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Varietal screening of strawberry (*Fragaria* x *ananassa* Duch.) under open field condition for fruit quality and yield in plain region of Chhattisgarh, India

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Abstract
The experiment was conducted at Horticulture Farm, Pt. K.L.S., College of Horticulture Rajnandgaon, IGKV, Raipur (C.G) to screen out the yield and quality character of different strawberry cultivars in Chhattisgarh plain. The experiment was conducted with six treatments and four replications in Randomized Block Design (R.B.D.). The treatments were six varieties, T1 (Nabila), T2 (Rania), T3 (Kamila), T4 (Camarosa), T5 (Flavia) and T6 (Flaminia). Results revealed that the highest fruit yield to the tune of 35.40 t/ha were produced by Nabila followed by Camarosa and Kamila. T.S.S., total sugar and reducing sugar was highest in Nabila, Rania, and Flavia respectively. Maximum ascorbic acid and acidity content was obtained by Camarosa followed by Flaminia.

Keywords: Strawberry, yield, quality, Nabila, Camarosa, Kamila

Introduction
The modern cultivated strawberry (*Fragaria x ananassa* Duch.) is a hybrid of two largely dioecious, octoploid species, *Fragaria chelonesis* Duch and *Fragaria virginiana* Duch. Basically, it is herbaceous perennial and short-day plant grows predominantly in the temperate climate. It is amongst the few crops, which gives quick and very high returns per unit area on the capital investment, as the crop is ready for harvesting within six months of planting (Bakshi *et al.*, 2014) [1]. The major constituents of strawberry oil are linalool and nonanal (Khanizdeh and Belanger, 1997) [4]. In strawberry ellagic acid (naturally occurring plant phenol) has been found to inhibit cancer disease. The regular consumption of this fruit also controls Asthma (Mangal, 1998) [6]. The red colour of the fruit is mainly due to the presence of an anthocyanin, i.e., pelargonidin 3- monoglucoside and traces of cyanidin (Mitra, 1991) [7] and is consumed not for the food value but for the flavor. Besides dessert purpose, strawberries are processed into various value-added products, canned strawberry, jam, jelly, ice-cream, freeze strawberry, wine and other soft drinks. The fresh ripe fruits of strawberry are the rich source of vitamins and minerals and among vitamins it is a fairly good source of vitamin-A (17 IU) and vitamin-C (84.7 mg/100g). Strawberry is grown throughout the world but the United States is the world's largest producer of strawberries, producing nearly 1.3 million metric tons in 2010 and accounting for 30 percent of the total world strawberry production (Morgan, 2012) [9].

Strawberry is a less known crop for Chhattisgarh region. It is grown only in Ambikapur and Surajpur district with production 12.50MT and 12.00MT respectively. In Chhattisgarh strawberry is a new crop to farmers or growers and its cultivation practices are very specific to take commercially, like selection of suitable variety, timing of the planting of the runners, nutrient requirement, water applications, weed, disease and pest management, So there is a need to standardize cultivation practices according to climate zone of Chhattisgarh, which help farmers to cultivation on commercial level.

There is a considerable variation among different strawberry cultivars regarding their adaptability to a particular set of agro-climatic conditions. In strawberry cultivation, fruit quality in terms of morphology and chemical composition is of prime importance and is greatly influenced by the weather conditions. The quality of strawberry is determined by its taste, flavour, texture, size, shape, gloss and skin colour, storage and transportability (Mochizuki, 1991) [8].

Materials and Methods

The experiment was conducted at Horticulture Research Farm Pt. Kishori Lal Shukla College of Horticulture and Research station Rajnandgaon (C.G.) from October 2016 to March 2017. Geographically, it is located at 17°14'N - 24°45'N latitude and 79°30'E - 84°15'E longitude. Rajnandgaon situated on the bank of Shivnath and falls between 21°06'N latitude and 81°02' E longitude at an altitude of 307 meter above the mean sea level.

The experimental material comprised of 6 varieties of Strawberry *viz*., Nabila (T1), Rania (T2), Kamila (T3), Camarosa (T4), Flavia (T5) and Flaminia (T6)., were used as planting material. The sapling of all 6 varieties of Strawberry was planted in a randomized block design with four replications. The planting of experimental material was done on 20 October, 2016. Recommended fertilizer and other cultural package of practices were adopted for better crop growth.720 vigorous, healthy, free from diseases, insect-pest and well rooted propagation material were selected to planting for the experiment. All plants were kept with uniform cultural practices, i.e. fertigation and irrigation. Five random competitive plants were selected from each plot and following observation were recorded. The average value of each observation was calculated on the basis of five plants for each cultivar in every replication.

Five fruits from each plot were selected for quality analysis. Fruit length and diameter was measured with the help of Vernier calipers, whereas, fruit weight was taken with the help of electronic balance. The yield of fruits per plant of each plot was multiplied with the number of plants per hectare, which was calculated on the basis of survival per cent of plants for that particular plot. Total soluble solids were recorded from the juice obtained from randomly selected fruits from all the varieties in each replication with the help of hand refractometer of 0–32º B range. Level of acidity was calculated by titration method by using phenolphthalein indicator. Total sugars were determined by Shaffer-Somogyi micro method (Ranganna, 1991) [12]. Reducing sugar was determined by Lane and Eynon method. These data were subjected to statistical analysis following standard procedures (Panse and Sukhatme, 1989) [11].

Research findings and discussion

The finding of the trial of different quality and yield parameters are presented under the following heads:

Fruit weight (g)

The table 1 was shown that the heaviest fruits were harvested from treatment Nabila (26.02) which was found statistically at par with Kamila (25.61) and Camarosa (22.43) and Flaminia (22.25) whereas lightest fruits were produced by Rania (14.85). According to Morgan (2006) [10], the final size and shape of the berry depend on the number of achenes formed, which is determined by pollination and fertilization during blooming.

Fruit length (cm)

The data (Table 1) showed significant variation in the length of fruits among the varieties. Nabila was found to have the longest fruit (4.36 cm) though being at par with Kamila (4.04 cm) while Rania had the shortest length (3.12 cm). The variations in the size of the fruit might be due to differential genetic make of the genotypes. This observation finds support from the findings of Dwiwedi *et al.* (2004) [3] in the cold condition of Ladakh.

Fruit diameter (cm)

The data presented in Table 1 showed that the average fruit diameter varied significantly among the cultivar. The maximum diameter (3.34) was recorded in Kamila, which were statistically similar to Nabila (3.16) and Camarosa (3.05) and the lowest (2.52) was in Flavia. This difference in the diameter of fruits may be due to the capacity of fruits to accumulate assimilates.

T.S.S. (°Brix)

Result showed (Table 1) that good quality fruit with higher TSS was found in Nabila (12.00 %) followed by Rania (11.58 %) whereas lowest TSS was noted in the Camarosa (9.5). The soluble solids content was more dependent on environmental condition during growth and development than genetic inheritance in strawberry (Shaw, 1990) [16].

Ascorbic acid (mg/100g)

The cultivars Camarosa and Flaminia were statistically superior than other cultivars in terms of ascorbic acid content whereas the lowest ascorbic acid content were recorded by Rania and Kamila cultivars (Table 2). The oxygen concentration which is more in the lower altitude of the earth caused oxidation of more ascorbic acid, consequently fruits showed decreased ascorbic acid content in comparison to the fruits obtained and analyzed at higher altitude. In this support reported that strawberries grown at higher altitude (860 m) have higher ascorbic acid content.

Acidity (%)

The data presented in Table 1 showed that the highest acidity was recorded in Camarosa (0.80) followed by Flaminia (0.71) while Nabila (0.58) had the lowest acidity percent. The possible explanation for lower acidity in strawberry may be due to difference between day and night temperature which are very narrow, whereas cooler nights and warmer days are helpful in synthesizing more acidity noticed by Wani *et al.*, (2007) [17].

Total sugars (%)

The marked response in total sugar percent was obtained by Nabila (7.12) which was statistically at par with Rania (6.91) and Flavia (6.53). Whereas the lowest content was recorded in Camarosa (4.98) and which had a close proximity with the findings of Belakhud *et al*. (2015) [2] who observe that cultivar Belrubi had highest percent of total sugar while minimum percent in Phenmenal.

Reducing sugars (%)

The data presented in Table 1 showed that the highest percentage (6.27) of reducing sugar was observed in the treatment Nabila which was statistically at par with Rania (6.14), Flaminia (5.88), Flavia (5.87) and Kmila (5.75). Significantly lowest percentage (4.52) of reducing sugars was observed in the treatment Camarosa. Lower content of reducing sugar in all the treatments was due to high temperature (increased respiration) and geographical situation of the experimental site (located at lower altitude). Once again, who reported that strawberries grown at higher altitude had higher sugar content, comes in the support of the above finding.

B:C ratio

B:C ratio of all cultivars were significantly different with Nabila (4.21) the highest, followed by, Camarosa and Kamila

whereas minimum B:C ratio was recorded in Rania (1.17) (Table 1) which was higher from the findings of Das *et al.* (2015) who observe that cultivar Festival (2.92) had maximum B:C ratio while minimum B:C ratio in (2.33) at Bihar condition. Benefit cost ratio could be seems highest due to the better utilization of climatic environment and photoperiod.

On the basis of results, it is concluded that out of six cultivar, the cultivar Nabila resulted in higher yield with better size fruits. Maximum TSS percent, total sugar percent and reducing sugar percent recorded in Nabila; simultaneously Nabila also showed lowest acidity percent among the treatment, while maximum ascorbic acid was observed in Camarosa whereas minimum ascorbic acid was recorded in Rania. The treatment that gave highest yield of marketable fruits, among treatment i.e. Nabila economically profitable in respect of net realization and higher B:C ratio (4.21).

Table 1: Varietal screening of strawberry (*Fragaria* x *ananassa* Duch.) under open field condition for fruit quality and yield in plain region of Chhattisgarh, India

Treatment	Fruit weight (g)	Fruit length (cm)	Fruit diameter (cm)	T.S.S. (°Brix)	Ascorbic acid (mg/100g)
T1	26.02	4.36	3.16	12.00	77.35
T2	14.85	3.12	2.75	11.48	61.88
T3	25.61	4.04	3.34	10.10	69.02
T4	22.43	3.52	3.05	9.5	83.30
T5	17.74	3.71	2.52	11.10	71.40
T6	22.25	3.75	2.78	9.9	80.92
SEm±	1.87	014	0.15	0.60	2.00
CD at 5 %	5.70	0.44	0.46	1.83	6.08

Table 2: Varietal screening of strawberry (*Fragaria* x *ananassa* Duch.) under open field condition for fruit quality and yield in plain region of Chhattisgarh, India

Treatment	Acidity (%)	Total sugars (%)	Reducing sugars (%)	Yield per hectare (tone)	B:C ratio
T1	0.58	7.12	6.27	35.40	4.21
T2	0.62	6.91	6.14	14.82	1.1775
T3	0.65	6.29	5.75	27.83	3.09
T4	0.80	4.98	4.52	27.92	3.1025
T5	0.64	6.53	5.87	19.24	1.825
T6	0.71	6.12	5.88	23.75	2.49
SEm±	0.02	0.22	0.23	3.40	0.45
CD at 5 %	0.06	0.69	0.71	10.35	1.38

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