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# OFF-SEASON AGRONOMIC PERFORMANCE OF THREE EXOTIC WATERMELON VARIETIES IN THE SOUTH-WESTERN REGION OF BANGLADESH

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**Abstract**

The watermelon [*Citrullus lanatus* (Thunb.)] - a herbaceous, annual, and monoecious fruit - belongs to the family Cucurbitaceae and is usually cultivated in Bangladesh during the period from February to April. However, they may be grown year-round, and off-season watermelon cultivation is more profitable than seasonal farming. The research was conducted at the Field Laboratory of Khulna University from August to December, 2021 to evaluate the off-season agronomic performance of the selected three watermelon varieties viz. Kanya, Black Super, and Tripti. The experiment investigated both the vegetative and reproductive growth of watermelon following a Randomized Complete Block Design with five replications. Kanya had the longest vines with the most leaves, and nodes followed by Black Super and Tripti. All the watermelon cultivars were found to be similar in producing male flowers, while Black Super and Kanya produced more female flowers, and Black Super also produced the highest fruit yield (6.37 t $ha^{-1}$), which was statistically similar to Kanya (5.84 t $ha^{-1}$) and the lowest yield was obtained from Tripti (3.69 t $ha^{-1}$). Kanya performed better regarding fruit length (22.47 cm), fruit width (30.89 cm), and fruit weight (1.03 kg). Black Super scored the highest TSS (8.43) ($Brix^0$) value, followed by Kanya (7.63) and Tripti (6.39). The amount of weight loss after the harvesting of fruits was less in Black Super, followed by Kanya and Tripti. Black Super had a longer recorded shelf life (28 days) than the other two varieties. The results of this study suggest that Black Super and Kanya can be grown during the off-season in the south-western region of Bangladesh.

**Keywords:** Watermelon, Off-season, Performance, Variety

## Introduction

Watermelon (*Citrullus lanatus*) is a herbaceous, annual, and monoecious fruit can be used as vegetable' that belongs to the Cucurbitaceae family. It is a vine plant with a huge edible fruit called 'pepo' that has a thick exocarp and a fleshy center (mesocarp and endocarp). It is frequently consumed as juice or as an ingredient in mixed drinks (Joy et al., 2020). Fruits can also be eaten raw or pickled, and the rind can be eaten afterward. It might be round or oblong, with delicious flesh (Anikwe et al., 2016).

Watermelon contains a variety of vitamins, as well as potassium, magnesium, and other minerals. Watermelon juice includes 30-46.2 kcal, 7.6-11.6 g carbohydrate, and 0.6-0.9 g protein per 100 g. 569-864.88 IU vitamin A, 8.1-12.31 mg vitamin C, 3.38-11.34 mg lycopene, 7 mg calcium, 0.24mg iron, 112mg potassium, 11 mg phosphorus, 0.0-0.001 mg sodium, 5.2-5.4% ash, 93.12-95.2% moisture (Maoto et al., 2019).

Bangladesh produces a wide range of watermelon cultivars, including those with a simple, pale green rind, a blackish green rind, diffused black, a green stripe on three light green or blackish green background rinds, a yellow rind with red inside flesh, etc. Just 10 or 12 years ago, when thousands of acres of land would lay uncultivated following the *Aman* paddy season, the farmers of Khulna had not even contemplated watermelon farming. Shrimp farming was practiced by locals in the district's Dacope and Dumuria upazilas; while, sesame growing took place on land in Batiaghata upazila. However, things have changed recently as numerous farmers in the area have started growing watermelons to generate rapid profits (Roy, 2021).

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In Bangladesh, watermelon is usually cultivated in the late *Rabi* season (sowing in December-January), after harvesting the *Aman* rice, although in some areas of Bangladesh during the off-season, small to medium-sized watermelons growing on trellises are also seen.

Bangladesh is one of the nations most exposed to the consequences of climate change, making it a crucial problem. Climate change is already evident and will probably continue in the future. Agricultural adaptation is becoming a greater threat. Therefore, diversity is one of the finest strategies to boost agricultural flexibility. Watermelon farming in the off-season will help with diversification and give the consumer options. It will also provide ways of mitigating malnutrition and combating climate change through seasonal diversification. Besides, there is very little published work on off-season watermelon cultivation in Bangladesh. In light of these facts, this study was conducted to evaluate the performance of three different exotic watermelon varieties during the off-season.

## Materials and Method

### *Experimental site*

The field experiment was conducted at Professor Dr. Purnendu Gain's Field Laboratory, Agrotechnology Discipline, Khulna University, Khulna from August to December 2021.

The experimental site is situated at latitude 22°79'88'' E, longitude 89°53'44'' N, and an elevation of 8 m (26 feet) above sea level. The experimental site falls in the Agroecological Zone 13, classified as the Ganges Tidal Floodplain. The climatic condition of this area is typically tropical with a mild winter from October to March, a hot and humid summer in March to June, and a humid, warm rainy monsoon from June to October with an annual rainfall of 1878.4 mm, summer maximum mean temperatures of 36.2°C and mean minimum temperature of 15.5°C (Anonymous, 2023). The soil properties of the study area were tested in the lab consisting of 16% sand, 36% silt, 51% clay, and 2.4% organic matter. The pH of the soil was 6.2.

### *Plant materials*

Three exotic varieties of watermelon viz. Kanya ($V_1$), Black Super ($V_2$), and Tripti ($V_3$) were in this study. Seeds of Tripti were collected from the Agriculture Extension Office of Dumuria and seeds of Kanya and Black Super were collected from the Agriculture Extension Office of Chuadanga, Bangladesh.

### *Experimental design and replications*

The experiment was conducted using a Randomized Complete Block Design (RCBD) with five replications.

### *Field preparation*

The field was thoroughly ploughed and cross-plowed three times using a power tiller 15 days prior to transplanting the watermelon seedlings. The stables and weeds were neatly cleaned up. Necessary fertilizers were applied, and well mixed with the soil during final land preparation. The size of each plot measured 3.0 m × 5.0 m. The space between each plot was kept at one meter. Each plot contained 10 plants, maintaining plant to plant distance in a line 1 m and between the lines 1.5 m. Paper mulch (black) was used to cover each and every plot. Hand-dug planting pits 1.0 m apart and the height of each pit was 30 cm. Seventy-eight kg of cow dung were applied during pit preparation.

### *Fertilizer application*

The following manures and fertilizers doses were applied: Cow dung 20 t $ha^{-1}$, Urea-280 kg $ha^{-1}$, TSP- 100 kg $ha^{-1}$, MOP- 320 kg $ha^{-1}$, Zn - 8 kg $ha^{-1}$. Cow dung and TSP were applied during final land preparation at a time. All the chemical fertilizers were applied locally in the pits. Urea and MOP were applied in four splits, after 10 to 15 days of transplanting 26 g $pit^{-1}$ of Urea and MOP 20 g $pit^{-1}$. During flowering 15.6 g $pit^{-1}$ Urea and MOP 20 g $pit^{-1}$. At fruit initiation time Urea 15.6 g $pit^{-1}$ and MOP 20 g $pit^{-1}$. After 15-20 days of initiation of fruits Urea 15.6 g $pit^{-1}$ and MOP 20 g $pit^{-1}$. A single dose of TSP was applied after 10-15 days of transplanting @26 g $pit^{-1}$. Zn was applied @ 2.08 g $pit^{-1}$ during fruit initiation time (Awal, 2015).

### *Growing seedlings and transplanting*

Seedlings were raised in a plastic bag (11 cm x 11 cm x 17 cm) using a 1:1 mixture of top soil and decomposed cow manure. Four hundred fifty seedlings in total were raised, with 1-month-old seedlings (4-5 leaves plant $^{-1}$) being transferred to the pits in the main field.

***Pruning***
Pruning was done at the 8-10 leaf stage, leaving at least 5 knots. Later, leaving 4-5 branches along with the main branch, the rest of the branches were cut off.

***Pest management***
Thrips infestation was noticed at the flowering stage and the plants were subsequently sprayed with Tido (Imidacloprid) at 10 ml per 10 liters of water. Another spray with the same preparation was applied after ten days of the first spray.

***Irrigation***
The first irrigation was done during fruit initiation, and the second irrigation was done after 20 days of fruit initiation.

***Harvesting of fruits***
Watermelons were harvested at their full maturity stage when the fruits gained deep color and a deep hollow sound after thumbing the rind with the hand. Harvesting was started 66 days after transplanting, and the last harvest was done 100 days after transplanting.

***Data collection***
Growth attributes of the plants were collected 24, 28, 32, 36, 40, 44, and 48 DAT (days after transplanting). In order to collect data, five sample plants were selected at random from the middle of each plot. Weight was collected 3 days' interval for 15 days and the average of lost weight was calculated for each variety separately. The total soluble solid was measured in the laboratory by using refractometer. Shelf life was measured by storing the watermelon in room condition.

***Statistical analysis***
Using the software package "IBM SPSS Statistics 20," analysis of variance (ANOVA) was performed on quantitative data on the performance of watermelon. The mean performance of treatments was compared using Duncan's New Multiple Range Test (DMRT). The "Microsoft Excel" program was used to construct the graphs.

**Results**
***Growth Attributes***
The data presented in Figure 1 revealed that there were no significant differences in vine length among the varieties from 24 to 28 DAT. From 32 to 44 DAT, $V_1$ (Kanya) differed significantly from $V_2$ (Black Super) and $V_3$ (Tripti); whereas, $V_2$ (Black Super) and $V_3$ (Tripti) showed no significant variation at this time point. Significantly higher values of vine length were observed in $V_1$ (Kanya) measuring 140 cm, followed by $V_2$ (Black Super) measuring 126.00 cm and measuring $V_3$ (Tripti) 119.34 cm at 48 DAT.

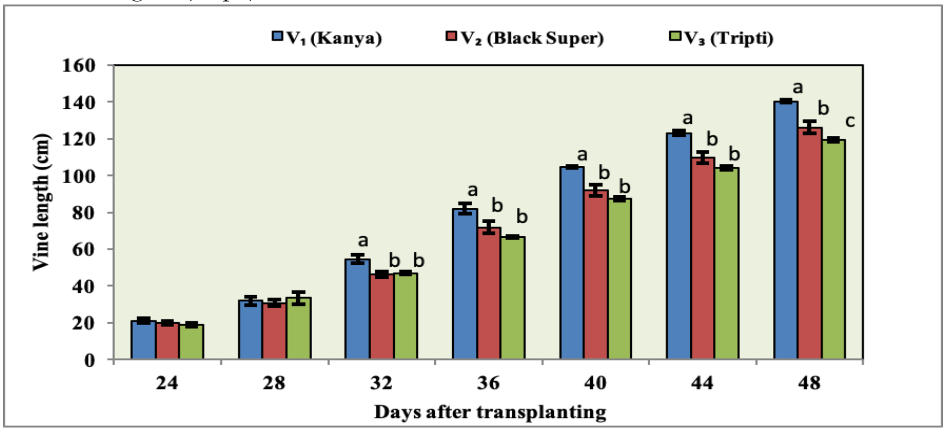


Figure 1. Vine lengths of three watermelon varieties (**=Significant at 0.05 probability level, **=Significant at 0.01 probability level)*

The graph shows the number of leaves of three watermelon varieties (Figure 2). $V_1$ (Kanya) had the fastest rate of increase, followed by $V_2$ (Black Super) and $V_3$ (Tripti). After 48 DAT, $V_1$ (Kanya) significantly differed from $V_2$ (Black Super) and $V_3$ (Tripti), but $V_2$ (Black Super) and $V_3$ (Tripti) were statistically similar. $V_1$ (Kanya) had the highest leaf number (66), followed by $V_2$ (Black Super) (57) and $V_3$ (Tripti) (54) at 48 DAT (Figure 2).

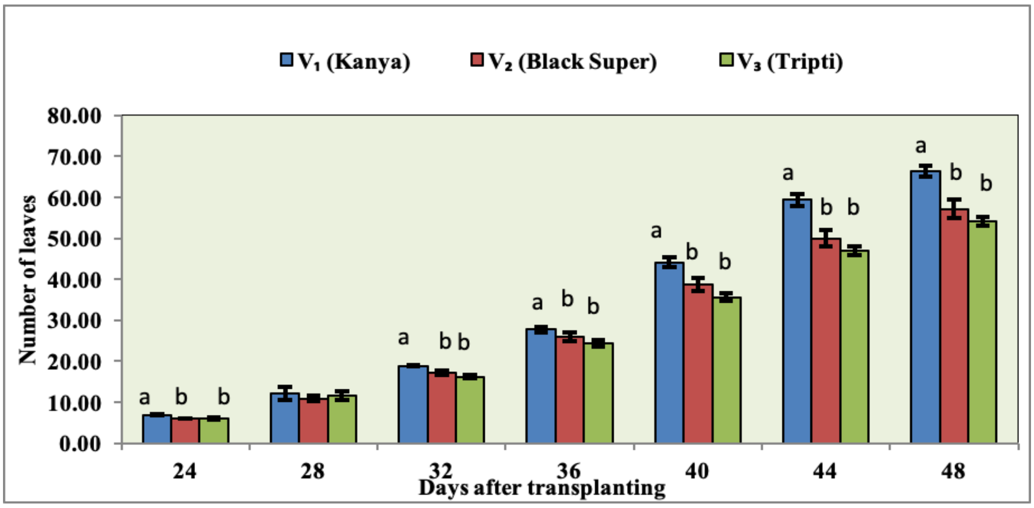


Figure 2. The number of leaves of three watermelon varieties (**=Significant at 0.05 probability level, **=Significant at 0.01 probability level)*

Varieties had no significant effect on the number of branches on the first day of transplanting to 32 DAT. The number of branches increased after 28 DAT, but finally there was no statistically significant difference among $V_1$ (Kanya), $V_2$ (Black Super), and $V_3$ (Tripti) (Figure 3).

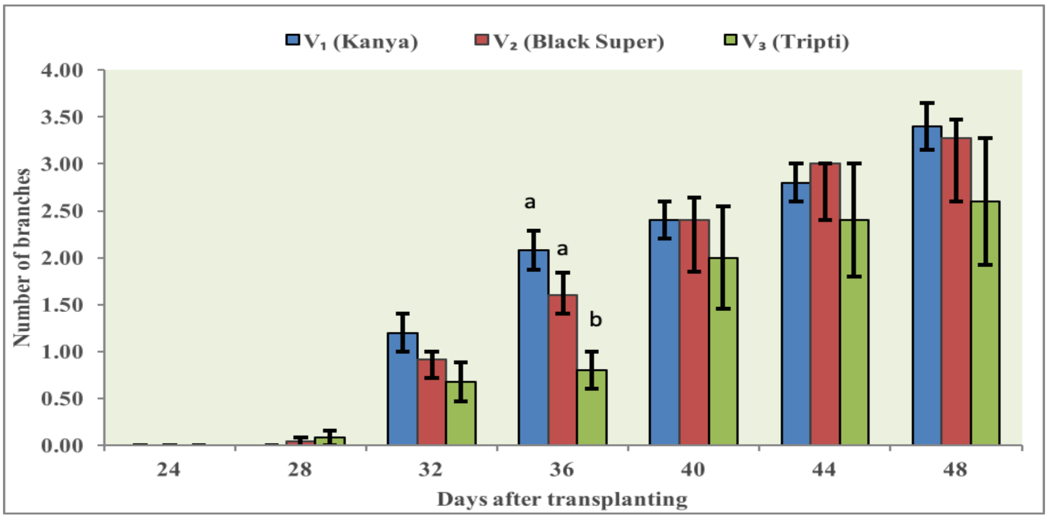


Figure 3. The number of branches of three watermelon varieties (**=Significant at 0.05 probability level)*

Data on no of nodes were taken at 24, 28, 32, 36, 40, 44 and 48 days after transplanting. Melon varieties showed significant variation on node formation in all DAT except 28 and 36 DAT. However, the number of nodes was higher in $V_1$ (Kanya) compared to $V_2$ (Black Super) and $V_3$ (Tripti) in all DAT. At 40 to 48 DAT; where $V_1$ (Kanya) showed the maximum number of nodes (42.40, 57.60 and 64.40, respectively) followed by $V_2$ (Black Super) (37, 49, 55.80, respectively) which in turn had generally higher values than $V_3$ (Tripti) (34.12, 44.80, 52.60, respectively).

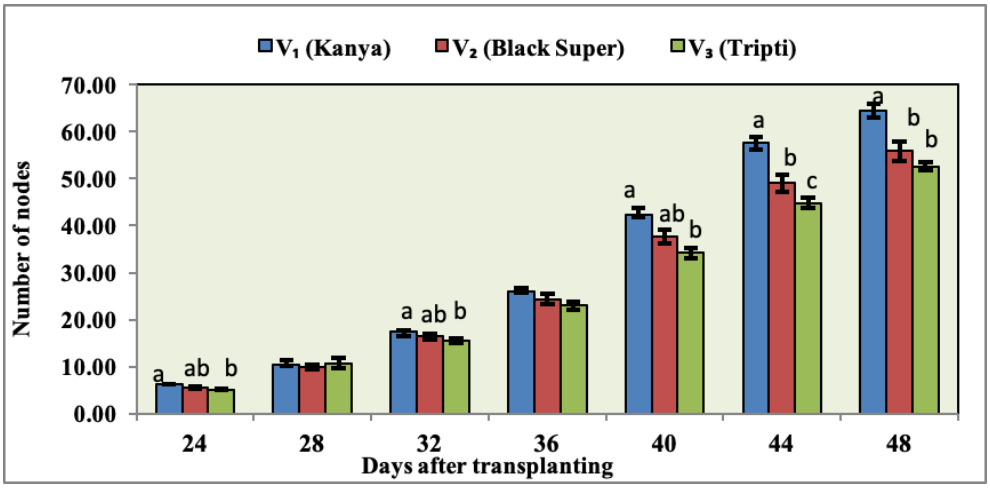


Figure 4. The number of nodes of three watermelon varieties (**=Significant at 0.05 probability level, **=Significant at 0.01 probability level)*

The data for the number of male flowers are shown in Figure 5. Male flower production started at 32 DAT, except for $V_3$ (Tripti), who produced a few flowers at 28 DAT. From 32 to 48 DAT, the number of male flowers increased gradually, but there was no statistically significant difference between these three varieties. At 48 DAT, $V_2$ (Black Super) produced the maximum number of male flowers (5), followed by $V_1$ (Kanya) and $V_3$ (Tripti), which produced an average of 4 male flowers, respectively.

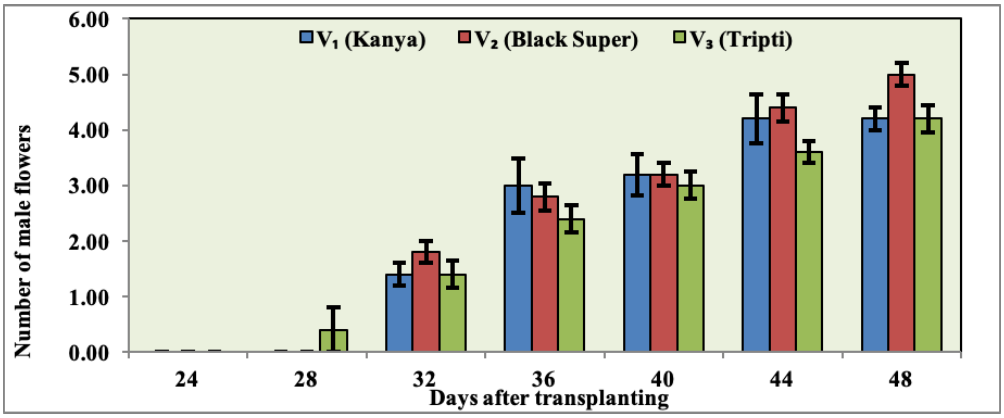


Figure 5. The number of male flowers of three watermelon varieties

Data on female flowers on different DAT were variable and significant except for 36 DAT (Figure 6). In all DAT, $V_2$ (Black Super) produced the maximum flower (1.60, 2.0, and 2.60 at 40, 44, and 48 DAT, respectively), which was statistically similar to $V_1$ (Kanya) (1.40, 1.50, and 2.0 at 40, 44, and 48 DAT, respectively). In addition, the minimum number of flowers was noticed in $V_3$ (Tripti) in all DAT.

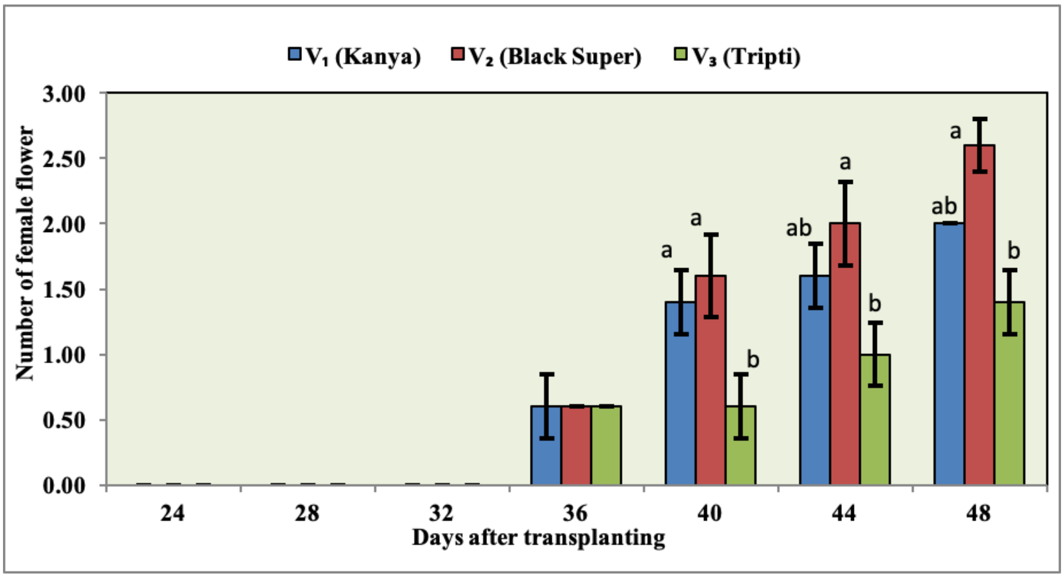


Figure 6. The number of female flowers of three watermelon varieties (**=Significant at 0.05 probability level, **=Significant at 0.01 probability level)*

***Yield attributes***

Data on different fruit parameters are presented in Table 1. Fruit size varied with the variety. The variety $V_1$ produced the largest fruit size (length 22.47 cm and width 30.89 cm); however, it was statistically similar to the variety $V_2$, but significantly larger than $V_3$. Average fruit weight was also highest (1.03 kg) in $V_1$, which was significantly higher than the rest of the varieties, but the number of fruit plot$^{-1}$ was highest (11) in $V_2$, whereas average yield was similar in $V_1$ and $V_2$, 5.84 t ha$^{-1}$ and 6.37 t ha$^{-1}$ respectively.

Table 1. Yield attributes of three watermelon varieties

| Varieties | Fruit length (cm) | Fruit width (cm) | Fruit weight (kg) fruit$^{-1}$ | Fruit no. plot$^{-1}$ | Yield (t ha$^{-1}$) |
|---|---|---|---|---|---|
| **Kanya** | 22.47 a | 30.89 a | 1.03 a | 9 a | 5.84 a |
| **Black Super** | 20.73 ab | 28.44 ab | 0.86 b | 11 a | 6.37 a |
| **Tripti** | 18.89 b | 26.65 b | 0.694 c | 8 b | 3.69 b |
| **Level of significance** | * | * | ** | * | ** |

*Kanya=$V_1$, Black Super= $V_2$, Tripti=$V_3$, *=Significant at 0.05 probability level, **=Significant at 0.01 probability level*

***Quality***

The graph (Figure 7) illustrates weight loss data for the three melon varieties at three-day intervals. As the storage period progressed, each of the melon varieties visibly lost weight. Kanya dropped the most weight (35.08 g) after 15 days of storage, followed by Tripti (31.16 g). There was relatively little weight loss (20.94 g) with Black Super. This cultivar lost significantly less weight than the other two cultivars during all storage durations.

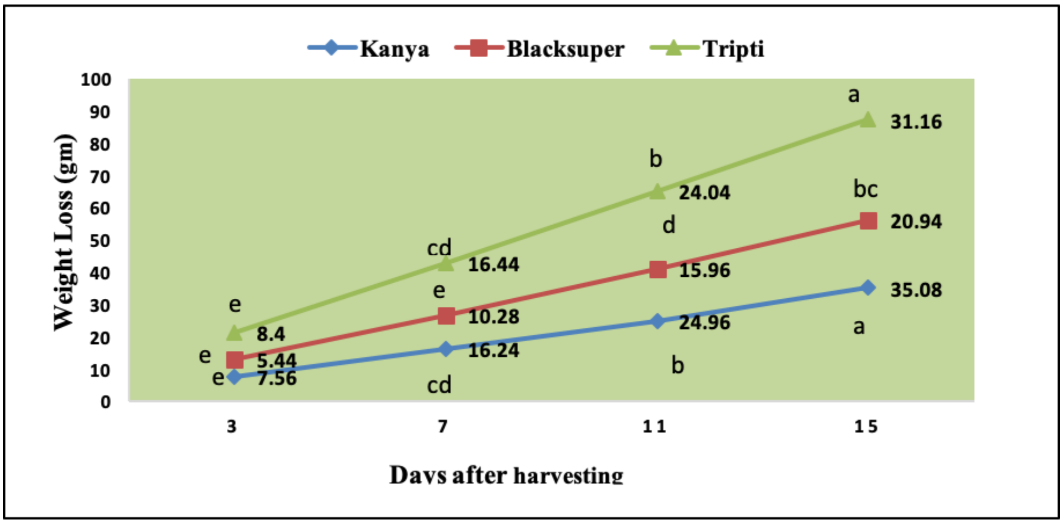


Figure 7. The Weight loss trend of three watermelon varieties

The TSS value represents the sugar and soluble mineral content of fruit. According to the TSS study, there was statistically significant variation between $V_1$ (Kanya), $V_2$ (Black Super), and $V_3$ (Tripti). The TSS value of $V_1$ (Kanya) was 7.63, followed by $V_2$ (Black Super) 8.43, and $V_3$ (Tripti) 6.39 (Table 2). The table (Table 2) also represents that the most durable variety is $V_2$, followed by $V_3$ and $V_1$. The $V_2$ (Black Super) had a shelf life of 28 days, followed by the $V_3$ (Tripti) at 23.2 days and the $V_1$ (Kanya) at 21 days.

Table 2. Total soluble solid and shelf life of three watermelon varieties

| Varieties | TSS (Brix°) | Shelf life (Days) |
|---|---|---|
| Kanya | 7.63 b | 21 c |
| Black Super | 8.43 a | 28 a |
| Tripti | 6.39 c | 23.2 b |
| Level of significance | ** | ** |

*Kanya=$V_1$, Black Super= $V_2$, Tripti=$V_3$, **= Significant at 0.01 probability level*

## Discussion

### *Growth attributes*

The vine length, number of leaves, nodes, branches, and male and female flowers are indicators of plant growth (Anikwe et al., 2016). In the present study, the highest vine length was found in Kanya ($V_1$) followed by Black Super $V_2$ and Tripti $V_3$. These results concur with Enujeke (2014) and Neppl & Wehner (2001). The variation in vine length of the varieties might be due to differences in genotypes, vigour, and environmental conditions (Joy et al., 2020). Rhoades (1983) reported that differences in growth and yield parameters are normally influenced by their genetic make-up. The number of leaves in three varieties gradually increased from 24 to 48 days after transplanting. The highest number of leaves, branches, and nodes were found in Kanya, followed by Black Super and Tripti. The number of branches and nodes is all related to vine length. This varietal difference is observed due to genotypic differences and environmental conditions (Joy et al., 2020; Enujeke, 2014, and Anikwe, 2016).

Significant variation in female flowers was observed between Black Super and Tripti. These findings are in harmony with Joy et al. (2020). The variation in male and female flowers is observed due to internodal length, number of internodes, genetic factors, environmental factors, hormonal factors, and vigour of the crop (Joy et al., 2020). Ethylene is considered the sex regulator in cucurbits conventionally, and this sex determination is controlled by hormonal and genetic control (Martínez and Jamilena, 2021). Ethylene biosynthesis and signalling genes determine the floral meristem towards male and female flowers. Sex expression of watermelon is affected by photoperiod, and temperature (Rudich and Peles, 1976). The earliness and sex ratio of watermelons are also influenced by plant growth regulators (Dixit et al., 2001).

***Yield attributes and quality of fruits***

There was a significant difference in fruit length and fruit width between Kanya and Tripti. Fruit size enlargement is a result of cell expansion. The size of fruits is affected by genetics, environment, and the conditions during the development of the pistillate flower and fruit (Maynard, 2007). The higher fruit weight was observed in Kanya ($V_1$), followed by Black Super ($V_2$), and Tripti ($V_3$). This result is harmonious with Enujeke (2014). Higher stomatal conductance, partitioning of photosynthetic materials towards economic yield, greater genetic structure, and greater potential to transport photosynthetic material within plants can all result in higher fruit weight (Enujeke, 2014). Sari et al. (2017) reported that there is a significant correlation between fruit length, fruit width, and fruit weight.

Significant yield variation was observed between Kanya and Tripti. According to Joy et al. (2020), yield variation might be due to sex ratio, fruit set percentage, genetic nature, and their response to varying environmental conditions. Maynard (2007) reported that pollination and fruit set were interfered with by weather conditions. Post-harvest weight loss has a great impact on fruit. It was revealed from the study that Black Super lost less weight than the other two varieties. The loss of substantial water is the main reason for water loss.

The highest total soluble solid was obtained from Black Super. Highly significant difference in TSS may occur due to the genetic constitution, ripening stages of melon, soil variability in the growing sites (Ammawath et al., 2009, Amin et al. 2014). The highest shelf life was obtained from Black Super. The shelf-life of melon fruit is correlated with the quality of flesh, size of seed and fruit, abscission of the peduncle, development periods of plant and fruit, rapid yellowing of the epidermis at maturity, Brix value, and color of the flesh and epidermis (Liu, 2004).

**Conclusion**

In the vegetative stage, Kanya performed better and had long vines with more leaves and nodes than Black Super and Tripti. In the reproductive stage, Black Super and Kanya produced the highest number of female flowers and fruit yield, including fruit length, width and weight. In addition, Black Super had high TSS value, minimal weight loss nature and a long shelf life than Kanya and Tripti. Overall, Black Super and Kanya can be grown during the off-season in the south-western region of Bangladesh.

**Conflict of Interest**

None of the authors present any conflicts of interest.

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