SHORT COMMUNICATION

Varietal Screening of Strawberry (*Fragaria* x *ananassa* Duch.) under Organic Production System for Fruit Quality and Yield in Mid-Hills of Sikkim Himalayas

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Experiments were conducted at ICAR Sikkim Centre, Tadong at an elevation of 1400 m amsl during 2006–09 to study the performance of 11 strawberry varieties in the mid-hills of Sikkim Himalayas. Observations on vegetative parameters, fruit quality and yield were recorded for the selected varieties. The highest fruiting stalk/plant (11.67) was recorded in Chandler followed by Ofra (10.87). Maximum number of runners were in Hasta and Etna (14 and 14, respectively). Fruits/inflorescence were highest in Seascab (7.67). Fruit diameter was highest in Blackmore (3.30 cm) followed by Ofra (3.16 cm) whereas the fruit length was longest in Ofra and Chandler (4.97 and 4.94 cm, respectively). Maximum fruit weight (20 g) was recorded in Ofra. Highest TSS (7.20%) and total sugar (6.18) were recorded in Elsanta. Lowest acidity (0.89 %) was observed in Chandler followed by Ofra and Selva. Highest yield (37.2 t/ha) was recorded in Ofra, and the maximum marketable yield and B:C ratio were recorded in Chandler (32.6 t/ha and 2.26, respectively).

Key Words: *Fragaria x ananassa*, Fruit quality, Fruit yield, Mid hills, Varietal screening, Sikkim

Sikkim is an entirely hilly state of India where settled agriculture is practiced in 10% of its total geographic area out of 14.9% cultivable area (Lama, 2007). Horticulture occupies a dominant position with mandarin, ginger and large cardamom as the main cash crops. Majority of farmers are categorized as small and marginal operating and also low input production system with low productivity and hence, resource poor. Strawberry can be easily cultivated up to 3000 m amsl elevation (Sharma, 2002) under open/ protected conditions especially with the advantages of being a low volume, high value crop that can be expected to significantly increase the household level income. Among the fruit crops, strawberry gives the quickest return in the shortest possible time. Strawberry fruits are in great demand by fruit processing industries owing to its distinct flavour/aroma, richness in vitamin C and minerals. Although, strawberry is a crop of temperate regions of the world, its cultivation has been extended to subtropical regions of India (Sharma and Yamadagni, 2000). There is a considerable variation among different strawberry cultivars regarding their adaptability to a particular set of agro-climatic conditions (Sharma and Thakur, 2008). 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). Strawberry has not been very popular as an alternate cash crop amongst the farmers of Sikkim owing to non-availability of location specific planting material and standardized package of practices. Therefore, suitable varieties need to be identified for different climatic conditions. In the present study, an attempt has been made to evaluate different strawberry varieties suitable for the mid-hill temperate region of Sikkim.

Eleven strawberry varieties *viz.*, Ofra, Chandler, Selva, Hasta, Red Coat, Etna, Belruby, Seascab, Dana, Blackmore and Elsanta were evaluated during 2005–09 at ICAR Farm at Tadong, Gangtok, at an altitude of 1400 m amsl. The field experiments were laid out in a randomized block design with three replications, in a plot size of 2 x 3 m^2 with 20 plants of uniform health and vigour. The soil of the location is well drained with pH 5.3, O.C. 1.36%, available nitrogen-221.8 kg/ha (alk. $KMnO_4$), available P_2O_5–28.5 kg/ha (Bray P_1) and available K-194.7 kg/ha. Transplanting was done in the first week of September at the spacing of 30 x 45 cm and 15 t/ha fully rotten FYM and 5 t/ha neem cake was applied as basal dose. Regular drenching of plants with diluted cow urine @ 20 % was done after one month of transplanting at fortnightly interval.

Data was recorded for quality parameters with randomly selected 10 fruits/plant. Fruit length and breadth was measured with vernier callipers. The weight of the representative fruits of each variety was recorded. The

marketable yield was calculated by subtracting damaged fruits during or prior to harvest from the total fruit yield. Total soluble solids were recorded from the juice obtained from randomly selected fruits from all the varieties in each replication with the help of refractometer of 0–32°B range. Level of acidity was calculated by titration method. TSS/acid ratio was determined by dividing acidity with TSS values. Total sugars were determined by Shaffer-Somogyi micro method (Ranganna, 1991). The data were analysed statistically following the method of Panse and Sukhatme (1985). The mean of attributes were compared by paired 't' test and the standard error of mean (SEM) was calculated at 5% level of probability. Net profit of cultivation was calculated by subtracting cost of cultivation from gross profit and B:C ratio was estimated. The market price of the fruits was fixed @ Rs 100/kg.

The study revealed significant differences among the varieties for different traits such as fruiting stalk/plant, fruits/inflorescence, runners/plant, fruit diameter, fruit length, fruit weight, TSS, acidity, total sugar, yield and marketable yield. Maximum number of fruiting stalks/plant were in Chandler (11.67) which was at par with Ofra (10.87) with significant difference in the fruit stalks of all other varieties. The minimum number of fruiting stalks/plant were in Blackmore (2.67) which was at par with Hasta (3.33). The highest number of fruits/inflorescence was observed in Seascab (7.67) which was at par with Blackmore, Elsanta, Ofra and Chandler while the lowest number of fruits/inflorescence was reported in Dana (3.23). Maximum number of runners was produced by Hasta and Etna (14) which were significantly higher than other treatments except Belruby (12.67). The minimum number of runners was seen in Blackmore (3.76). The highest fruit diameter was recorded for Blackmore (3.3 cm) and the lowest (2.12 cm) for Selva. The longest fruits were in Ofra (4.97 cm) and the shortest fruits were in Seascab (2.57 cm). Ofra (20.0 g) produced the heaviest fruits whereas Belruby produced fruits with lowest fruit weight (12.02 g). TSS was highest in Elsanta (7.20%) which significantly differed from the other varieties while

Table 1. Varietal performance of strawberry for yield attributing traits

Varieties	Fruiting stalks/plant	Fruits/inflorescence	Runners/plant	Fruit diameter (cm)	Fruit length (cm)	Fruit weight (g)
Ofra	10.87	7.12	4.00	3.16	4.97	20.00
Chandler	11.67	6.87	4.00	2.37	4.94	18.10
Selva	4.00	5.95	4.00	2.12	4.63	12.60
Hasta	3.33	5.50	14.00	2.57	4.13	14.20
Red Coat	7.00	6.10	11.33	2.36	4.16	16.06
Etna	4.00	5.95	14.00	2.33	3.43	10.00
Belruby	6.67	5.07	12.67	2.60	4.27	12.02
Seascab	6.00	7.67	4.67	2.23	2.57	14.01
Dana	8.00	3.23	5.00	2.83	4.27	11.50
Blackmore	2.67	7.35	3.67	3.30	4.33	15.10
Elsanta	7.00	7.10	4.33	2.55	3.97	19.00
SEM±	0.68	0.47	0.86	0.27	0.27	0.35
LSD (P = 0.05)	1.42	0.98	1.79	0.57	0.57	0.72

Table 2. Performance of strawberry varieties for fruit quality, yield and economics

Varieties	TSS %	Acidity %	Total Sugar (%)	TSS:acid Ratio	Yield (t/ha)	Marketable yield (t/ha)	Net profit (Rs in lakhs)	B:C Ratio
Ofra	6.30	0.96	3.67	6.56	37.20	26.70	16.70	1.67
Chandler	6.60	0.89	4.05	7.42	36.30	32.60	22.60	2.26
Selva	6.50	1.02	4.31	6.37	7.32	5.80	–4.20	–0.42
Hasta	6.10	1.21	4.11	5.04	7.74	6.10	–3.90	–0.39
Red Coat	6.20	1.15	4.00	5.39	18.96	15.20	5.20	0.52
Etna	6.70	1.06	4.92	6.32	8.16	5.85	–4.15	–0.42
Belruby	5.10	1.18	3.57	4.32	12.96	11.05	1.05	0.11
Seascab	5.30	1.16	3.14	4.57	12.66	9.85	–0.15	–0.02
Dana	6.20	1.25	4.34	4.96	12.30	9.40	–0.60	–0.06
Blackmore	5.70	1.15	3.16	4.96	17.34	14.60	4.60	0.46
Elsanta	7.20	1.20	6.18	6.00	27.60	22.60	12.60	1.26
SEM±	0.14	0.08	0.10	–	0.43	0.49	–	–
LSD (P=0.05)	0.29	0.17	0.22	–	0.89	1.02	–	–

the lowest was recorded in Belruby (5.10%). The findings of TSS are not in conformity with those of Singh *et al.* (2008) where TSS was to the tune of 12.8^{0}B but similar to the findings of Sharma (2002) who reported TSS of 7.8^{0}B in Chandler. Lower TSS content of the varieties may be due to the high relative humidity during the fruit growth, development and ripening period. The lowest acidity was recorded in Chandler (0.89%) and the highest in Dana (1.25%). Good quality fruit with higher TSS/acid ratio was in Chandler (7.42 %) followed by Ofra (6.56 %). Similar varietal differences in acidity were reported by Chandel and Badiyala (1996) and Singh *et al*. (2008). The highest total sugar was observed in Elsanta (6.18%) while the lowest was in Seascab (3.14 %). These findings on varietal differences in total sugar were similar to those reported by Mondal *et al.* (2001), Sharma and Thakur (2008) and Singh *et al*. (2008). The highest fresh fruit yield was recorded for Ofra (37.2 t/ha) which was significantly higher than all other varieties and the lowest was in Selva (7.32 t/ha). Among all the varieties, the highest marketable yield was observed in Chandler (32.60 t/ha) which was significantly different from other varieties. The lowest marketable yield was recorded in Selva (5.80 t/ha). These findings are in conformity with those reported by Mondal *et al.* (2001) and Sharma and Thakur (2008).

Cultivation cost of the strawberry production includes the cost of planting material, manure, field preparation, mulch material, packing material and the labour. Maximum net profit (Rs. 22.6 lakh/ha) was recorded for Chandler followed by Ofra (Rs. 16.7 lakh/ha) and Elsanta (Rs. 12.6 lakh/ha) whereas negative return was recorded for Selva, Hasta, Etna, Seascab and Dana. The highest B: C ratio was in Chandler (2.26) followed by Ofra (1.67) and Elsanta (1.26). Financial loss in production was observed with Selva, Hasta, Etna, Seascab and Dana.

Chandler and Ofra were identified as the varieties that could be profitable under the mid-hill conditions of Sikkim. Both the varieties can be promoted amongst the resource poor farmers of the state which could considerably increase monetary benefits through strawberry cultivation at the household level.

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