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PERFORMANCE OF STRAWBERRY GENOTYPES IN BANGLADESH

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Abstract

An experiment was conducted to study the variability and performance of six strawberry genotypes at the Research field and Laboratory of the Department of Horticulture, Bangabandhu Sheikh Mujibur Rahman Agricultural University, Salna, Gazipur, during November 2007 to April 2008. Remarkable variabilities were recorded among the genotypes in respect of days to flower initiation, flowers/truss, flower disk diameter, fruit weight, fruit length, fruit width, number of fruits/plant, weight of fruits/plant, yield/ha and fruit TSS(%). Days to flower initiation, flowers per truss, flower trusses per plant, flower diameter and flower disk diameter ranges from 71.64 to 81.87, 7.40 to 12.73, 2.49 to 3.94, 1.74 cm to 2.44 cm, 0.66 cm to 0.90 cm, respectively. The heaviest (24.70 g) and the lightest (8.34 g) fruits were obtained from the genotypes FA002 and FA005 respectively. Number of fruits per plant, weight of fruits per plant and fruit TSS (%) ranged from 13.74 to 25.00 and 129.85 g to 442.50 g and 8.57 to 13.44 respectively. The genotype FA002 gave the maximum fruit yield (22.78 t/ha) while the genotype FA005 gave the minimum (7.05 t/ha).

Keywords: Strawberry, variability, truss, achene.

Introduction

Strawberry (*Fragaria ananassa*) is a fruit of temperate regions of the world (Hossain, 2009). It belongs to the family Rosaceae (Sing, 2002). The garden strawberry (*Fragaria ananassa*) known as pineapple strawberry or ananas strawberry was first bred in Brittany, France, in the 1750s via a cross of *Fragaria virginiana* from eastern North America and *Fragaria chiloensis* from Chile. (Hossain, 2009). The strawberry is, in technical terms, an aggregate accessory fruit, meaning that the fleshy part is derived not from the plant's ovaries but from the receptacle that holds the ovaries. Each apparent "seed" (achene) on the outside of the fruit is

actually one of the ovaries of the flower, with a seed inside it. In both culinary and botanical terms, the entire structure is considered as fruit.This fruit is widely appreciated for its characteristic aroma, bright red color, juicy texture, and sweetness. Strawberries are grown throughout Europe, in every state of the United States, as well as in Canada and South America. The wide variation in climates within these regions and the wide adaptation of the strawberry plant permit harvesting and marketing the fruit during greater part of the year. Strawberry has a tremendous scope for cultivation near towns and canning units where the produce can be utilized immediately after harvest. It is more profitable in the shortest possible time as compared to other fruits (Sing, 2002). Strawberry is a delicious fruit taken fresh in several ways. It also makes excellent ice cream and jam on account of its pleasant aroma and delicate flavor. It is also nutritious and beneficial to anemic persons. One cup (236 g) of strawberries contains approximately 45 calories (188 kJ) and other nutrients such as water (132 g), protein (0.88 g), fat (0.53 g) carbohydrate (10.10 g), fiber (3.3 g), calcium (20.00 g), iron (0.55 g), vitamin C (82 μg), thiamin (0.03 μg), riboflavin (0.1 μg), vitamin (B-6 0.09 mg), folate (25 μg) and vitamin A (IU 39).

Department of Botany, Rajshahi University is the pioneer of introducing strawberry in Bangladesh. Under the leadership of Dr. Monjur Hossain, Professor of the Department, strawberry research and development has been initiated since 1998. Since, strawberry is a new exotic crop in Bangladesh, a package of production technology is urgently needed to enhance its production. The yield of strawberry is influenced by many factors, among which cultivar is very important. Bangladesh Agricultural Research Institute released one variety of strawberry, named BARI strawberry-1 which is not enough to meet increasing demand of strawberry cultivation which is expanding day by day. There is very little studies have been done on the variabilities and performance of strawberry genotypes in Bangladesh. However, a good number of investigators were done in India, Pakistan and elsewhere in the world. With these view in mind, the study was therefore undertaken to study the variability and performance of six strawberry genotypes in Bangladesh.

Materials and Method

Source of the genotypes

Six strawberry genotypes viz. FA001, FA002, FA003, FA004, FA005 and FA006 were used for the study. Out

of these, the genotypes FA002 and FA003 were collected from Rajshahi University and BAU respectively. Rest of four were collected from different reputed nurseries of the country.

Experiment site and land preparation

The experiment was conducted at the Horticulture Research Farm, Bangabandhu Sheikh Mujibur Rahman Agricultural University, Salna, Gazipur during the period from November 2007 to April 2008. The experimental site is located at the center of Madhupur Tract (24.09 degree North latitude and 90.26 degree East longitude) at 8.5 m above the sea level and about 40 km north of Dhaka. The land was deep ploughed with tractor followed by harrowing and laddering up to a good tilth. All weeds and stubbles were removed. The plots were prepared with drains which were made around each plot and the excavated soil was used for raising the plots about 10 cm from soil surface. Ridges were made around each plot to restrict the lateral run-off of irrigation water. Well decomposed cow dung or compost and fertilizers- DAP, MP were applied @ 37 tons, 640 kg and 333 kg per hectare in general (Hossain, 2009). Full dose of cow dung and DAP and half of MP were applied at final land preparation and rest of MP in two installments. Immediately after manuring and fertilizing and preparing the field for planting, solarization was done by laying clear plastic mulch on moist soil so that heat was trapped under the plastic, raising the soil's temperature, killing or debilitating pests. This solarization took about six weeks and after that mulch was removed before planting of strawberry saplings.

Design and layout

The experiment was laid out in a Randomized Complete Block Design with four replications. The unit plot size was 1.5 m x 1.2 m accommodating 10 daughter plants in each plot having row and plant spacing of 60.96 cm x 30.48 cm respectively (Hossain, 2006). The unit plots and blocks were separated by 0.6 m and 0.75 m respectively.

Planting of saplings and intercultural operations

Saplings were transplanted on 06 November 2007 with the row and plant spacing 60.96 cm x 30.48 cm and placed the sapling in the soil in such a way that both the level of soil and of polyethylene pots remain in same level. Water was applied immediately after transplanting. Under the intercultural operations, runners were removed at every 3 to 4 days intervals in order to make the shoot tip capable to initiate

flower and help develop the plants producing good size and quality fruits. Later on 2 to 3 runners per plant were allowed to produce 1st daughter plant which normally rooted to the soil. The daughter plants were then removed with soil and placed in another bed for multiplication. This practice helps to increase fruit yield as well as multiplication of daughter plants quite in large number for next season planting. Straw mulch was applied around the plants as a normal practice in order to conserve soil moisture, decreasing weed growth and to provide healthy condition for the fruits. Irrigation was given whenever necessary to keep the soil moisture available in the field for better plant growth.

Plant protection, data collection and statistical analysis

The crop was protected from the attack of insect pests by applying Sumithion 60 EC @ 1ml/l. Phytophthora crown rot is a most important strawberry disease in Bangladesh which was observed at fruiting stage and it was controlled by spraying Ridomil gold @ 2 g/l. Strawberries were harvested by hand picking when it was firm and well-colored and early in the day at an interval of 3 to 4 days. After harvest, fruits were cooled under shade. The data were recorded from randomly selected five plants from each plot. The recorded data on different parameters were compiled and statistically analyzed using MSTATC computer program and the treatment means were compared by DMRT (Gomez and Gomez, 1984).

Results and Discussion

Plant height

Plant height increased with the progress of different days after planting (DAP) in all the treatments and varied significantly with variation ranged from 5.20 to 7.20 cm, 7.80 to 10.53cm and 9.50 to 13.23cm at 20 DAP, 40 DAP & 60 DAP respectively (Table 1). Irrespective of growth stages, the highest and lowest plant height was recorded in the genotype FA006 and FA002 respectively. The variation in plant height might be due to the influence of the genetical characteristics of the genotypes. At the early stage of the crop, the plant height was increased rapidly due to the favorable temperature and clear sunny days which presumably promoted the growth and development of plants.

Table 1. Plant height (cm) of strawberry at different days after planting (DAP)

Genotypes	20 DAP	40 DAP	60 DAP
FA001	5.50cd	7.80c	9.80d
FA002	5.20d	8.00c	9.50d
FA003	6.50b	9.30b	11.90b
FA004	6.00bc	9.00b	11.20c
FA005	6.20b	9.00b	11.00c
FA006	7.20a	10.53a	13.23a
LSD	0.643	0.731	0.654
CV%	4.08	3.16	2.28

In a column, means followed by common letters are not significantly different from each other at 5 % level of probability by DMRT.

Plant spread (north-south direction) (NS)

Regarding plant spread (NS), all the genotypes showed increasing trend up to 60 DAP (Table 2). At the three growth stages (20 DAP, 40 DAP & 60 DAP), the highest Plant spread (north-south direction) (NS) of 17.21cm, 24.50cm, & 28.40 cm respectively were obtained from the genotype FA005 and the lowest plant spread of 14.25 cm, 20.51 cm & 24.71 cm were recorded from the genotype FA006. The variation in plant spread (NS) might be due to the influence of the genetical characteristics of the genotypes. At the early stage of the crop, the plant spread was increased rapidly due to the favorable temperature and clear sunny days which presumably promoted the growth and development of plants.

Plant spread (east-west direction) (EW)

In case of plant spread (EW), all the genotypes also showed increasing trend up to 60 DAP (Table 3). At 20 DAP, the highest plant spread (east-west direction) (EW) of 16.50cm was found from the genotype FA001 whereas at 40 and 60 DAP, the highest plant spread (east-west direction) (EW) of 24.30 cm and 28.00cm were obtained from the genotype FA005. On the other hand, at all the growth stages, the lowest plant spread (east-west direction) (EW) of 14.00 cm, 20.11cm and 24.31 cm were respectively recorded from the genotype FA006. The variation in plant spread (east-west direction) might be due to the influence of the genetical characteristics of the genotypes. At the early stage of the crop, the plant spread (east-west direction) was increased rapidly due to the favorable temperature and clear sunny days which presumably promoted the growth and development of plants.

Table 2. Plant spread (cm) NS of strawberry at different days after planting (DAP)

Genotypes	20 DAP	40 DAP	60 DAP
FA001	16.60b	23.10b	26.12b
FA002	16.20c	23.50ab	26.00bc
FA003	15.50d	21.50c	25.30cd
FA004	15.24d	21.54c	25.15d
FA005	17.21a	24.50a	28.40a
FA006	14.25e	20.51c	24.71d
LSD	0.306	1.101	0.741
CV%	0.73	1.90	1.84

In a column, means followed by common letters are not significantly different from each other at 5 % level of probability by DMRT

Number of leaves per plant

The number of leaves per plant increased as the age of the plants increased. At all the growth stages, maximum number of leaves of 12.11, 21.21 and 40 respectively were recorded from the genotype FA003 whereas the minimum number of leaves 8.00 was recorded from the genotype FA002 at 20 DAP (Table 4). At 40 and 60 DAP, the minimum number of leaves of 16.25 and 30.00 were recorded from the genotype FA006 and FA002 respectively. The number of leaves/plant in different genotypes varied mainly due to inherent characters of the genotypes.

Table 3. Plant spread (cm) EW of strawberry at different days after planting (DAP)

Genotypes	20 DAP	40 DAP	60 DAP
FA001	16.50a	23.20c	26.11b
FA002	16.10b	23.61b	26.20b
FA003	15.10c	21.40d	25.00c
FA004	14.80c	21.00e	25.11c
FA005	15.02c	24.30a	28.00a
FA006	14.00d	20.11f	24.31d
LSD	0.325	0.385	0.3639
CV%	1.18	0.95	0.78

In a column, means followed by common letters are not significantly different from each other at 5 % level of probability by DMRT.

Days to flower initiation

Days to flower initiation differed significantly among the genotypes (Table 5). The maximum days of 81.87 were required for flower initiation by the genotype FA003 which was statistically identical to the genotypes FA005 & FA006. The minimum of 71.64 days required for flower initiation by the genotype FA004 which was statistically identical to the genotype FA002. Days to flower initiation in different genotypes varied mainly due to inherent capacity of the genotype.

Flower trusses per plant

Flower trusses per plant differed significantly among the genotypes (Table 5). The maximum flower trusses/plant of 3.94 was produced by the genotype FA004 which was statistically identical to the genotypes FA003, FA001 and FA002 (3.76, 3.79 and 3.90 respectively). The minimum of 2.49 was obtained by the genotype FA006 which was statistically identical to FA005 (2.51). Flower trusses per plant indifferent genotypes varied mainly due to inherent capacity of the genotypes. Verma *et al.* (2002) found more or less similar result. They found variation ranged from 0.89 to 2.25 in different genotypes which is lower compared to present findings because of genotypic variation and growing environment.

Table 4. Number of leaves of strawberry at different days after planting (DAP)

Genotypes	20 DAP	40 DAP	60 DAP
FA001	8.50e	16.26e	32.00e
FA002	8.00f	17.00d	30.00f
FA003	12.11a	21.21a	40.00a
FA004	10.13c	18.00c	37.00b
FA005	10.51b	18.81b	35.50c
FA006	9.11d	16.25e	33.21d
LSD	0.263	0.349	0.986
CV%	1.48	1.07	1.57

In a column, means followed by common letters are not significantly different from each other at 5 % level of probability by DMRT

Flowers/truss

Flowers/truss differed significantly among the genotypes (Table 5). The maximum number of flowers per truss of 12.73 was recorded in the genotype FA006 which was statistically identical tothe genotype FA002 (12.47). The minimum of 7.40 was produced by the

genotype FA005. Number of flowers/truss in different genotypes varied mainly due to inherent characters of the genotypes. Verma *et al.* (2002) found the number of flowers/truss ranged from 3.20 to 6.69 in different genotypes whereas the above range is 7.40 to 12.73.

Flower diameter

Flower diameters differed significantly among the genotypes (Table 5). The maximum flower diameter of 2.44 cm was recorded in the genotype FA006which was statistically identical to all other genotypes except FA005. The minimum of 1.74 cm flower diameter was recorded by the genotype FA005. Flower diameter in different genotypes varied mainly due to inherent capacity of the genotypes. This result agrees with the findings of Verma et al. (2002). They found flower diameter ranged from 1.40 cm to 2.36 cm in different genotypes.

Table 5. Floral characteristics of six strawberry genotypes

Genotypes	Days to flower initiation	Flower trusses/plant	Flowers/ truss	Diameter (cm)	
				Flower	Disk
FA001	77.11b	3.79a	11.50bc	2.43a	0.82ab
FA002	72.42c	3.90a	12.47ab	2.03ab	0.90a
FA003	81.87a	3.76a	11.21cd	1.95ab	0.66c
FA004	71.64c	3.94a	10.27d	2.38a	0.85ab
FA005	78.37ab	2.51b	7.40e	1.74b	0.70b
FA006	79.40ab	2.49b	12.73a	2.44a	0.86ab
CV%	0.22	2.15	1.79	11.23	5.11
LSD (0.05)	0.440	0.183	0.504	0.359	0.066

In a column, means followed by common letters are not significantly different from each other at 5 % level of probability by DMRT

Flower disk diameter

Flower disk diameter differed significantly among the genotypes (Table 5). The maximum flower disk diameter of 0.90 cm was found in the genotype FA002 which was closely followed by the genotypes FA004, FA006 and FA001 (0.85 cm, 0.86 cm and 0.82 cm respectively). The minimum diameter of 0.66 cm was observed in the genotype FA003. Verma *et al.* (2002) found flower disk diameter ranged from 0.31 cm to 0.65 cm which was more or less agrees with the above findings.

Individual fruit wt. (g)

As regards to the individual fruit weight, it was observed that it varied significantly among the genotypes and ranged from 8.34g to 24.70g (Table 6 and Figure 1). The maximum fruit weight of 24.70g was found from the genotype FA002 and the minimum of 8.34g was recorded in FA005 which was statistically identical to the genotype FA003 (9.72g). These results agree with the findings of Maurer and Umeda (1997). They found individual fruit weight ranged from 10.6 g to 11.63 g. The present finding is more than that of reported due to difference of genotypes and growing environment.

Table 6. Fruit characteristics and fruiting behavior in six strawberry genotypes

Genotypes	Individual fruit wt. (g)	Fruit		Number of fruits/plant
		Length (cm)	Width (cm)	
FA001	17.61b	3.52b	3.04b	17.94c
FA002	24.70a	4.26a	4.04a	25.00a
FA003	9.72cd	2.17c	2.66c	22.05b
FA004	10.25c	2.61c	2.54c	13.74e
FA005	8.34d	2.26c	1.85d	15.57d
FA006	10.37c	2.87bc	2.70c	16.48cd
CV%	3.98	9.10	12.65	3.78
LSD (0.05)	1.391	0.694	0.918	1.806

In a column, means followed by common letters are not significantly different from each other at 5 % level of probability by DMRT.

Fruit length (cm)

Fruit length differed significantly among the genotypes (Table 6). The longest fruit of 4.26 cm was recorded in the genotype FA002 which was not statistically identical to any of the genotype. The shortest of 2.17 cm fruit length was recorded in the genotype FA003 which was closely followed by the genotypes FA005, FA004 and FA006. This result agrees with the findings of Asrey and Singh (2004). They found fruit length of different genotypes ranged from 3.49 cm to 4.21 cm.

Fruit width(cm)

As regards to the fruit width, it varied significantly among the genotypes (Table 6). The maximum fruit width of 4.04 cm was recorded in the genotype

FA002 which was significantly different from rest of the genotypes. The minimum fruit width of 1.85 cm was recorded in the genotype FA005. Asrey and Singh (2004) found fruit width of different genotypes ranged from 2.91 cm to 3.40 cm which was more or less close to the present findings.

Number of fruits/plant

Fruits/plant is one of the most important yield contributing characters in all fruits and as well as strawberry. The genotypes significantly influenced the number fruits per plant where the highest 25.00 fruits per plant was observed in the genotype FA002 (Table 6) and the lowest of 13.74 was recorded in the genotype FA004.

Weight of fruits per plant (g)

Weight fruits weight/plant is also one of the most important yield contributing characters in all fruits and as well as strawberry. The genotypes significantly influenced the fruits weight per plant (Table 7). The maximum weight of 442.50 g per plant was recorded in the genotype FA002 and the minimum of 129.85 g was recorded in the genotype FA005 which was significantly different from rest of the genotypes. This was might be due to the inherent control of the genotypes.

Yield per hectare (t)

The genotypes exerted significant influence on the strawberry yield per hectare (Table 7). Among the entries, the genotype FA002 produced the highest strawberry yield of 22.78 t per hectare which was significantly superior to any of the genotype (Table 7). The lowest yield of 7.05 t per hectare was obtained from the genotype FA005 which was closely followed by the genotype FA004. This result was supported by the findings of Legard *et al.* 2000. Among three cultivars, they found yield of strawberry per hectare ranged from 14.81 ton to 22.38 t.

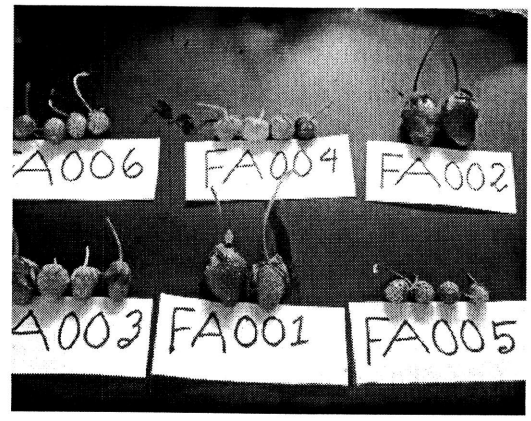

Fig.1. Fruit characteristics of different genotypes of strawberry.

Fig. 2. The genotype FA002 produced plenty of fruits in the Horticulture Farm of BSMRAU.

Table7. Yield and yield contributing characteristics in strawberry

Genotypes	Weight of fruits per plant (g)	Yield per ha (t)	Fruit TSS (%)
FA001	315.92b	16.68b	12.37b
FA002	442.50a	22.78a	13.44a
FA003	214.33c	11.67c	10.00c
FA004	140.84d	7.83d	9.44cd
FA005	129.85e	7.05e	8.57d
FA006	170.90d	9.17d	9.94c
CV%	4.24	8.51	7.93
LSD (0.05)	25.85	8.636	1.248

In a column, means followed by common letters are not significantly different from each other at 5 % level of probability by DMRT.

Fruit TSS (%)

A significant variation was observed regarding the TSS (%) among the genotypes (Table 7). The highest (13.44 %) TSS was recorded from the genotype FA002 which was not statistically similar to any of the genotypes. The minimum fruit TSS per cent of 8.57 was recorded in the

genotype FA005 which was statistically identical to the genotype FA004. Fruit TSS per cent varied mainly due to inherent control of the genotypes. Anon (2010) found fruit TSS per cent of strawberry ranged from 8.5 to 11.0 in different genotypes including BARI Strawberry-1 which was more or less supported by the above findings.

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