refuse and mustard oil-cake again showed better results and confirmed their use as an effective practice for controlling soil-borne diseases and to produce vegetables without the use of pesticides.

Table 4. Effects of soil amendment practices on seedling mortality, RKN infestation, yield and economic returns in cucumber, 2002 summer season, Sripur and Kashimpur.

Treatments	Seedling mortality (%)			Gall index (0-10 scale)			Yield (t/ha)	Net income (US$)
	F1	F2	F3	F1	F2	F3		
Poultry refuse	16.8ab	7.8b	8.5d	1.8b	1.9b	1.1b	17.5a (84%)	2680 (176%)
Mustard oil-cake	13.0b	7.6b	5.7e	1.5b	1.6b	1.0b	12.6b (33%)	1636 (69%)
Sawdust burning	16.0ab	7.9b	11.8c	1.5b	1.4b	1.4b	11.4bc (20%)	1171 (21%)
Farmer practice	27.0a	16.2ab	13.6a	1.8b	1.7b	0.8b	9.5cd	970
Untreated control	30.8a	19.4a	12.1b	3.1a	3.4a	2.9a	9.2d (0%)	986 (2%)

F= Farmer. US$ 1.00= Taka 58.00. Values followed by a common letter are not significant at 5% level. Yields and net income data were available from one farmer only. Figures in parentheses are the increases over the farmer practice.

Impacts

All the soil amendment treatments were highly effective for the control of soil-borne diseases in tomato and cucumber, effecting better plant growth, producing higher yields and giving higher economic returns. Among the treatments, the use of poultry refuse and mustard oil-cake consistently produced better results. These materials are easily available at affordable costs and some farmers have already adopted this practice in their vegetable fields. It is now amply demonstrated that healthy, pesticide-free and better vegetables can be grown by using poultry refuse and mustard oil-cake.

Project Highlights

As observed in the previous years, organic soil amendment treatments effectively controlled the soil-borne diseases in tomato and cucumber. The treated fields had better crop establishment with minimal plant mortality, produced much higher yields and fetched higher economic returns. The use of poultry refuse and mustard oil-cake gave better results consistently, and these results confirm the ones obtained earlier on these crops and others.

Characteristics of Parasitism and Greenhouse and Microplot Tests for Management of Eggplant Fruit and Shoot Borer by the Parasitoid *Trathala flavoorbitalis*

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Abstract

***Trathala flavoorbitalis*, a larval and pupal parasitoid of eggplant fruit and shoot borer (FSB) is widely available in eggplant fields. It is dependent on its host density. Its population can increase about 10-fold and parasitism rate about three-fold in a year if insecticide use in eggplant fields is avoided. The development period from egg laying to adult emergence is about 16 days and it is a uniparental type of parasitoid, which produces about 98% females. Greenhouse and micro-plot tests have shown that the parasitoid is highly efficient in controlling the FSB infestation, amounting to about 90% parasitism in greenhouse and 70% in micro-plot tests.**

Objectives

To study the development time of *Trathala flavoorbitalis*, a larval and pupal parasitoid of eggplant fruit and shoot borer (FSB) in the laboratory, and to determine the parasitism characteristics and efficiency of the parasitoid for the control of eggplant fruit and shoot borer through greenhouse and field tests.

IPM Constraints

Parasitoids of eggplant FSB are available in the field and they are known to be effective for the control eggplant FSB. Utilization of the parasitoids for the control of FSB will greatly cut down the use of pesticides and help produce healthy eggplants free of toxic residues.

Research Methods

The eggplant FSB (*Leucinodes orbonalis*) is parasitized in the field by a few parasitoids. A larval and pupal parasitoid, *Trathala flavoorbitalis*, is one of the most important and widely prevalent in eggplant fields. Four studies were conducted from June 2000 to September 2002 on parasitism characteristics, developmental time of the parasitoid, and parasitism efficiency for the control eggplant FSB.

Population abundance and parasitism activity of the parasitoid, *Trathala flavoorbitalis* in pesticide-free eggplant fields:
A local eggplant variety was grown throughout the year in three 100m^2 parcels at BARI farms at Gazipur (central region) and at Jessore (southwestern region) starting from June 2000. The eggplants were exposed to natural infestation of FSB and no pesticide was used. Every month, 30 FSB-infested eggplant shoots and 30 similar fruits were collected from each field and maintained in the laboratory until pupation. Pupae were observed for emergence of pest or parasitoid adults. The number of FSB and parasitoid adults emerged were recorded and the percentage of pest larvae parasitized were calculated by dividing the number of parasitoid adults emerged by the number of parasitoid + pest adults and multiplying the quotient by 100.

Parasitoid developmental time:
The study was carried out at BARI laboratory using third instar larvae of eggplant FSB. Earlier research indicated that the first and second instars can not properly support the development of the parasitoid, *Trathala flavoorbitalis* (Sandanayake and Edirisinghe, 1992). A total of 30 FSB larvae, reared on eggplant fruit, was exposed individually to a single parasitoid female confined in clear plastic container for 5 minutes. All larvae exposed in this manner were placed individually on eggplant shoots of potted eggplant plants and allowed to bore inside the host plant to continue their development. Immediately after FSB larvae pupated, all pupae were removed and held in laboratory until the pest or parasitoid adults emerged. The total developmental period from egg laying to adult emergence, and the number of male and female parasitoids that emerged was recorded.

Parasitism of FSB larvae by *Trathala flavoorbitalis*

<u>Greenhouse test</u>: The experiment was carried out at BARI greenhouse, Gazipur. Forty-five eggplant seedlings of a local variety were transplanted in each of 18 steel trays (92cm x 77cm x 15cm) containing well manured soil. Twenty –five days after transplanting, six trays each were infested with 1st, 2nd, or 3rd instars of FSB larvae at the rate of 4 larvae per plant. Each of the six trays served as a treatment replicate. After infestation, all the trays were covered individually with a 70cm high rectangular plastic cage having nylon netted windows on all sides and top for proper aeration. One day after larval infestation, five newly emerged female adults of the parasitoid were introduced in each of the three trays having 1st, 2nd, and 3rd instar larvae of FSB. The remaining nine trays, three each with 1st, 2nd, and 3rd instars were kept without the parasitoid and served as control treatment. Shoot infestation by FSB, manifested by wilting symptoms, was determined 18 days after infestation by different instars of FSB larvae. A plant was counted "infested" if one or more of its shoots showed wilting symptoms. If the plant remained alive and put out substantial growth, it was considered "survived" having weathered pest infestation. Percentages of infested and surviving plants were calculated.

<u>Caged micro-plot study</u>: The study was conducted at BARI farm, Gazipur. Eggplant seedlings of variety "Uttara" were transplanted in several 3m x 3m plots in three replications. Fifteen days after transplanting, the plots were covered on all sides and top with 2m high 32-mesh nylon net. Ten pairs of newly emerged FSB adults were released inside the covered plots 60 days after transplanting. Ten days before FSB infestation, plants within plots were made arthropod-free by physical removal of infested leaves, shoots, and fruits followed by an insecticide spray. After 10 days of FSB adult release within each plot, 10 newly emerged adult females of the parasitoid (*Trathala flavoorbitalis*) were introduced in each caged plot. Fifteen days after parasitoid release, the number of healthy and infested shoots in each plot was counted to calculate the percent of plant infestation.

Results

Abundance and parasitism activity of *Trathala flavoorbitalis* in pesticide-free eggplant fields:
Seasonal variations in the population of both FSB and parasitoid were observed in both Gazipur and Jessore. During the winter season (November to February), the FSB population was low and the pest was not found at Gazipur in January-February. In the southwestern region of Jessore, some infestation occurred during this period. Results of both the locations indicate that parasitoid population is dependent upon the density of its host, FSB (Fig. 1). A significant positive correlation between the number of FSB and the parasitoid was observed at both the locations (Gazipur, $r = 0.87$. $p<0.05$; Jessore, $r = 0.71$, $p<0.05$). The population of the parasitoid increased gradually in both the locations during the year-long study period. During the early stage of the study in August 2000, the average number of the parasitoid reared from the collected shoots and fruits was 4.33 at Jessore and 7.0 at Gazipur. After 12 months of withholding insecticide use, the number of parasitoids from

he same number of infested shoots and fruits increased to 10.67 and 61.67 at Jessore and Gazipur, respectively. This was reflected in increasing levels of parasitism of FSB by the parasitoid; there was about 3-fold increased parasitism after one year of eggplant cultivation without intervention of pesticide use. The parasitism rates during August and September 2001 were considerably high in both the locations; 39.27% and 44.26% at Gazipur, and 44.94% and 48.92% at Jessore. The level of parasitism as high as this, if maintained throughout the year, can reduce the FSB population on a sustainable basis and will definitely minimize pesticide use for combating FSB.

Parasitoid development time:
The developmental period from egg laying to adult emergence of *Trathala flavoorbitalis* was 15.8 ± 0.84 days. Among the emerged adults, 97.96% was female and 2.04% was female. This indicates that like many other Hymenopteran species, *T. flavoorbitalis* is deuterototokous, which produces maximum number of females and few males. This type of parasitoids having uniparental adults has a unique advantage in the field of biological control of FSB, a menacing pest of eggplant.

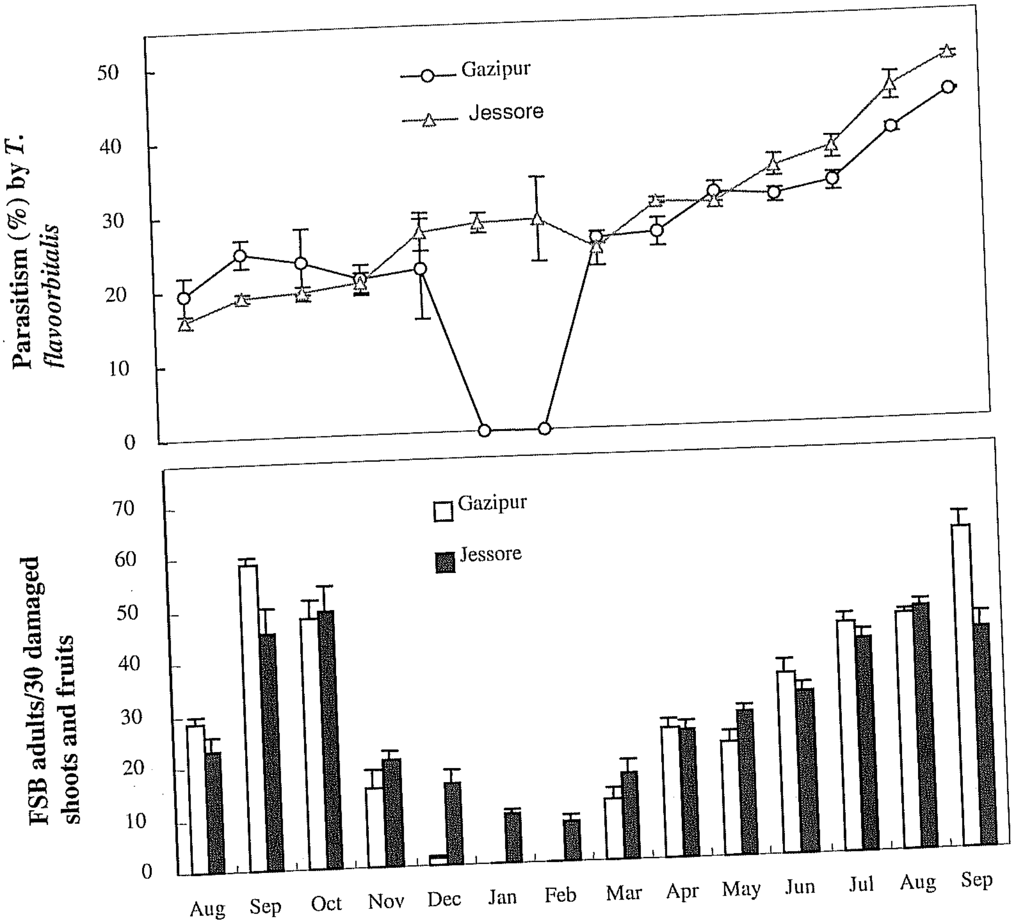

Fig. 1. Abundance and parasitism patterns of *T. flavoorbitalis* in pesticide-free eggplant fields in Jessore and Gazipur from August 2000 to September 2001.

Parasitism Efficiency of *Trathala flavoorbitalis*

Greenhouse study: A test with 1st instar FSB larvae showed that only 8.9% of the plants were infested when parasitoid was introduced on the FSB larvae, as compared to 100% infestation without parasitoids. In other words, 99.1% of the plants survived in presence of the parasitoid, and none in absence of it (Fig. 2). This result amply demonstrated the low FSB infestation and high plant survival were due to effective parasitism of FSB larvae.

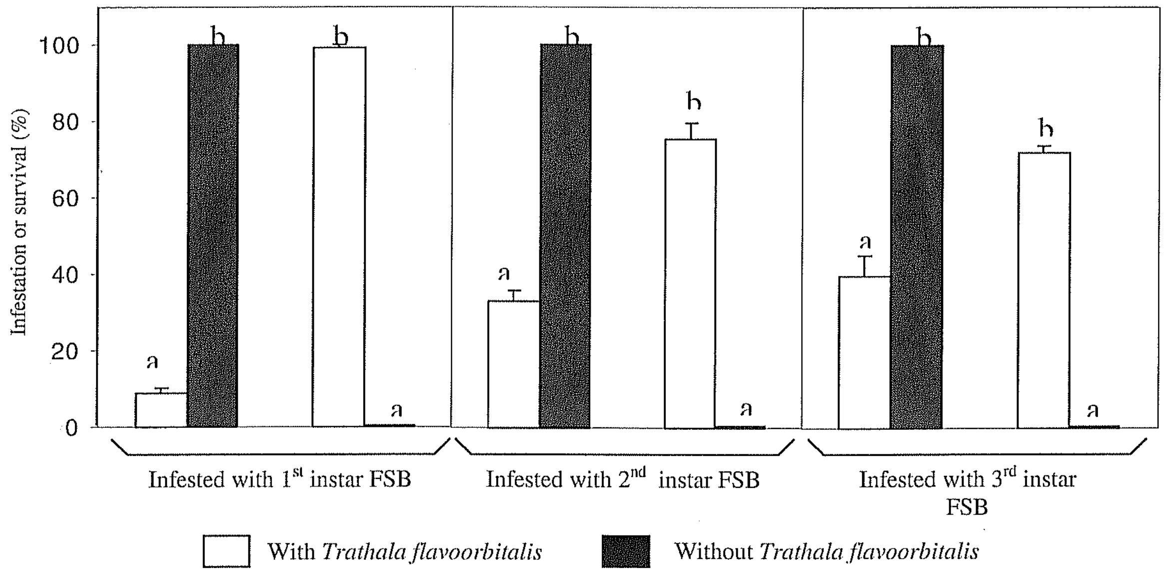

Fig. 2. Infestation (left columns) of FSB and eggplant survival (right columns) rates in presence or absence of parasitoid, Greenhouse study, BARI.

A test with 2nd instar FSB larvae showed that the plant infestation and survival were 33.2% and 75.6%, respectively, in the presence of the parasitoid (Fig. 2); while with 3rd instar FSB larvae, plant infestation and survival were 39.8% and 72.2%. respectively, under similar conditions. In the control treatments where no parasitoid was introduced, all the plants died from FSB damage. In the case of 2nd and 3rd instar larvae, a number of the released FSB larvae were parasitized, but unlike the 1st instar larvae, not all of them were killed instantly. Rather, the surviving larvae continued to develop within the shoots and some of the plants could not survive.

Caged micro-plot study: In all the micro-plots where the parasitoid adults were released, FSB infestation in shoots averaged only 5% as compared to 17% in plots without parasitoids. As a result, there was over 70% reduction in pest damage to the eggplant crop due to introduction of the parasitoid. These results strongly suggest that the parasitoid, *Trathala flavoorbitalis*, is an efficient larval parasitoid capable of controlling FSB damage in eggplant.

Impacts

Studies in pesticide-free eggplant fields in distant locations have clearly shown that FSB larval parasitoid, *Trathala flavoorbitalis*, is abundant in eggplant fields and its population can build up ten-fold in a year to cause high parasitism of FSB if pesticide applications are avoided. The adults of this parasitoid are uniparental with about 98% female, which is uniquely advantageous for biological control of pests, such as FSB. Both greenhouse and micro-plot tests have shown that the parasitoid is highly effective for FSB control, and FSB management on a sustainable basis is possible without the intervention of pesticide use.

Project Highlights

The green house and field studies on FSB larval parasitoid, *Trathala flavoorbitalis*, were highly encouraging. This parasitoid is widely abundant in eggplant fields. Because of its uniparental characteristics, more than 98% of its adults are female, and therefore, its population can increase about ten-fold in a year and can cause high parasitism of FSB larvae. Greenhouse and micro-plot tests have shown that infestation of eggplant by FSB was reduced by about 70% in presence of the prasitoid, but none in absence of it.