Sustainable management of *Spodoptera litura* (Fab.) in tropical Sugar Beet

Muhammad Abu Talha, M. M. Rahman, Ruhul Amin, Md. Emam Hossain and Md. Shahidul Islam Khan

ABSTRACT

Control of *Spodoptera litura* in the tropical sugar beet is a critical issue for sustainable agriculture. The purpose of this field experiment was to assess the efficacy of botanical and non-chemical techniques against *S. litura* to identify ecologically viable management alternatives. *Spodoptera litura* responded best to a neem oil solution at a concentration of 3.0 mL/L. In terms of insect infestation, the plot treated with neem oil outperformed the untreated control plot. The infection rates for plants, leaves, and beets were 5.66/plot, 5.33/plant, and 11.00/plot, respectively. In terms of larvae decrease over control, the plot treated with neem oil had the greatest effectiveness (84.33%), followed by pheromones, which had an efficiency of 80%. Plants treated with neem oil showed the highest Brix and Pol values (17.61% and 12.62%, respectively). Weight per beet was lowest in the control plot (690.33 g), and highest in the best treatment (791.33 g). It clearly shows that when insect infestation grows, beet yield falls. The control plot was unable to effectively resist *S. litura*, resulting in unhealthy sugar beet output. In contrast, eco-friendly techniques such as NPV spraying, Bio Neem Plus®, Tracer 45SC (spinosad), hand picking, light trap, and polythene mulching trap outperformed the control plot.

Keywords: *Spodoptera litura***,** Sugar beet, NPV, Spinosad, Neem oil

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INTRODUCTION

The second most significant crop for sugar production, after sugarcane, is the tropical sugar beet, *Beta vulgaris* L., a temperate crop belonging to the Chenopodiaceae (Amaranthaceae) family. It produces around 35-40% of the world's sugar each year (Amr and Gaffer, 2010; Wu *et. al.,* 2016) and sugar beet has emerged as a promising biofuel contender to fossil fuels in recent years (Zhang *et al.,* 2008). According to Kapur and Kanwar (1990), sugar beets are suitable for winter cultivation in subtropical and arid regions. Its extensive range includes the temperate and tropical regions of Asia, the islands of the Pacific, Sudan, Pakistan, and Australia. There are 270–300 days in a year when sugar beets can be processed (Asadi, 2007). Countries in the tropics and subtropics, such as Bangladesh, India, and Pakistan, are now successfully cultivating sugar beet cultivars. The vast range of agroclimatic conditions in Bangladesh makes it an ideal location for growing sugar beets, even in coastal regions. If sugar beets are cultivated in Bangladesh, the country's sugar output might reach an acceptable level.

Since sugar beets are still a relatively young crop, there are a number of challenges associated with growing them. One of the most significant is the high prevalence of pests and diseases caused by insects (Patil *et al.,* 2007). Insect pests in sugar beets may reduce yields by 18 t ha^{-1}. One of the major challenges for sugar beet cultivation in Bangladesh is the presence of insect pests. Eight different types of insect pests have been documented: webworms, sugar beet caterpillars, cutworms, aphids, red mites, grasshoppers, hairy caterpillars, flea beetles, and fleas. The caterpillar of the sugar beet plant, *Spodoptera litura*, is the most harmful pest to the crop (Nakasuji and Mastsuzaki, 1976). According to Zhou *et al.* (2010) and Navasero (2011), this caterpillar is both cosmopolitan and polyphagous, meaning it feeds on a wide variety of crops. It may damage cotton, grains, oil seeds, vegetables, ornamental plants, and even certain weed species.

Many economically significant crops may be defoliated by the larvae of the *S. litura*, making it a very dangerous pest (CABI, 2010). Adult female moths deposit their eggs in clumps on the undersides of leaves. In the beginning, they feed haphazardly, and injured leaves seem skeletonized. The bigger caterpillar feeds at a rate of 10-15 g day-1 and may defoliate a crop entirely in a week, according to Seth *et al.* (2004). According to Patel *et al.* (1971), sugar beet output was lowered by 24.4%, 44.2%, and 50.4%, respectively, when two, four, or eight larvae were planted per plant. When there are no young succulent leaves available, the larvae will attack the exposed tubers. The recommendations for managing sugar beet caterpillars have included resistant cultivars, cultural approaches, mechanical control, biological control, and chemical control. Among these approaches, chemical control remains popular among our farmers. However, the widespread use of synthetic pesticides has led to pesticide resistance, more frequent outbreaks, the introduction of new pests, pollution, and health risks for humans. The purpose of this experiment was to determine the effectiveness of botanicals and other non-chemical management practices in controlling *S. litura*, an insect pest of sugar beets, in a field setting, taking into account the aforementioned concerns.

MATERIALS AND METHODS

In an effort to promote ecologically friendly management techniques, this study sought to evaluate the efficacy of botanicals, pheromone traps, and other non-chemical methods in controlling *S. litura* in tropical sugar beet. The study was done in Dhaka's Sher-e-Bangla Agricultural University (SAU) experimental field between November 2019 and May 2020. By using a range of management techniques, BSRI Sugar beet-2 (Cauvery) sugar beets were sown into the field to defend against the *S. litura* caterpillar. There is a wide variety of organic pesticides available, including Bio Neem plus® 1% EC, Tracer 45SC, NPV, neem oil, hariken light trap, polythene mulch, and pheromone trap, all of which include azadirachtin. The investigation was carried out utilizing a Randomized Complete Block Design (RCBD) with three replicates at SAU's Experimental field. The whole area, measuring 0.042 hectares, was divided into three equal halves. The dimensions of each block were 3.0 m × 2.0 m, and there was a 2 m space between the blocks and a 1 m space between the plots. There was a total of twenty-seven plots. The experimental design required that treatments be allocated to each block. Several more non-chemical control methods were used during the project. Researchers followed the eight management techniques as a result. Here are the items that are classified as bellows: Neem Oil at 3 ml/lit of water every 7 days (T1), NPV sprayed every 7 days at 0.2 g/L of water (T2), Bio Neem plus® 1% EC (azadirachtin) at 1 mL/lit of water every 7 days (T3), Tracer 45SC (spinosad) at 0.5 mL/L of water every 7 days (T4), Egg mass and larvae collected and destroyed by hand every 7 days (T5), Light trap (T6), Polythene mulching trap (T7), Phromone trap (T8) and Untreated control (T9).

The seeds of a tropical sugar beet cultivar were collected from Bangladesh Sugar Crop Research Institute (BSRI). On November 18, 2019, at the SAU Experimental Farm, the seeds were scattered using ridge techniques at a spacing of 50 cm. x 20 cm., with a plant-to-plant distance of 50 cm. and a row-to-row distance of 20 cm. It is recommended to put one seedling in each hill for the desired plant and remove the others after 15 days of growth. When it came to intercultural operations like labeling, watering, and weeding, everything was done correctly. Each plot of the sugar beet field was subjected to a variety of treatments, as previously stated. About two months after seed planting, the treatments were initially applied. Beet length, girth, weight, brix, pol %, number of bores, number of infected plants, leaves, number of larvae/5 plant, number of treatments, and data were taken at 7-day intervals prior to treatment application.

Brix percentage of beet

When a plant processes its juice for the first time, the refractometer measures the concentration of soluble solids, which is called brix. The Brix level may be determined with this equipment by observing the bending of light as it passes through a liquid sample. Light is more strongly refracted by sugar-containing solutions than by water-only ones. The refractometer determines the Brix value by comparing the bending of light with the refraction in water.

Sucrose percentage of beet (Pol)

As measured by a polarimeter, the sucrose concentration in juice is represented as % Pol, also known as percent sucrose. Juice Pol% was measured with the use of an automated polarimeter (AP-300, Atago Co., Ltd., Japan).

Data analysis

The recorded data on growth and growth-related characteristics were compiled and organized for statistical analysis. Statistical analysis was performed using the Statistics 10 computer software. Mean differences among the treatments were compared using the Least Significant Difference (LSD) technique at a 5% significance level.

RESULTS AND DISCUSSION

Efficacy of botanicals and non-chemicals

Insect resistance was shown by the fact that the number of affected plants changed as the plants progressed through their development phases. The lowest number of affected plants were 5.66 for the neem oil and the highest were 19.33 for the control. The second-lowest number of affected plants at 7.33, was seen in the pheromone trap. Treatments had a statistically significant effect on infected plant counts (Table 1) at the 5% level of significance. Each treatment has its own unique pattern of leaf infestation.

Table 1. Botanical, bio-pesticide, and non-chemical methods' effects on tropical sugar beet plants, leaves, beets, and bores by *Spodoptera litura*

Treatments	Plant/plot	Leaf/plant	Beet/plot	Bore/beet
T_1 (Neem oil)	5.66^{g}	5.33^{de}	11.00^{h}	4.60^{g}
T_2 (NPV)	8.33^{f}	6.00^{d}	13.66^{g}	5.60^{ef}
T_3 (Bio-Neem plus 1% EC)	9.66^{e}	7.66^{c}	16.66^{f}	5.73^{def}
T_4 (Tracer 45SC)	10.66^{de}	8.33^{c}	19.33^{e}	6.00^{cde}
T_5 (Hand picking)	11.00^{d}	6.33^{d}	21.33^{d}	6.60^{bcd}
T_6 (Light trap)	15.66^{b}	10.66^{b}	27.66^{b}	7.20^{b}
T_7 (Polythene mulching trap)	13.00^{c}	8.66^{c}	24.00^{c}	6.73^{bc}
T_8 (Pheromone trap)	7.33^{f}	4.66^{e}	12.66^{g}	4.93^{fg}
T_9 (untreated control)	19.33^{a}	12.60^{a}	30.33^{a}	9.53^{a}
CV	6.20	8.71	4.75	8.37
LSD (0.05)	1.20	1.17	1.61	0.91

At p<0.05, there is a significant difference between the means in the same column that are followed by different letters

The least number of affected leaves per plant was 4.66 for the T_8 treatment and the peak infested leaves at 12.60 observed for the control. With 5.33 infested leaves, the T_1 treatment ranked second lowest in Table 1. The largest number of infested beets was 30.33 in the control, while the lowest was at 11.00 in the T_1 treatment. In the T_6 treatment, the number of infested beets was 27.66, which was the second highest. There was a statistically significant ($p < 0.05$) effect of the treatments on the infestation rate of beets per plot (Table 1). The T_1 treatment had the fewest bores 4.60/beet, while the control had the highest number of bores/beet. With 4.93 bores, the T_8 treatment ranked second lowest. At the 5% level of significance, the treatments had a significant impact on the number of bores per beet (Table 1).

Effect of botanicals, bio-pesticides and non-chemical on number of larvae 5 plant $^{-1}$

Over the course of three months, larvae were collected. Based on the data shown in Table 2,

Table 2. Impact of natural remedies, biological insecticides, and non-chemical methods on tropical sugar beet larval populations of *Spodoptera litura* on 5 plants during March, April and May

Treatments	March	April	May	Pool data	% reduction over control
T_1 (Neem oil)	1.00^{d}	2.00^{g}	1.75^{e}	1.58^{e}	84.34
T_2 (NPV)	2.00^{c}	3.33^{ef}	2.33^{e}	2.55^{de}	74.74
T_3 (Bio-Neem plus 1% EC)	2.33^{c}	3.80^{e}	3.20^{d}	3.11^{cd}	69.24
T_4 (Tracer 45SC)	2.00^{c}	4.80^{d}	3.20^{d}	3.33^{cd}	67.03
T_5 (Hand picking)	2.33^{c}	5.33^{cd}	4.00^{c}	3.88^{bc}	61.56
T_6 (Light trap)	4.20^{b}	5.80^{c}	5.00^{b}	5.00^{b}	50.54
T_7 (Polythene mulching trap)	2.33^{c}	7.00^{b}	3.33^{cd}	4.22^{bc}	58.26
T_8 (Pheromone trap)	1.33^{d}	2.50^{fg}	2.00^{e}	1.94^{e}	80.78
T_9 (untreated control)	9.33^{a}	10.8^{a}	10.20^{a}	10.11^{a}	0.00
CV	12.82	11.19	11.78	16.76	-
LSD (0.05)	0.65	0.96	0.78	1.15	-

At $p<0.05$, there is a significant difference between the means in the same column that are followed by different letters.

the research found that the months of April and May had the largest and lowest numbers of larvae, respectively. Results showed that the T1 treatment, which consisted of applying neem oil at a concentration of 3 milliliters per liter of water every seven days, had the lowest larval population (1.58/five plants), while the T_8 treatment, which used a pheromone trap, had the second-lowest population (1.94/five plants). The T_9 treatment (control) had the most larvae, 10.11. Nearly half of the larvae may be controlled by bio-agents, as shown by Siddiquee *et al.* (2017). Neem oil (3 mL/Lof water applied weekly) outperformed control by 84.34%, while pheromone trap demonstrated an efficiency of 80.78%. Table 2 shows that at the 5% significance level, the treatments significantly affected the larval number. Research by Suganthy and Sakthivel (2013) on the efficacy of bio-pesticides against *S. litura* in fields of *Gloriosa superba* suggests that flavonoids may be useful in organic pest control as a substitute for chemical pesticides.

Sugar beet yield

A sugar beet variety's harvest value is highly dependent on its beet weight. In the T1 treatment, the beet weight reached a maximum of 791.33 g, whereas the T9 generated 690.33 g of beet. The second-highest beet weight, 784.00 g, was obtained using the pheromone trap. Treatment had a statistically significant effect on beet weight in this experiment (Table 3), with a 5% level of significance. In ideal circumstances, beet length is an additional indicator of sugar beet variety quality at harvest. Longer beets yield more sugar. The plots that were treated with Bio Neem produced the longest beet at 27.89 cm, whereas the shortest at 23.44 cm of beet achieved through pheromone trap were. The second-longest beet, measuring 27.33 cm, was produced by the Tracer 45SC. Table 3 shows that at the 5% level of significance, this study likewise demonstrated a treatment impact on beet length. The beet girth was also measured; the NPV yielded the maximum girth measurement of 40.44 cm. In the T5 treatment, which included manually collecting and destroying the egg mass and larvae, the lowest girth was 36.66 cm. The neem oil had the second-highest girth at 39.55 cm. Nonetheless, according to Table 3, there was no significant effect of treatments on beet girth at the 5% significance level in this study.

Table 3. The impact of various treatments on tropical sugar beet yield-related traits

Treatments	Beet weight (g)	Beet length (cm)	Beet girth (cm)
T_1 (Neem oil)	791.33[a]	26.66[a]	39.55
T_2 (NPV)	779.67[ab]	26.88[a]	40.44
T_3 (Bio-Neem plus 1% EC)	761.00[ab]	27.89[a]	39.44
T_4 (Tracer 45SC)	752.00[ab]	27.33[a]	37.55
T_5 (Hand picking)	747.33[ab]	26.44[ab]	36.66
T_6 (Light trap)	712.33[ab]	25.33[ab]	37.11
T_7 (Polythene mulching trap)	726.33[ab]	25.77[ab]	37.44
T_8 (Pheromone trap)	784.00[a]	23.44[b]	37.66
T_9 (untreated control)	690.33[b]	26.11[ab]	38.11
CV	15.88	7.15	9.09
LSD (0.05)	0.92	3.19	NS

At $p<0.05$, there is a significant difference between the means in the same column that are followed by different letters

Brix and Pol (%) levels of sugar beet

The treatment neem oil had the highest brix percentage at 17.61%, while control had the lowest at 14.61%. The pheromone trap treatment had the second-highest Brix percentage at 17.38%, after T_2 and T_3 (Figure 1).

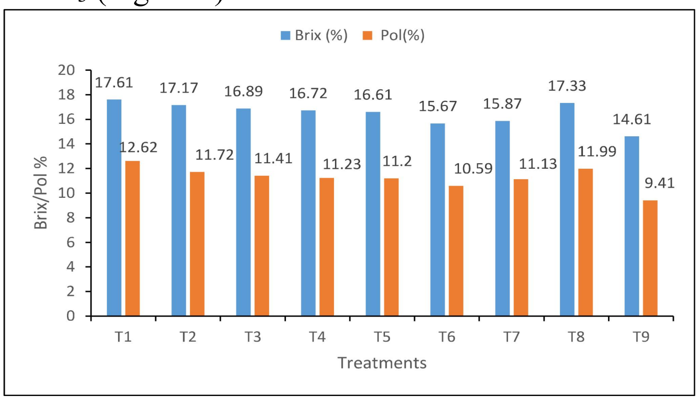

Figure 1. Effects of botanicals, bio-pesticides and non-chemical approaches on brix (%) and pol (%) of sugar beet. [T_1=Neem oil, T_2= NPV, T_3=Bio-Neem plus 1% EC, T_4=Tracer 45SC, T_5=Collection and destruction of egg mass and larvae (hand picking), T_6= Light trap, T_7= Polythene mulching trap, T_8=Pheromone trap and T_9=Control]

At the 5% level of significance, this experiment showed that the treatments had a significant impact on Brix percentages. Neem oil had the highest Pol percentage reported at 12.62%, while control had the lowest at 9.41%. With a Pol percentage of 11.99%, the pheromone trap ranked second. Also, at the 5% level of significance, the therapies had a significant impact on the Pol percentages in this experiment (Figure 1). The most successful treatment in the trial was T_1, which consisted of applying neem oil at a concentration of 3 ml/liter of water every seven days. Because of the neem oil's chemical characteristics that increase resistance against *S. litura*, this treatment exhibited consistently higher values across all measures, including the highest brix and pol percentages.

AUTHOR CONTRIBUTION

Muhammad Abu Talha did the whole research as well as data collection during the post-graduate programme under the supervision of M. M. Rahman. Ruhul Amin, Md. Emam Hossain and Md. Shahidul Islam Khan were involved in data analysis and preparation of the manuscript.

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CONFLICT OF INTEREST

No conflict of interest exists, according to the author.

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