# Influence of Staking and Non-Staking on Tomatillo (*Physalis ixocarpa* Brot.) Cultivation in Coastal Areas

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**Abstract**

An experiment was carried out at Nabogram Khamarbari, near the Manannogor, Sadar Upazila, Noakhali District, Noakhali-3814, Bangladesh during the period from 12th January 2018 to 17th April 2018, with two varieties of tomatillo (*Physalis ixocarpa* Brot.) SAU tomatillo-1 and SAU tomatillo-2. It was laid out in RCBD method having three replications and was conducted to observe the influence of staking and non-staking on tomatillo cultivation in coastal areas. For the study, growth indicating characters like no. of leaves plant$^{-1}$, size of leaf plant$^{-1}$, height of each plant, no. of branches plant$^{-1}$ and yield attributing parameters such as days to first flowering, days to 50% flowering, no. of fruits branch$^{-1}$, fruit weight and yield were obtained from the plants with

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the treatments of staking and non-staking. A wide variation was observed between two varieties of tomatillo with the effect of these treatments. According to the results highest no. of leaves branch$^{-1}$, maximum size of leaves branch$^{-1}$, tallest height of each plant, uppermost no. of branches plant$^{-1}$, highest no. of fruits branch$^{-1}$, maximum weight of each fruit and yield were obtained in the staking treatment over the non-staking treatment of SAU tomatillo-1 and in case of SAU tomatillo-2, with the same parameters the result indicated significantly upper in the staking treatment over non-staking treatment. Considering the two varieties of tomatillo, the outcome were significantly superior with staking treatment for the similar parameters. The findings of the experiment indicated that the best yield (21 tha$^{1}$) and highest financial benefit could be obtained by SAU tomatillo-1 and the best tomatillo production in saline soil of coastal areas is possible by cultivating SAU tomatillo-1.

**Keywords:** SAU Tomatillo-1; SAU Tomatillo-2; Staking; Yield; Fruit length**.**

## 1. Introduction

Tomatillo (*Physalis ixocarpa* Brot.) is a fleshy vegetables belonging to the family solanaceae bearing round or spherical and green or green-purple fruit. The tomatillo fruit is surrounded by an inedible, paper-like husk formed from the calyx [1]. From the outside it looks like a common weed of our country “Foshka Begun”. At maturity stage, it fills the husk and can split it open by harvest. The husk turns brown gradually. Inside the husk, tomatillo fruits look same as green tomato but inside the fruit it is compact, firm and bright green. From inside, it has juicy pulp and tiny seeds [2]. Green and Purple color and tart flavor are the main culinary contributions of tomatillo fruit. Tomatillos originated in Mexico and distributed in India, Australia, South Africa and Kenya. Recently Tomatillo varieties have been cultivated fruit vegetable in Bangladesh [3]. Varieties were developed by the Professor Dr. Naheed Zeba, honorable teacher of Sher-e-Bangla Agricultural University, Dhaka.

Tomatillo contain Energy 32 Kcal, Carbohydrates 5.84 g, Protein 0.96 g, Total Fat 1.02 g, Dietary Fiber 1.9g, Vitamins (Folates7 µg, Niacin 1.850 mg, Pyridoxine 0.056 mg, Thiamin 0.044 mg, Vitamin A 114 IU, Vitamin C 11.7 mg, Vitamin E 0.38 mg, Vitamin K 10.1 µg), Sodium 1 mg, Potassium 268 mg, Calcium 7 mg, Copper 0.079 mg, Iron 0.62 mg, Magnesium 20 mg, Manganese 0.153 mg, Phosphorus 39 mg, Selenium 0.5 µg, Zinc 0.22 mg, Carotene-ß 63 µg, Carotene-α 10 µg, Lutein-zeaxanthin 467 µg [4]. A

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recently-discovered set of naturally occurring phytochemical compounds called withanolides, such as Ixocarpalactone-A, is one of the compounds in tomatillo found to be not only antibacterial, but also a natural cancer fighter. Traditional healers in India have been known to prescribe foods containing these compounds as a tonic for arthritis and other musculoskeletal conditions, even if they didn't know why it worked [5].

Tomatillo can be used as cooking vegetables, fried vegetables, salad and in processing industries like sauces, pickles etc. Mexican salsa is very popular in Mexico, USA and other adjacent countries [6]. The total volume of table sauces, pickled, and other items processed in Louisiana is around 22,277,000 kg with an estimated value of $58,427,000. Table sauces accounted for approximately 77% of the total volume [7].

Tomatillo is gaining ground as a new crop in California due to the increased popularity of Mexican food in the United States [8]. In Bangladesh summer tomato production is very much costly but tomatillo can manage the demand of tomato consumption in summer season due to its low production cost and annually availability [9].

The variety of SAU tomatillo-1 and SAU tomatillo-2 are used for the conducted research. Tomatillo is an annual bushy plant as like as tomato plant. During the growth phase both variety will require the same intercultural operation as well as tomato. So, Staking is one of the most important intercultural operation to maintain quality fruit production and for the better yield.

## 2. Materials and Methods

### *2.1. Experimental site and design*

The experiment was conducted at Nabogram Khamarbari, near the Manannogor, Sadar Upazila, Noakhali District, Noakhali, Bangladesh during the period from 12$^{th}$ January 2018 to 17$^{th}$ April 2018. Location of the site is 24°75' N latitude and 90°5' E longitude which fall under the AEZ 18 i.e. Young Meghna Estuarine Flood plain. The experimental site is indicated on the map of AEZ of Bangladesh. Particle size constitution of the soil of that site is Sand: Silt: Clay =40%: 40%: 20%. The soil type is loam with organic matter (0.68 %), with total nitrogen of 0.04 g kg$^{-1}$, available P of 27.79 µg/g, and available K

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of 0.18 meq /100 g soil. The soil indexes were determined before fertilization. The growth and yield ofSAU tomatillo-1 and SAU tomatillo-2 was compared under stalking (Treatment) and non stalking (control) conditions.


**Experimental Site with GPS icon.**

The experiment was designed in Randomized Complete Block Design (RCBD) with two treatments. Four Plots that indicates as P1, P2, P3, and P4 were prepared for transplanting the seedlings for SAU tomatillo-1 and SAU tomatillo-2. P1 and P2 were for SAU tomatillo-1 and P3 and P4 were for SAU tomatillo-2. Each plot was 13m².Therewas 30 plants in every plot which are divided in three blocks, representing 3 replications, and distance between plants to plant was 40 cm and row to row 60 cm**.** All plots received a basal rate of 1kg/m² $P_2O_5$ and 400g/m² $K_2O$ based on local practice. The field was fertilized, irrigated, harrowed, ploughed, and then sewed. Land was well ploughed at tilt condition. All fertilizers and well decomposed cow dung except urea were applied during final land preparation.

Seed sowing was done on January 12, 2018 in the seedbed. Each seed bed size was 0.3626 m² and each variety for total seed bed size was 0.7252 m² and every seed bed height was 0.05m. Before sowing, seed treatment was done with Furadan @ 5g. All cultural practices necessary for seed bed

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preparation were done properly. 22 days old seedlings were transplanted in the main field of both varieties. The rate of application of fertilizer for both varieties is presented in ***Table 1.*** During the growing period, all the plots were irrigated once. Planting methods and cultivation management used the conventional high-yield cultivation mode.

**Table 1. Doses of manures and fertilizers used in the study**

| Sl. No. | Fertilizers/Manures | Dose(quantity/$m^2$) |
|---|---|---|
| 01. | Urea | 500g |
| 02. | TSP | 1kg |
| 03. | MOP | 400g |

**Urea was applied as a nitrogen fertilizer (N, 46%); Triple superphosphate was applied as a phosphate fertilizer ($P_2O_5$, 12%); Muriate of potash was applied as a potassium fertilizer ($K_2O$, 60%); P and K fertilizer were both applied as a base.**

*2.2. Sampling and Investigation*

10 plants from P1and P2 for SAU tomatillo-1 as well as P3 and P4 for SAU tomatillo -2 were selected and tagged at vegetative stage, flowering stage and fruiting stage respectively.

*2.3. Physiological Measurements and Sampling*

The tagged plants were sampled after 22 DAYS after transplanting between 7 and 8 am in the morning.

The number of leaves per plant was recorded both varieties of SAU tomatillo with naked eyes.

Size of leaf (cm) per plant was recorded both varieties of SAU tomatillo by measuring tape. The length of the midrib of leaf was considered as size of leaf. Height of each plant was recorded both varieties of SAU tomatillo with the help of measuring tape.

No. of days from sowing to first flower opening was recorded. The number of branches per plant was also recorded. Total number of marketable fruits, harvested from the ten tagged plants of P1, P2, P3, and P4 were counted and the number of fruits per tagged plant was calculated as average. Fruits were harvested from the tagged plants and individual fruit weight (g) was calculated as average weight.

*2.4. Statistical analysis*

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The recorded data on the different parameters of the study were analyzed statistically using SPSS software and Excel data sheet. Analysis of variance of different parameters was performed by "t" test. The mean difference was performed by Least Significant Difference(LSD) test (5% level of significance) suggested by Gomez and Gomez (1984).

## 3. RESULTS

*3.1 No. of leaves per plant:*

It was observed that data was recorded the leaves started to come out among all varieties from 12th January, (22 days after sowing) 2018 and that continued up to 16th February, 2018. The data regarding the no. of leaves per plant had been affected by different varieties (***Table 5***). The average no. of leaves per plant of SAU tomatillo -1 was found highest (24.4) followed by SAU tomatillo-2 was found lowest (22.43) (***Fig. 01***).

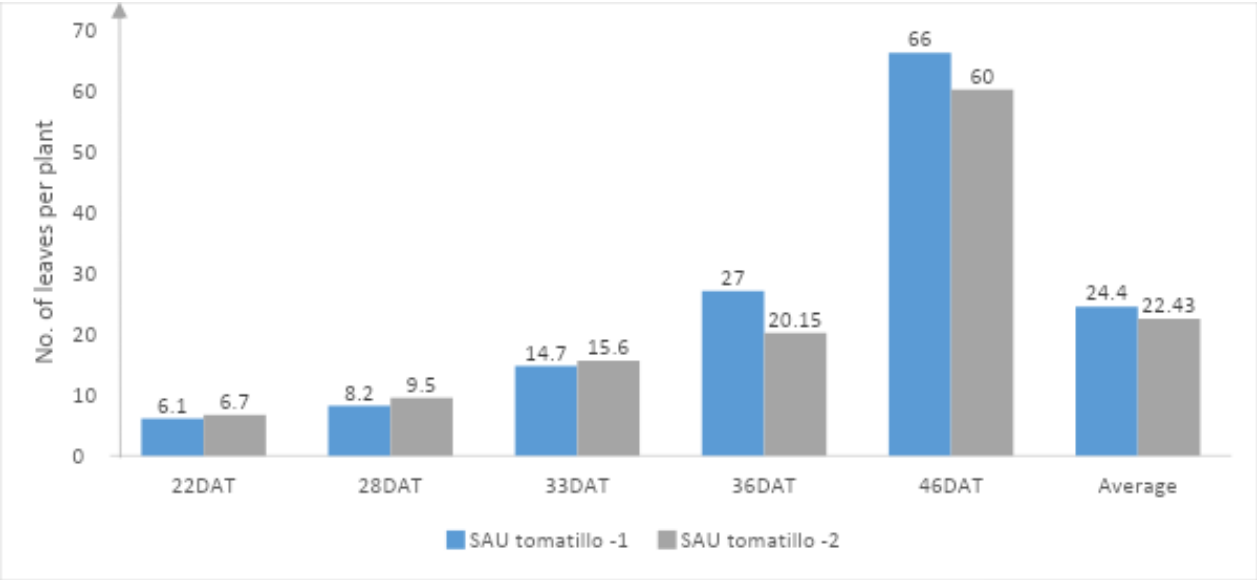


**Fig. 1. No. of leaves per plant between SAU tomatillo-1 and SAU tomatillo-2. Values represent the mean from three replications at 5% level of significance.**

*3.2 Size of leaves per branch (cm):*

The size of leaves per branch was varied from variety to variety. The average size of leaves per branch of SAU tomatillo-1 was found uppermost (8.1) whereas lowermost average size of leaves per branch SAU

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tomatillo-2 was found (6.1) (***Fig. 02***).During data collection period, it was significantly observed that there was a fluctuation of size of leaves per variety betweenSAU tomatillo-1 and SAU tomatillo-2. (***Fig. 02***)

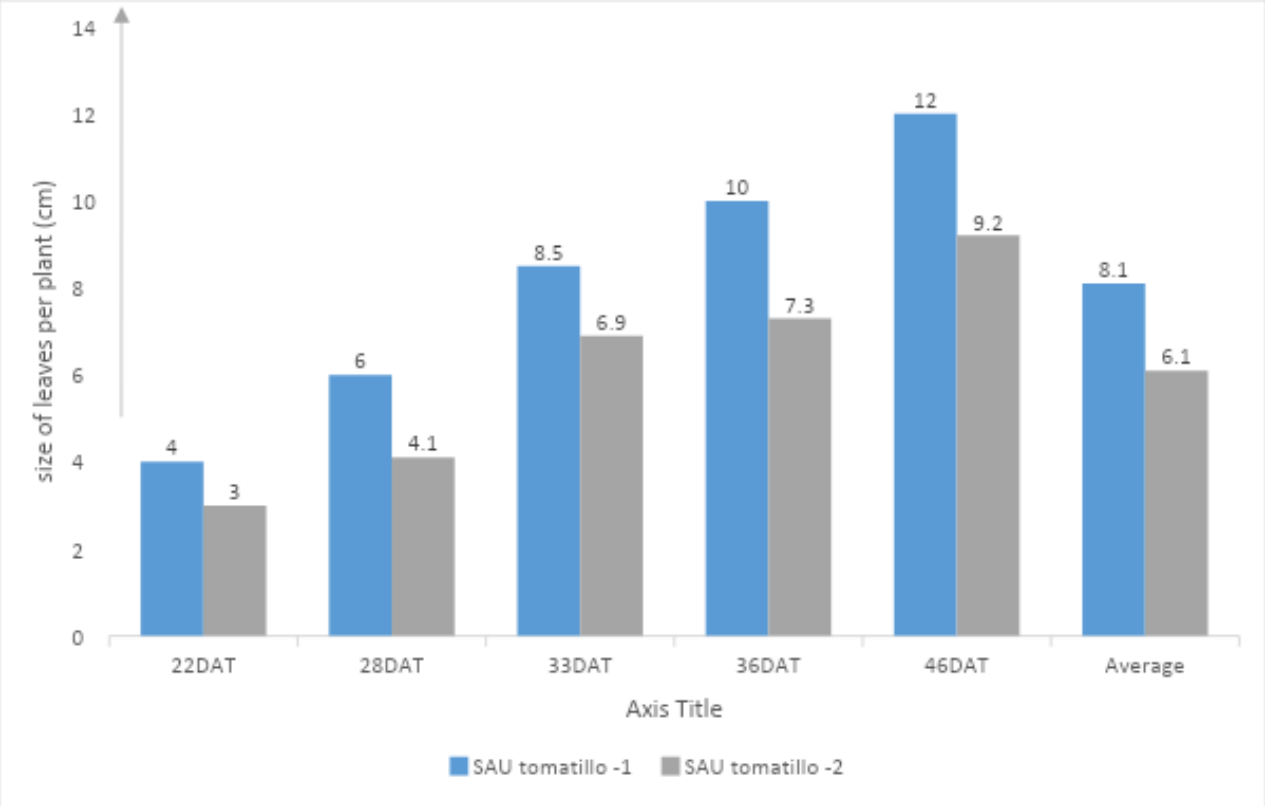


**Fig. 2. Size of leaves per plant between SAU tomatillo-1 and SAU tomatillo-2. Values represent the mean from three replications at 5% level of significance**

*2.3 Height of each Plant (cm):*

As shown in ***Fig 03***, the height of each plant was varied from variety to variety. The data regarding the height of each plant had been affected by different varieties (***Table 7***). It was resulted that average result of height of each plant had wide variation whereas SAU tomatillo-1 was found 15 cm compared to SAU tomatillo-2 (13.09 cm).

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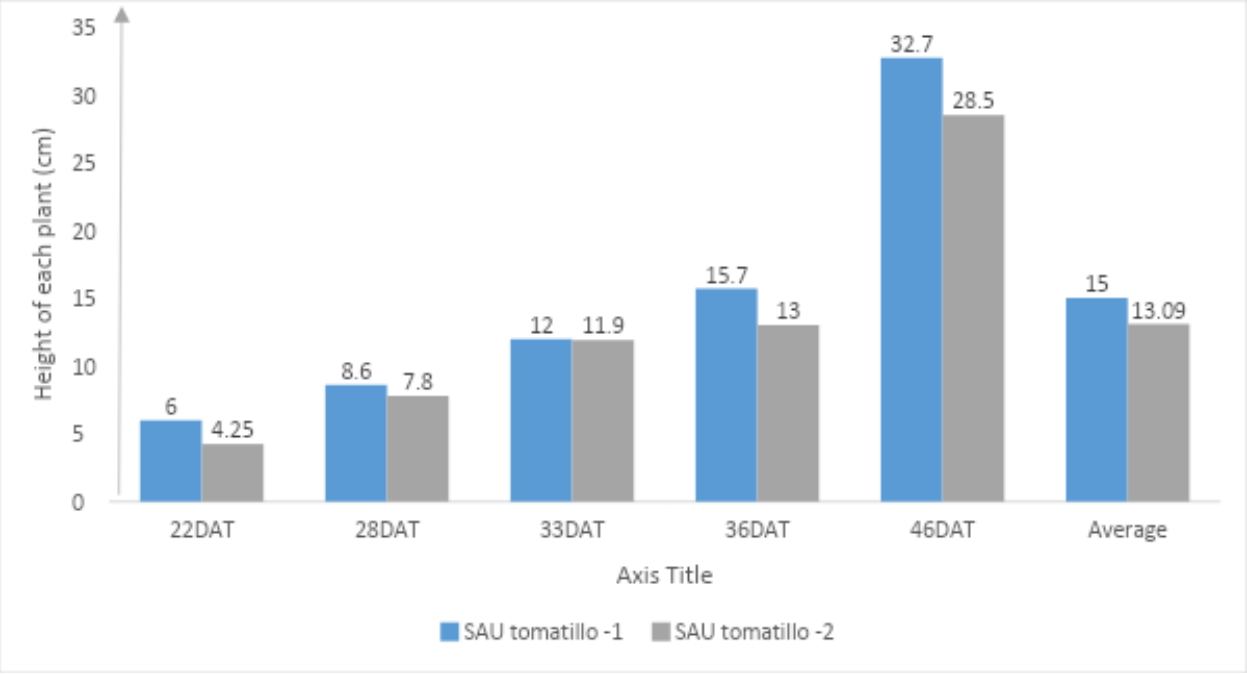


**Fig. 3. Height of each plant between SAU tomatillo-1 and SAU tomatillo-2. Values represent the mean from three replications at 5% level of significance**

*3.4No. of Branches per Plant:*

Staking of each plant was influenced by the no. of branches per plant and was differ from variety to variety (***Table 8***).A wide variation of no. of branches per plant was observed when two varieties was affected by the staking treatment (***Fig: 4***). Result indicated that the maximum no. of branches per plant was observed 7.1 in the staking treatment of SAU tomatillo-1 followed by the staking treatment of SAU tomatillo-2 was observed 5.5. The lowest no. of branches per plant was observed 3.93 of the no treatment of SAU tomatillo-1 and the result of no treatment of SAU tomatillo-2 was statistically identical (3.4).

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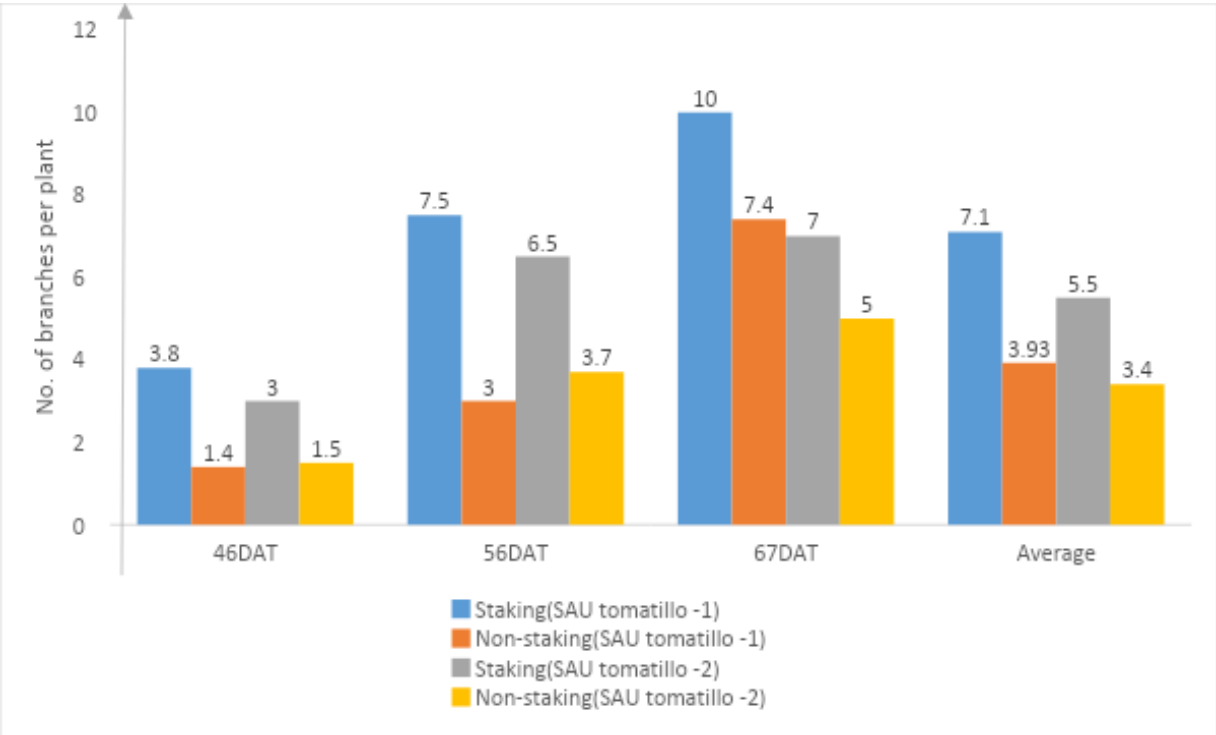


**Fig 4: No. of branches per plant between SAU tomatillo-1 and SAU tomatillo-2. Values represent the mean from three replications at 5% level of significance**

*4.5 No. of fruits per branch:*

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As shown in Fig 05, number of fruits per plant varied extensively due to treatment. The maximal (36.33) number of fruits per plant was recorded from staking treatment of SAU tomatillo-1 followed by staking treatment of SAU tomatillo-2 (33.33) whereas the minimal (10.66) number of fruits per plant was recorded no treatment of SAU tomatillo-1 followed by no treatment of SAU tomatillo-2 (11.67) (***Table 9***).

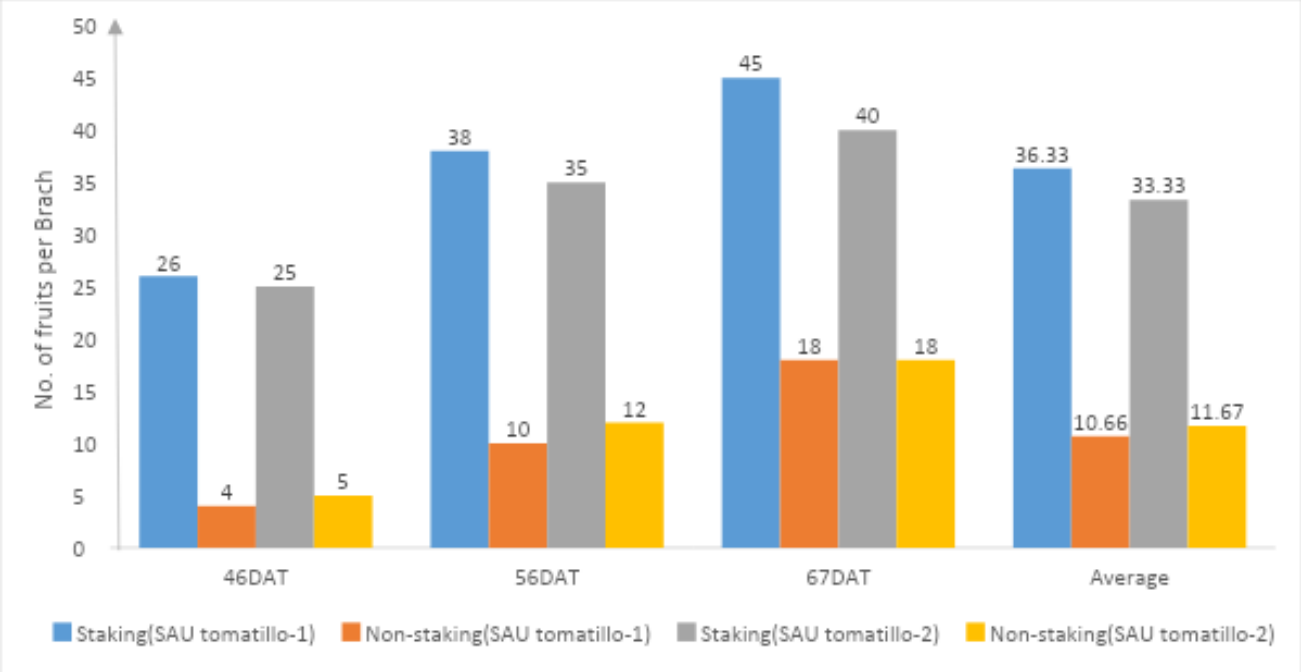


**Fig 5: No. of fruits per plant between SAU tomatillo-1 and SAU tomatillo-2. Values represent the mean from three replications at 5% level of significance.**

*3.7 Fruit Weight (g):*

Data regarding the weight of each fruit (g) showed an extensive difference appeared between variety to variety and treatment to treatment (***Table 10***). Result indicated that the uppermost fruit weight was observed 46.46g in the staking treatment of SAU tomatillo-1 due to regular shape, bigger size and smooth skin whereas the staking treatment of SAU tomatillo-2 was observed 41g due to irregular shape and smaller size. The lowermost no. of branches per plant was observed 35.23 of the no treatment of

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206 SAU tomatillo-1 and the result of no treatment of SAU tomatillo-2 was statistically identical
207 30.3g (***Fig. 6***).
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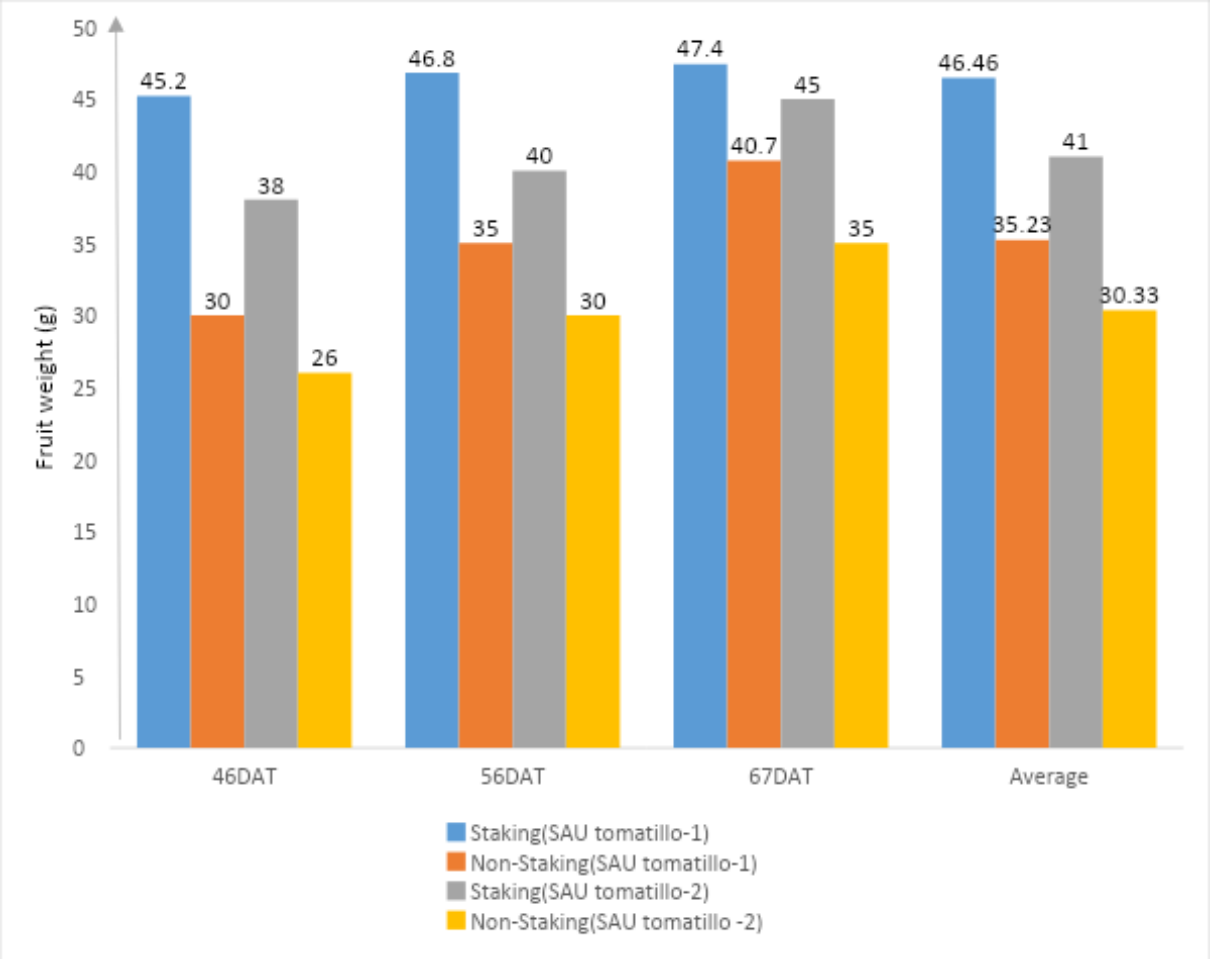


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215 **Fig 6: Weight of each fruit (g) between SAU tomatillo-1 and SAU tomatillo-2. Values represent the**
216 **mean from three replications at 5% level of significance**

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*3.8 Combined effect of staking and non-staking on yield attributing characters of both of the varieties*

*3.8.1 Combined effect of stacking and non-staking in different parameters of SAU tomatillo-1:*

No. of branches per plant, no. of fruits per branch, weight of each fruit were affected by the staking treatment. It was found that the significant consequence of the no. of fruits per plant and weight of each fruit (g). LSD (at 5%) resulted SAU tomatillo-1 with staking treatment produced the highest quality fruits per branch (36.33) and maximum weight of each fruit (46.46g) whereas no treatment of SAU tomatillo-1 produced lowest no. of quality fruits (10.68) and minimum weight of each fruit (35.23g) (**Fig. 7**). The absolute difference between SAU tomatillo-1 (Staking) and SAU tomatillo-1 (Non-staking) was calculated 25.66 and 11.23 for the no. of quality fruits per branch and weight of each fruit which were greater than LSD (at 5%) value of no. of quality fruits per branch (25.18) and weight of each fruit (7.16). Therefore SAU tomatillo-1 (Staking) and SAU tomatillo-1 (Non-staking) were significantly different. Staking treatment was no significant effect on no. of branches per plant (LSD at 5%) of SAU tomatillo-1. So, it was clear that no. of quality fruits per branch and weight of each fruit (g) were significantly affected by staking treatment (***Table 11***).

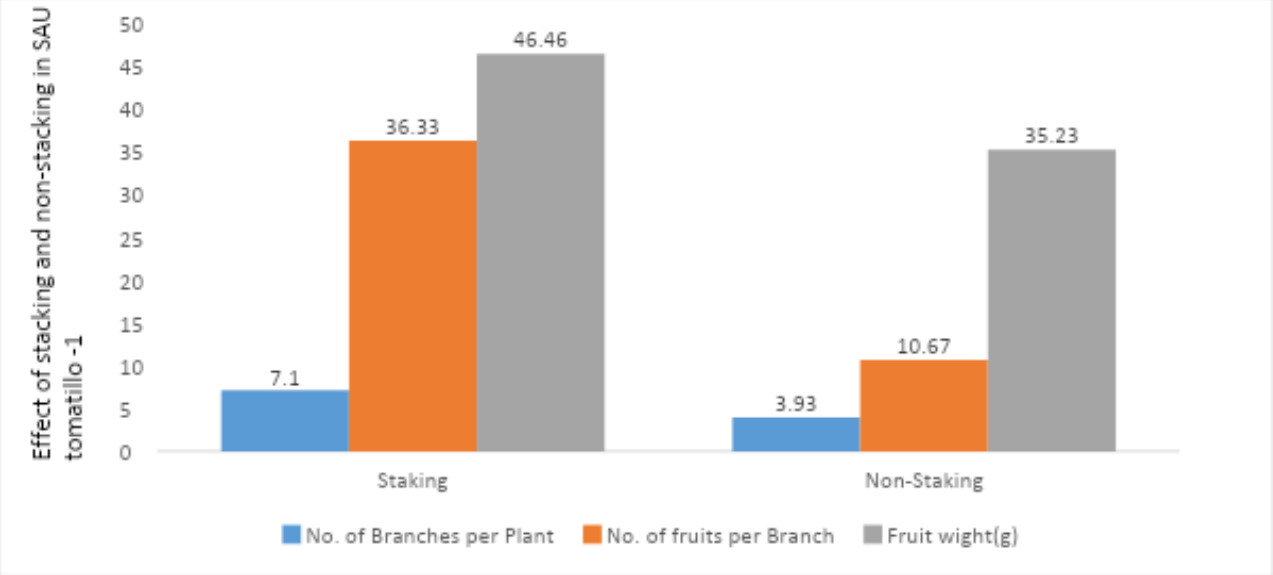


**Fig 7: Comparison of staking and non-staking effect on different parameters of SAU tomatillo-1. (Values represent the mean from three replications at 5% level of significance)**

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238 *3.8.2 Combined effect of stacking and non-stacking in different parameters of SAU tomatillo-2:*

239 No. of branches per plant, no. of fruits per branch, weight of each fruit were affected by the staking
240 treatment. It was found that the significant effect on the no. of fruits per branch and weight of each fruit
241 (g). LSD (at 5%) resulted SAU tomatillo-2 with staking treatment produced the highest quality fruits per
242 plant (33.3) and maximum weight of each fruit (41g) whereas no treatment of SAU tomatillo-2 produced
243 lowest no. of quality fruits (11.67) per branch and minimum weight of each fruit (30.33g) (Fig. 8). The
244 absolute difference between SAU tomatillo-2(Staking) and SAU tomatillo-2(Non-staking) was calculated
245 21.67 and 10.67 for the no. of quality fruits per branch and weight of each fruit which were greater than
246 LSD (at 5%) value of no. of quality fruits (20.43) and weight of each fruit (10.46). Therefore SAU tomatillo-
247 2(Staking) and SAU tomatillo-2(Non-staking) were significantly different. Staking treatment was no
248 significant effect on no. of branches per plant (LSD at 5%) of SAU tomatillo-2. So, it was clear that no. of
249 quality fruits and weight of each fruit (g) were significantly affected by staking treatment (***Table 12***).

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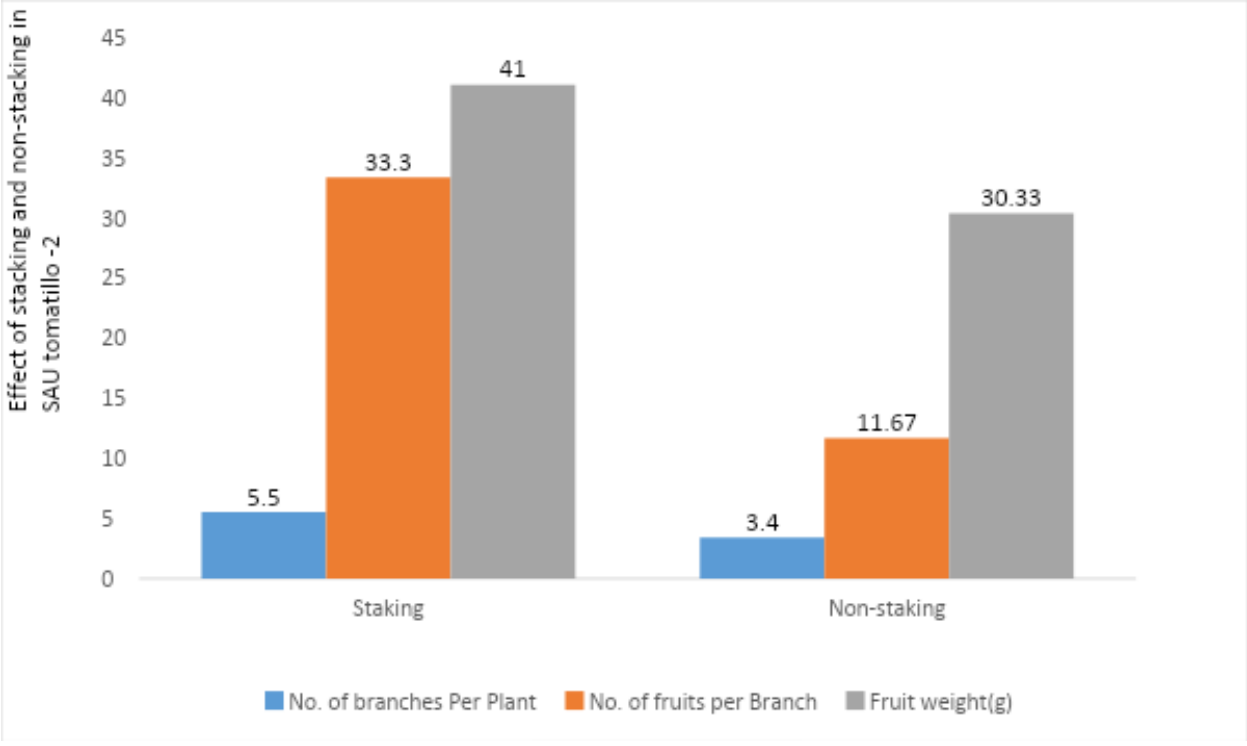

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**Fig 8: Comparison of staking and non-staking effect on different parameters of SAU tomatillo-2. (Values represent the mean from three replications at 5% level of significance)**

*3.8.3 Effect of staking in SAU tomatillo-1 and SAU tomatillo-2:*

It was found that the significant effect was resulted between SAU tomatillo-1 and SAU tomatillo-2 by the staking treatment. Uppermost no. of branches per plant (7.1), highest no. of fruit per branch (36.33) and maximum weight of each fruit (46.46g) were recorded in staking treatment of SAU tomatillo-1 whereas lowermost no. of branches per plant (5.5), lowest no. of fruit per branch (33.3) and minimum weight of each fruit (41g) were recorded in staking treatment of SAU tomatillo-2 (***Fig. 9***). It was clear that SAU tomatillo-1 resulted better performance compared to SAU tomatillo-2.

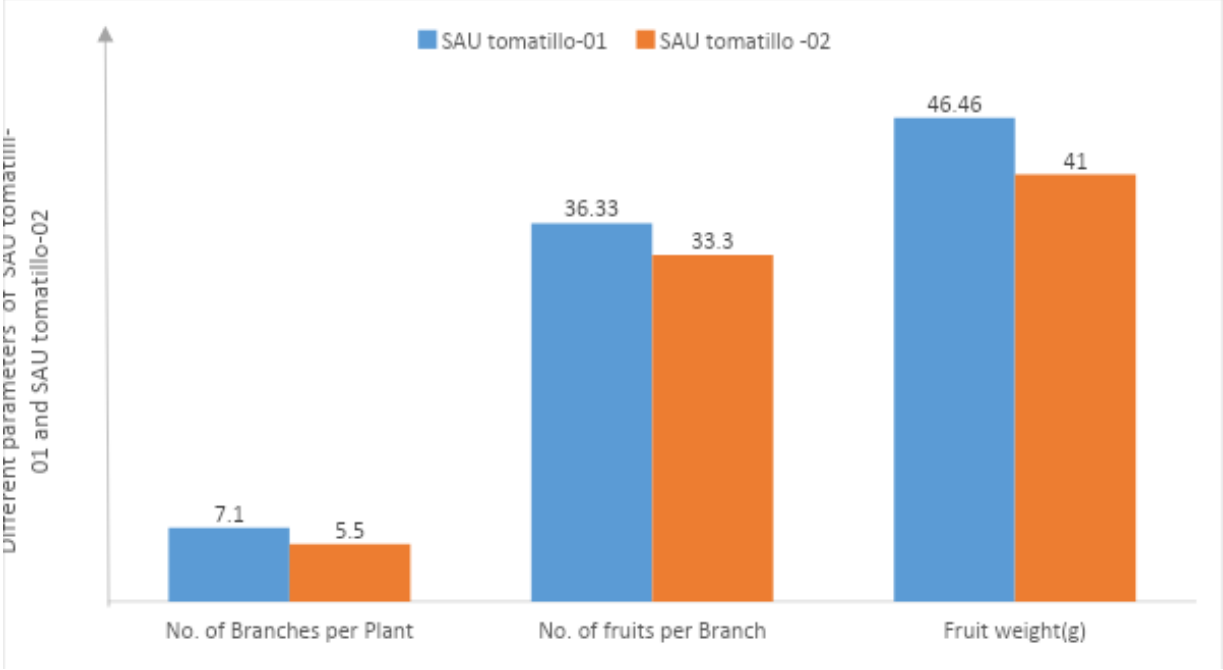


**Fig 9: Comparison of staking and non-staking effect on different parameters between SAU tomatillo-1 and SAU tomatillo-2. (Values represent the mean from three replications at 5% level of significance)**

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## 4. DISCUSSIONS

In this paper, we found that the number of fruit per plant, fruit weight, number of branches per plant, number of leaves per plant, leaf size and plant height were significantly affected by staking in both varieties of Tomatillo.

A Variation difference of tomato varieties that no. of leaves per plant was varied from variety to variety [10]. The size of leaves per branch was deferred from variety to variety.

The effect of staking on the different varieties of tomato found that there was no significant effect on plant height but in the present study we found that staking significantly affect plant height of Tomatillo [11, 12].

The no. of branches of local cultivar was the number of branches per plant was higher in unstaked – unpruned (10) similarly to stake – unpruned the similar results were found in the present experiment [13, 14].

The maximum (35.33) number of fruits per plant from staking while the minimum (27.05) number of fruits per plant was found from non-staking and pruning in Tomato and similar results were found in SAU Tomatillo 1 and SAU Tomatillo 2 in the presented experiment [15] .

Larger and smooth skin when the plants were restricted to single stem it was found that fruit size increased when plants were pruned and staking. Maximum fruit weight (89.19 g) in the case of single stem pruning and staking plant while fruit weight was lowest (63.07) in unpruned plants and non-staking plants [16].

Fruit weight was significantly the largest with string staking (50.2 g) and the lowest with high platform (44.7 g). Stem pruning had much influence on individual fruit weight. Significantly the highest weight of fruit was obtained from the plant with two stems (50.1 g) and the lowest from no pruning treatment (45.0 g) [17]. Different tomato cultivars behaved significantly different from each other concerning various parameters [18]. Among these cultivars, Roma resulted in the highest production, followed by Rio Grande while Super Classic resulted in the lowest production. The results concluded that organic regime gave the best production.

## 5.CONCLUSIONS

Considering the performance of the two varieties of tomatillo have significance differences affected by the treatment of staking. SAU tomatillo-1 had given better outcome such asforemost no. of leaves per branch (24.4), maximum size of leaves per branch (8.1cm), tallest height of each plant (15 cm), topmost no. of branches per plant (7.1), higher no. of fruits per branch (36.33), maximum weight of each fruit (46.46g), total yieldcompared to SAU tomatillo-2. In the analysis of the combined effect of staking and non-staking on the two varieties of tomatillo it is proved that SAU tomatillo-1 performed better in the saline condition of coastal area of Bangladesh.

It is concluded that different tomatillo varieties behaved significantly different from each other concerning various parameters. Among these varieties, SAU tomatillo-1 resulted in the highest production, followed by SAU tomatillo-2.

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