

Enhancing the Attraction of Male Oriental Fruit Flies (*Bactrocera* spp.) to Methyl Eugenol Using Low Cost Plastic Bottle Colored Traps in Pummelo Orchard (*Citrus maxima*), Davao Province, Philippines

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Abstract— Fruit flies are considered the most important pests of many fruits in the Philippines particularly the high-valued fruit crop pummelo. Hence, management of the pest is deemed necessary for higher pummelo production. In the Philippines, chemical control is commonly the management strategy against pest but its use must be reduced due to adverse impact to the environment and brought ill effects to humans and animals. Hence, exploration of alternative control in consideration of the pest's behavior was highlighted from this study. The purpose is to reduce fruit fly number through attraction using olfaction (parapheromones) and visual (colored traps) methods. This study sought to explore the efficacy of colored and non-colored traps with methyl eugenol in luring fruit flies from two pummelo orchards at the University of Southeastern Philippines (USEP) Mabini, Compostela Valley Province and San Vicente, Asuncion, Davao del Norte, Philippines. The experiment was arranged following the Randomized Complete Block Design (RCBD) having eight treatments replicated three times.

Results revealed that the transparent plastic bottle trap consistently and significantly lured the highest number of fruit flies across treatments and sampling periods for both orchards at USEP Mabini, COMVAL, Province and San Vicente, Asuncion, Davao del Norte, Philippines conditions.

Index Terms—Colored traps, transparent traps, parapheromones, Fruit flies, pummelo

1 INTRODUCTION

PUMMELO (*Citrus maxima*) is one of the most important species of the Citrus family. It is usually pale green to yellow when ripe, with sweet white (or more rarely, pink, red) flesh and very thick. The fruit is an excellent source of flavonoids, a powerful antioxidant; rich in potassium and provide twice the amount of daily needed Vitamin C. These antioxidative phytochemicals are widely recognized for their role in scavenging free radicals that act as anticancer, antiviral, anti-inflammatory and in lowering cholesterol level and inhibiting human platelet [1].

However, all pummelo varieties were very susceptible to pest infestation. One of these pests is the oriental fruit fly, *Bactrocera* spp. Fruit flies are the most dominant pest particularly during fruit maturity.

Various strategies have been studied and devoted for the management of this notorious pest but with varying degrees of success. One such approach is the use of parapheromones like the methyl eugenol. This parapheromone is usually partnered with traps. This method has been tested and

successfully used in the eradication of several *Bactrocera* species [2].

Bactrocera adult uses both olfactory and visual cues to find their host. Olfactory cues such as the methyl eugenol is an effective attractant compound that can lure *Bactrocera* male adult up to a distance of 800 meters [3]. Visual cues such as color are also used by the pest to locate its host. In the study of Ravikumar and Viraktamath (2007) recorded that yellow and transparent traps attracted a significantly high number of *Bactrocera* *correcta* in guava and mango, respectively. Moreover, for *Bactrocera* *dorsalis*, green and orange colored traps were more attracted to the pest in guava and black colored traps in mango, while *Bactrocera* *azonata* was more attracted to red-colored trap [4]. On the other hand, Haworth and Haworth (2000) revealed that clear traps significantly captured higher number of oriental fruit flies, *Bactrocera* *dorsalis* over yellow, red, blue and green. They further stressed that placing the clear trap to an open area or exposed site could improve the attractiveness of the trap to oriental fruit fly [5]. On the study of Drew et al, (2003) the polyphagous *Bactrocera* *triyoni* on host guava trees were more attracted to color blue or white tangletrap-coated 50 mm diameter spheres than on other color of red, orange, yellow, green and black [6]. Liburd et al. (1998) on their study on the use of color to sphere traps in attracting blueberry maggot,

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Rhagoletis sp. revealed that sphere trap colored yellow, green, red and blue were equal or better over the commercial Pherocon AM yellow trap[7].

These varying responses of the many fruit fly species to color had encouraged the proponent to work on it to increase attraction of fruit flies to methyl eugenol using low cost or garbage plastic bottle painted with color. In Davao region, Philippines, where pummelo is one of its major fruit crops, the oriental fruit fly is considered as one of the most important pests of pummelo other than the citrus rind borer. There have been no reported studies conducted on the preference of the Bactrocera spp. on different colored traps in pummelo in the Davao Region, Philippines.

Hence, this study will focus on enhancing the attraction of fruit fly to methyl eugenol by partnering it with various colored traps to enhance control of one of the most destructive pests of pummelo, the fruit flies.

1.1 Objective of the Study

This study was conducted to monitor and record the number of male fruit flies lured to different colored traps with 0.5 ml methyl eugenol in pummelo orchards of University of Southeastern Philippines, Mabini, Compostela Valley, Philippines and at Lara Farm, San Vicente, Asuncion, Davao del Norte, Philippines.

2 METHODOLOGY

2.1 Site and duration of the study

The study was conducted at the Pummelo research and production area of the University of Southeastern Philippines (Site 1, Longitude, 125.853240o and Latitude, 7.273382o), Mabini, Compostela Valley Province, Philippines and at Lara Pummelo Farm, Barangay San Vicente, Asuncion, Davao Del Norte, Philippines (site 2, Longitude, 125.749452o and Latitude, 7.588659o) from November 2013 to February 2014. Site 1 was characterized by the pummelo trees of 15 years old with non-overlapping of canopies between trees spaced at distance of 8 x 8 m, "Magallanes" variety planted in a one hectare area (Figure 1). On the other hand, site 2 was with overlapping canopies of "Magallanes" variety spaced at a distance of 5 x 5 m of more or less 15 years old pummelo trees planted in a 10 hectare land area (Figure 2).



Figure 1. Pummelo orchard at USEP (site 1)



Figure 2. Pummelo orchard at Asuncion, Site 2

2.2 Experimental design and treatments

The study was arranged following the Randomized Complete Block Design (RCBD) with eight treatments replicated three times. The different treatments were as follows:

T1- Transparent plastic bottle trap applied with 0.5 ml methyl eugenol charged at two weeks interval

T2- Yellow-colored plastic bottle trap applied with 0.5ml methyl eugenol charged at two weeks interval

T3- Red-colored plastic bottle trap applied with 0.5ml methyl eugenol charged at two weeks interval

T4- Green-colored plastic bottle trap applied with 0.5ml methyl eugenol charged at two weeks interval

T5- Blue-colored plastic bottle trap applied with 0.5ml methyl eugenol charged at two weeks interval

T6- White-colored plastic bottle trap applied with 0.5ml methyl eugenol charged at two weeks interval

T7- Black-colored plastic bottle trap applied with 0.5ml methyl eugenol charged at two weeks interval

T8- Orange-colored plastic bottle trap applied with 0.5ml methyl eugenol charged at two weeks interval

2.3 Establishment of the Trapping Materials and Treatments

Each treatment was hung on the pummelo branch of about 1.5 m from the ground with 10 meters distance between treatments and replication. Plastic bottle of 500 ml size were used in the study (Figure 3) as trap and painted according to the color treatment. The painted plastic bottles were allowed to dry for two weeks before using. Each trap was provided with four window-type holes around the plastic bottle with a dimension of 1 cm². A cotton ball was impregnated with the 0.5 ml methyl eugenol as indicated in the treatments.

The cotton ball with the parafferomones was placed inside the bottle trap in a loop made of iron wire. Each trap was impregnated with the parafferomones at two weeks interval for trapping male oriental fruit fly. The trap was maintained at a distance of 10 meters between traps throughout the duration of the study.

The plastic bottle trap was provided with 100 ml 70% ethyl alcohol to allow insects to be killed while preserving its body for ease of counting and identification. Ethyl alcohol was replenished whenever it will be diminished from the trap.



Figure 3. Installation of the colored traps at San Vicente, Asuncion, Davao Del Norte,

2.4 Cultural Management of the Pummelo Trees

The pummelo trees were maintained by applying recommended rates of fertilizer, watering, weeding and pruning.

2.4.1 Weeding

Weeding was done as soon as the weeds appear using grass hook.

2.4.2 Watering

Watering and irrigation were done when there is no rain or when 30 cm of the soil is dry.

2.4.3 Pruning

Unproductive, infected branches and water sprouts were pruned before the conduct of the study. Pruning tool was used.

2.4.4 Fertilizer application

Fertilizers were applied by broadcast application based on soil analysis.

2.5 DATA GATHERED

2.5.1 Population of Fruit Fly

Population was counted based on the number of fruit fly trapped in every 14 days up to three months duration (Figure 4).



Figure 4. Counting of trapped fruit flies at the Crop Protection Research Laboratory of USeP Mabini, COMVAL, Philippines

2.6 Statistical Analysis

The Analysis of Variance (ANOVA) was used in data analysis and the Duncan Multiple Range Test (DMRT) was used to separate mean difference when significant result was obtained from ANOVA. Further, the data were transformed using the square root transformation before ANOVA.

3 RESULT AND DISCUSSION

3.1 Mean population of male fruit flies as affected by different colored traps at Pummelo Orchard, USeP, Mabini, COMVAL, Philippines condition

The summary of the average number of fruit fly collected from six sampling periods as affected by different colored traps with 0.5 ml methyl eugenol in USeP, Mabini, COMVAL Province, Philippines (site 1) is presented in Table 1.

Results of statistical analysis during the first collection period revealed significant differences among treatments. Transparent trap obtained the greatest density of trapped fruit flies which is significantly comparable with red colored traps with population means of 120 and 76 fruit flies respectively. Yellow, green, blue, white, black and orange colored traps obtained a comparable number of fruit flies with population that ranged from 20 to 54 fruit flies.

No significant difference was noted in second collection period with population count that ranged from 30.66 to 126.30 trapped fruit flies. During the third sampling period, again no significant differences were analyzed. The population of fruit flies ranges from 4.66 to 15.00. However, numerically, the transparent traps obtained the greatest number of trapped fruit flies.

During the fourth collection, statistical analysis showed that the transparent trap got the greatest density of fruit flies but significantly comparable to yellow and red colored traps with population that ranged from 13.36 to 23.30 fruit flies.

On 5th sampling period, transparent plastic bottle trap consistently captured the greatest number of fruit flies over the other treatments with population count of 72.66 significantly superior over the other treatments with population count that ranged from 15.33 to 34.66 fruit flies. During the last collection period, transparent trap continuously obtained the greatest number of fruit flies which is significantly superior over the other treatments.

The result of this undertaking revealed that transparent trap significantly and consistently lured the greatest density of male fruit flies over the other treatments.

The study of Howarth and Howarth(2000) supported the result of this study where they found out that clear or transparent traps significantly captured higher number of oriental fruit flies, *Bactrocera dorsalis* over yellow, red, blue and green. Moreover, they further stressed that placing the clear trap to an open area or exposed site could improve the attractancy to oriental fruit fly. The conclusion of Howarth and Howarth (2000) was also observed in this study wherein more fruit flies are attracted when the traps are fully expose to sunlight (site 1) than in shaded areas (site 2)[5]. Stark and Vargas (1992) also suggest that the attractiveness of traps was due primarily to the intensity of light that reflected on the trap[8].

Moreover, the study of Ravikumar and Viraktamath revealed that a transparent trap is as effective as yellow trap in attracting a high number of *B. correcta* in guava and mango [4]. However, Wu et al., (2007) opposes the result of the study and concluded that the green color could enhance the attractiveness of colored bottles to the oriental fruit fly, and blue stimuli would diminish the attractiveness [9]. Ravikumar and Viraktamath (2007) also found out that *B. dorsalis* was more enticed to green and orange colors in guava and black colored traps in mango [4]. In another study conducted in Bangalore, Madhura (2001) found that deep yellow color traps attracted a maximum number of *Bactrocera* spp. [10]. Sarada et al. (2001) observed that significantly more number of *B. dorsalis*, *B. correcta* and *B. zonata* were attracted to white (16.95 flies/trap/week) and yellow (15.31 fruit flies/trap) colored traps followed by green, orange, red and blue, respectively [11].

Table 1. Mean collected male fruit flies, *Bactrocera* spp. in pummelo as affected by different colored traps with parapheromones in USEP Mabini, COMVAL Province, Philippines. 2014.

TREATMENTS	COLLECTION PERIODS						
	1st**	2nd ^{NS}	3rd ^{NS}	4th*	5th*	6th**	TOTAL
TRANSPARENT	120.00a	126.30	15.00a	23.30a	72.66a	47.33	404.59
YELLOW	54.00b	67.77	5.66abc	13.66abc	31.33b	14.66	186.64
RED	76.00a	101.66	5.33ab	18.00ab	30.00b	11.67	242.66
GREEN	45.66b	47.33	6.33bc	7.66bc	28.33b	9.67	144.98
BLUE	30.00b	43.66	3.00bc	5.33c	34.66b	3.33	119.98
WHITE	20.00b	30.66	4.66c	8.33c	15.33b	4.67	83.65
BLACK	22.66b	54.66	6.00abc	6.00bc	19.66b	7.00	115.98
ORANGE	36.00b	51.33	4.66abc	6.66bc	21.00b	12.33	131.98
CV(%)	20.00	53.18	25.50	27.95	25.20	3.00	

Means with the same letter do not differ significantly at $p=0.05$ (*); $p=0.01$ (**) by DMRT

3.2 Mean population of fruit flies as affected by different colored traps at pummelo orchard, San Vicente, Asuncion, Davao del Norte, Philippines condition

The summary on the mean number of fruit fly collected from three sampling periods as affected by different colored traps with parapheromones in San Vicente, Asuncion, Davao Del Norte, Philippines is presented in Table 2. Here, the collection of data was only up to three times since very low population was monitored in the later collection periods, hence, not included in the paper.

In first collection period, result of statistical analysis revealed significant differences among treatments wherein transparent trap obtained the greatest number of lured fruit flies (56.66). Yellow, Red, Green, Blue, White, Black and Orange colored traps obtained a comparable low number of trapped fruit flies with population that ranged from 7 to 14.33.

No significant difference was noted in second collection period with population count that ranged from 0.66 to 10.00 lured fruit flies. Also, during the third collection period, no significant differences were noted but transparent trap based on numerical figure consistently obtained the greatest number of fruit flies over the other treatments with population count that ranged from 1.00 to 10.33 fruit flies.

Result implies that the transparent trap proved to attract more fruit flies than the colored traps. The result is also consistent from what had been found under USEP, Mabini condition. In this site (site 2), lower count was observed due possibly to the management activity of the grower in the area since pesticide application particularly using various pesticide groups were sprayed at shorter interval of three days particularly during flowering and fruiting stage to control fruit fly and other pests. Also, the pummelo trees have overlapping canopies which possibly contributory to the lower count of lured fruit flies in the study site 2. Haworth and Haworth (2000) reported that higher count of *Bactrocera dorsalis* was caught in higher number in pummelo orchard installed in open area or exposed site, such condition could improve the attractiveness of the trap to oriental fruit fly [5].

Table 2. Mean collected male fruit flies, *Bactrocera* spp. in pummelo as affected by different colored traps with parapheromones in San Vicente, Asuncion, Davao Del Norte, Philippines. 2014.

TREATMENTS	COLLECTION PERIODS			TOTAL
	1st**	2nd ^{NS}	3rd ^{NS}	
TRANSPARENT	56.66a	10.00	10.33	76.69
YELLOW	7.00b	1.00	3.66	11.66
RED	8.66b	0.66	2.33	11.65
GREEN	14.33b	5.00	2.33	21.66
BLUE	10.00b	4.00	6.00	20.00
WHITE	4.66b	5.00	6.33	15.99
BLACK	8.33b	5.00	3.00	16.33
ORANGE	12.66b	1.66	1.00	15.32
CV(%)	39.80	42.78	39.31	

Means having identical letter do not differ significantly at $p=0.01$ (**) by DMRT; NS = Not Significant

4 CONCLUSIONS

Results can be concluded that the transparent plastic bottle trap consistently lured the greatest number of male fruit flies throughout the course of data collection over the other treatments in both study sites.

Based from the result, the use of transparent plastic bottle trap in combination with 0.5 ml of methyl eugenol is an effective trapping technique for fruit flies of pummelo and therefore is highly recommended as an alternative management component against the fruit fly pest of pummelo. Further, the author recommends validating the result to other areas.

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