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DETERRENCE EFFECT OF COLORED DIVERSION SHEETS ON THE POPULATION DENSITY OF MELON FRUIT FLIES *BACTROCERA CUCURBITAE* (COQUILLETT) AND YIELD PARAMETERS OF BITTER GOURD (*MOMORDICA CHARANTIA* L.)

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Abstract *The bitter melon, or the bitter gourd (Momordica charantia L.), is a tropical and subtropical area vegetable. Bactrocera cucurbitae (Coquillett), causes 30 to 100% crop loss. This study used refractive color sheets to examine reduced-risk insecticide spinosad formulations of prevalence and infestation of fruit flies on bitter gourd plants. Three different angles (30°, 60°, and 90°) of reflective sheets were put in M. charantia beds. Results showed that fruit flies were substantially more prevalent (60%) in the control condition. Compared to other color sheets, treatments using yellow refractive sheets showed the highest occurrence of fruit flies. Spinosad, a low-risk insecticide, had the lowest fruit FI% (6%) and the highest commercial yield (860g/bed), followed by blue-colored refractive sheets. Installation angles had no appreciable impact on any of the examined characteristics. Additionally, treatments using yellow-colored refractive sheets and the spinosad formulation (1:1.8), (1:4.9) were found to have the highest and lowest CBR. Installing refractive sheets in colors other than yellow at angles of 30° or 60° has been determined to be a more successful and cost-efficient technique for reducing fruit fly incidence on several vegetable crops. This is especially true when combined with biorational insecticides like Spinosad.*

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Keywords: *Bactrocera cucurbitae; Momordica charantia;* reflecting sheet; yield loss; Fruit Infestation

Introduction

Fruit flies (Diptera: Tephritidae) are a major pest of fruits and vegetables, causing significant quality and quantity loss (Zafar-ul-Hye et al., 2020a). Tephritidae contains approximately 4000 species organized into 500 genera (Chen and Huang, 2019). In India, 392 of these 4000 species have been identified (Chen and Huang, 2019). Fruit flies caused the most damage to cucurbit crops out of all harmful insect pests, rendering more than half of the cucurbit crops unfit for human consumption (Vijayan et al., 2020). The main pest of cucurbitaceous vegetables is the melon fruit fly, *Bactrocera cucurbitae* (Coq.) (Sun et al., 2021), and results in a 30 to 100% loss to crops of cucurbits (Nakate et al., 2018). Fruit flies lay their eggs in the fruits, and as they develop into larvae, they feed on the fruit pulp before pupating in the soil (Fletcher, 1987). The parental fly's oviposition is essential for her offspring's future survival and efficiency since larvae are constrained to a single fruit piece. Since fruit is the only place where reproduction can occur, fruit supply becomes crucial for individual reproduction and the dynamics of the fruit fly population (Drew et al., 1982), (Fletcher, 1987). Melon fruit flies directly harm the fruits by ovipositing on the fruits and leaving small punctures behind. The fruit pulp is consumed internally by maggots. The biggest impediment to good yields and high-quality fruits is the melon fruit fly, *Bactrocera cucurbitae* (Coquillett) (Diptera: Tephritidae). The fruit fly, *B. cucurbitae*, is a serious pest of cucurbitaceous vegetables, particularly bitter gourd (*Momordica charantia*), muskmelon (*Cucumis melo*), snap melon (*C. melo* var. momordica), and snake gourd (*Momordica charantia* (Sorifa, 2018). Because of the entrance of numerous infections, the fruits affected in the early stages fail to mature properly and frequently fall or rot on the plant (Yan et al., 2021). For the control of fruit flies, many management tactics such as indigenous, chemical, mechanical, cultural, pheromones, cue lures, and baits are applied (Chakraborty et al., 2020). Methyl eugenol is a potent attractant for numerous Bactrocera species. A cue-lure trap was utilized to monitor and mass trap *B. cucurbitae* males in bitter gourd (Zafar-ul-Hye et al., 2020b). MAT traps use irresistible lure materials to attract flies and a compound that kills them when they touch or feed, preventing flies from reproducing. It also decreases the risk to humans and non-target creatures by spraying insecticides directly on crops (Huang et al., 2020).

Traditionally, fruit fly management and control have been accomplished through bait applications in which an attractant, such as hydrolyzed protein, is combined with a killing agent (Adhikari et al., 2021). For use in Hawaii against *Bactrocera* spp. For fruit flies, several different bait stations have been created using male-specific lures. For instance, (Cui et al., 2020) for the area-wide control of the Asian fruit fly, *Bactrocera dorsalis* (Hendel), and the melon fly, *B. cucurbitae* (Coquillet), respectively, spray-able attract-and-kill dispensers with spinosad, methyl eugenol, and cue-lure were tested. Various chemicals and attractants are used to draw in and kill fruit fly adults (Cui et al., 2020). Infected fruits and flowers do not develop to the proper size, which ultimately reduces productivity. Melon fruit fly infections cause 41–95% of fatalities, 95% of losses, and 31.27% of gains (Naik et al., 2021).

Chemicals that pose a lower environmental or human health risk make up reduced-risk insecticides. Reduced-risk pesticides don't necessarily mean they pose no risk; they do so slightly less than other products with the same use pattern. Such insecticides are less harmful to human health, less toxic to organisms that aren't their targets, less likely to contaminate groundwater, surface water, or other important environmental resources, have low rates of use, pose little risk of pest resistance, and are compatible with IPM techniques (Coupland et al., 2017).

Fruit fly capture is further influenced by surface color, fluorescence, adhesive substance, and feeding source (Wang et al., 2022). Fruit flies prefer yellow, green, red, orange, and blue hues, which vary depending on the species. Fruit flies find colored surfaces with broad spectrum wavelengths least appealing (Wang et al., 2022). Compared to other colors, green (with a spectrum between 490 and 560 nm) attracts oriental fruit flies the most (Matsumura et al., 2020). There is some literature on the melon fruit fly's visual sensitivity to various hues. Since no single technique is effective enough to control fruit flies, it is necessary to look for and use contemporary strategies that may address these issues. These facts call for creating management and control methods that would be practical, environmentally friendly, and compatible with nature while having the fewest negative effects. With the following goals, the current study was created to assess the effects of integrating low-risk insecticides and colored refraction sheets on melon fruit flies and bitter gourd yield incidence.

To determine how using colored refraction sheets and low-risk insecticides affects the prevalence of melon fruit flies in bitter gourds.

To assess the effect of combining low-risk insecticides with colored refraction sheets on bitter gourd yield.

MATERIALS AND METHODS

Experimental layout

The University of the Punjab Lahore's Department of Entomology planted bitter gourd seeds in its experimental area. The main plot measured 100 feet long by 70 feet wide. Seventy-two beds were separated from the main site. The distances between the beds and the plants were 60 cm and 30 cm, respectively. Each bed measured 13 feet long and 3.5 feet wide. There were ten bitter gourd plants in one bed (Figure 1).

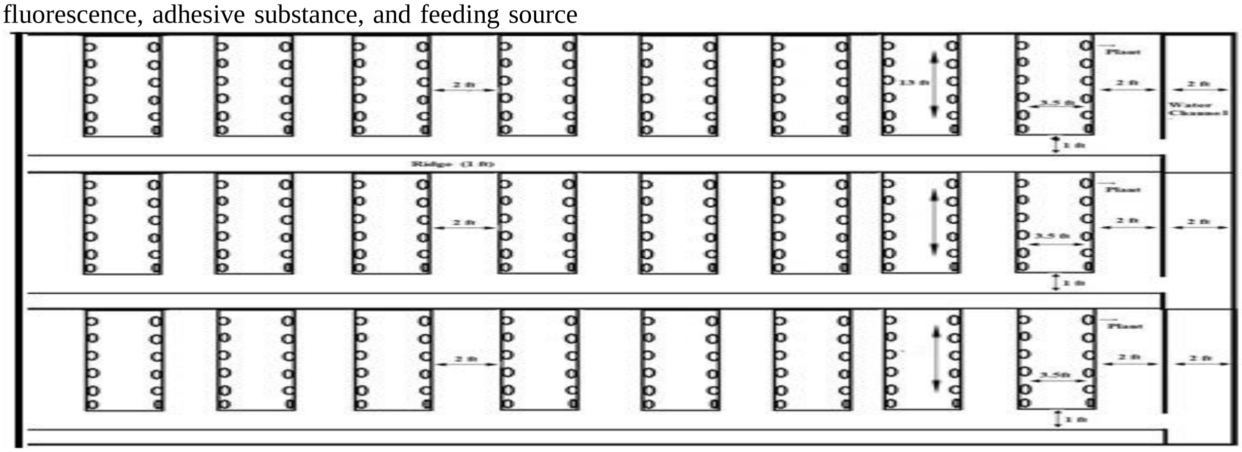

Figure 1: Experimental Layout

Treatments

The treatments listed below were included in the experiment.

Table 1: Treatment allocation of different colours and angles installed in flied

Combinations of Treatment	
Reflective sheet color	**Angles**

	30º	60º	90º
R	$Treat_1$	$Treat_8$	$Treat_{15}$
B	$Treat_2$	$Treat_9$	$Treat_{16}$
O	$Treat_3$	$Treat_{10}$	$Treat_{17}$
Bl	$Treat_4$	$Treat_{11}$	$Treat_{18}$
Y	$Treat_5$	$Treat_{12}$	$Treat_{19}$
G	$Treat_6$	$Treat_{13}$	$Treat_{20}$
W	$Treat_7$	$Treat_{14}$	$Treat_{21}$
Standard (RR-insecticides)		$Treat_S$ ($Treat_{22}$)	
Control (Water)		$Treat_0$ ($Treat_{23}$)	

Red: R, **Black**: B, **Orange**: O, **Blue**: Bl, **Yellow**: Y, **Green**: G, **White**: W

Preparation of colored refractive sheets and their installation

Red, black, orange, blue, yellow, green, and white reflective sheets were acquired from the market. With wooden stakes inserted deeply into the ground at three angles, the sheets were put in the bitter gourd field (30, 60, and 90 degree). All of these coverings were placed when the bitter gourd plants were flowering and bearing fruit. Every damaged sheet was replaced when necessary (Singh Chauhan et al., 2018).

Reduced-risk insecticides (R-R-Insecticides) and their application

Spinosad or lufenuron, two insecticides with reduced risks (recommended doses), and GF-120, an insecticide with a reduced-risk formulation or technology, were all purchased from the market. In contrast to standard treatment, where their alternate spray was applied every two weeks, their application scheme for integrated treatments involved a board-spray of GF-120 followed by one alternate spray of spinosad and lufenuron when necessary (Gogi et al., 2021).

Collecting information to find out how common melon fruit flies are in bitter gourd

Net sweeping was used every three days to segregate the sexes of the flies caught in the sweep-net and count them to assess the prevalence of melon fruit flies with bitter gourd treated with different colored refractive sheets combined with R-R-insecticides.

Data collection for detecting fruit quality

The harvested fruits were taken inside the IPM laboratory and weighted at random to acquire data regarding fruit quality. Ten were chosen to examine under a microscope from the assortment of fruits. The contaminated fruits were sorted, counted, and weighted to determine the percentage of fruit infection and yield loss. The number of maggots in each of the infected fruits was counted to estimate their maggot density. The marketable yield was calculated by counting and weighing the healthy fruits. Total yield, marketable yield, yield loss, and fruit infection were all tallied after the most recent picking. For each treatment, the cost-benefit ratio was estimated based on the input used in plant protection methods and the revenue from bitter gourd yield.

Statistical Analysis

ANOVA was used to analyze the data collected on the incidence of fruit flies, fruit infestation, marketable yield, yield loss, and cast benefit ratio. The Tucky HSD test was used to compare the means of significant results (Mawtham et al., 2020).

RESULTS

Fruit fly densities captured on sheets of various colors showed a significant difference. During first picking, the results showed that in treatments, the TFF (Total Fruit Fly) is maximum (5.66 flies) at the angle of 30° in a yellow color sheet. It comprises the maximum number (2.33 flies) of MFF (Male Fruit Fly) in a yellow sheet at the angle of 90°. It also contains the maximum number (3.33 flies) of FFF (Female Fruit Fly) in a yellow sheet at an angle of 90°. The FI% (Fruit Infestation Percentage) is a minimum (6.00 flies) at the angle of 30° in a white color sheet (Table: 2). The MD/F (Maggot Density per Fruit) is maximum (4.33 flies) at the angle of 30° in a yellow color sheet. It comprises of maximum TY/P (Total Yield per Plant) of (936.00 flies) in an orange sheet at an angle of 60°. The MY/P (Market Yield per Plant) is a maximum (809.00 flies) in a blue sheet at the angle of 90°. The YL/P (Yield Loss per Plant) is minimum (90.33 flies) at the angle of 60° in a white color sheet (Table: 2).

During second picking, the results showed that in treatments, the TFF (Total Fruit Fly) is maximum (6.33^{AB}) at the angle of 30° in a yellow color sheet. It comprises the maximum number (2.66 flies) of MFF (Male Fruit Fly) in a yellow sheet at the angle of 30°. It also contains the maximum number (2.66 flies) of FFF (Female Fruit Fly) in a yellow sheet at the angle of 30°. The FI% (Fruit Infestation Percentage) is minimum (6.33 flies) at the angle of 90° in a Blue color sheet (Table: 3). The MD/F is maximum (7.33 maggots) at the angle of 30° in a yellow color sheet. It comprise of maximum TY/P of (1014.7 g/bed) in an orange sheet at an angle of 30°. The MY/P is maximum (764.33 g/bed) in a black sheet at the angle of 30°. The YL/P (Yield Loss per Plant) is minimum (180.00 g/bed) at the angle of 90° in a blue color sheet **(Table: 3)**. During third picking the results showed that in treatments, the TFF is maximum (7.00 flies) at the angle of 90° in a yellow color sheet. It comprises of the maximum number (3.00 flies) of MFF in a yellow sheet at the angle of 30°. It also contains the maximum number (4.33 flies) of FFF in a yellow sheet at the angle of 30°. The FI% is minimum (6.33%) at the angle of 30° in a white color sheet **(Table: 4)**. The MD/F is maximum (6.33 maggots) at the angle of 30° in a yellow color sheet. It comprises of maximum TY/P of (959.67 g) in a black sheet at an angle of 60°. The MY/P is maximum (830.00g) in a black sheet at the angle of 60°. The YL/P is minimum (80.33g) at the angle of 30° in a white color sheet **(Table: 4).**

Discussion

The highest fruit infestation percentage was visible on color-refraction sheets in yellow, orange, and green following control. According to Burns et al. (2001), a serious Mediterranean fruit fly invasion in Florida during 1997 and 1998 prompted the widespread use of malathion-bait sprays on foliage and in the air. Groundwork using spinosad, a novel soil microbe developed by Dow Agrosciences and a brand-new attraction (Sol- Bait), provides assurance. Three meadow studies were carried out employing foliar and aerial applications. In comparison to normal malathion with NU-LURE® or SolBait treatment by application of aerial or foliar sprays, the results show that spinosad-Sol Bait sprays offered similar and considerable control levels for sterile Mediterranean and Caribbean fruit flies (MAWTHAM et al., 2022). According to statistical psychotherapy data, there was no sign of a harmful effect on beneficial insects or the environment. Prokopy et al. (2003) conducted field studies in Hawaii using color-marked protein and protein-feeding female melon fruit flies. A cucumber-related bacterium The favored hosts of melon flies were border areas, bait-sprayed sorghum plants, or open cucumber spaces. Unsprayed Coquillette sorghum plants were used because they aren't melon fly hosts (Nagendran et al., 2020). In Hawaii, the bait was sprayed on sugarcane and sorghum to suppress melon flies. The GF-120NF fruit fly bait resulted in the release of flies that were 89% dead in cucumber and 14% dead in sorghum, but was less effective in the area where it was used in cucumber. There are no dead fruit flies in the unsprayed area. After treatment, the fruit flies were extremely attracted to the water droplets of the GF-120FN fruit fly bait in the greenhouse cage on the sorghum within an hour. However, under dry conditions in the greenhouse, they lost all of their attractiveness within 24 hours. The bait spray droplets are still extremely hazardous to females deficient in protein after 24 hours, but they become less toxic after 4 days in the lab and completely stop being toxic after about 8 mm of rain. In comparison to bait spray droplets and bait spray, the combined effectiveness of the GF-120NF fruit fly bait spray to non-host plants was quite high (Shinde et al., 2021).

Mexican fruit flies were the target of bait sprays administered by Thomas and Mangan (2005) to citrus groves in the Rio Grande Valley of Texas. These sprays contained the toxicant Spinosad (GF-120). Sprays that were applied served as a supplement to a continuous release program for sterile insects. Compared to the control orchard, sterile fly catches were 47–63% lower in the treated orchard (Prasannakumar et al., 2022). Eight out of ten secondary pest populations in the test orchard decreased after spray applications. Still, they also decreased in the control orchard, indicating that the decline was likely caused by seasonal factors rather than the administration of bait. Because of the spinosad bait application in this instance, at the same time, no breakout of inferior pests occurred, contrary to what was reported for Malathion bait application in citrus orchards. The effectiveness of the fruit fly bait GF-120 has been employed as a crucial instrument for the regional management and eradication of fruit flies (Muthukumar et al., 2020). To evaluate the direct contact toxicity of GF-120 to three major tephritid parasites in Hawaii: Diachasmimorpha tryoni (Cameron), Fopius arisanus (Sonan), and Pysttalia fletcheri (Silvestri) (Hymenoptera: Braconidae) (Hymenoptera: Aphidiidae). Four parasitoid species could affect GF-120.

Both males and females of every species were equally sensitive to GF-120. A small variety of braconid species met the LC50 for opium throughout a 24-hour period (8.3–17.5 ppm). In contrast to opiates, aphidiid appeared more vulnerable to the glueyness of GF-120. It was discovered that adults of *F. arisanus* (as a representative species) do not feed openly in the presence of GF-120 or without water and honey. *F. arisanus* taste, distinguish and reject GF-120 droplet after a brief (one) oral evaluation. The effects of death were felt by GF-120 from closed touch (Islam et al., 2019). Females of *F. arisanus* were given free reign to forage on host brown branches liberally sprayed with droplets at the optional field rate for employing GF-120 (80 ppm). Still, action death was noticeably more developed than that of the treatment group (which had been sprayed with water) and increased with experience. Foliar and aerial treatments (Zhang et al., 2019) compared the effectiveness of bait sprays based on spinosad and malathion. Florida served as the site of this experiment. The findings demonstrated that spinosad-based bait sprays offer superior control over malathion-based bait sprays. The data also showed that the honeybee colonies and bees in the application location did not notice any differences between the two treatments. These treatments have no negative effects on beneficial insects or other non-target animals. Since bait systems could lower fruit fly populations, their usage in fruit fly management should be considered (Sen et al., 2019).

Table 2: Efficacy of different colours deterrence sheet on population density, percent fruit infestation, maggots density per fruit, total yield per plant, market yield per plant and yield loss per plant after 1st picking

Colors	TFF			MFF			FFF			FI (%)		
	Angle of reflection sheet											
	30°	60°	90°	30°	60°	90°	30°	60°	90°	30°	60°	90°
R	2.33^{D}	3.33^{BCD}	3.00^{CD}	1.00^{B}	1.33^{B}	1.33^{B}	1.33^{CD}	2.00^{BCD}	1.66^{BCD}	6.66^{B}	6.66^{B}	6.66^{B}
B	3.33^{BCD}	3.00^{CD}	2.66^{D}	1.66^{B}	1.33^{B}	1.00^{B}	2.33^{BCD}	1.66^{BCD}	1.33^{CD}	8.00^{B}	8.00^{B}	7.00^{B}
O	3.00^{CD}	3.33^{BCD}	3.66^{BCD}	1.33^{B}	1.33^{B}	1.66^{B}	1.66^{BCD}	2.00^{BCD}	2.66^{BCD}	7.00^{B}	9.00^{B}	8.33^{B}
Bl	2.33^{D}	2.66^{D}	3.00^{CD}	1.00^{B}	1.00^{B}	1.33^{B}	1.33^{CD}	1.33^{CD}	1.66^{BCD}	7.00^{B}	8.66^{B}	6.66^{B}
Y	5.33^{BC}	5.33^{BC}	5.66^{B}	2.33^{B}	2.33^{B}	2.33^{B}	3.00^{BC}	3.00^{BC}	3.33^{B}	11.66^{B}	14.00^{B}	16.33^{B}
G	3.33^{BCD}	3.33^{BCD}	3.00^{CD}	1.33^{B}	1.33^{B}	1.33^{B}	2.33^{BCD}	2.00^{BCD}	1.66^{BCD}	7.66^{B}	7.33^{B}	7.66^{B}
W	3.33^{BCD}	3.33^{BCD}	3.66^{BCD}	1.33^{B}	1.33^{B}	1.66^{B}	2.00^{BCD}	2.00^{BCD}	2.33^{BCD}	6.00^{B}	8.33^{B}	8.33^{B}
	MD/F			**TY/P**			**MY/P**			**YL/P**		
R	3.00^{B}	2.33^{B}	2.33^{B}	933.00^{A}	888.67^{A}	882.67^{A}	750.67^{A}	792.33^{A}	776.33^{A}	165.67^{B}	123.67^{B}	114.33^{B}
B	2.00^{B}	2.33^{B}	3.00^{B}	874.33^{A}	883.67^{A}	926.33^{A}	773.00^{A}	792.33^{A}	724.33^{A}	96.67^{B}	119.33^{B}	162.00^{B}
O	2.33^{B}	3.66^{B}	2.66^{B}	890.67^{A}	936.00^{A}	903.33^{A}	794.67^{A}	758.33^{A}	760.67^{A}	131.00^{B}	175.66^{B}	142.67^{B}
Bl	2.66^{B}	3.33^{B}	2.66^{B}	914.00^{A}	933.00^{A}	902.00^{A}	707.00^{A}	755.00^{A}	809.00^{A}	146.67^{B}	172.00^{B}	142.67^{B}
Y	4.33 ^{AB}	2.00 ^{B}	4.00^{AB}	750.67^{A}	765.67^{A}	736.00^{A}	525.67^{A}	515.67^{A}	575.33^{A}	225.00^{B}	250.00^{B}	161.67^{B}
G	3.33^{B}	3.00^{B}	2.66^{B}	934.00^{A}	931.33^{A}	901.67^{A}	757.67^{A}	727.67^{A}	805.00^{A}	172.67^{B}	162.67^{B}	141.00^{B}
W	2.66^{B}	2.00^{B}	2.66^{B}	909.00^{A}	849.67^{A}	896.67^{A}	697.67^{A}	771.00^{A}	804.67^{A}	146.00^{B}	90.33^{B}	139.00^{B}

TFF (Total Fruit Fly), MFF (Male Fruit Fly), FFF (Female Fruit Fly), FI% (Fruit Infestation Percentage), MD/F (Maggot Density per Plant), TY/P (Total Yield per Plant), MY/P (Market Yield per Plant), YL/P (Yield Loss per Plant). Red: R, Black: B, Orange: O, Blue: Bl, Yellow: Y, Green: G, White: W

Table 3: Efficacy of different colours deterrence sheet on population density, percent fruit infestation, maggots density per fruit, total yield per plant, market yield per plant and yield loss per plant after 2nd picking

Colors	TFF			MFF			FFF			FI (%)		
	Angle of reflection sheet											
	30°	60°	90°	30°	60°	90°	30°	60°	90°	30°	60°	90°
R	3.00^{D}	2.66^{D}	2.66^{D}	1.33^{BC}	1.00^{C}	1.00^{C}	1.33^{BC}	1.00^{C}	1.00^{C}	10.00^{CDE}	9.00C^{DE}	9.00C^{DE}
B	2.66^{D}	4.33^{BCD}	3.00^{D}	1.00^{C}	2.00^{ABC}	1.33^{BC}	1.00^{C}	2.00^{ABC}	1.33^{BC}	9.00C^{DE}	13.66^{BCDE}	9.33C^{DE}
O	5.00^{BCD}	5.00^{ABC}	4.33^{BCD}	2.00^{ABC}	2.66^{AB}	1.66^{ABC}	2.00^{ABC}	2.66^{AB}	1.66^{ABC}	14.66^{BCD}	15.66^{BC}	13.33^{BCDE}
Bl	3.00^{D}	3.00^{D}	2.33^{D}	1.00^{C}	1.33^{BC}	1.00^{C}	1.00^{C}	1.33^{BC}	1.00^{C}	9.33^{CDE}	9.66^{CDE}	6.33^{E}
Y	6.33^{AB}	6.00^{ABC}	4.33^{BCD}	2.66^{AB}	2.33^{ABC}	1.66^{ABC}	2.66^{AB}	2.33^{ABC}	1.66^{ABC}	17.66^{B}	15.00^{BCD}	12.33^{BCDE}
G	3.66^{BCD}	3.33^{CD}	4.00^{BCD}	1.33^{BC}	1.33^{BC}	1.33^{BC}	1.33^{BC}	1.33^{BC}	1.33^{BC}	11.00^{BCDE}	10.33^{BCDE}	11.33^{BCDE}
W	2.33^{D}	3.00^{D}	2.66^{D}	1.00^{C}	1.33^{BC}	1.00^{C}	1.00^{C}	1.33^{BC}	1.00^{C}	7.66^{DE}	9.66C^{DE}	8.00^{DE}
	MD/F			TY/P			MY/P			YL/P		
R	3.66^{C}	3.00^{C}	3.00^{C}	874.7^{AB}	862.3^{AB}	838.3^{AB}	589.33^{A}	715.33^{A}	713.33^{A}	253.67^{A}	233.33^{A}	220.67^{A}
B	3.00^{C}	5.33^{ABC}	3.33^{C}	864.3^{AB}	935.0^{A}	865.0^{AB}	764.33^{A}	611.33^{A}	556.33^{A}	234.00^{A}	287.67^{A}	235.67^{A}
O	5.66^{ABC}	6.66^{ABC}	5.00^{ABC}	1014.7^{A}	962.3^{A}	922.7^{AB}	618.00^{A}	643.33^{A}	609.00^{A}	296.33^{A}	319.00^{A}	287.33^{A}
Bl	3.33^{C}	3.66^{C}	2.66^{C}	864.7^{AB}	873.3^{AB}	566.7^{B}	647.67^{A}	587.33^{A}	667.67^{A}	234.67^{A}	253.33^{A}	180.00^{A}
Y	7.33^{AB}	6.33^{ABC}	6.66^{BC}	966.7^{A}	948.3^{A}	922.3^{AB}	547.67^{A}	542.33^{A}	566.33^{A}	337.33^{A}	317.00^{A}	280.67^{A}
G	4.00^{C}	4.00^{C}	4.00^{C}	893.7^{AB}	893.0^{AB}	896.7^{AB}	602.67^{A}	595.00^{A}	604.00^{A}	257.67^{A}	256.00^{A}	278.67^{A}
W	2.66^{C}	3.66^{C}	3.00^{C}	795.0^{AB}	868.3^{AB}	828.3^{AB}	680.00^{A}	557.00^{A}	688.67^{A}	191.33^{A}	253.33^{A}	207.00^{A}

TFF (Total Fruit Fly), MFF (Male Fruit Fly), FFF (Female Fruit Fly), FI% (Fruit Infestation Percentage), MD/F (Maggot Density per Plant), TY/P (Total Yield per Plant), MY/P (Market Yield per Plant), YL/P (Yield Loss per Plant). Red: R, Black: B, Orange: O, Blue: Bl, Yellow: Y, Green: G, White: W

Table 4: Efficacy of different colours deterrence sheet on population density, percent fruit infestation, maggots density per fruit, total yield per plant, market yield per plant and yield loss per plant after 3rd picking

Colors	TFF			MFF			FFF			FI (%)		
	Angle of reflection sheet											
	30°	60°	90°	30°	60°	90°	30°	60°	90°	30°	60°	90°
R	2.66^{D}	3.33^{D}	3.66^{CD}	1.00^{C}	1.66^{BC}	2.00^{BC}	1.66^{D}	1.66^{D}	1.66^{D}	9.00^{BC}	7.66^{BC}	6.33^{C}
B	2.33^{D}	3.33^{D}	3.33^{D}	1.00^{C}	1.00^{C}	1.33^{BC}	1.33^{D}	2.33^{BCD}	2.00^{CD}	9.00^{BC}	10.00^{BC}	9.66^{BC}
O	4.33^{BCD}	5.00^{BCD}	4.33^{BCD}	2.00^{BC}	2.33^{BC}	2.00^{BC}	2.33^{BCD}	2.66^{BCD}	2.33^{BCD}	8.00^{BC}	12.66^{B}	10.33^{BC}
Bl	3.33^{D}	3.33^{D}	3.33^{D}	1.33^{BC}	1.00^{C}	1.33^{BC}	1.66^{D}	2.33^{BCD}	2.00^{CD}	10.00^{BC}	10.00^{BC}	9.00^{BC}
Y	6.66^{BC}	5.33^{BCD}	7.00^{B}	2.33^{BC}	2.33^{BC}	3.00^{B}	4.33^{AB}	3.00^{BCD}	4.00^{BC}	11.00^{BC}	7.33^{BC}	12.00^{BC}
G	3.00^{D}	3.00^{D}	3.33^{D}	1.33^{BC}	1.00^{C}	1.66^{BC}	2.00^{CD}	2.00^{CD}	1.66^{D}	8.66^{BC}	9.33^{BC}	10.66^{BC}
W	2.33^{D}	3.00^{D}	3.33^{D}	1.00^{C}	1.00^{C}	1.33^{BC}	1.33^{D}	2.00^{CD}	2.00^{CD}	6.33^{C}	9.00^{BC}	8.66^{BC}
	MD/F			TY/P			MY/P			YL/P		
R	3.66^{B}	4.00^{B}	3.33^{B}	906.67^{A}	920.33^{A}	915.33^{A}	770.00^{A}	814.00^{A}	795.33^{A}	136.67^{B}	106.33^{B}	120.00^{B}
B	3.33^{B}	4.00^{B}	3.33^{B}	901.00^{A}	959.67^{A}	878.33^{A}	703.33^{A}	830.00^{A}	697.00^{A}	197.67^{B}	129.67^{B}	181.33^{B}
O	4.33^{B}	6.00^{AB}	3.33^{B}	871.67^{A}	878.33^{A}	835.67^{A}	732.00^{A}	729.00^{A}	743.00^{A}	139.67^{B}	149.33^{B}	92.67^{B}
Bl	4.00^{B}	4.00^{B}	3.33^{B}	897.33^{A}	906.33^{A}	884.33^{A}	762.33^{A}	783.67^{A}	761.33^{A}	135.00^{B}	148.67^{B}	123.00^{B}
Y	6.33^{AB}	5.33^{AB}	6.00^{AB}	908.67^{A}	953.00^{A}	887.67^{A}	764.00^{A}	800.00^{A}	695.00^{A}	144.67^{B}	153.00^{B}	192.67^{B}
G	5.00^{AB}	4.00^{B}	3.00^{B}	917.67^{A}	935.33^{A}	905.00^{A}	800.67^{A}	733.67^{A}	760.67^{A}	117.00^{B}	201.67^{B}	144.33^{B}
W	3.33^{B}	3.33^{B}	3.66^{B}	916.00^{A}	896.33^{A}	839.33^{A}	835.67^{A}	760.67^{A}	749.67^{A}	80.33^{B}	135.67^{B}	89.67^{B}

TFF (Total Fruit Fly), MFF (Male Fruit Fly), FFF (Female Fruit Fly), FI% (Fruit Infestation Percentage), MD/F (Maggot Density per Plant), TY/P (Total Yield per Plant), MY/P (Market Yield per Plant), YL/P (Yield Loss per Plant). Red: R, Black: B, Orange: O, Blue: Bl, Yellow: Y, Green: G, White: W

Declarations

Conflict of interest

The authors have no conflict of interest.

Data Availability statement

All data generated or analyzed during the study are included in the manuscript.

Ethics approval and consent to participate

Not applicable

Consent for publication

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