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LOW ENVIRONMENTAL IMPACT METHOD FOR CONTROLLING THE PEACH FRUIT FLY, *BACTROCERA ZONATA* (SAUNDERS) AND THE MEDITERRANEAN FRUIT FLY, *CERATITIS CAPITATA* (WIED.), IN MANGO ORCHARDS IN EGYPT

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ABSTRACT. The study was carried out at two experimental farms in Ismailia Governorate, Egypt, during season of 2015 and 2016. GF-120 (Conserve® 0.024% CB) was selected in this study to evaluate its efficacy for controlling the peach fruit fly, *Bactrocera zonata* (Saunders) and the Mediterranean fruit fly, *Ceratitis capitata* (Wied.), on mango fruits by using partial bait spray and spots method. GF-120 was used as low environmental impact method and new way to control *B. zonata* and *C. capitata*, compared with malathion 57%, as traditional insecticide. During both seasons, data revealed that the number of *C. capitata* captured weekly from different treatments and untreated plots was higher than the number of *B. zonata* captured in both seasons of experiment. Data revealed that the number males of *B. zonata* and *C. capitata* captured weekly from sticky traps were lower in trees treated with GF-120 than malathion and untreated plots. In the farm of Faculty of Agriculture, Suez Canal University, the lowest percentages of infestation of both dropping and setting fruits per tree were recorded in plots treated with GF120 (spots), with an average of 25.14 and 17.022% for dropping fruits and 2.2 and 2.0% for setting fruits for 2015 and 2016 season, respectively. Data indicated that the all tested formulation under field condition caused significant reduction in the rate of infestation from 54.92 to 81.79 for both dropping and setting fruits. The lowest percentages of infestations in the private farm of both dropping and setting fruits per tree were recorded in GF-120 (spray treatment), with an average of 20.0, 12.12 for dropping fruits and 3.4 and 4.0 for

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setting fruits for 2015 and 2016 seasons, respectively.

Keywords: *B. zonata*; *C. capitata*; partial - spot spray; efficacy; infestation; monitoring; GF-120; malathion.

INTRODUCTION

Mango (*Mangifera indica* L.) is universally considered one of the most important fruit crop in tropical and subtropical areas of the world (Krishnan *et al*., 2009). Egypt is reported to be the third African country after Nigeria and Kenya in the production areas (71009 ha) with a total production of 598084 Mt (FAOSTAT, 2015). Ismailia Governorate occupies top position among mango producing areas of Egypt, where more than 40% of the total mango cultivated area of Egypt exists (Wahdan, 2011).

Mango trees are subject to severe attack with scores of insect pests, which affect its production and reduce its quality and quantity. Nevertheless, the most dangerous pests are those related to ripening fruits, with an estimated yield losses caused in some cases by more than 50% depending on the season and management practices (Abdullahi *et al*., 2011).

The peach fruit fly, *Bactrocera zonata* (Saunders), is one of the most destructive pest species of Tephritidae originates in South and South-East Asia. It is a highly polyphagous species attacking more than 50 host plants, including peach, guava, mango, apricot, fig and citrus (Pena *et al*., 1998). Also, it infests some vegetables as a secondary pest (Fletcher, 1987). It causes serious economic losses, either by direct damage to fruits or indirectly by warranting the need for quarantine and phytosanitary measures. It is thought to have been introduced to the Middle East, namely Saudi Arabia, Oman, and Egypt. *B. zonata* was detected for the first time in Egypt in 1998 (Taher, 1998) and spread throughout the country (Amro & Abdel-Galil, 2008). It is now well-established, widespread, and well-adapted to local conditions (Hashem *et al*., 2001). Obviously, it outcompetes and displaced other tephritid fruit fly species, such as *C. capitata*, to become the most economically important fruit fly of fleshy fruits (Elnagar *et al*., 2010; Mahmoud, 2010).

In Egypt, the infestation of fruits reached up to 30-40%, with an annual loss of 177 million US$. Intensive control of both fruit flies is dependent upon the application of insecticide from various groups, like dipterex, imidacloprid, triazophos and neem products (Saikia & Dutta, 1997; Singh *et al*., 2000; Mahmoud & Shoeib, 2008). The use of cover insecticide sprays against fruit flies is wide spread and provides good control (Allwood, 1997). In order to reduce the fruit fly populations to low levels, chemical control using malathion bait sprays has been considered as the most common method used worldwide (Romoser & Ferro, 1994 and Rosseler *et al*., 2000). Bait spray technique depends on the use of a mixture of protein bait plus an insecticide, which is applied as a spot at an approximate rate of about 50 ml per tree. This technique reduces markedly the amount of insecticide sprayed into the environment, as compared to cover spray application (Prokopy *et al*., 2003).

In conventional farming, fruit fly is usually controlled by intensive use of pesticides or poisoned protein baits (Roessler, 1989). However, the intensive use of such chemical insecticides have resulted in residues on commodities that affect fruit safety, human health concerns, limit export markets, conflict with the increasing demand for organic products, as well as their impact on environment, beneficial and non-target organisms (Vijaysegaran, 1994). Moreover, despite of the popularity of the organophosphate malathion, its use in protein bait sprays has raised serious concerns, mainly due to potential adverse effects on non target organisms and environment (Daane *et al*., 1990; Messing *et al*., 1995).

To address this vital environmental problem it is necessary to find safer alternatives to traditional insecticides. In this respect, a need for safer toxicants in protein baits, the (Dow AgroSciences LLC, Indianapolis, IN) has developed GF-120 NF Naturalyte, a spinosad-based fruit fly bait, as a replacement for malathion based fruit fly baits. GF- 120, a new bait combination consisting of an attractant, a feeding stimulant and spinosad insecticide (Mangan *et al.,* 2006). In many regions of the world, GF-120 has been used successfully in an area-wide management program in conjunction with natural enemies, the sterile insect technique, male annihilation and field sanitation (Vargas *et al*., 2008).

Therefore, the present study aimed to evaluate the efficacy of GF-120 (Conserve 0.024% CB), as bioinsecticide with comparison to malathion as conventional insecticide, in partial bait and spots technique against *B. zonata* and *C. capitata* in two mango orchards at Ismailia Governorate, Egypt.

MATERIALS AND METHODS

Field study site

This study was carried out in mango orchards (*Mangifera indica*) in two experimental farms. The first one was farm of Faculty of Agriculture, Suez Canal University at 4.5 km from, Ismailia, Egypt. The planting density of mango was 118 trees per feddan (1 feddan = 0.42 ha), and the trees are about 20 years old. The main mango varieties was Fager Klan and Alphonse (representing about 50% of the area) and in lower number Zebda, White Succary, Langra Benares, Ewais, Hindi Besennara. Each one was approximately 10% of the area.

The second farm was at 17 km from Ismailia and the planting density was White Succary, and the mango density was 120 tree per feddan, the tree were about 20 years old too. The field experiments were conducted during the period from first May to mid August in two successive fruiting seasons of 2015 and 2016.

In two farms, the experimental area (6 feddans) was divided into four treatment plots (three tested insecticides and control). The treatments were replicated three times with 0.5 feddan each.

Tested insecticides

Biological tested formulation was taken from Dow AgroSciences. This formulation was GF-120 (known commercially as Conserve®), contains 0.024% spinosad (AI) and 98.8% inert ingredients consisting of water, sugars, and attractants. The traditional insecticide was malathion 57%, as a common one for controlling *B. zonata* and *C. capitata* in Egypt.

Treatments

Partial bait spray and spot bait spray technique were used in these experiments. The application of tested compounds was performed when the mango fruits reached their half sizes. The spot bait spray was applied directly to host trees as "spots" (Burns *et al.,* 2001) onto the underside of leaves, on the trunk in the north side of the selected trees using backpack sprayer.

The tested compounds were applied at concentration of 500 ml insecticide + 10 l water / feddan for GF-120, and at concentration of 500 ml insecticide + 500 ml buminal + 19 l water. Both insecticides GF-120 and malathion 57% were applied four times at an interval of 15 days.

Monitoring

To monitor adult population of *B. zonata* over the study period, yellow sticky traps (Jackson traps) baited with an aqueous solution of the sex pheromone methyl eugenol to capture the peach fruit fly, *B. zonata* adults and trimedlure to capture the Mediterranean fruit fly, *C. capitata* adults. Traps were installed in treated and control orchards. A total of 12 traps (one trap of each replicate per treatment) were hanged on the mango trees at head height within the tree canopy. Traps were hanged one week before the first spray to evaluate the population level prior to treatment. The traps were inspected at least once a week during the study period (15 weeks). The number of captured adult males of *B. zonata* and *C. capitata* in both orchards were weekly recorded.

Fruit damage

To estimate the infestation rate of *B. zonata* or *C. capitata* on the setting fruits, five trees of each treatment were selected randomly. Samples of 50 fruits were investigated visually every week and the punctured fruits were recorded and marked. By the end of fruiting season all dropped fruits were also investigated. In order to assess fruit damage during ripening, at the end of the study period, the total number of punctured and dropped fruits per tree was calculated.

Meteorological data

Records of average temperature, relative humidity throughout the inspection periods were obtained from the meteorological data (2015-2016) (http://ar.weather-forecast.ru /forecast/ eg/ ismailia/)

Statistical analysis

The obtained data were statistically analyzed through ANOVA (SAS Institute, 2002). When F-test was significant, means were separated using Tukey's HSD Test at the 0.05 level of significance.

RESULTS AND DISCUSSION

The mean numbers of *B. zonata* males and *C. capitata* males, captured weekly per trap over the study period of 2015 and 2016 seasons from Agriculture Farm of Suez Canal University are presented in *Figs. 1, 2, 3 and 4*. The weekly trend of males' population of *B. zonata* and *C. capitata* showed almost similar fluctuations during the inspection periods in both seasons, except the notable decrease in its population by the end of 2016 season, compared to 2015. The averages of males captured per trap were at its lowest record in treatments of GF-120 for both fruit flies. Whereas, the average number of males was medium in malathion 57% treatment and it was high in untreated plots in both *B. zonata* and *C. capitata*. The recorded captured of males per trap started to increase either in treatments or in control from the onwards ninth week and showed highest peak in the 30 week of inspection, then decrease in 2015 season for GF-120 and malathion. While, it was increased till the end of inspection for males captured from both treated plots and untreated one. Therefore, males captured throughout the study period were found to be lower in all treatments than control. Data showed that the average numbers of *B. zonata* was higher than the average numbers of *C. capitata* in both treatments of GF-120 and malathion and untreated plots in 2015 and 2016 season.

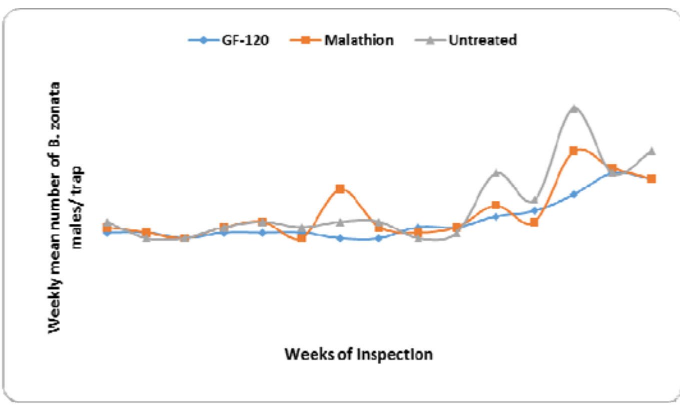

Figure 1 - Mean number of *B. zonata* males captured weekly using sticky yellow traps baited with methyl eugenol in treated and control plots of agriculture farm of Suez Canal University through season of 2015

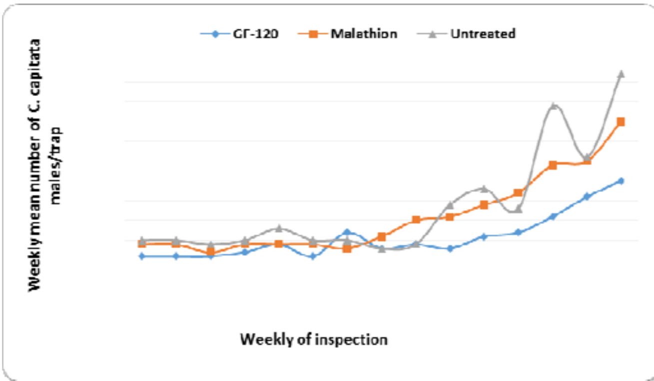

Figure 2 - Mean number of *C. capitata* males captured weekly using sticky yellow traps baited with trimedlure in treated and control plots of agriculture farm of Suez Canal University through season of 2015

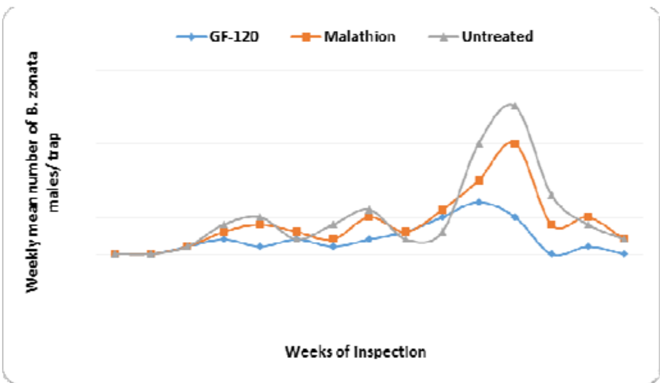

Figure 3 - Mean number of *B. zonata* males captured weekly using sticky yellow traps baited with methyl eugenol in treated and control plots of agriculture farm of Suez Canal University through season of 2016

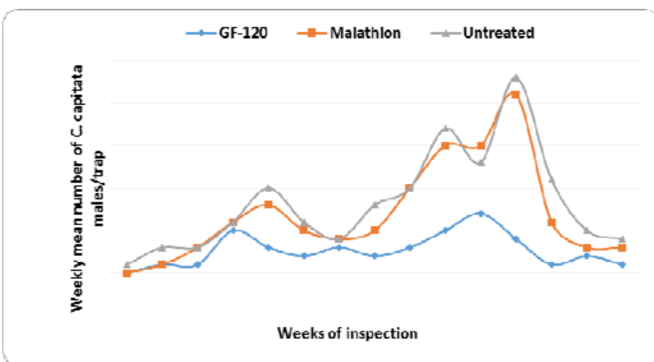

Figure 4 - Mean number of *C. capitata* males captured weekly using sticky yellow traps baited with trimedlure in treated and control plots of agriculture farm of Suez Canal University through season of 2016

Data of weekly catches of *B. zonata* males and *C. capitata* males per trap over the study period of 2015 and 2016 seasons from the private farm located at the km 17, Ismailia Governorate, are presented in *Figs. 5, 6, 7 and 8*. The obtained results revealed that the captured males of *B. zonata* and *C. capitata* were abundant during 2016 season than 2015 season in untreated plot, GF-120 and malathion.

The season averages in 2015 season were 0.93, 1.57 and 4.86 *B. zonata* males/week for GF-120, malathion and untreated plot, respectively. Also, they were 2.71, 4 and 11.2 *C. capitata* males/week for GF-120, malathion and untreated plot, respectively.

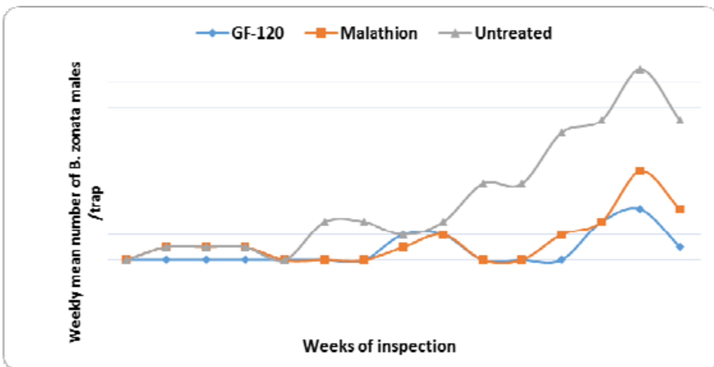

Figure 5 - Mean number of *B. zonata* males captured weekly using sticky yellow traps baited with methyl eugenol in treated and control plots of private farm located at the km 17 from Ismailia Governorate during season 2015

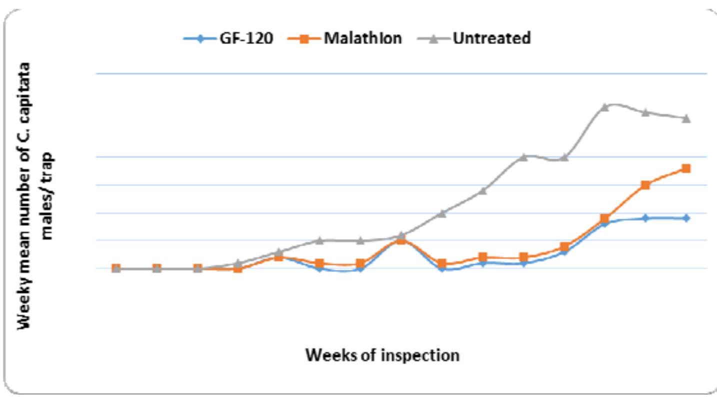

Figure 6 - Mean number of *C. capitata* males captured weekly using sticky yellow traps baited with methyl eugenol in treated and control plots of private farm located at the km 17 from Ismailia Governorate during season 2015

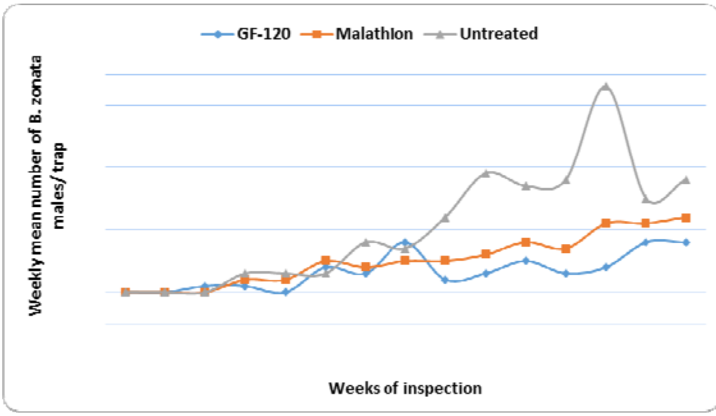

Figure 7 - Mean number of *B. zonata* males captured weekly using sticky yellow traps baited with methyl eugenol in treated and control plots of private farm located at the km 17 from Ismailia Governorate during season 2016

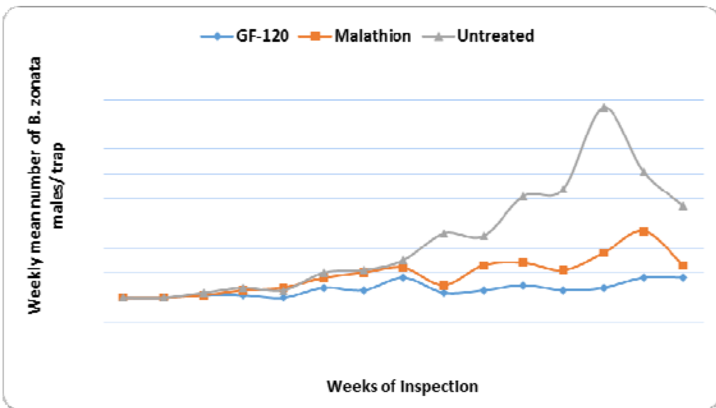

Figure 8 - Mean number of *C. capitata* males captured weekly using sticky yellow traps baited with methyl eugenol in treated and control plots of private farm located at the km 17 from Ismailia Governorate during season 2016

During both seasons, captured males of *B. zonata* and *C. capitata* were nil and a few numbers in the first 6 weeks of inspection. Afterwards, the male population increased gradually throughout the successive weeks and recorded a maximum peak period throughout weeks 13, 14 and 15. Data revealed that the number of *C. capitata* captured weekly from different treatments and untreated plots was higher than the number of *B. zonata* captured in both seasons of experiment. Data revealed that the number males of *B. zonata* and *C. capitata* captured weekly from sticky traps was lower in trees treated with GF-120 than malathion and untreated plots.

Fruit damage

Data in *Table 1* showed infestation of dropping and setting fruits per tree in different treatments throughout the both seasons of 2015 and 2016 at the farm of Faculty of Agriculture, Suez Canal University. The mean number of dropping fruits per tree at the end of experiment was significantly lower in the tested treatments, as compared to control during 2015 season (F=36.373, P=0.0000). Likewise, significant differences were found during the season of 2016 (F=3.787, P=0.0000) between treatments and control in decreasing of the mean number of dropping fruits per tree.

Moreover, data revealed that the lowest mean number of dropping fruits per tree in both seasons was 6.2 and 7.2 in the season 2015 and 2016, respectively with the treatment of GF-120 (spots application). The lowest percentages of infestation of both dropping and setting fruits per tree were recorded in plots treated with GF120 (spots), with an average of 25.14 and 17.022% for dropping fruits and 2.2 and 2.0% for setting fruits for 2015 and 2016 season, respectively (*Table 1*).

The percentages of infested dropping fruits was highly significant between treatments and control in both seasons of study (F=80.015, P=0.000 for 2015 season and F=34.86, P=0.000 for 2016 season). Likewise, the differences between treatments and control in the percent of infestation for setting fruits was significant in both seasons (F=54.295, P=0.000 for 2015 season and F=78.85, P=0.000 for 2016 season).

Table 1 - Infestation of dropping and setting fruits in the different treatments during fruiting season of 2015 and 2016 in the Farm of Agriculture Faculty, Suez Canal University in Ismailia Governorate

Treatment	2015			2016		
	Mean number of dropping fruits	% Infestation of dropping fruits	% Infestation of setting fruits	Mean number of dropping fruits	% Infestation of dropping fruits	% Infestation of setting fruits
Control	13.4 a	76.30 a	10.4 a	9.8 a	67.45 a	11.2 a
Malathion (Partial spray)	8.2 b	36.62 b	3.8 b	8.2 ab	26.23 b	4.2 b
GF-120 (Partial spray)	6.8 b	26.42 bc	3.0 b	7.6 ab	21.42b	3.0 bc
GF-120 (Spots)	6.2 b	25.14 c	2.2 b	7.2 b	17.02 b	2.0 c
F	36.373	80.015	54.295	3.787	34.86	78.85
P	0.0000	0.0000	0.0000	0.316	0.0000	0.0000
Sig	***	***	***	*	***	***

Means marked by the same letters (column wise) are not significantly different (Tukey' HSD; P≤ 0.05).

Table 2 - Effectiveness of different treatments on the percent reduction in the infestation by *B. zonata* and *C. capitata* in mango treated plots during 2015 and 2016 in the Farm of Agriculture Faculty, Suez Canal University in Ismailia Governorate

Treatment	2015		2016	
	Dropping fruits	Setting fruits	Dropping fruits	Setting fruits
Malathion (Partial spray)	54.92	63.5 b	61.00	67.11 b
GF-120 (Partial spray)	65.58	70.83 ab	68.43	73.52 ab
GF-120 (Spots)	67.01	79.5 a	74.60	81.79 a
F	2.524	7.332	1.098	5.075
P	1.221	0.0083	0.365	0.025
Sig	ns	**	Ns	*

Means marked by the same letters (column wise) are not significantly different (Tukey' HSD; P≤ 0.05).

Data presented in *Table 2* revealed the effectiveness of different treatment on the percent reduction in the infestation of *B. zonata* and *C. capitata* in the both seasons of 2015 and 2016 at the farm of Faculty of Agriculture, Suez Canal University. Data indicated that the all tested formulation under field condition caused significant reduction in the rate of infestation from 54.92 to 81.79 for both dropping and setting fruits. Also, data showed significant differences among treatments in the percent reduction of setting fruits per tree (F=7.322, P=0.0083 and F=5.075, P=0.025) in the both seasons of study 2015 and 2016, respectively. However, no significant differences were recorded of percent reduction of infestation of dropping fruits per tree in the both studied seasons.

Results obtained from *Table 3* indicated that the infestation of dropping and setting fruits in the different treatments throughout the both seasons of 2015 and 2016 in the private farm located at the km 17 from Ismailia Governorate. Data showed that the GF-120 (partial spray) gave the lowest mean number of dropping fruits in both seasons of study; it was 5.0 and 12.12 in 2015 and 2016 season, respectively. Results showed significant differences among treatment and control in both seasons of study (F=21.053, P=0.0000 for 2015 season and F=22.532, P=0.0000 for 2016 season).

The lowest percentages of infestations of both dropping and setting fruits per tree were recorded in GF-120 (spray treatment), with an average of 20.0, 12.12 for dropping fruits and 3.4 and 4.0 for setting fruits for 2015 and 2016 seasons, respectively (*Table 4*). The percentages of infested dropping fruits and infested setting fruit showed significant differences among different treatment in both seasons of study (F=93.22, P=0.0000 in infested dropping fruit per tree for 2015 season and F=77.16, P=0.0000 in infested dropping fruit for 2016); likewise, the F=44.12, P=0.0000 in infested setting fruit for 2015 season and F=34.9, P= 0.0000 in infested setting fruit for 2016 season.

Table 3 - Infestation of dropping and setting fruits in the different treatments during fruiting season of 2015 and 2016 in the private farm located at the km 17 from Ismailia Governorate

Treatment	2015			2016		
	Mean number of dropping fruits	% Infestation of dropping fruits	% Infestation of setting fruits	Mean number of dropping fruits	% Infestation of dropping fruits	% Infestation of setting fruits
Control	23.75 a	84.2 a	17.0 a	28 a	78.5 a	19.2 a
Malathion (Partial spray)	18 ab	27.7 b	5.0 b	9.75 b	30.7 b	6.6 b
GF-120 (Partial spray)	5.0 c	20 b	3.4 b	8.25 b	12.12 c	4.0 b
GF-120 (Spots)	11.5 bc	26.08 b	4.4 b	9.75 b	21.5 bc	6.2 b
F	21.053	93.22	44.12	22.532	77.16	34.9
P	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Sig	***	***	***	***	***	***

Means marked by the same letters (column wise) are not significantly different (Tukey' HSD; P≤ 0.05).

Table 4 - Effectiveness of different treatments on the percent reduction in the infestation by *B. zonata* and *C. capitata* in mango treated plots during of 2015 and 2016 in the private farm located at the km 17 from Ismailia Governorate.

Treatment	2015		2016	
	Dropping fruits	Setting fruits	Dropping fruits	Setting fruits
Malathion (Partial spray)	67.1	70.59	60.89 c	65.62b
GF-120 (Partial spray)	76.25	80.0	84.56 a	79.17 a
GF-120 (Spots)	69.03	74.12	72.61 b	67.71 b
F	3.123	5.764	22.156	6.421
P	1.114	1.986	0.0003	0.0019
Sig	ns	ns	**	**

Means marked by the same letters (column wise) are not significantly different (Tukey' HSD; P≤ 0.05).

Results obtained indicated that the effectiveness of different treatments on the percent reduction in the infestation of the both fruit flies in the both seasons of study in the private farm located at the km 17 from Ismailia Governorate. Data showed that significant reduction in the rate of season of study (F=22.165, P=0.0003 and F=6.421, P= 0.0019). Results were insignificant in both dropping and setting fruit through the first season of study (F=3.123, P=1.114 and F= 5.764, P= 1.986, respectively).

The mango leaves treated with spot bait spray of GF-120 were outdoors and exposed to full sunlight and relative humidity. Therefore, the maximum temperature in the first season of 2015 ranged between 36.9 and 24.6 and the minimum ranged between 23.8 and 15.2. While, in the second season of 2016 ranged between 39.7 and 30.5 in maximum, 24.5 and 16.6 in minimum. The whole period of experiment was characterized by sunny weather and moderate humidity, with an average ranged from 61.0 to 41.0 in 2015 and 66.0 to 30.0 in 2016.

Correlation coefficient between weekly catches of *B. zonata* and *C. capitata* males and mean temperature and relative humidity showed moderate positive correlation between temperature and the mean number of males captured. It was 0.547 in 2015 and 0.622 in 2016. Also, there was moderate positive correlation (0.432) between males catches and relative humidity in 2015 season. On the other hand, there was negative correlation (-0.269) between the mean number of males captured and relative humidity in 2016 season. More males of *B. zonata* and *C. capitata* were caught when relative humidity were high during some weeks, but this relationship was not constant throughout the experiment.

The use of protein bait sprays in fruit fly field control is extremely important in integrated pest management (IPM) programs. This study evaluated the efficacy of GF-120 protein bait in combination with spinosad applied on mango leaves as partial and spot sprays, with comparison to malathion as the most common insecticide for controlling fruit flies in Egypt, and their quantified impact on *B. zonata* and *C. capitata* trapping and fruit infestation data. The trapping data presented here indicate that GF-120 to be affected than malathion in suppressing population of *B. zonata* and *C. capitata* males for the first 4 weeks that followed the first bait spray and extend its influence to some extend until the 8 weeks at the end of experiment. This trapping period corresponded with significant decreases in incidence of fruit infestation in treated plots relative to control plots. For the last 4 weeks of the study there was a decrease in the effectiveness of the bait sprays as determined by trap captures and fruit infestation rates. Use of spinosad combined with protein bait against certain species of fruit flies were evaluated previously by several authors. Piñero *et al*. (2009) found that GF-120, applied either as foliar sprays or onto bait stations, resulted in reducing the population density and level of fruit infestation of the oriental fruit fly (*B. dorsalis*) in commercial papaya orchards in Hawaii. Similar results were obtained by Braham *et al*. (2007) (in Tunisia) and El-Aw *et al*. (2008), who reported that spinosad was more efficient than Malathion in controlling *C. capitata* and *B. zonata*. Whereas, Moustafa *et al*. (2009) demonstrated that spinosad came in the second rank against *B. oleae*, followed by malathion. Moreover, Rice (2000) mentioned that control of olive fly (*B. oleae*), for the immediate future will rely upon protein hydrolysate bait sprays containing spinosad insecticide.

Otherwise, results showed that protein baits containing spinosad, applied on mango leaves and weathered outdoors, demonstrated shorter residual effectiveness in killing flies than conventional insecticides, such as malathion (Yee, 2007). Also, results demonstrated that spinosad degraded more rapidly than the other conventional insecticides used in management programs. Several other studies have also reported a short residual activity for spinosad (Williams *et al*., 2003).

Generally, conventional insecticides in the field will be more persistent than spinosad. They are highly toxic to *B. zonata* and *C. capitata* in different studies, but they will most likely leave a similar impact of non target organisms. Spinosad, on the other hand, has to be ingested to be effective and is regarded as having minimum contact toxicity (Mangan *et al*., 2006). Indeed, GF-120 applied to small grapefruit trees in a greenhouse remained highly toxic to tephritid flies over a 5 weeks period (Mangan *et al*., 2006). Therefore, using spinosad can potentially reduce the chances of non target organisms being killed by random contact. Apart from this, modern pest management requires pesticides, that do not persist for a longer period than necessary to achieve the purpose for which they are applied (Mangan *et al*., 2006). Also, because spinosad broke down after 7 to 10 days of outdoor weathering and at the same time demonstrated a high toxicity during that period (during the three periods of spray), killing up to 90% of the flies, it fits the concept of toxicant, that can be used in modern pest management programs. Vargas & Prokopy (2006) and Vargas *et al*. (2008) suggest that spinosad is promising substitute for organophosphate insecticides in protein bait sprays for control of *B. dorsalis* and *B. cucurbitae* in Hawaii and California.

CONCLUSION

The present work demonstrated that GF-120 proved to be effective and viable alternative to broad spectrum of insecticides in baits and spots spray and could be a valuable tool in integrated pest control (IPM) programs for controlling *Bactrocera* *zonata* and *Ceratitis capitata* in Egypt. In order to obtain more effective results until harvesting time it is recommended to increase the number of spot spraying times from three to four or five times, and must be suspended 10 days, prior harvesting.

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