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EFFICACY OF DIFFERENT SOIL AMENDMENTS TO CONTROL CUCURBIT FRUIT FLY, *Bactrocera cucurbitae* (COQUILLETT) OF BITTER GOURD

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Abstract

The experiment was carried out from April to May, 2011 at the laboratory of Mennonite Central Committee Bangladesh in Bogra district to know the efficacy of different soil amendments to control cucurbit fruit fly (CFF) *Bactrocera cucurbitae.* Seven treatments viz. Control (untreated), Dursban 20EC (@ 10 l ha^{-1}), Furadan 3G (@ 10 kg ha^{-1}), Neem oil cake (@ 1500 kg ha^{-1}), Mustard oil cake (@ 1500 kg ha^{-1}), Tricho compost (@ 2500 kg ha^{-1}) and poultry refuse (@ 1500 kg ha^{-1}) were used in the experiment and each treatment was replicated thrice. A similar effectiveness was found with the use of Dursban 20EC (@ 10 l ha^{-1}), Furadan 3G (@ 10 kg ha^{-1}) and poultry refuse (@ 1500 kg ha^{-1}) for controlling of puparium. The experimental findings indicated that the use of poultry refuse (@ 1500 kg ha^{-1}) in soil is a non-chemical way and could be a good practice in destroying the puparia of cucurbit fruit fly effectively for the bitter gourd farmers to manage the menace of fruit fly.

Keywords: *Bactrocera cucurbitae,* soil amendments, poultry refuse, pupal mortality, bitter gourd

Introduction

Vegetable cultivation has become an important means for reducing poverty in rural areas in Bangladesh. Now a day's vegetable sector is contributing a lot in Bangladesh economy and it is about USD 718 million from gross domestic product in 2010 with reaching 3.2 million metric tons production and covering 936,000 acres of land. More than 12% of the rural population is employed in the sector (Katalyst, 2010). Bitter gourd, *Momordica charantia* L. is a typical vegetable crop in Bangladesh which helps to generate valuable income for farmers. Cultivation of bitter gourd helps farmer to generate valuable cash income. It is considered one having medicinal properties and with a compound named 'Charantin' which is useful to reduce blood sugar for diabetic patients (Dhillon *et al.,* 2005). In recent years, cultivation of bitter gourd has become costly and hazardous to farmers due to the increased use of chemical pesticides to control insect pests and especially for cucurbit fruit fly, *Bactrocera cucurbitae* (Coquillett) and it has been mentioned as a major pest of bitter gourd (Singh *et al.,* 2006). The production of bitter gourd is hindered due to several factors like disease and insect pests (Wasim *et al.,* 2010).

The cucurbit fruit fly, *B. cucurbitae* is distributed widely in temperate, tropical, and sub-tropical regions of the world. It has been reported to damage 81 host plants and is a major pest of cucurbitaceous vegetables. The extent of losses varies between 30% and 100%, depending on the cucurbit species and season. Its abundance increases when the temperature falls below 32°C and the relative humidity ranges between 60% and 70% (Dhillon *et al.,* 2005 and Sapkota *et al*., 2010).

In Bangladesh Jessore, Comilla, Narshingdi, Bogra and Nilphamari districts are known as vegetable growing zone, where bitter gourd is the potential one to farmer for good income. To get rid of cucurbit fruit fly problem, farmers use pesticides indiscriminately and as a result development of pesticide resistance is common. Those who avoid routine application of insecticide face the fruit fly problem to an increasing level. Knowledge of farmer's perception regarding cucurbit fruit fly problem and its control is very important to develop a management package for successful solution of the problem.

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It observed that farmers always intend to control the adult cucurbit fruit fly, not the maggot or pupa. But hamper of life cycle at any stage can control the fruit fly well. The full-grown larvae come out of the fruit by making one or two exit holes for pupation in the soil. The larvae pupate in the soil at a depth of 0.5 cm to 15 cm. The depth up to which the larvae move in the soil for pupation, and survival depend on soil texture and moisture (Jackson *et al.,* 1998; Pandey and Misra, 1999). Doharey (1983) observed that the pupal period lasts for 7 days on bitter gourd and 7.2 days on pumpkin and squash gourd at 27 ± 1°C. In general, the pupal period lasts for 6 to 9 days during the rainy season, and 15 days during the winter (Narayanan and Batra, 1960). According to Dhillon *et al*. (2005) pupation of cucurbit fruit fly occurs at 0.5 cm to 15 cm below the soil surface. Synthetic pesticides can kill the pupa directly and sometime the botanicals do not kill insects immediately; instead these repel and disrupt their growth and reproduction.

Samalo *et al.* (1995) tested 5 insecticides against immature and adults of *B. cucurbitae* where results showed that soil incorporation of 10% Aldrin dust at 0.06 g kg^{-1} soil caused 66.6% pupal mortality, closely followed by granular Carbofuran (60.0%) at the same rate. About 60.0% of the immature insects (last instar larvae and pupae) were killed when last instars larvae were allowed to pupate in soil treated with Aldrin dust at 0.6 g kg^{-1} soil.

Cultural controls most effectively used are the ploughing and/or harrowing of soil to destroy pupae and the collection and destruction of fallen fruit. In general, in other areas, the difficulty with fruit collection is its destruction burial must be to at least 15 cm to prevent adult emergence (Patel, 1994). Burial at shallower depths may actually increase the survival: Makhmoor and Singh (1999) found that the survival of *B. cucurbitae* pupae was 87% at 10 cm depth, but only 7% on the surface. Neem oil (1.2%) and neem cake (4.0%) have also been reported to be as effective as Dichlorvos (0.2%), (Ranganath e*t al.,* 1997) in the controlling of cucurbit fruit fly at pupal stage in the soil. Research over the last 20 years has shown that it is one of the most potent growth regulators and feeding deterrents. Azadirachtin is structurally similar to insect hormones called "ecdysones", which control the process of metamorphosis as the insects pass from larva to pupa to adult. On an average, neem kernels contain 0.2 - 0.4 percent azadirachtin. Therefore, in this experiment, testing of efficacy of different soil amendments on pupal stage of cucurbit fruit fly was important to get an alternative solution.

Materials and Methods

To know the efficacy of different soil amendment to control cucurbit fruit fly (CFF), *Bactrocera cucurbitae,* the experiment was carried out in the laboratory of Mennonite Central Committee Bangladesh at Sadar Upazila of Bogra district from April to May, 2011.

Treatments

There were seven treatments viz. T_1 = Control (untreated), T_2 = Dursban 20EC (@ 10 l ha^{-1}), T_3 = Furadan 3G (@ 10 kg ha^{-1}), T_4 = Neem oil cake (@ 1500 kg ha^{-1}) and T_5 = Mustard oil cake (@ 1500 kg ha^{-1}), T_6 = Tricho compost (@ 2500 kg ha^{-1}) and T_7 = Poultry refuse (@ 1500 kg ha^{-1}).

Experimental design

The experimental design was completely randomized (CRD) and each treatment was replicated thrice.

Larval and pupal management

Larvae of cucurbit fruit fly, *B. cucurbitae* were collected from infested bitter gourd of untreated plots. All infested fruits were kept in the rearing cage (12"×18") on a plastic tray. The maggots were in close visit for three to four days till they attained jumping stage. At this stage they became mature and ready to pupate. The test containers were earthen pot of 26 cm height with open top and 60 cm diameter. The top opening was covered with very fine mosquito net after releasing the maggots to prevent them from escaping. Soil was collected from the experimental field from 0 - 15 cm depth. Before being placed in the container the soil sample was sieved through 0.5 cm × 0.5 cm sieve and dried in hot sunny day. Materials of different treatments were collected from the local market.

Treating soil by different amendments

All the treatment materials were incorporated with soil of earthen pot according to the treatments. Dursban 20EC was applied with water in the soil @ 10 l ha^{-1}, Furadan 3G, Neem oil cakes, mustard oil cake, tricho compost and poultry refuses were crushed to make them dust and applied in the soil of the container as per the dosage specified in the treatments. In control container, only tap water was applied.

Observation on the development of pupa and adult flies

For each replication ten pupae were selected from the mass rearing on infested fruits of untreated plots and released to the treated pot. All the earthen pots were caged with very fine mosquito net to protect the fly of newly mature cucurbit fruit fly. Condition of the pupa for developing in the next stage and how many live adults of cucurbit fruit fly (CFF) come out were recorded.

Data collection and statistical analysis

Data were recorded on emerging of fruit flies from pupa to newly mature at 07, 15 and 21 days after pupal release to find out effectiveness of soil amended materials. After completion of pupal period, when the adults emerged, they were counted and the percentage of adult emergence in respect of total larvae released was worked out. The data thus obtained were subjected to statistical analysis. The data recorded from the study were arranged in tabular form in excel worksheet and processed for further analysis. All the statistical analysis was performed using SPSS statistical package 11.5 version, at 1% level of significance.

Results

Percent of CFF pupal mortality after application of different soil amendments

Statistically significant difference ($p \leq 0.01$) was found among the soil amendment treatments in mortality of CFF pupa (Fig. 1). The highest mortality was 70% in both the treatments Dursban 20EC (@ 10 l ha^{-1}) and Furadan 3G (@ 10 kg ha^{-1}) and the lowest percent (3.33%) was found in the untreated control. The second highest of pupa (63.33 %) was found in the treatment poultry refuse (@ 1500 kg ha^{-1}) and was identical (70.00%) with the treatments Dursban 20EC (@ 10 l ha^{-1}), Furadan 3G (@ 10 kg ha^{-1}) and tricho compost (@ 2500 kg ha^{-1}) (53.33%). The damage of pupa was also high (53.33%) in the treatments tricho compost (@ 2500 kg ha^{-1}) and mustard oil cake (@ 1500 kg ha^{-1}) (46.67%). Amendment of soil with neem oil cake (@ 1500 kg ha^{-1}) causes the pupal damage of 36.67%. The fourth highest damaged puparia (36.67%) was found in the treatment neem oil cake was also significantly higher than that of untreated control.

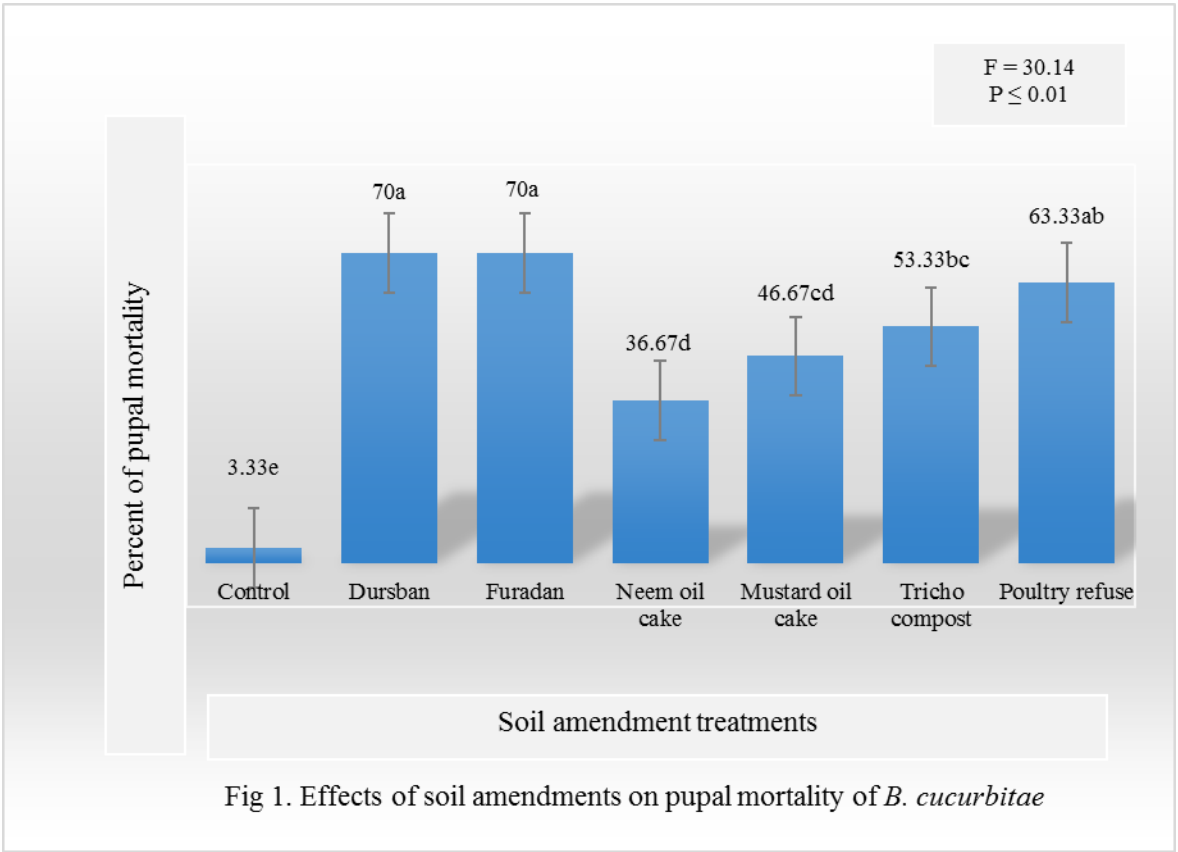

Fig 1. Effects of soil amendments on pupal mortality of *B. cucurbitae*

Effect of soil amendments on the adult emergence of CFF at different time intervals

After one week of soil amendments, significant difference ($p \leq 0.01$) was found among the treatments in adult emergence of CFF (Table 1). The maximum percentage of adult (43.30%) emerged from the control treatment and the lowest emergence (3.3 %) was found in the treatment poultry refuse (@ 1500 kg ha^{-1}) and it was similar with the treatments Dursban 20EC (@ 10 l ha^{-1}) (13.30%) and tricho compost (@ 2500 kg ha^{-1}) (6.70%). The higher emergence of adult were also found in the treatments neem oil cake (@ 1500 kg ha^{-1}) and mustard oil cake (@ 1500 kg ha^{-1}) (26.70%), which was statistically similar with the treatments Furadan 3G (@ 10 kg ha^{-1}) and Dursban 20EC (@ 10 l ha^{-1}). The third highest percentage of adult (13.30%) was found in the treatment Dursban 20EC (@ 10 l ha^{-1}) and Furadan 3G (@ 10 kg ha^{-1}) (20.00%) which showed statistical similarity with the treatment tricho compost (@ 2500 kg ha^{-1}) (6.70%).

After two weeks of soil amendments, significant difference ($p \leq 0.05$) was found among the treatments (Table 1). The highest percentage (46.70%) adult fruit flies emerged from the untreated control treatment and showed statistical similarity with the treatment neem oil cake (@ 1500 kg ha^{-1}) (26.70%) and mustard oil cake (@ 1500 kg ha^{-1}) (23.30%). The lowest percentage of adult was found in the treatments poultry refuse (@ 1500 kg ha^{-1}) (20.00%), Dursban 20EC (@ 10 l ha^{-1}) (13.30), tricho compost (@ 2500 kg ha^{-1}) (13.30%) and Furadan 3G (@ 10 kg ha^{-1}) (10.00%) and showed statistical similarity with the treatments neem oil cake (@ 1500 kg ha^{-1}) (26.70) and mustard oil cake @ 1500 kg ha^{-1}) (23.30%).

There was significant difference in adult emergence ($p \leq 0.05$) among the treatments after three weeks of soil amendments (Table 1). The highest percentage (26.70 %) of adult fruit flies emerged from the treatment tricho compost (@ 2500 kg ha^{-1}) and statistically similar emergence was found in the treatments poultry refuse (@ 1500 kg ha^{-1}) (13.30%) and neem oil cake (@ 1500 kg ha^{-1}) (10.00%). The lowest adult emergence was found in the control treatment (6.70 %), Dursban 20EC (@ 10 l ha^{-1}) (3.30%), mustard oil cake (@ 1500 kg ha^{-1}) (3.30 %) and Furadan 3G (@ 10 kg ha^{-1}) (0.00%).

Table 1. Effects of soil amendments on adult emergence of CFF in different intervals

Soil Amendment Treatments	Percentage of emerged adult fruit fly		
	After 1 week	After 2 weeks	After 3 weeks
Dursban 20EC (@ 10 l ha^{-1})	13.30 ± 0.58^{bcd}	13.30 ± 1.53^{b}	3.30 ± 0.58^{b}
Furadan 3G (@ 10 kg ha^{-1})	20.00 ± 1.00^{bc}	10.00 ± 0.00^{b}	0.00 ± 0.00^{b}
Neem oil cake (@ 1500 kg ha^{-1})	26.70 ± 0.58^{b}	26.70 ± 0.58^{ab}	10.00 ± 0.00^{ab}
Mustard oil cake (@ 1500 kg ha^{-1})	26.70 ± 0.58^{b}	23.30 ± 0.58^{ab}	3.30 ± 0.58^{b}
Tricho compost (@ 2500 kg ha^{-1})	6.70 ± 0.58^{cd}	13.30 ± 1.53^{b}	26.70 ± 1.53^{a}
Poultry Refuse (@ 1500 kg ha^{-1})	3.30 ± 0.58^{d}	20.00 ± 2.00^{b}	13.30 ± 1.53^{ab}
Control (untreated)	43.30 ± 1.53^{a}	46.70 ± 1.53^{a}	6.70 ± 1.15^{b}
F-Value	8.5	2.99	3.34
P-Value	0.01	0.05	0.05

Means in a column followed by same letter(s) are not significantly different at 1 % level of significance

Discussion

Effects of soil amendments

After soil amendment the highest percent (70.00%) of pupal mortality was found in both the treatments of Dursban 20EC (@ 10 l ha^{-1}) and use of Furadan 3G (@ 10 kg ha^{-1}) showing similarity with the treatment of poultry refuse (63.33%). The lowest percent (3.33%) was found in the untreated control treatment. According to Pandey and Misra (1999) the larvae pupate in the soil at a depth of 0.5 to 15 cm of soil for, and survival depend on soil texture and moisture. According to Samalo *et al.,* (1995) incorporation of 10 % Aldrin dust at 0.06 g kg^{-1} in soil caused 66.6% pupal mortality of *Bactrocera cucurbitae.* This finding is about similar with the result of present study. From the present study it reveals that using Furadan 3G @ 10 kg ha^{-1} can damage 70% puparia which is closely similar to the result found by Samalo *et al.,* (1995) that granular Carbofuran can kill 60.0% pupa at 0.06 g kg^{-1} in soil. It is mentioned in several experiments that the control of plant-parasitic nematodes has been successful with poultry manure (Babatola 1982; Chindo *et al.,* 1991). Though this experiment was not exactly similar with plant parasitic

nematode, but showed the ability to kill living something when poultry refuses mixed with soil. There is variation in the findings of the present study, which might be for different organisms or different environmental and management conditions.

When adult emergence of cucurbit fruit flies were counted in different time intervals it was found that after 1 week the maximum number of live adult fruit flies came out from the untreated control pot and the lowest number of cucurbit fruit flies came out from the poultry refuse treated pot. Statistically similar and the lowest number of adult CFF was also found in the Dursban 20EC (@ 10 l ha^{-1}) and tricho compost (@ 2500 kg ha^{-1}) treated plots. The results indicated that use of poultry refuse has a positive impact to suppress the development of pupal stage of cucurbit fruit flies, which is possible through using chemical insecticide like Dursban 20EC (@ 10 l ha^{-1}). The result also indicated that use of tricho compost was also effective in controlling of pupal stage of cucurbit fruit flies. The second highest number of live adult flies emerged from the treatment soil treated with neem oil cake (@ 1500 kg ha^{-1}) and mustard oil cake (@ 1500 kg ha^{-1}) and showed the statistical similarities with the treatments soil treated with Furadan 3G (@ 10 kg ha^{-1}) and Dursban 20EC (@ 10 l ha^{-1}). From the present study, the results indicated that use of neem oil cake (@ 1500 kg ha^{-1}) and mustard oil cake (@ 1500 kg ha^{-1}) can suppress the development of pupal stage of cucurbit fruit fly, which equally as effective as the chemical insecticides like Furadan 3G and Dursban 20EC. In an experiment by Ranganath *et al.,* (1997) neem oil (1.2 %) and neem cake (4.0 %) have been reported to be as effective as Dichlorvos (0.2 %) in the controlling of cucurbit fruit fly at pupal stage in the soil. In an experiment by Agu (2008), it was observed that root-gall nematode damage on pineapple was best controlled with poultry manure application. In another experiment Daramoly *et al.,* (2013) found that poultry manure (@ 25 mt ha^{-1}) and Carbofuran (@ 3.4 kg ha^{-1}) treatments significantly suppressed plant-parasitic nematode populations.

Two weeks after application, it was found that the maximum number of live adult fruit flies emerged from the untreated control and showed statistical similarities in soil treated with neem oil cake (@ 1500 kg ha^{-1}) and soil treated mustard oil cake (@ 1500 kg ha^{-1}). The results indicated that after two weeks, the efficacies of neem oil cake and mustard oil cake have been reduced and it was equivalent to untreated control. It might be for passing a certain period or environmental factors like temperature, relative humidity or soil condition or the insecticidal capacity of neem oil cake, mustard oil cake reduce than the first week. The lowest number of adult files came out from soil treated with poultry refuse (@ 1500 kg ha^{-1}), soil treated with Dursban 20EC (@ 10 l ha^{-1}), soil treated with tricho compost (@ 2500 kg ha^{-1}) and soil treated with Furadan 3G (@ 10 kg ha^{-1}). From the present study, after 15 days of pupa release, it has been assumed that use of organic materials like soil treated with tricho compost (@ 2500 kg ha^{-1}) and poultry refuses (@ 1500 kg ha^{-1}) has a great impact to stop pupal development and it was equivalent to soil treated with chemical pesticides like Furadan 3G (@ 10 kg ha^{-1}) and Dursban 20EC (@ 10 l ha^{-1}). According to Thomas and Jacob (1990) that when granular Carbofuran is applied to the soil @ 1.5 kg a.i. ha^{-1} at the time of sowing, vining and flowering it provides 83.36% protections against the tephritid, *Bactrocera cucurbitae* on bitter gourd. From the present study, the results also indicated that using pesticide of Carbofuran group has effectiveness to lowering pupal population in soil and which support use of tricho compost and poultry refuses to control pupal population in the soil.

After three weeks it was found that the maximum number of live adult fruit flies emerged from the soil treated with tricho compost (@ 2500 kg ha^{-1}) and showed statistical similarities with soil treated with poultry refuse (@ 1500 kg ha^{-1}) and neem oil cake (@ 1500 kg ha^{-1}). The lowest number of adult flies was found in untreated control soil, soil treated with Dursban 20EC (@ 10 l ha^{-1}), soil treated with mustard oil cake (@ 1500 kg ha^{-1}) and soil treated with Furadan 3G (@ 10 kg ha^{-1}). Results from the present study indicate that organic materials which were used for treating soil lose their efficacy to control pupal stage of cucurbit fruit flies after a certain period. As an organic matter mustard oil cake held its performance like chemical insecticides. The treatment untreated control also did better than some organic soil amendments, which might be the remained pupa had died in soil for unknown causes or most of the puaria already emerged within 2 weeks and that's why after third week number of adult emerged flies was lesser than few other treatments. Hollingsworth *et al.,* (1997) stated that depending on temperature and the host, the pupal period may vary from 7 to 13 days. According to Gupta and Verma (1995) on different hosts, the pupal period varies from 7.7 to 9.4 days on bitter gourd, cucumber, and sponge gourd. The pupal stage may vary from 6.5 to 21.8 days on bottle gourd (Koul and Bhagat, 1994; Khan *et al.,* 1993). The studied data of the present experiment supports to the findings of above authors. In the present study, there were differences in process and management of pupal stage of cucurbit fruit fly, findings of above mentioned authors indicated the similar trend for pupal control in soil.

Conclusion

The present studies conclude that, against pupal stage of cucurbit fruit fly, *B. cucurbitae*, among six different types of soil amendments, the maximum percent of puparium was damaged by the use of Dursban 20EC (@ 10 l ha^{-1}), use of Furadan 3G (@ 10 kg ha^{-1}) and use of Poultry refuse (@ 1500 kg ha^{-1}) which were 70.00%, 73.33% and 66.67%, respectively. When amendments were mixed with soil, it delayed the emergence of adult cucurbit fruit flies. Considering the experimental findings, poultry refuse (@ 1500 kg ha^{-1}) in soil may be useful for the bitter gourd growers to manage the menace of fruit fly in a non-chemical way, this could be a good practice in destroying the puparia of cucurbit fruit fly effectively.

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