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SCREENING OF TROPICAL SUGAR BEET VARIETIES AGAINST SUGAR BEET CATERPILLAR (*SPODOPTERA LITURA)* IN BANGLADESH

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ABSTRACT

Screening of tropical sugar beet varieties against the sugar beet caterpillar, *Spodoptera litura*, is important for understanding how different varieties respond to caterpillar pressure and developing pest-resistant cultivars, and increasing sugar beet crop productivity in Bangladesh. A study was carried out to identify the most tolerant sugar beet cultivars against *Spodoptera litura* attack as well as the extent of infestations by this insect pest. Results revealed that Cauvery was the best-suited cultivar, whereas PAC-60008 was the most susceptible to *S. litura*. The PAC-60008 variety had the highest (7.73) number of bores plant^{-1} and caterpillar (14.66), whereas the Cauvery variety had the lowest (2.20) number of bore plant^{-1} and the fewest (2.00) caterpillar. Sugar beet yield and its associated attributes were higher in Cauvery variety but lower in PAC-60008 variety. Cauvery had the highest yield (89.96 t ha^{-1}), while the PAC-60008 variety had the lowest (76.06 t ha^{-1}). Cauvery exhibited the highest Brix (18.23%) and Pol (13.45%), whereas PAC-60008 showed the lowest Brix (14.70%) and Pol (11.18%). Cauvery variety was more tolerant to *Spodoptera litura*, and further study may be undertaken in multiple locations to get more information on the causes of lower pest infestation and production increase before providing recommendation for commercial cultivation of Cauvery variety.

Keywords: *Spodoptera litura*, Sugar Beet, Variety, Tolerant variety, Cauvery, PAC-60008, Brix, Pol

INTRODUCTION

Tropical sugar beet, scientifically known as *Beta vulgaris* L., is a temperate crop that produces 35–40% of the world's sugar annually. It is the second most significant sugar crop in the world, after sugarcane (Amr and Gaffer 2010, Wu *et al.*

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2016). According to Chen *et al.* (2008), sugar beet has lately become a major biofuel alternative to energy produced by fossil fuels. Asadi (2007) states that sugar beet can be processed from 270 to 300 days in a year. India, Pakistan, and Bangladesh are among the tropical and subtropical nations that are now cultivating sugar beet with great success. The vast range of agroclimatic conditions in Bangladesh makes it an ideal location for growing sugar beets, even in coastal regions (Tayyab *et al.* 2023). Sugarcane takes 12–16 months to harvest, while sugar beet need only 4-6 months, resulting 2-3 times greater sugar yields per hectare (Baloach *et al.* 2002). Cultivation of sugar beet might alleviate the sugar/goor shortage, meet demand, and improve country's economic condition. There has to be extensive study into all facets of effectively 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. There is a great deal of untapped potential for sugar beet farming in Bangladesh, which may lead to more than enough sugar output.

The high prevalence of insect pests and diseases are of the many challenges associated with growing sugar beets, a relatively young crop (Patil *et al.* 2007). A production loss of 18 t ha^{-1} is possible due to sugar beet insect infestations. One of the major issues with sugar beet farming is the presence of insect pests. Aphids, webworms, cutworms, red mites, grasshoppers, hairy caterpillars, flea beetles, and fleas are different insect pests that have been recorded (Zhang *et al*. 2008). Among sugar beet insect pests, the *Spodoptera litura* caterpillar is the most damaging (Mehta *et al*. 2022). This caterpillar has been shown to feed on a wide variety of plants and crops, including cotton, legumes, oil seeds, vegetables, ornamental plants, and even certain weeds (Zhou *et al*. 2010, Navasero 2011). Many commercially significant crops may be defoliated by the caterpillar of the *Spodoptera litura*, classified it as a very dangerous pest. Sugar beet infestations by the *Spodoptera litura* begin in March and reach its peak in late March and early April (Chatterjee and Nayak 1987, Iqbal *et al.* 2015). Leaf skeletonization and feeding holes in roots caused by severe infestations and made the crop unfit for marketing. Particularly hard-hit crops are harvested later in the season; in the worst instances, damage to all of the roots which may reduce yields by as much as 100% (Baitha *et al*. 2022). So far, several approaches of pest management have been suggested for suppressing sugar beet caterpillars, including using of resistant cultivars, cultural practices,

mechanical control, biological and chemical treatments, and so on. No effective method of varietal screening against this invasive pest has been implemented yet in Bangladesh. Therefore, the present study was aimed to find out the more tolerant sugar beet variety (ies) against *Spodoptera litura.*

MATERIALS AND METHODS

Twelve tropical sugar beet varieties viz., SV-35, SV-887, SV-889, SV-891, SV-892, SV-893, SV-894, PAC-60008, Danicia, Serenada, BSRI Sugar beet-1 (Shubhra), BSRI Sugar beet-2 (Cauvery) were grown from seed in the research field. The varieties were collected from the Bangladesh Sugarcrop Research Institute (BSRI). The field of the Experimental Farm of SAU was used for the study, which followed the Randomized Complete Block Design (RCBD) with three replications. The whole field was 0.055 hectares and divided into three blocks. Each block included twelve plots, each measuring 3.0 m x 2.0 m. There was a two-meter gap between the blocks, and a one-meter gap between the plots. So, in all, thirty-six plots were included. In accordance with the experimental design, treatments were distributed to each block. The seeds were planted at SAU Experimental Farm using ridge techniques with a spacing of 50 cm. x 20 cm, where seed to seed and row to row distances were 50 cm. and 20 cm, respectively. There were four lines in each plot, and fourteen seeds at each line. The first watering was done two days after the seeds sowing. The plant was irrigated second time after one month and third irrigation after two months avoiding water stagnation in the field. After the second and third irrigations, urea was applied as top dressing. Each trench was sown with two seeds. After two weeks, the remaining seedlings were thinned and one healthy seedling was retained for the study. The soil crust was broken and the plots were kept free of weeds by weeding as needed. After 20 days of sowing, the first weeding was done, and further weeding was done after 25 days interval to maintain a weed-free plot. To ensure that every plant had an adequate quantity of soil at its base, earthing up was done in every row. Prior to irrigation, this was done on 30 and 60 days after seeding.

Data recorded: Data was collected from seedlings after one month of age and contained upto the last harvest. Data were gathered in various conditions. The leaf area index (LAI), dry matter, number of bores, number of larvae, beet weight (g), beet diameter (cm), beet length (cm), yield, brix %, and pol % were recorded.

Germination Percentage: An indicator of a seed's potential for sprouting is its germination percent which was determined by using the following formula:

$$\text{Germination Percentage (GP)} = \frac{\text{No. of germinated seeds}}{\text{Total no. of seeds}} \times 100$$

Leaf area index (LAI): A dimensionless metric that describes plant canopy is the leaf area index (LAI). In broadleaf canopies, it is the ratio of the area of the green side of the leaves to determine the area of the ground is expressed as:

$$\text{LAI} = \frac{\text{Leaf coverage area plant}^{-1}}{\text{Soil covered area plant}^{-1}}$$

An indication of a plant's growth rate, the leaf area index (LAI) measures the area of a plant's leaves relative to its stem or ground surface.

Brix percentage: Brix is the refractometer-measured concentration of soluble solids in the plant's first-stage juice processing. By monitoring the light's refraction as it passes through a liquid sample, a refractometer may ascertain the degree of Brix. Sugary liquids have a higher index of refraction because they are denser than water. The device then calculates the Brix value by comparing it to the rate at which light refracts through water.

Determination of Sucrose (Pol) percentage of beet: The polarimeter can only measure the sucrose concentration in the juice as a percentage, either as Pol or sucrose. Atago Co., Ltd. of Japan provided the automated polarimeter (Model AP-300) that was used to measure the pol percent juice. A 200 mm polarimeter tube was filled with the transparent liquid. After the tube was filled with clarified juice, great care was taken to ensure that no air bubbles would be seen within. As the image's location was altered, the polarimeter/saccharimeter was fine-tuned and focused clearly. After making the necessary adjustments, the scale gave the direct pol and the two parts of the field of vision seemed equally bright. Using Schmittz's Table for sucrose (pol) for use in Horne's Dry Lead technique with an undiluted solution, the pol was adjusted against brix.

Data analysis: Proper form was used to combine and tabulate the data acquired for growth, phonology, yield, and yield contributing characteristics for statistical

analysis. Computer software called "Statistix 10" was used for statistical analysis of the obtained data and compared the means of the treatments using the Least Significant Difference (LSD) method, which was described by Gomez and Gomez in 1984. The significance threshold was set at 5%.

RESULTS AND DISCUSSION

The impact of sugar beet genotypes on the *Spodoptera litura* caterpillar: Germination percentage: Table 1 displays the germination % of the sugar beet varieties those were investigated. Around fifteen days after seed planting, germination took place. At a depth ranging from three-quarters to 3.81 cm, the seeds were sown into somewhat damp soil. Although sugar beets thrived in a wide range of soil types, the ideal growing conditions included well-drained soil devoid of roots and big stones, which may stunt root development. Soil pH between 6.0 and 6.5 is ideal for sugar beets. The proportion of sugar beet seeds that germinated seed showed statistically significant variation. The percentage of germination has a substantial impact on sugar beet production. The Cauvery variety had the best germination rate of 94.87%, which was statistically close to Shubhra (93.59%). Among the tested varieties, PAC-60008 had the poorest germination rate (84.62%). Nevertheless, the variety PAC-60008 had the greatest germination rate of 93.14%, followed by Cauvery (92.85%), and Shubhra (81.52%), as reported by Islam *et al.* (2014).

Leaf area index (LAI): Leaf area index (LAI), a crucial metric in plant ecology. It served as a proxy for the photosynthetic active area and the area transpired as it revealed the amount of vegetation present. It is also the place where air contaminants first make contact. The quantity of leaf material in a canopy may be measured using the leaf area index (LAI). It is defined as the ratio of the area of the one-sided leaf to the area of the ground. The smallest leaf area index (LAI) reported was 6.75 m^2 for the Serenada variety, while the highest was 9.37 m^2 for the Cauvery variety. With 8.64 m^2, the Shubhra variety has the second-highest LAI. The variety SV892 has the greatest LAI (3.05), as reported by Islam *et al.* (2015). While the treatments' effects were noticeable in later stages and they were inconsistent at early stages

when it came to leaf area. At the 5% level of significance or above, the variety had a significant influence on the leaf area index in this study (Table 1).

Dry matter (DM): When water is removed from feed, grain, and fresh or dried forages, what's left is the dry matter. The dry matter percentage of fresh pasture is lower than that of hay or grain of the same weight because of the pasture's high-water content. One measure of a feed's nutritional availability is its dry matter content. From the time of seeding until the plant reached maturity, the dry weight per plant grew steadily. As shown in Table 1, the percentage of dry matter found in the sugar beet varieties. The findings showed that the variations were significantly different from one another. The sugar beet variety SV-887 had the greatest percentage of dry matter (14.34%), while the sugar beet variety SV-35 had the lowest percent (9.73%). The SV-889 variety had the second highest % DM of 14.20 (Table 1).

Number of *S. litura* larvae plant^{-1}: There are five stages of larval life cycle, with the last two stages reaching a weight of 800 mg. The fresh weight of one larva was taken after they were feed to four to eight grams of sugar beet leaves. But at the end of the process, eighty percent of the food is gone. The number of larvae per plant changed with each stage of development, which in turn indicates the plant's resistance to *Spodoptera litura* (Table 1). There was a minimum of 2.00 larvae per plant in the Cauvery variety and a maximum of 14.66 in the PAC-60008 were recorded. At Shubhra variety, the second-lowest number of larvae (7.33) was recorded. The number of larvae per plant was significantly affected by the variety in this study (5% level of significance). The effects of the sugar beet variety were shown in this study (Table 1).

Number of bore beet^{-1}: The number of bores per Sugar beet varies with the phases of development and showed how much resistant the plant is to a particular kind of pest. Bores per Sugar beet ranged from 2.20 in the Cauvery variety to 2.26 in the Shubhra variety, with 7.73 in the PAC-60008 variety being the highest. There were notable variations in the number of bore per plant across the sugar beet varieties (Table 1).

Beet weight: Worthiness of sugar beet varieties is determined by the weight of beet at harvest. Under ideal conditions, high-quality sugar beets may have higher beet weight compared to other varieties. The Cauvery beet variety had the highest

Table 1. Germination %, Leaf area index, Dry matter, larvae per plant and number of bore beet^{-1} observed in twelve sugar beet varieties

Variety	Germination (%)	Leaf area index (m^2)	Dry matter (%)	Number of larvae plant^{-1}	Number of bore beet^{-1}
SV-35	85.90^{de}	6.87^{c}	9.73^{b}	13.33^{a}	5.86^{abc}
SV-887	88.46^{cde}	7.23^{bc}	14.34^{a}	10.66^{ab}	4.80^{abcd}
SV-889	89.74^{bcd}	7.57^{bc}	14.20^{a}	8.66^{ab}	3.60^{bcd}
SV-891	89.10^{bcde}	7.35^{bc}	11.76^{ab}	9.33^{ab}	3.80^{bcd}
SV-892	90.38^{abcd}	7.66^{bc}	10.61^{b}	8.00^{ab}	3.86^{bcd}
SV-893	86.54^{de}	8.00^{abc}	12.54^{ab}	11.33^{ab}	6.13^{ab}
SV-894	91.67^{abc}	8.06^{abc}	10.42^{ab}	8.66^{ab}	2.93^{bcd}
PAC-60008	84.62^{e}	6.77^{c}	11.14^{ab}	14.66^{a}	7.73^{a}
Danicia	87.18^{cde}	7.07^{c}	11.37^{ab}	10.00^{ab}	5.13^{abcd}
Serenada	89.74^{bcd}	6.75^{c}	11.06^{ab}	11.00^{ab}	5.66^{abcd}
Shubhra	93.59^{ab}	8.64^{ab}	12.07^{ab}	7.33^{ab}	2.26^{cd}
Cauvery	94.87^{a}	9.37^{a}	10.49^{b}	2.00^{b}	2.20^{d}
CV	3.30	11.34	17.05	66.62	47.49
LSD (0.05)	2.59	1.46	3.36	10.81	3.61

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

weight of 851.67 g, followed by Shubhra variety (813.33 g), and the PAC-60008 variety (693.67 g) (Table 2). The variety influenced beet weight significantly in this study (5% level of significance). In the current study, beet weight is somewhat lower than that of the Cauvery variety (995.70 g) and the Shubhra variety (835.95 g), as reported by Islam *et al.* (2014). Soil and climatic variations could be the reason.

Beet girth: Beet girth at harvest might affect the varietal quality of Sugar beet. Table 2 showed that the SV-35 variety had the lower beet girth of 24.67 cm, while the Cauvery and Shubhra varieties had 31.33 and 31.00 cm respectively. The SV-887 cultivar had the second-highest beet girth of 29.33 cm. Significant girth variations among the sugar beet cultivars were shown. Islam *et al.* (2014) reported that the Aranka variety of beets had the widest girth of 34.46 cm.

Beet length: The quality of a sugar beet variety was also determined by its length. Table 2 showed that the highest length of 31.67 cm was found in the Cauvary variety,

and the shortest length was (26.33 cm) obtained in the SV-35 variety. The Shubrha variety had the second-longest length of 29.66 cm, while SV-894 had 28.66 cm length. The present findings are in agreement with those of Islam *et al.* (2014), who also measured beet length and reported that variety Cauvery had the longest (31.24 cm). There were significant variations among the tested varieties.

Yield (t ha^{-1}): Sugar beet yields have been steadily rising globally over the last few decades. Developing better breeding methods is crucial for maximizing the crop's output potential. The change occurred when the plants assimilate partitioning shifted toward store carbohydrates (sucrose) while structural carbohydrates (leaves, cell wall components) dropped inadvertently. Table 2 shows that the yield ranged from 76.06 t ha^{-1} for the PAC-60008 variety to an impressive 89.96 t ha^{-1} for the Cauvary variety followed by Shubrha with 87.86 t ha^{-1}, while the SV-894 variety had the third-highest beet yield with 87.15 t ha^{-1}. Islam *et al.* (2014) reported that among the varieties tested, Aranka had the highest yield (98.80 t ha^{-1}) and Shubrha the lowest (59.90 t ha^{-1}). At the 5% level of significance, the varieties were shown to have a significant influence on yield in this study.

Table 2. The parameters that contribute in yield of sugar beet varieties

Variety	Yield contributing attributes of sugar beet			Yield (t ha^{-1})
	Beet weight (g)	Girth of beet (cm)	Length of beet (cm)	
SV-35	711.67^{f}	24.67^{e}	26.33^{e}	76.88^{e}
SV-887	740.67^{ef}	26.67^{cde}	27.67^{cd}	84.44^{abcd}
SV-889	765.00^{cd}	27.33^{cde}	28.33^{c}	84.73^{abcd}
SV-891	753.00^{de}	27.00^{cde}	27.67^{cd}	86.20^{abc}
SV-892	798.00^{bc}	28.33^{bcd}	28.33^{c}	85.65^{abc}
SV-893	710.00^{f}	25.67^{de}	26.83^{de}	79.34^{de}
SV-894	808.00^{b}	28.67^{abc}	28.67^{bc}	87.15^{ab}
PAC-60008	693.67^{g}	27.67^{cd}	26.67^{de}	76.06^{e}
Danicia	731.67^{def}	26.33^{cde}	27.00^{de}	83.17^{bcd}
Serenada	718.33^{ef}	26.00^{cde}	26.67^{de}	80.94^{cde}
Shubhra	813.33^{b}	30.67^{ab}	29.67^{b}	87.86^{ab}
Cauvery	851.67^{a}	31.33^{a}	31.67^{a}	89.96^{a}
CV	3.13	5.96	2.78	4.29
LSD (0.05)	37.14	2.77	1.31	6.07

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

Brix Percentage: An aqueous solution's sugar concentration is represented by its Brix percentage. As a percentage of mass, the solution's strength is represented by its Brix, which is 1 g of sucrose in 100 g of solution. Twelve different sugar beet varieties were tested, and the brix ranged from 14.70% to 18.23%. Cauvery had the greatest brix percent (18.23%), which was statistically similar with that of Shubhra (18.13%), SV-894 (17.80%), SV-892 at (17.76%), and SV-889 (17.73%). Figure 1 showed its comparable brix of SV-35 (15.40%), Serenada (15.50%), and SV-887 (15.83%), but the lowest brix was in PAC-60008 (14.70%) and (15.06%) in SV-893. Islam *et al.* (2014) reported that varieties HI-0044 had the lowest brix percentage of 17.39% and varieties Shubhra, Cauvery, and Aranka had the highest, ranging from 18.48% to 18.87%.

Pol Percentage: In Figure 1, the varieties with the greatest Pol percentage were 13.45% in Cauvary and 13.36% in Shubrha and PAC-60008 had 11.18% pol. In a study conducted by Islam *et al.* (2014), the pol percentage was determined to be 10.08 % in the Aranka variety. When comparing the Pol percentages of several sugar beet varieties, it was found some notable variation. According to the results, the sugar beet variety Cauvary performed best in this study. In comparison to other varieties, this one had a high germination percentage, Leaf Area Index (LAI), and Dry Matter (DM). There was a favorable correlation between yield and other yield-related characteristics of the Cauvery variety. Among these varieties, Shubhra was ranked the second.

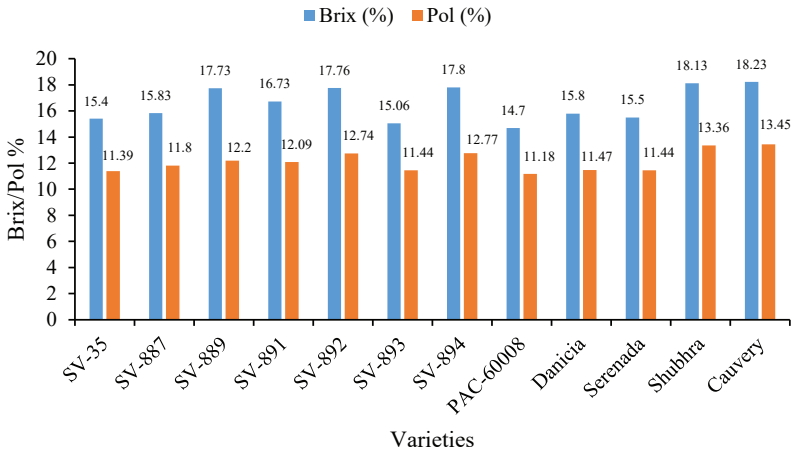


Fig. 1. Brix (%) and Pol (%) of the studied sugar beet varieties

CONCLUSION

The Cauvery variety exhibited the highest germination rate, LAI, and yield, along with the highest a brix and pol percentage, indicating its superior performer. Additionally, the number of caterpillar per plant and the number of bores per beet were significantly influenced by the sugar beet genotype, with the PAC-60008 variety showing the highest infestation rates with the lowest brix and pol percentage, indicating its inferior performer. This research can inform future breeding programs aimed at improving sugar beet yield and pest resistance.

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