×8+1.54×10 =17.24	10	1.724
Tulsi Lure	50gm Tulsi paste Jaggary-10gm Water-90ml Malathion-10ml	50×0.48+10×0.15+1.54×10 =40.9	10	4.1
Local Liquor Lure	Liquor-90ml Malathion-10ml	0.2×90+1.54×10 =33.1	10	3.31
Pumpkin Lure	Mashed pulp-100gm Malathion-10ml	0.06×100+1.54×10 =21.4	3	7.13

Table 3 shows that the cost of commercially use traps viz. Cue Lure & Methyl Eugenol was NRs. 109.3 & NRs. 102.6 respectively. The effective home-based traps like Apple Cider Vinegar, Yeast Lure & Pumpkin Lure costed NRs. 9.1, NRs. 1.724 and NRs. 7.13 respectively which is 12×, 63×, 15× lower compared to Cue Lure & 11×, 59×, 14× lower compared to Methyl Eugenol Lure respectively.

4. Conclusion

Tephritid Fruit Fly Management is a big challenge for fruits & vegetable production in Nepal and around the globe. The current techniques revolve around the indirect method of fruit fly management which included use of male sex pheromone lures like Cue Lure in cucurbitaceous vegetable crops & Methyl Eugenol in fruit orchards. Although there is substantial decrease in fruit fly infestation with this approach, but as not all male fruit flies are killed, the female fruit flies is still able to mate with multiple male partners and in most of the cases with fruit flies of other species too due to abundance of male counter parts. Thus, after all the toiling effort, the infestation of fruits and vegetables could still take place. Thus, the better option would stand as directly managing the female adult fruit flies. This liberty can be availed by making use of the home based lures used in this experiment like Apple Cider Vinegar Lure and Yeast Lure which attracted both male and female flies of diverse genre while the Pumpkin Lure was able to attract only female flies. However, these lures were able to attract female flies of genre *Z. tau* & *Z. cucurbitae* and no bait was able to attract the female counter parts of *B. dorsalis* & *B. zonata*. As the formers ones are found to be more abundant in cucurbitaceous field, the home based baits like Apple Cider Vinegar, Yeast Lure & Pumpkin Lure can be suggested for use in female adult fruit flies management in cucurbit vegetable cultivation. Similarly, the home based baits are very economical compared to the commercial ones.

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