

## Varietal Performance Of Strawberry Under Different Growing Conditions

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### Abstract

An experiment was conducted at the Horticulture Research Field, Bangladesh Institute of Nuclear Agriculture (BINA), Mymensingh during the period from November 2020 to March 2021 to evaluate the performance of strawberry variety under different growing conditions. The experiment consisted of two factors; Factor A: two varieties viz. i) Rabi strawberry-1 ii) Sweet sensation and Factor B: Growing condition (two different environmental conditions) viz. i) Ambient condition ii) Agro-shade condition. The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. About 35 days old healthy and disease free daughter plants of strawberry variety Rabi strawberry-1 and sweet sensation were collected from Rajshahi University, Bangladesh and Kolkata, India, respectively and planted in the experimental field on 26 October, 2020. The plot size was 1 m × 1m, total number of unit plots were 48 and total number of plants plot<sup>-1</sup> were 12. The distance between row to row was 30 cm and plant to plant was 25 cm. Intercultural operations were done as and when necessary. From the result, it was found that higher plant height, number of leaves plant<sup>-1</sup>, canopy spread, % survivability, number of fruits plant<sup>-1</sup>, % Brix, Titratable Acidity, Vit. C, % Reducing Sugar, % Non-Reducing Sugar, % Total Sugar, % Juice content, yield plot<sup>-1</sup> and yield (t ha<sup>-1</sup>) were obtained from ambient condition. Results showed that plant height, number of leaves plant<sup>-1</sup> and canopy spreads were better in sweet sensation than Rabi-1 variety. Highest % survivability, number of fruits plant<sup>-1</sup>, yield plot<sup>-1</sup>, yield tha<sup>-1</sup>, TA, Vit. C and % JC were obtained from sweet sensation. It was observed that the highest plant height (19.30 cm), number of green leaves (39.67 plant<sup>-1</sup>) and canopy spread (3139cm<sup>3</sup>) was found in sweet sensation from ambient condition, while the highest % survivability (100%) was found from sweet sensation in ambient condition and the lowest % survivability (59%) was found in Rabi-1 strawberry variety under agro shed condition. The highest mean value of fruit yield plot<sup>-1</sup> (2043 g plot<sup>-1</sup>) and fruit yield (20.42 tha<sup>-1</sup>) was obtained in ambient condition from sweet sensation strawberry variety. Results showed that, higher values of TA (0.806) and Vit. C were found under ambient condition with sweet sensation variety while maximum value of JC was found from ambient condition in Rabi-1 strawberry variety. Eventually, sweet sensation strawberry variety in ambient condition gave better result in case of all the mentioned parameters than agro-shed condition.

**Key words:** Strawberry, variety, plant growth, yield and quality.

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### I. Introduction

Strawberry (*Fragaria sp*) is belonging to the family Rosaceae, is one of the most delicious and sweet flavored fruit throughout the world. Though it is a major fruit of temperate region but it can be grown even in both tropical and subtropical region (Ram *et al.*, 2009) and the area under this crop in the sub-continent is increasing rapidly (Singh and Asrey, 2009). Strawberries were the 19th most important fruit crop worldwide with approximately 8.367 Million metric tons produced on 395,844 hectares of land (FAOSTAT, 2018). The leading countries of strawberry cultivation are the China (7489.63 thousand MT) and U.S.A. (2880.33 thousand metric tons) by 2016-2017 total production (FAO, 2018). Strawberries have been introduced in Bangladesh recently and getting popularity with a very small scale cultivation (FAO, 2018, Chaudhuri, 2013, Chowdhury *et al.*, 2013). Bangladesh is suitable to cultivate strawberry in terms of photoperiod, temperature and humidity. Bangladesh Agricultural Research Institute (BARI) has developed

a variety named BARI Strawberry 1, Rajshahi University has developed three varieties, namely Rabi 1, Rabi 2 and Rabi 3 and BAU also developed a variety viz. FTIP-BAU-Strawberry-1. It is now cultivated in many parts of Bangladesh. There has been a bright prospect of farming strawberry, a high-value crop, everywhere in the country except the coastal districts (Chowhan *et al.*, 2016). In Bangladesh strawberry fruit production is dominated by only few cultivars as it is the exotic fruit in the country. Strawberries are producing well in our Bangladeshi adverse condition but shelf life is very poor. Suitable variety is a limiting factor for strawberry because of the short winter in Bangladesh and furthermore the production of strawberry depends greatly on the day temperature, humidity, growing condition and day length. In order to improve cultivars and growing condition farmers have to meet new problems of cultivation. As it is adaptable, there are prospects to expand its culture in our country because of its marketability is high and it can bring back the investment in a short period. It could easily achieve self-reliance in strawberry production to save foreign exchange being spent every year in importing this costly fruit. Apart from these, the income per unit area is higher in strawberry cultures compared to some other quick growing seasonal fruits. The present study was, therefore, undertaken to study the optimization of growth, yield characteristics under ambient and shaded condition. Hence, the present piece of research work was undertaken to find out the following objectives-i) to assess and select appropriate variety for a potential growth and yield of strawberry and ii) to select the appropriate growing condition for increased growth and yield and iv) to find out the suitable interaction effect of environmental condition (Ambient and Agro-shed condition) and strawberry variety.

## **II. Materials and Method**

The present investigation was carried out at the Horticulture Research Field, Bangladesh Institute of Nuclear Agriculture (BINA), Mymensingh during the period from November 2020 to March 2021 to performance of strawberry variety under different growing conditions to assess the suitable growing condition. The experiment consisted of two factors; Factor A: two varieties viz. i) Rabi-1 ii) Sweet sensation and Factor B: Growing condition (two different environmental conditions) viz. i) Ambient condition ii) Agro-shade condition. The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. About 35 days old healthy and disease free daughter plants of strawberry variety Rabi-1 and sweet sensation were collected from Rajshahi University, Bangladesh and Kolkata, India, respectively and planted in the experimental field on 26 October, 2020. The plot size was 1 m × 1m, total number of unit plots were 48 and total number of plants plot<sup>-1</sup> were 12. The distance between row to row was 30 cm and plant to plant was 25 cm. Intercultural operations were done as and when necessary. According to the recommended dose, fertilizer was applied to the experimental plots. Full dose of cow dung (37 tha<sup>-1</sup>), MoP (333 kg ha<sup>-1</sup>), TSP and Urea were applied at final land preparation and rest of MoP and Urea in two installments. The transplanted seedlings were lightly watered up to few days where necessary for well establishment of the seedlings in the soil. Plots with transplanted seedlings were regularly observed to find out any damaged and death seedlings for replacement. Harvesting were done by plot wise at different days after attaining maturity. Data on the following parameters were recorded from the sample plants during experiment. Three plants were randomly selected for this purpose from each plot. Data recorded on height, number of leaves plant<sup>-1</sup>, canopy spread, % survivability, number of fruits plant<sup>-1</sup>, % Brix, Titratable Acidity, Vit. C, % Reducing Sugar, % Non-Reducing Sugar, % Total Sugar, % Juice content, yield plot<sup>-1</sup> and yield (t ha<sup>-1</sup>). The collected data on various parameters under different experiments were statistically analyzed using the program MSTAT to find out the significance of the treatment effects. The means for all the treatments were calculated, and analysis of variance for all the characters were performed by the F-test. The significance of difference between the pair of means was evaluated by the Least Significant Difference (LSD) test (Gomez and Gomez, 1984).

## **III. Results**

The results of the study are presented comprising yield and yield contributing characters of strawberry, qualitative characteristics, correlation and regression analysis. The experiment was conducted during November 2020 to March 2021 to achieve the objectives of the study.

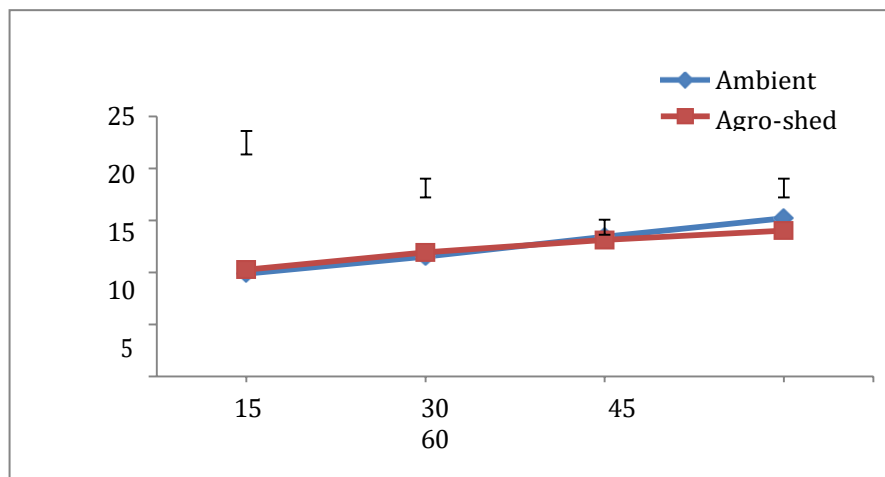
### **Effect of ambient and shaded conditions**

#### **Plant height**

Plant height was increased with the age of plant up to a limit. At 15 DAT the highest plant height (10.29 cm) was obtained from agro-shed condition and the lowest plant height (9.90 cm) was obtained from ambient condition. Similar pattern was also found at 30 DAT. At 45 DAT higher (13.45 cm) plant height was observed from ambient condition and the lower (13.14cm) plant height was observed in agro shed condition. Similar pattern was also found at 60 DAT (Fig. 1). The highest plant height (15.23 cm) was recorded

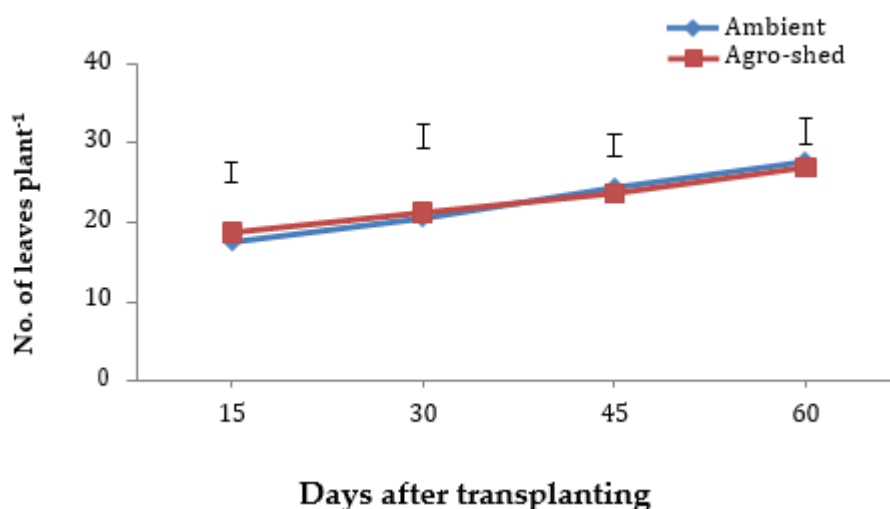
from ambient condition at 60 days after transplanting and the lowest plant height (14.04 cm) was recorded from agro condition at 60 DAT. Agro shed decrease the temperature as a result the plant height was reducing with days in shaded condition.

**Fig. 1. Effect of growing condition on plant height (cm) at different DAT. Vertical bars represent standard error**



#### Number of leaves plant<sup>-1</sup>

The number of leaves plant<sup>-1</sup> differed significantly on growing conditions. At 15 DAT the maximum number of leaves (18.71 plant<sup>-1</sup>) was recorded from agro-shed condition and the minimum number of leaves (17.50 plant<sup>-1</sup>) was from ambient condition. Similar pattern was also found at 30 DAT (Fig. 2). At 45 DAT higher number of leaves (24.38 plant<sup>-1</sup>) was observed from ambient condition and the lower leaves (23.63 plant<sup>-1</sup>) was observed in agro shed condition. Similar pattern was also found at 60 DAT (Fig. 2). The higher number of leaves per plant (27.63 plant<sup>-1</sup>) was recorded from ambient condition at 60 DAT and lower numbers of leaves (26.92 plant<sup>-1</sup>) was recorded from agro shed condition at 60 DAT.



**Fig. 2. Effect of growing condition on number of leaves plant<sup>-1</sup> at different DAT. Vertical bars represent standard error**

#### Canopy spread

Significant variation on growing condition was observed for canopy spread. The highest canopy spread (514.06 cm<sup>3</sup>) was recorded in the agro-shed condition and the lowest (473.60 cm) in the ambient

condition at 15 DAT. The highest Canopy spread (865.53 cm<sup>3</sup>) was recorded in the agro shed condition and the lowest (786.37 cm<sup>3</sup>) in the ambient condition at 30 DAT. There was a no significant difference in terms of canopy spread between the growing conditions at 45 DAT. The higher canopy spread (1534.45 cm<sup>3</sup>) was recorded from ambient condition at 60 DAT and lower canopy spread (1374.80 cm<sup>3</sup>) was recorded from agro-shed condition at 60 DAT (Table 1).

**Table 1.** Main effect of growing condition on canopy spread at different days after transplanting of strawberry

Condition	Canopy spread at different days after transplanting (cm <sup>3</sup> )			
	15	30	45	60
C1 (Ambient)	473.60 b	786.37 b	1118.76	1534.45 a
C2 (Agro-shed)	514.06 a	865.53 a	1134.31	1374.80 b
LSD0.05	27.93	28.87	38.15	45.44
Level of significance	**	**	NS	**
CV(%)	9.59	5.93	5.75	5.30

\*\* = Significant at 1% level of probability, NS = Not significant

#### Plant mortality and survivability (%)

Plant mortality and survivability in different strawberry was significantly influenced by growing condition. The highest plant mortality (24.63%) was found from agro shed condition and ambient condition exhibited the lowest mortality (13.25%). Whereas, the highest survivability (86.75%) was found from ambient condition and the lowest survivability (75.38%) was found in agro-shed condition (Table 2).

#### Runner plant<sup>-1</sup>, number of fruits plant<sup>-1</sup>, number of fruits plot<sup>-1</sup>, individual weight of fruits, fruit length diameter of fruit, fruit yield plot<sup>-1</sup> and yield (t ha<sup>-1</sup>)

The number of runner plant<sup>-1</sup>, number of fruits plant<sup>-1</sup>, number of fruits plot<sup>-1</sup>, individual weight of fruits, fruit length diameter of fruit, fruit yield plot<sup>-1</sup> and yield (t ha<sup>-1</sup>) of strawberry differed significantly in growing condition. The maximum number of runner plant<sup>-1</sup>(2.42), number of fruits plant<sup>-1</sup>(7.25 plant<sup>-1</sup>), number of fruits plot<sup>-1</sup>(74.88 plot<sup>-1</sup>), individual weight of fruits(16.42 g fruit<sup>-1</sup>), fruit length(3.38cm), diameter of fruit(2.43 mm), fruit yield plot<sup>-1</sup>(1270 g plot<sup>-1</sup>) and yield ((12.67 t ha<sup>-1</sup>) was found in ambient condition and whereas the minimum was counted in agro shed condition (0.88,4.38 plant<sup>-1</sup>, 53.67 plot<sup>-1</sup>, 14.46 g fruit<sup>-1</sup>, 3.75cm,2.16 mm, 790 g plot<sup>-1</sup>, 7.87 t ha<sup>-1</sup>) (Table 2).

#### Fruit quality traits

Different growing condition (ambient and agro shed) in this research work exhibited significant variation in respects of brix percentage (Appendix V). Results showed that, ambient condition showed higher values (12.48%) in terms of brix percentage than the brix percentage value (11.23%) of agro shed condition (Table 3). Perkinsveaze (1995) reported that brix percentage of strawberry cultivars varied from 4-11% depending on cultivar and also on the growing environment. The results in Table 3, generally showed the presence of some significant differences on titratable acidity, vitamin C, reducing and non- reducing and total sugars and juice content of different growing condition. It was observed that strawberry from ambient condition contained more, titratable acidity (0.77), Vit. C (55.58) reducing sugar (3.38), non-reducing sugar (3.93%), total sugars (7.20%) and juice content (75.25%) than agro shed condition titratable acidity (0.73), Vit. C (53.99)reducing sugar (3.03), non-reducing sugar (3.71%), total sugars (6.87%) and juice content (74.68%). However, no significant difference in pH was detected.

**Table 2.** Main effect of growing condition on percent mortality, survivability, runner plant<sup>-1</sup>, number of fruit plant<sup>-1</sup>, number of fruits plot<sup>-1</sup>, individual weight fruit<sup>-1</sup>, yield plot<sup>-1</sup>, yield (t ha<sup>-1</sup>) length of fruit and diameter of fruit of strawberry

Condition	Survivability (%)	Mortality (%)	Runner plant <sup>-1</sup>	No. of fruit plant <sup>-1</sup>	No. of fruits plot <sup>-1</sup>	Individual weight fruit <sup>-1</sup> (g)	Yield plot <sup>-1</sup>	Yield (t ha <sup>-1</sup> )	length of fruit	Diameter of fruit
C1 (Ambient)	86.75 a	13.25 b	2.42 a	7.25 a	74.88 a	16.42 a	1.27 a	12.67 a	3.75 a	2.43 a
C2 (Agro shed)	75.38 b	24.63 a	0.88 b	4.38 b	53.67 b	14.46 b	0.79 b	7.87 b	3.38 b	2.16 b
LSD <sub>0.05</sub>	0.67	0.59	0.26	0.34	2.71	0.76	0.04	0.43	0.11	0.13
Level of significance	**	**	**	**	**	**	**	**	**	**
CV(%)	1.42	5.31	26.79	9.91	7.17	8.32	7.09	7.05	5.40	9.55

\*\* = Significant at 1% level of probability

**Table 3.** Main effect of growing condition on % Brix, TA, Vit. C, pH, % of RS, % of NRS, % of TS and % of JC of strawberry

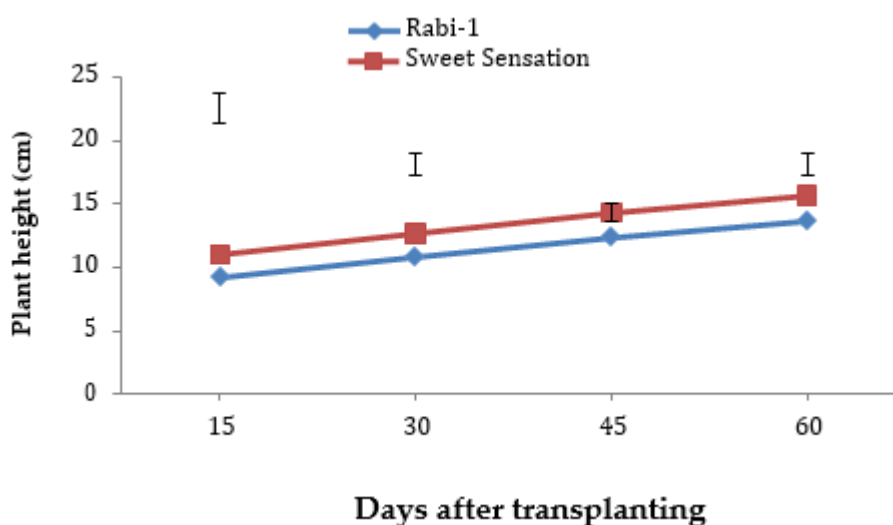
Condition	% of Brix	TA	Vit. C	pH	% of RS	% of NRS	% of TS	% of JC
C1 (Ambient)	12.48 a	0.77 a	55.58 a	3.35	3.38 a	3.93 a	7.20 a	75.25 a
C2 (Agro shed)	11.23 b	0.73 b	53.99 b	3.35	3.03 b	3.71 b	6.87 b	74.68 b
LSD <sub>0.05</sub>	0.38	0.01	0.49	0.03	0.05	0.09	0.04	0.50
Level of significance	**	**	**	NS	**	**	**	*
CV(%)	5.45	2.56	1.51	1.35	2.55	4.05	0.97	1.13

\*\* = Significant at 1% level of probability, \* = Significant at 5% level of probability, NS = Not significant

**Effect of varieties**

**Plant height**

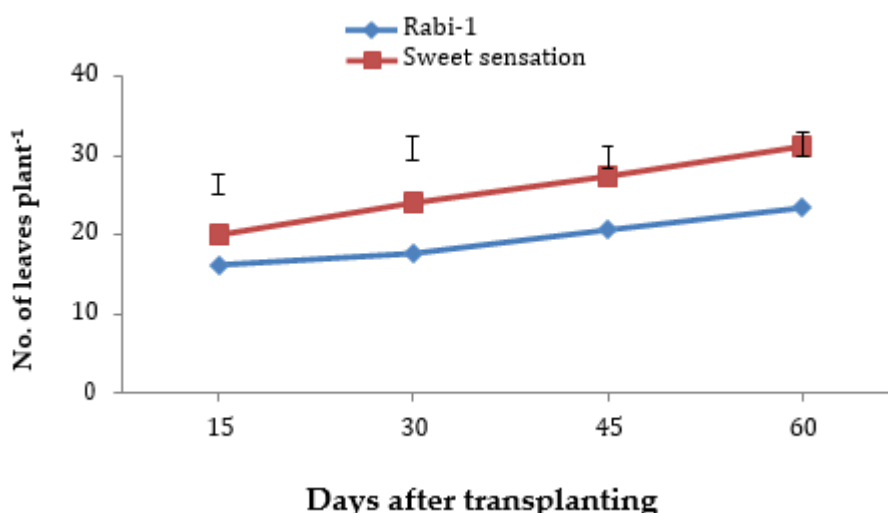
The variation in plant height of strawberry was found to be significant due to the use of different varieties (Rabi-1 and Sweet sensation). Significant effect of varieties on plant height was measured at 15, 30, 45 and 60 DAT. The highest plant height was found in Sweet sensation (15.64 cm) and the lowest plant height was showed in Rabi-1 (13.63 cm) at all the DAT (Fig. 3).



**Fig. 3.** Effect of varieties (Rabi-1 strawberry and sweet sensation) on plant height (cm) at different DAT. Vertical bars represent standard error

**Number of leaves plant<sup>-1</sup>**

The number of leaves plant<sup>-1</sup> differed significantly between varieties (Rabi-1 and sweet sensation). The maximum number of leaves plant<sup>-1</sup> (31.17 plant<sup>-1</sup>) was recorded in sweet sensation and the minimum (23.38 plant<sup>-1</sup>) was in Rabi-1 at 60 days after transplanting (Fig. 4).



**Fig. 4.** Effect of varieties (Rabi-1 and sweet sensation) on number of leaves plant<sup>-1</sup> at different DAT. Vertical bars represent standard error

**Canopy spread**

Canopy spread varied significantly between two varieties at 15 DAT, 30 DAT, 45 DAT and 60 DAT. The highest canopy spread was measured 609.23 cm<sup>3</sup>, 1075.82 cm<sup>3</sup>, 1451.50 cm<sup>3</sup> and 1983.41 cm<sup>3</sup> in sweet sensation respectively. The highest canopy spread (1983.41 cm<sup>3</sup>) was recorded in sweet sensation at 60 DAT and lower canopy spread (1374.80 cm<sup>3</sup>) was recorded in Rabi-1 at 60 DAT (Table 4).

**Table 4.** Main effect of varieties (Rabi-1 and sweet sensation) on canopy spread at different days after transplanting of strawberry

Variety	Canopy spread at different days after transplanting (cm <sup>3</sup> )			
	15	30	45	60
V1 (Rabi-1)	378.44 b	576.08 b	801.57 b	925.84 b
V2 (Sweet sensation)	609.23 a	1075.82 a	1451.50 a	1983.41 a
LSD0.05	27.93	28.87	38.15	45.44
Level of significance	**	**	**	**
CV(%)	9.59	5.93	5.75	5.30

\*\* = Significant at 1% level of probability, \* = Significant at 5% level of probability, NS = Not significant

**Plant mortality and survivability (%)**

Plant mortality and survivability in different strawberry was significantly influenced by varieties (Rabi-1 and Sweet sensation). The highest plant mortality (21.50 %) was found in Rabi-1 strawberry and Sweet sensation strawberry exhibited the lowest mortality (13.25 %), whereas, the highest survivability (83.63 %) was found in Sweet sensation and the lowest survivability (78.50%) was found in Rabi-1 strawberry shown in (Table 5).

**Runner plant<sup>-1</sup>, number of fruits plant<sup>-1</sup>, number of fruits plot<sup>-1</sup>, individual weight of fruits, fruit length diameter of fruit, fruit yield plot<sup>-1</sup> and yield (t ha<sup>-1</sup>)**

The number of runner plant<sup>-1</sup>, number of fruits plant<sup>-1</sup>, number of fruits plot<sup>-1</sup>, individual weight of fruits, fruit length and diameter of fruit of strawberry did not show any significant difference on variation in growing condition. There was a significant variation between the varieties in respect of fruit yield plot<sup>-1</sup> and

yield (t ha<sup>-1</sup>). The maximum fruit yield (1060 g plot<sup>-1</sup> and 10.55 tha<sup>-1</sup>) were obtained in Rabi-1 strawberry and the minimum fruit yield (1000 g plot<sup>-1</sup> and 9.99 tha<sup>-1</sup>) in Sweet sensation strawberry (Table 5). **Table 5.** Main effect of variety on percent survivability, mortality, runner plant<sup>-1</sup>, number of fruit plant<sup>-1</sup>, number of fruits plot<sup>-1</sup>, individual weight fruit<sup>-1</sup>, yield plot<sup>-1</sup>, yield tha<sup>-1</sup>, length of fruit and diameter of fruit of strawberry

Variety	Survivability (%)	Mortality (%)	Runner plant <sup>-1</sup>	No. of fruit plant <sup>-1</sup>	No. of fruits plot <sup>-1</sup>	Individual weight fruit <sup>-1</sup> (g)	Yield plot <sup>-1</sup>	Yield tha <sup>-1</sup>	length of fruit	Diameter of fruit
V1 (Rabi-1)	78.50 b	21.50 a	1.54	6.04 a	64.42	15.75	1.06 a	10.55 a	3.58	2.35
V2 (Sweet sensation)	83.63 a	16.38 b	1.75	5.58 b	64.13	15.13	1.00 b	9.99 b	3.55	2.23
LSD <sub>0.05</sub>	0.67	0.59	0.26	0.34	2.71	0.76	0.04	0.43	0.11	0.13
Level of significance	**	**	NS	**	NS	NS	**	**	NS	NS
CV(%)	1.42	5.31	26.79	9.91	7.17	8.32	7.09	7.05	5.40	9.55

\*\* = Significant at 1% level of probability, NS = Not significant

**Table 6.** Main effect of variety on % Brix, TA, Vit C, pH, % of RS, % of NRS, % of TS and % of JC of strawberry

Variety	% of Brix	TA	Vit. C	pH	% of RS	% of NRS	% of TS	% of JC
V1 (Rabi-1)	11.73	0.74 b	53.86 b	3.35	3.22	3.81	7.14 a	74.23 b
V2 (Sweet sensation)	11.98	0.76 a	55.71 a	3.35	3.19	3.83	6.92 b	75.69 a
LSD <sub>0.05</sub>	0.38	0.01	0.49	0.03	0.05	0.09	0.04	0.50
Level of significance	NS	**	**	NS	NS	NS	**	**
CV(%)	5.45	2.56	1.51	1.35	2.55	4.05	0.97	1.13

\*\* = Significant at 1% level of probability, NS = Not significant

### Fruit quality traits

Two different varieties (Rabi-1 and Sweet sensation) in this research work exhibited significant variation in respects of titratable acidity, vitamin C and juice content. Results showed that, Sweet sensation had higher values (0.76), (55.71) and (75.69%) in terms of titratable acidity, vitamin C and juice content respectively than Rabi-1 strawberry (Table 6). The lowest value of titratable acidity (0.74), vitamin C (53.86) and juice content (74.23%) was found in Rabi-1 strawberry. The results in (Table 6), generally showed the presence of some significant differences in total sugar as a result of different varieties. It was observed that, Rabi-1 strawberry contained more, total sugars (7.14%) than Sweet sensation strawberry. However, no significant difference in brix percentage, pH, reducing sugar and non-reducing sugar was detected.

### Interaction effect of growing condition and variety

#### Plant height, Leaves plant<sup>-1</sup> and Canopy spread

The interaction effect between condition and variety on plant height, numbers of leaves plant<sup>-1</sup> and canopy spread were found significant at 15, 30, 45 and 60 DAT. The maximum plant height (15.88 cm), number of green leaves (32 plant<sup>-1</sup>) and canopy spread (2026 cm<sup>3</sup>) were recorded at 60 DAT from the ambient condition in Sweet sensation and the minimum plant height (12.69 cm), number of leaves (23.50 plant<sup>-1</sup>) and canopy spread (808.9 cm<sup>3</sup>) were recorded from the agro-shed condition of Rabi-1 strawberry (Table 10).

**Table 10.** Combined effects of growing condition and variety on plant height, leaves plant<sup>-1</sup> and canopy spread at different days after transplanting of strawberry

Condition x variety	Plant height (cm)				Leaves plant <sup>-1</sup> (cm)				Canopy spread (cm <sup>3</sup> )			
	15	30	45	60	15	30	45	60	15	30	45	60
C1V1 (Ambient x Rabi-1)	9.46 c	11.03 c	12.96 c	14.58 c	15.67	17.50	20.50 c	23.75 c	433.3 c	614.7 c	858.3 c	1043. c
C1V2 (Ambient x Sweet sensation)	10.35 b	12.01 b	13.95 b	15.88 a	19.33	23.50 a	28.25 a	32.00 a	513.9 b	958.0 b	1379. b	2026. a
C2V1 (Agro shed x Rabi-1)	8.95 c	10.59 d	11.71 d	12.69 d	16.75	17.83	20.75 c	23.50 d	323.6 d	537.4 d	744.8 d	808.9 d

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C2V2 ((Agro shed x Sweet sensation)	11.63 a	13.29 a	14.58 a	15.39 a	20.67	24.58	26.50 b	30.33 b	704.5 a	1194. a	1524. a	1941. b
LSD0.05	0.51	0.40	0.33	0.41	0.66	0.77	0.74	0.78	39.50	40.83	53.95	64.26
Level of significance	**	**	**	**	NS	NS	**	**	**	**	**	**
CV(%)	6.12	4.14	2.94	3.34	4.34	4.41	3.70	3.45	9.59	5.93	5.75	5.30

\*\* = Significant at 1% level of probability, NS = Not significant

**Plant mortality and survivability (%)**

The variation due to condition (ambient and agro-shed) and two different varieties (Rabi-1 and Sweet sensation) under the study was significant of percent mortality and survivability. The highest plant mortality (28.75%) was found in Rabi-1 strawberry at agro-shed condition and Sweet sensation at ambient condition exhibited the lowest mortality (12.25%). Whereas, the highest survivability (87.75%) was found in Sweet sensation at the ambient condition and the lowest survivability (71.25%) was found in Rabi-1 strawberry at agro shed shown in (Table 11).

**Runner plant<sup>-1</sup>, number of fruits plant<sup>-1</sup>, number of fruits plot<sup>-1</sup>, individual weight of fruits, fruit length diameter of fruit, fruit yield plot<sup>-1</sup> and yield (t ha<sup>-1</sup>)**

The interaction effect of growing conditions and varieties on number of runner plant<sup>-1</sup> of strawberry was found not significant (Table 11).

The number of fruits plant<sup>-1</sup>, number of fruits plot<sup>-1</sup>, individual weight of fruits, fruit length diameter of fruit, fruit yield plot<sup>-1</sup> and yield (t ha<sup>-1</sup>) of strawberry differed significantly in growing condition. The maximum number of fruits plant<sup>-1</sup>(7.33 plant<sup>-1</sup>), number of fruits plot<sup>-1</sup>(74.42 plot<sup>-1</sup>), individual weight of fruits(17.17 g fruit<sup>-1</sup>), fruit length(3.95cm), diameter of fruit(2.6 mm), fruit yield plot<sup>-1</sup>(1290 g plot<sup>-1</sup>) and yield ((12.84 t ha<sup>-1</sup>) was found in ambient condition and whereas the inimum was counted in agro shed condition (3.83 plant<sup>-1</sup>, 50.83 plot<sup>-1</sup>, 14.33 g fruit<sup>-1</sup>, 3.20cm, 2.08 mm, 830 g plot<sup>-1</sup>, 7.48 t ha<sup>-1</sup>) (Table 2)

**Fruit quality traits**

The table (12) showed the presence of some significant interaction effects among the growing conditions and varieties on Vit. C, total sugars and juice content. The highest mean values of Vit. C and juice content were obtained from strawberry plant cv. Sweet sensation which grown in ambient condition. Total sugars found maximum in Rabi-1 strawberry under ambient condition and minimum was found in Sweet sensation under agro shed condition. However, no significant difference in total brix percentage, titratable acidity, pH, percentage of reducing and non- reducing sugar, was detected.

**Table 11.** Combined effects of growing condition and variety on percent survivability, mortality, runner plant<sup>-1</sup>, number of fruit plant<sup>-1</sup>, number of fruits plot<sup>-1</sup>, individual weight fruit<sup>-1</sup>, yield plot<sup>-1</sup>, yield tha<sup>-1</sup>, length of fruit and diameter of fruit of strawberry

Growing condition x variety	Survivability (%)	Mortality (%)	Runner plant <sup>-1</sup>	No. of fruit plant <sup>-1</sup>	No. of fruits plot <sup>-1</sup>	Individual weight fruit <sup>-1</sup> (g)	Yield plot <sup>-1</sup>	Yield tha <sup>-1</sup>	length of fruit	Diameter of fruit
C1V1 (Ambient x Rabi-1)	85.75 b	14.25 c	2.33	7.167 a	72.33 b	17.17 a	1.29	12.84	3.950 a	2.625 a
C1V2 (Ambient x Sweet sensation)	87.75 a	12.25	2.50	7.333 a	77.42 a	15.67 b	1.01	12.30	3.542 b	2.233 b
C2V1 (Agro shed x Rabi-1)	71.25	28.75 a	0.75	3.833	50.83	14.33	0.83	8.26	3.208	2.083 b
C2V2 (Agro shed x Sweet sensation)	79.50	20.50 b	1.00	4.917 b	56.50	14.58	0.75	7.48	3.558 b	2.233 b
LSD0.05	0.95	0.84	0.37	0.48	3.84	1.07	0.06	0.60	0.16	0.18
Level of significance	**	**	NS	**	**	*	**	**	**	**
CV(%)	1.42	5.31	26.79	9.91	7.17	8.32	7.09	7.05	5.40	9.55

\*\* = Significant at 1% level of probability, \* = Significant at 5% level of probability, NS = Not significant



**Table 12.** Combined effects of growing condition and variety on % Brix, TA, Vit C, pH, % of RS, % of NRS, % of TS and % of JC of strawberry

Condition x variety	% of Brix	TA	Vit. C	pH	% of RS	% of NRS	% of TS	% of JC
C1V1 (Ambient x Rabi-1)	12.48	0.76	55.20 b	3.36	3.37	3.95	7.279 a	76.76 b
C1V2 (Ambient x Sweet sensation)	12.49	0.78	55.97 a	3.34	3.39	3.91	7.120 b	73.73
C2V1 (Agro shed x Rabi-1)	10.98	0.72	52.52	3.33	3.07	3.66	7.009	71.70
C2V2 (Agro shed x Sweet sensation)	11.47	0.75	55.45 ab	3.36	3.00	3.75	6.727 d	77.65 a
LSD <sub>0.05</sub>	0.54	0.01	0.69	0.04	0.07	0.13	0.06	0.71
Level of significance	NS	NS	**	NS	NS	NS	**	**
CV(%)	5.45	2.56	1.51	1.35	2.55	4.05	0.97	1.13

\*\* = Significant at 1% level of probability, \* = Significant at 5% level of probability, NS = Not significant

#### IV. DISCUSSION

A Randomized Complete Block Design (RCBD) experiment was carried out at the Horticulture Research Field, Bangladesh Institute of Nuclear Agriculture (BINA), Mymensingh to performance of strawberry variety under different growing conditions to assess the suitable interaction effect of environmental condition under of two varieties of strawberry.

##### Effect of growing condition

Plant height is one of the most important growth contributing characteristics for strawberry plant. Its growth depends on shed and ambient light condition. From the results it was found that the effect of growing condition (ambient and agro-shed) was found to be statistically significant on plant height at different days after transplanting during the growth period the height gradually increased with the advancement of growth time at reached to peak at 60 days. Pandey *et al.* (2015) was evaluated that the fruits harvested from the open field condition had higher root volume, root weight, number of roots plant<sup>-1</sup> and total chlorophyll content (2.02 mg g<sup>-1</sup>), maximum leaves plant<sup>-1</sup> (73.33), fruit length and fruit weight. In naturally ventilated poly-house, strawberry plants had higher crown height, plant spread and produced higher fruit yield (242.77 g plant<sup>-1</sup>) with maximum number of fruits plant<sup>-1</sup> (29) and total anthocyanin content (45.51 mg per 100 g) in the fruits. Caillouet (2016) investigated that shed treated plants had reduced plant growth and development, especially dry weights compared to the un-shaded control. The plant height is better in ambient than shaded condition. It might be due to the fact that strawberry actually grown in month of November to March in which time weather condition is favorable for plant growth. Number of leaves plant<sup>-1</sup> showed significant variation due to ambient and agro shed condition at different days after transplanting 15, 30, 45 and 60 days. Pandey *et al.* (2015) conducted that the number of leaves plant<sup>-1</sup> of strawberry are better in ambient condition than agro shed condition. According to Demirsoy *et al.* (2007), the crown and leaf number were generally lower in the open field than constant shading as a result of low temperatures. The higher number of leaves plant<sup>-1</sup> was recorded from ambient condition at 60 days after transplanting and lower number of leaves plant<sup>-1</sup> at 15 days after transplanting. The highest canopy spread was found under ambient condition at 60 days after transplanting and the lowest canopy spread was also found in ambient condition at 15 days after transplanting, it's seems that canopy spread was increase with days after transplanting the plants. Highest survivability was found in ambient condition whereas, the lowest survivability was observed from agro-shed condition. Other parameter such as number of fruits plant<sup>-1</sup>, yield plot<sup>-1</sup> and yield tha<sup>-1</sup> was found maximum in ambient condition. The highest % of Brix, TA, Vit. C, % of RS, % of NRS, % of TS and % of JC were found in ambient condition. Hyo *et al.* (2014) investigated that, when the strawberry plants were subjected to the shading treatments, their photosynthesis and fruit yields were significantly reduced. Although the mineral element and organic acid contents of the fruits were not affected by the shading treatments, the total nitrogen (T-N) of the stems and roots were noticeably reduced. Furthermore, the shading treatments of the plants also resulted in reductions in the sugar contents and total phenolics of the fruits.

##### Effect of variety

Effect of variety (Rabi-1 and Sweet sensation) was found to be statistically significant on plant height at different days after transplanting during the growth period the height gradually increased with time at reached to peak at 60 days. The plant height was better in sweet sensation than Rabi-1. The higher

number of leaves plant<sup>-1</sup> was recorded from Sweet sensation at 60 days after transplanting. The highest canopy spread was found from Sweet sensation at 60 days after transplanting and the lowest canopy spread was also found in Rabi-1 at 15 days after transplanting. Highest survivability was obtained from Sweet sensation whereas, the lowest survivability was observed from Rabi-1. Other parameter such as number of fruits plant<sup>-1</sup>, yield plot<sup>-1</sup> and yield tha<sup>-1</sup> were found maximum from Rabi-1. Adnan *et al.* (2017) noticed that number of leaves, leaf length, plant height and fruit yield were found higher in Rabi strawberry-1. Paul *et al.* (2017) found that the fruit yield per plant (319.22 g), fruit yield per hectare (13.30 tha<sup>-1</sup>) and fresh individual fruit weight (20.45 g) were found maximum in Rabi strawberry-1. The influence of variation was found significant in respect to TA, Vit. C and % of JC. The highest TA, Vit. C, and % of JC were found in sweet sensation. Soliman *et al.* (2015) observed that, Festival or Sweet Charlie cultivars contained more total soluble solids, Vit. C, reducing and non-reducing as well as total sugars than Gaviota one.

## V. CONCLUSIONS

The result of the experiment revealed that most of the parameters showed positive response to ambient condition. The tallest plant (15.23 cm), the maximum number of leaves plant<sup>-1</sup> (23.63) and the highest canopy spread (1534.45 cm<sup>3</sup>), maximum % Brix (12.48), TA (0.77), Vit. C (55.58), % of RS (3.38), % of NRS (3.93), % of TS (7.20) and % of

JC (75.25) as well as survivability (86.75%), yield plot<sup>-1</sup> (2090 g) and yield tha<sup>-1</sup> (20.9tha<sup>-1</sup>) were found at ambient condition and the lowest values were found on all mentioned parameters in agro-shed condition. The variety was significant effect on plant height, number of leaves plant<sup>-1</sup>, canopy spread, yield plot<sup>-1</sup>, yield tha<sup>-1</sup> of strawberry. The highest plant height (15.88 cm), number of leaves plant<sup>-1</sup> (31.17), canopy spread (1983.41 cm<sup>3</sup>), was recorded from the Sweet sensation. The yield plot<sup>-1</sup> (1060 g), yield tha<sup>-1</sup> (10.55 tha<sup>-1</sup>) was obtained from the variety Rabi-1 strawberry. Interaction effects of growing condition and variety were found significant in all parameters like plant height, number of leaves plant<sup>-1</sup>, canopy spread of strawberry. The highest plant height (15.88 cm), number of leaves plant<sup>-1</sup> (32.00), canopy spread (2026 cm<sup>3</sup>), yield plot<sup>-1</sup> and yield tha<sup>-1</sup> were obtained from ambient condition in Sweet sensation. The result obtained from the present study indicates that the growing condition and variety played an important role on growth, yield contributing characters and yield of strawberry. From overall consideration, it was found that at ambient condition with Sweet sensation variety gave better result in case of all the mentioned parameters than agro-shed condition.

## REFERENCES

- [1]. Adnan, M. M., Rahim, M. A., Haque, T., Hossain, M. M. 2017: Growth and yield performance of strawberry (*Fragaria × ananassa* Duch.) as influenced by variety and mulch materials. *Fundamental and Applied Agriculture* 2(1): 202-206.
- [2]. Asrey, R., Jain, R.K., Singh, R. 2009: Effect of pre-harvest chemical treatments on shelf life of Chandler strawberry. *Indian Journal of Agricultural Sciences* 74: 485-487.
- [3]. Caillouet O. C. 2016: The Effects of Shade on Growth, Development and Yield of a Primocane Fruiting Blackberry, 'Prime-Ark 45' to Extend the Market Season. *Horticulture Undergraduate Honors Theses*. 4
- [4]. Chaudhuri, S. K. 2013: A simple and reliable method to detect gamma irradiated lentil (*Lens culinaris* Medik) seeds by germination efficiency and seedling growth test. *Radiation Physics and Chemistry* 64: 131-136.
- [5]. Chowdhury, A. N., Nargis, A., Rahman, M. Z., Alam, A. K. M. S., Ibrahim, M., Akhter, S. 2013: Freezing adaptability and chemical composition of strawberry (*Fragaria x ananassa*) in Bangladesh. *Journal of Environmental Science, Toxicology and Food Technology* 7(4): 50-54.
- [7]. Chowhan, S., Hossain, M. M., Hoque, M. A., Rasul, Roni, M. S. 2016: Yield performance of strawberry genotypes. *Bangladesh Journal of Agricultural Research* 41(3): 481-489
- [8]. Demirsoy, L., Demirsoy, H., Uzun, S., Öztürk, A. 2007: The Effects of Different Periods of Shading on Growth and Yield in 'Sweet Charlie' Strawberry. *European Journal of Horticultural Science* 72 (1): 26-31.
- [9]. FAO, 2011: <http://faostat.fao.org/site/567/DesktopDefault.aspx?PageID=567#ancor>. Food and FAOSTAT Agricultural Data (2014) <http://www.faostat.fao.org>. Agriculture Organization, Italy, Rome.
- [10]. FAO, 2018: <http://faostat.fao.org>.
- [11]. FAOSTAT, 2018: <http://faostat.fao.org>
- [12]. Gomez, K.A. and Gomez, A. 1984: *Statistical Procedure for Agricultural Research— Hand Book*. John Wiley & Sons, New York.
- [13]. Hyo, R., Wali, V. K., Bakshi, P., Singh, G., Shah, R. A., Rani, S. 2014: Effects of Gamma Irradiation on Shoot, Root and Survival Percent in Strawberry cv. Chandler under in vitro Conditions. *International Journal of Current Microbiology and Applied Sciences* 7(03): 1173-1182.
- [14]. Pandey, S., Singh, J., Singh, K. S., Mouray, I. B. 2015: Influence of growing environment on growth, yield and chemical composition of strawberry (*Fragaria × ananassa*) fruits under open vs naturally ventilated polyhouse conditions. *Indian Journal of Agricultural Science* 85(12): 1540-5.
- [16]. Paul, C., Gomasta, J., Hossain, M. M. 2017: Effects of planting dates and variety on growth and yield of strawberry.

- International Journal of Horticulture, Agriculture and Food Science (IJHAF) 1: 2456-8635.
- [17]. Ram, R. B., Maurya, D., Dwivedi, D. H., Chaturvedi, S. K. 2009: Effect of different spacing on growth, flowering, fruiting, yield and quality of Strawberry (*Fragaria x ananassa*) cv. Chander. *Advanced Plant Science* 22(2): 517-519.