**Development of an Integrated Pest Management Package for Effective Control of *Spodoptera litura* (Fab.) in Tropical Sugar Beet Production in Bangladesh**

**ABSTRACT**

*Spodoptera litura* (Fab.) can cause severe economic losses to sugar beet crops by reducing their production. To ensure risk-free tropical sugar beet production in Bangladesh, this study set out to develop an Integrated Pest Management (IPM) package to suppress *S. litura*. The most effective treatment was determined to be T10, which consists of a pheromone trap, hand picking, and Nitro 505EC. When compared to the control, the experimental plots treated with this treatment (T10) had the greatest effectiveness in lowering larval population, at 78.43% with a maximum percentage of Brix (19.50%) and Pol (12.00%), followed by T9 treated plots (pheromone trap + hand picking + Virtako 40WG), which had 18.66% Brix and 11.83 % Pol. In the T10 treated plot, the individual beet weight was 814.67 g, followed by 807.33 g in T9, and 722.67 g in T11 (the untreated control) plot. It suggests that beet output declined in correlation with the severity of insect infestation. The results show that using a combination of pheromone traps, hand picking, and Nitro 505EC effectively reduces *S. litura* infestation and maximizes crop production and quality. This might lead to safer and more sustainable ways to grow tropical sugar beets in Bangladesh.

**Keywords:** Sugar beet, IPM, *Spodoptera litura,* Nitro 505EC, Pheromone trap

**1. INTRODUCTION**

As a temperate crop belonging to the Chenopodiaceae (Amaranthaceae) family, tropical sugar beets (*Beta vulgaris* L.) are the world's second-most-important sugar crop, after sugarcane, yielding 35–40% of the world's sugar each year (Amr & Gaffer 2010, Wu *et al*. 2016). According to Zhang *et al.* (2008), sugar beet is rapidly emerging as a viable biofuel substitute for energy produced by fossil fuels. There has to be extensive study into all facets of efficiently producing the crop in order to fulfill the growing demand for sugar, and this research is happening quickly in every country where sugarcane is grown. Sugar beet cultivation in Bangladesh has enormous potential, and the country may reach an acceptable level of sugar yield. The high prevalence of insect pests and diseases is one of the many challenges associated with growing sugar beets (Patil *et al.* 2007). Sugar beet production in Bangladesh is severely threatened by insect infestations. There are eight known species of pest insects: webworms, sugar beet caterpillars, cutworms, aphids, red mites, grasshoppers, hairy caterpillars, flea beetles, and fleas. According to Shabir *et al.* (2023), the caterpillar of the *Spodoptera litura* is the most detrimental insect to sugar beets. This caterpillar is likely a polyphagous pest, according to Shabir *et al.* (2023), Zhou *et al.* (2010), and Navasero (2011). It has been reported to be widespread around the globe. Cotton, legumes, oil seeds, veggies, ornamental plants, and even certain weeds are among the many crops that this pest preys on. Many economically significant crops can be defoliated by the larvae of the *Spodoptera litura*, making it a very dangerous pest (CABI 2010). Damaged leaves seem skeletonized, and they feed erratically in the beginning. Within a week, the crop may be entirely stripped of its leaves by the large caterpillar (Seth *et al.* 2004). Damage to late-harvested crops is the worst; in the worst-case scenario, it might impact all of the roots, resulting in a significant drop in production (Iqbal *et al.* 2015). Various approaches to pest management have been suggested for the control of sugar beet caterpillars, including resistant cultivars, cultural practices, mechanical control, biological and chemical treatments, and so on. However, no single approach has demonstrated 100% effectiveness and reliability at this time. The chemical control approach remains popular among our farmers out all of these options due to its immediate and apparent effects. Insecticide resistance, new pests appearing, pollution, human health risks, and widespread use of synthetic pesticides in farming are all consequences of this practice. Most people choose Integrated Pest Management (lPM), which involves controlling insect pests using all possible methods in a coordinated effort to minimize economic harm and environmental impact. In Bangladesh, the efficiency of different management options for sugar beet pest control by means of an integrated pest management approach is inadequately explored. Hence, the objective of this research was to find a way to control the *Spodoptera litura* pest that infests on tropical sugar beets utilizing integrated pest management approaches.

**2. MATERIALS AND METHODS**

From November 2020 until May 2021, the experiment took place at SAU, Dhaka at their experimental field. The sugar beet variety BSRI Sugarbeet-2 (Cauvery) was cultivated in the field. The Experimental field was set up using randomized complete block design (RCBD) with three replications. Eleven (11) plots of identical size (3.0 m x 2.0 m) were separated into three blocks, with 2 m space between the blocks and 1 m space between the plots, and the entire field (0.051 hectare) was divided into these 3 blocks. So, in all, thirty-three plots were included. Each block was given a treatment according to the experimental design. Tropical sugar beet seedlings were collected from the Bangladesh Sugar Crops Research Institute (BSRI). On November 30, 2020, 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. All of the essential intercultural operations, including watering, weeding, and earthing up, were carried out correctly. Table 1 shows different treatment combinations where pheromone trap was used commonly for all combinations and the treatments were applied at 7 days interval.

**Table 1. IPM packages with their combination used in this experiment**

|  |  |
| --- | --- |
| **Treatments** | **IPM packages (Combination)** |
| T1 | Hand Picking |
| T2 | Neem oil @ 3 ml liter-1 of water |
| T3 | Nitro 505EC @ 2 ml liter-1 of water |
| T4 | Virtako 40WG @ 0.2 g liter-1 of water |
| T5 | Nitro 505EC @ 2 ml liter-1 of water + Neem oil @ 3 ml liter-1 of water alternatively |
| T6 | Virtako 40 WG @ 0.2 g liter-1 of water + Neem oil @ 3 ml liter-1 of water alternatively |
| T7 | NPV @ 0.2 g liter-1 of water at |
| T8 | Neem oil @ 3 ml liter-1 of water + Hand Picking |
| T9 | Virtako 40WG @ 0.2 g liter-1 of water + Hand Picking |
| T10 | Nitro 505EC @ 2 ml liter-1 of water + Hand Picking |
| T11 | Control |

**2.1 Data collection**

Data collection commenced immediately prior to the implementation of the treatments, with measurements taken at 7-day intervals for the following parameters:

Plant infestation count, Leaf infestation count per plant, Total count of bores: Weight of beet (grams), Length of beet (centimeters), Diameter of beet (centimeters), The Brix % of beet was determined using a manual refractometer, whereas the sucrose percentage of beet (Pol) was measured using an automated polarimeter (model AP-300, Atago Co., Ltd., Japan).

**2.2 Data analysis**

The data were evaluated using the "Statistix 10" program for statistical analysis. The mean differences among the treatments were compared using the Least Significant Difference (LSD) test at a significance threshold of 5%.

**3. RESULTS AND DISCUSSION**

**3.1 Effects of IPM practices on number of infested plants, leaves and beets**

As a measure of plant resistance to some pests, the number of infested plants changed with each developmental stage. T10 (hand picking + Nitro 505EC @ 2ml liter-1 of water had the fewest infested plants (4.33), whereas T11 (control) had the most (9.00). Table 2 shows that the second-lowest number of infested plants was 5.00 in the T9 treatment, which included a pheromone trap, hand-picking, and Virtako 40WG applied at a rate of 0.2 g liter-1. The number of infested leaves per 5 plants changed during the different growth phases, which shows how resistant the plants were to *Spodoptera litura.* Treatment T10 (hand picking + Nitro 505EC) had the fewest infested leaves (21.00) whereas T11 (untreated control) had the most (31.33) (Table 2). Hand picking with Virtako 40WG treatment had the second-lowest number of infested leaves (22.00). On the contrary, hand picking with Nitro 505EC had the fewest infested beets (6.00) whereas T11 (untreated control) had the most (10.66) (Table 2). In the T9 treatment, which included hand-picking, and Virtako 40WG applied at a rate of 0.2 g/liter of water showed the second-lowest number of infested beets (6.33). Thus, there were notable variations in the quantity of affected beets per plot throughout the investigated integrated pest control strategies.

**Table 2. Effects of IPM practices on number of infested plants, leaves and beets**

|  |  |  |  |
| --- | --- | --- | --- |
| **IPM Packages** | **Infestation level (On the basis of number)** | | |
| **Infested plants plot-1** | **Infested leaves per 5 plants** | **Infested beets plot-1** |
| T1 (Hand Picking) | 8.00ab | 28.00ab | 10.00ab |
| T2 (Neem oil) | 6.66bcd | 25.33abc | 8.00abcd |
| T3 (Nitro 505EC) | 5.33cde | 23.00bc | 6.66cd |
| T4 (Virtako 40WG) | 5.66cde | 23.33bc | 7.33bcd |
| T5 (Neem oil+ Nitro 505 EC) | 6.00bcde | 24.33bc | 7.66abcd |
| T6 ((Neem oil+ Virtako 40WG) | 6.33bcde | 25.00abc | 7.33bcd |
| T7 (NPV) | 7.00abcd | 26.00abc | 8.66abcd |
| T8 (Hand Picking + Neem Oil) | 7.33abc | 26.66abc | 9.33abc |
| T9 (Hand Picking + Virtako 40WG) | 5.00de | 22.00bc | 6.33cd |
| T10 (Hand Picking + Nitro 505EC) | 4.33e | 21.00c | 6.00d |
| T11 (Untreated Control) | 9.00a | 31.33a | 10.66a |
| **CV** | **21.18** | **25.09** | **24.43** |
| **LSD (0.05)** | **2.31** | **6.92** | **3.32** |

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

**3.2 The impact of IPM strategies on larval populations**

Statistical significance was found among the treatments in each of the three months' worth of data on the number of larvae collected. In April, the most larvae were reported, followed by May. According to Table 2, the larval population was most concentrated in March. T10 (hand picking + Nitro 505EC) had the lowest larval population (1.22 according to pool data), whereas T11 (control) had the largest population (5.67). After the pheromone trap and hand-picking treatments, the T9 treatment (Hand Picking + Virtako 40WG)) had the second-lowest larval count at 1.67. The treatment with the highest percentage of efficacy compared to the control was T10 (Hand picking + Nitro 505EC), whereas the treatment with the lowest percentage was T1 (Hand picking) based on pool data. The number of larvae population was significantly affected by the treatment in this study (at least at 5% level of significance; table 3). According to Siddiquee *et al.* (2017), the sugar beet field had the lowest larvae population in Nirto 505EC @ 4.5 L/ha at 15-day intervals, and the highest percent efficacy above control was 81.06% in the 2013–2014 season, which is similar to our findings.

**Table 3. The impact of different IPM strategies on larval populations of *Spodoptera litura***

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Treatments** | **Number of larvae per 5 infested plants** | | | **Pooled data** | **% reduction over control** |
| **March** | **April** | **May** |
| T1 (Hand Picking) | 3.33b | 3.67b | 4.00b | 3.67 | 35.29 |
| T2 (Neem oil) | 2.33bcde | 3.00bc | 3.00bcd | 2.78 | 50.98 |
| T3 (Nitro 505EC) | 1.67cde | 2.33bc | 2.33de | 2.11 | 62.74 |
| T4 (Virtako 40WG) | 1.67cde | 2.67bc | 2.33de | 2.22 | 60.78 |
| T5 (Neem oil+ Nitro 505 EC) | 2.00bcde | 2.33bc | 3.00bcd | 2.44 | 56.86 |
| T6 ((Neem oil+ Virtako 40WG) | 2.33bcde | 3.00bc | 2.67cd | 2.67 | 52.94 |
| T7 (NPV) | 2.67bcd | 3.33bc | 3.00bcd | 3.00 | 47.05 |
| T8 (Hand Picking + Neem Oil) | 3.00bc | 3.33bc | 3.67bc | 3.33 | 41.17 |
| T9 (Hand Picking + Virtako 40WG) | 1.33de | 1.67bc | 2.00de | 1.67 | 70.58 |
| T10 (Hand Picking + Nitro 505EC) | 1.00e | 1.33c | 1.33e | 1.22 | 78.43 |
| T11 (Untreated Control) | 5.33a | 6.33a | 5.33a | 5.67 | 0.00 |
| **CV** | **33.83** | **41.44** | **21.46** | **-** | **-** |
| **LSD (0.05)** | **1.39** | **2.11** | **1.08** | **-** | **-** |

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

**3.3 Effects of IPM tactics on beet weight, beet length and beet girth**

The sugar beet variety's harvest value is based on the beet weight. Under ideal growing conditions, high-quality sugar beets can outproduce lower-quality varieties. The weight of the beets ranged from 722.33 g in the controlled plots to 814.67 g in the T10 treatment (hand picking + Nitro 505EC) (Table 4). In the T9 treatment, which included hand-picking and Virtako 40WG at a concentration of 0.2 g/liter of water, the second-heaviest beet weighed 807.33g. The length of a sugar beet variety is a good indicator of its quality when harvested. According to Table 4, the beets in the T10 treatment reached a maximum length of 29.66 cm, whereas the beets in untreated controlled plots reached a minimum length of 22.00 cm. The beet had the second-longest length of 28.33 cm in the T9 treatment. Hand picking with Nitro 505EC produced a maximum girth of beet (42.66 cm) whereas in T11 (control), they reached a minimum girth of 26.66 cm (Table 4). During the 2015–16 growing season, Rahman *et al.* (2017) discovered that the Nitro treated plot had the greatest yield at 78.00 t ha-1, followed by Virtako 40WG treated plot (72.67 t ha-1) in the NBSM (Natore, Bangladesh) site.

**Table 4.** **Effects of different IPM strategies on yield contributing parameters of tropical sugar beet**

|  |  |  |  |
| --- | --- | --- | --- |
| **Treatments** | **Sugar beet yield maximizing characters (Single fruit basis)** | | |
| **Weight (g)** | **Length (cm)** | **Girth (cm)** |
| T1 (Hand Picking) | 741.00ab | 23.00de | 27.66bc |
| T2 (Neem oil) | 779.67ab | 25.66bcde | 30.66bc |
| T3 (Nitro 505EC) | 794.33ab | 27.66abc | 37.00abc |
| T4 (Virtako 40WG) | 785.33 ab | 27.33abc | 34.66abc |
| T5 (Neem oil+ Nitro 505 EC) | 780.67ab | 26.66abcd | 32.66abc |
| T6 ((Neem oil+ Virtako 40WG) | 779.00ab | 26.33abcd | 31.33bc |
| T7 (NPV) | 759.67ab | 25.33bcde | 30.66bc |
| T8 (Hand Picking + Neem Oil) | 750.67ab | 24.00cde | 28.33bc |
| T9 (Hand Picking + Virtako 40WG) | 807.33ab | 28.33ab | 38.00ab |
| T10 (Hand Picking + Nitro 505EC) | 814.67a | 29.66a | 42.66a |
| T11 (Untreated Control) | 722.67b | 22.00e | 26.66c |
| **CV** | **6.20** | **8.38** | **20.06** |
| **LSD (0.05%)** | **81.77** | **3.71** | **11.19** |

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

**3.4 Brix and Pol percentage**

Figure 1 shows that the brix percentage values ranged from 13.57% (control) to 19.50% (Hand picking + Nitro 505EC) in the T10 treatment. In the T9 treatment, which included hand picking and Virtako 40WG applied at a rate of 0.2 g liter-1 of water, the second-highest brix was 18.66 percent. In case of pol percentage, lowest (7.66%) percentage was in the controlled plots and highest 12.00% in the T10 treatment (Hand picking + Nitro 505EC). During the 2013–14, 2014–15, and 2015–16 seasons at BSRI farm Ishwardi, Siddique et al. (2017) discovered the greatest levels of pol was in the Nitro 505EC treated plot at 14.93%, 16.32%, and 15.27%, respectively.



Fig. 1. Effects of IPM tactics on brix percentage and pol percentage

**4. CONCLUSION**

Enhancing sugar beet production in Bangladesh through safe Integrated Pest Management (IPM) techniques against *Spodoptera litura* is crucial for sustainable agriculture. This study demonstrated that combining pheromone traps, hand picking, and Nitro 505EC significantly reduces pest infestations and improves crop yield and quality. By adopting these IPM practices, farmers can achieve higher productivity and better crop health, ensuring more reliable and profitable sugar beet production in Bangladesh.

**Disclaimer**

Author(s) hereby declares that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

**5. REFERENCES**

Amr, A.H.R., Ghaffar, M.S.A. (2010). The economic impact of sugarbeet cultivation in new lands (Study of Al-Salam Canal Area Status). Australian Journal of Basic and Applied Sciences, 4(7), 1641-1649.

CABI. (2010). Crop protection compendium: global module. Commonwealth Agricultural Bureau International, Wallingford, UK. <http://www.cabi.org/compendia/cpc/>.

Iqbal, M.A., Saleem, M.A. (2015). Sugar Beet Potential to Beat Sugarcane as a Sugar Crop in Pakistan. American-Eurasian Journal of Agricultural & Environmental Sciences*,* 15(1), 36-44.

Navasero, M.V., Navasero, M.M. (2011). Farm-level production and utilization of nuclear polyhedrosis virus of the common cutworm, *Spodoptera litura* Fabricius (Noctuidae, Lepidoptera) for tomato production. **In:** Manual of integrated production and pest management in processing tomato S.M.F., Calumpang, and D.P., Callo, Jr, (Eds.). Department of Agriculture, KASAKALIKASAN, ASEAN IPM, NCPC, UPLB and CHARM-2 Project. pp. 316.

Patil, A.S., Salunkhe, A.N., Pawar, B.H., Ghodke, P.V., Shivankar, S.B., Zende, N.B., Shewate, S.R., Patil, D.J. (2007). Sugar beet cultivation in tropical India: A new experience. Proc. 68th Annual Conf., 22–24 August 2007, STAI, New Delhi. 85–111.

Rahman, M.A., Siddiquee, M.N.A., Islam, M.S., Reza, M.E., Alam, K.S., Begum, M. (2017). Effects of new organophosphate and synthetic pyrethroid insecticides in controlling sugar beet caterpillar of Bangladesh. Bangladesh journal of sugarcane, 38, 21-30.

Seth, R.K., Kaur, J.J., Rao, D.K., Reynolds, S.E. (2004). Effects of larval exposure to sublethal concentrations of the ecdysteroid agonists RH-5849 and tebufenozide (RH-5992) on male reproductive physiology in *Spodoptera litura.* Journal of Insect Physiology*,* 50(6), 505-517.

Shabir, A., Sarwar, Z.M., & Ali, H. (2023). Eco-friendly approaches of zinc oxide and silver nitrate nanoparticles along with plant extracts against *Spodoptera litura* (Fabricius) under laboratory conditions. Science progress, 106(4). <https://doi.org/10.1177/00368504231219171>.

Siddiquee, M.N.A., Rahman, M.A., Islam, M.S., Reza, M.E., Ahmed, T., Alam, K.S., Begum, M. (2017). Development of integrated management approaches against *Spodoptera litura* in tropical sugar beet of Bangladesh. Bangladesh Journal of Sugarcane*,* 38,1-13.

Wu, G., Feng, R., Shui, Q. (2016). Effect of osmotic stress on growth and osmolytes accumulation in sugar beet (*Beta vulgaris* L.) plants. Plant Soil Environment, 62, 189-194.

Zhang, J., Chen, F., Liu, L., Peter, H., Kevin, B., Hicks. (2008). Performance Enhancement of Poly(lactic acid) and sugar beet pulp composites by improving interfacial adhesion and penetration. Industrial & Engineering Chemistry Research*,* 47(22), 8667–8675.

Zhou, Z., Chen, Z., Xu, Z. (2010). Potential of trap crops for integrated management of the tropical armyworm, *Spodoptera litura* in tobacco. Journal of Insect Science*,* 10(1), 117.