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Response of Strawberry Cultivars to Different Planting Dates and Growing Conditions in Jorhat, Assam

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ABSTRACT

Background: Strawberry has started gaining attention in the Assam region since past few years. But, due to sufficient knowledge in varieties and cultivation package, farmers were not able to yield satisfying results.

Methods: In this context, an experiment was conducted to study the performance of various strawberry varieties namely Sabrina, Winter Dawn, Chandler, Sweet Charlie, Cristal, Selva and Camarosa with different dates of planting like 1st November, 15th November, 1st December and 15th December under open conditions and fifty per cent shade net conditions.

Result: Results revealed that the Variety Sweet Charlie was found to have the highest values of Anthocyanin content (21.07 mg/100 g and 18.71 mg/100 g), total soluble solids content (7.62°Brix and 6.88°Brix) and Total sugars (6.07% and 4.60%) in both the growing conditions. In addition Sweet Charlie also showed impressive results amongst the varieties in calcium content (9.51 mg/100 g and 9.41 mg/100 g) and Phosphorus content (1.15 mg/100 g and 1.09 mg/100 g) in open conditions and fifty percent shade net conditions respectively. Finally, the best variety found was Sweet Charlie and the best date of planting was found to be the 15th of November which showed highest values of all the biochemical parameters along with the mineral content.

Key words: Chandler, Strawberry, Sweet charlie, Winter Dawn.

INTRODUCTION

Strawberry (*Fragaria ananasa* Duch.) is one of the most attractive fruit widely grown all over the world due to the acceptance for its sweet flavour, aroma and nutritional values. It belongs to the family Rosaceae and is native of America. The fruit is popular for its tantalizing aroma (Sharma and Yamdagni, 2000), eye-catching colour, nutrient compositions and worthy pharmaceutical properties (Rahman *et al*., 2015).

Strawberry basically, is a fruit plant of temperate climate. However, in recent years, there has been phenomenal increase in its area and production in tropical and subtropical plains of India (Sharma and Sharma, 2004). Moreover, after the entry of the day neutral cultivars this crop had made a successful trade in the tropical and sub tropical regions also (Sharma *et al*., 2003). It is consumed as raw and also processed for preparing jams, jellies, squashes, ice creams, canned strawberry, wine and other soft drinks (Mitra, 1991; Joshi *et al*., 2005). Assam has also recently found to have some good results with future prospect for the crop. But, the available information for the suitable cultivars in Assam conditions is very scanty. Choice of cultivars is of paramount importance for successful strawberry cultivation (Asrey and Singh, 2004; Ahsan *et al*., 2014).

Due to inadequate information on specific growing conditions and suitable cultivars, its commercial cultivation could not become popular in a state like Assam. Under these circumstances, an experiment has been conducted to evaluate the best cultivar, date of planting and growing environment for Assam conditions.

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MATERIALS AND METHODS

The present experiment was carried out in the Experimental Farm, Department of Horticulture, Assam Agricultural University, Jorhat (26°44′N and 94°10′S with 90 m above mean sea level) during the year 2015-16 to 2016-17. The soil of the experimental plot was a sandy loam having pH of 5.06. The study was conducted with 07 (seven) treatments *viz*. T_1- Sabrina, T_2- Winter Dawn, T_3- Chandler, T_4- Sweet Charlie, T_5- Cristal, T_6- Selva, T_7- Camarosa and 04 (four) planting dates *viz*. S_1-1st November, S_2-15th November, S_3-1st December, S_4-15th December under open field conditions and protected conditions (50% shade net condition). The experiment was laid out in split plot design with three replications. Healthy tissue cultured planting materials with

uniform crown and well developed root systems were planted in Hill row system in 15-20 cm raised beds with spacing of 30 cm × 60 cm. The outer leaves were pinched off and coco peats of the roots of the seedlings were washed properly.

The experimental area (open condition and 50 per cent shade net house) was thoroughly ploughed followed by harrowing and levelling. For one date of planting seven equal sized plots each measuring 90 cm × 180 cm were laid out accommodating nine plants in each plot. Each treatment contained three number of replication accommodating nine plants in each plot. A gap of 50 cm was left between two adjacent plots. 05 (Five) uniformly grown plants in each plot were selected to record the observations on some biochemical parameters like total soluble solids (TSS), titrable acidity (%), ascorbic acid (mg/100 g), total sugars (%), reducing sugars (%), non- reducing sugars (%), calcium and phosphorus. Observations were recorded at proper time during the crop cycle.

RESULTS AND DISCUSSION

The results of the experiment are detailed as below along with the supported tables.

Anthocyanin

Anthocyanin is one of the most important compounds which determine antioxidant activity in strawberries. It depends on many factors, like choice of cultivar, agricultural conditions, light availability, nitrogen content in soil, degree of fruit ripeness and storage temperature (Bacchella *et al*., 2009; Roussos *et al*., 2009). In this study, significant variation was found among the varieties (Table 1). Maximum mean values for anthocyanin content was found in variety Sweet Charlie, both in open conditions as well as in 50% shade net conditions. To be precise, highest value was evident in case of the second date of planting *i.e* 15th November (S_2) in open conditions (21.88 mg/100 g) and 50% shade net conditions (19.55 mg/100 g) with the lowest values in the variety Chandler in S_4 (13.39 mg/100 g in open conditions and 13.04 mg/100 g in 50% shade net). This variation in anthocyanin might be due to the genetic factors and edaphic-climatic factors and degree of maturity. Wang and Hsin-Shan, (2000) also reported that total anthocyanin content in strawberry increased with maturity.

Total soluble solids (TSS)

Pertaining to the Table 2, it was understood that the changes in TSS followed the trend of increasing with the advancement of maturity and ripening. Fruits under the experiment showed considerable variation with respect to TSS ranging between 7.86°Brix to 4.17°Brix. In open condition the highest (7.6°Brix) and the lowest (5.26°Brix) contents were recorded in Sweet Charlie (V_4) and Camarosa (V_7), respectively. Again in 50 per cent shade net condition the highest TSS (6.88°Brix) is recorded in Sweet Charlie and lowest (5.64°Brix) was recorded in Camarosa variety. Whereas, the highest mean values in case of date of planting was found highest in S_2 (6.64°Brix in open conditions and 6.39 °Brix in 50% shade net conditions) and lowest in S_4 (6.26 °Brix in open conditions and 6.04°Brix in 50% shade net conditions) for both the conditions.

The variation in TSS contents might be due to genetic makeup of the varieties of strawberry. The results found are in line with the experiments of Bakshi *et al.,* (2014). Moreover, Rahman, (2014) also reported that TSS content of fruits was highly influenced by interaction effect of time of planting and cultivars and found that fruits of early planting contained more TSS than late planting which might be due to the exposure of favourable environment and getting enough time for sugar and acid accumulation in early planting. The favourable temperature and relative humidity especially in night during fruit growth and ripening period might have led to higher TSS contents in strawberry fruits (Sharma and Sharma, 2002).

Titratable acidity

In the present study (Table 3), significant differences were observed among the treatments. Under open conditions, highest mean values were recorded for Chandler (0.61%) and lowest for Sweet Charlie, Cristal and Camarosa which

Table 1: Effect of date of planting and strawberry varieties on anthocyanin (mg/100 g) content.

Treatments	Open condition					50% Shade vet condition				
	S_1	S_2	S_3	S_4	Mean	S_1	S_2	S_3	S_4	Mean
T_1	20.46	20.87	20.75	19.09	20.29	17.40	17.27	17.32	15.48	16.87
T_2	20.53	20.82	20.45	18.96	20.19	17.63	17.94	17.85	15.82	17.31
T_3	16.55	15.84	15.84	13.39	15.41	13.95	14.00	13.77	13.04	13.69
T_4	21.08	21.88	21.43	19.88	21.07	19.13	19.55	19.43	16.75	18.71
T_5	20.10	20.98	20.35	18.99	20.10	17.47	18.07	17.74	15.67	17.24
T_6	19.94	20.67	20.33	19.08	20.00	18.25	18.34	17.65	15.57	17.45
T_7	20.03	21.05	20.92	19.67	20.42	17.08	17.73	17.87	16.07	17.19
Mean	19.81	20.30	20.01	18.44	-	17.27	17.56	17.38	15.48	-
			SEd (±)	**CD (P=0.05)**				**SEd (±)**	**CD (P=0.05)**	
V × S			0.61	1.23				0.60	1.20	
V at the same level of S			0.33	0.67				0.26	0.52	
S at the same or different levels of V			0.39	0.79				0.26	0.52	

Table 2: Effect of date of planting and strawberry varieties on total soluble solids (°Brix) content.

Treatments	Open condition					50% Shade net condition				
	S_1	S_2	S_3	S_4	Mean	S_1	S_2	S_3	S_4	Mean
T_1	6.93	7.06	6.95	6.73	6.92	6.67	7.02	6.77	6.60	6.78
T_2	6.88	6.82	6.76	6.72	6.79	6.57	6.71	6.30	6.13	6.43
T_3	5.96	6.43	6.03	5.90	6.08	5.67	6.30	5.60	5.47	5.76
T_4	7.56	7.86	7.58	7.47	7.62	6.93	7.07	6.77	6.80	6.88
T_5	5.93	6.28	6.17	6.67	6.26	5.80	6.11	5.93	5.70	5.89
T_6	6.24	6.32	6.33	6.17	6.26	6.10	6.09	5.97	5.93	6.02
T_7	5.47	5.71	5.68	4.17	5.26	5.33	5.40	6.17	5.67	5.64
Mean	6.42	6.64	6.50	6.26		6.15	6.39	6.21	6.04	
			SEd (±)	**CD (P=0.05)**				**SEd (±)**	**CD (P=0.05)**	
V × S			0.61	1.22				0.59	1.19	
V at the same level of S			0.32	0.64				0.20	0.41	
S at the same or different levels of V			0.23	0.47				0.15	0.31	

Table 3: Effect of date of planting and strawberry varieties on titrable acidity (%) content.

Treatments	Open condition					50% Shade net condition				
	S_1	S_2	S_3	S_4	Mean	S_1	S_2	S_3	S_4	Mean
T_1	0.61	0.56	0.61	0.59	0.59	0.61	0.62	0.59	0.61	0.60
T_2	0.59	0.56	0.59	0.59	0.58	0.63	0.59	0.61	0.64	0.62
T_3	0.64	0.58	0.62	0.61	0.61	0.65	0.61	0.61	0.62	0.62
T_4	0.54	0.52	0.54	0.52	0.53	0.55	0.53	0.54	0.54	0.54
T_5	0.55	0.53	0.53	0.52	0.53	0.58	0.56	0.58	0.57	0.57
T_6	0.58	0.56	0.58	0.56	0.57	0.58	0.58	0.58	0.58	0.58
T_7	0.55	0.53	0.51	0.51	0.53	0.58	0.54	0.55	0.57	0.56
Mean	0.59	0.56	0.57	0.56		0.59	0.57	0.57	0.59	
			SEd (±)	**CD (P=0.05)**				**SEd (±)**	**CD (P=0.05)**	
V × S			0.58	1.16				0.58	1.16	
V at the same level of S			0.01	0.02				0.01	0.02	
S at the same or different levels of V			0.02	0.03				0.01	0.02	

were at par with 0.53%. In case of 50% shade net conditions, variety Winter Dawn and Chandler recorded highest Titrable acidity with 0.62% and lowest was found in case of Sweet Charlie (0.54%). The findings are in line with that of Bakshi *et al.,* (2014). Probably lower acidity might be due to the difference between day and night temperatures which were very narrow. Similar opinion was also put forwarded by Wani *et al.,* (2007).

Ascorbic acid

It is one of the most important components which determine the quality of a strawberry fruit. The data on ascorbic acid content (Table 4) revealed that the varieties under the study differed significantly. In both the growing conditions, highest mean value was found in Cristal (30.29 mg/100 g in open conditions and 26.19 mg/100 g in 50% shade net conditions) whereas, lowest values are observed in Sweet Charlie (25.24 mg/100 g and 19.96 mg/100 g). The results of present study are more or less in close proximity with the report of Bakshi *et al.,* (2014). Lee and Kader, (2000) reported that the ascorbic acid content in fruits and vegetables is affected by many factors, such as genotypic differences, climatic conditions, cultivation and fruit ripening conditions and the time of storage. Date of planting also recorded a notable difference pertaining to the ascorbic acid content. Highest value was found when planted in 15th November (S_2) by the variety Cristal (31.59 mg/100 g) and lowest when planted in 15th December (S_2) by the variety Sweet Charlie (22.67 mg/100 g) under open field conditions. Similar trend was followed in case of 50% shade net conditions as well. Highest value was found for S_2 whereas and S_4 recorded the lowest in Cristal (27.55 mg/100 g) and Sweet Charlie (21.36 mg/100 g) respectively.

Sugars

In the present experiment, significant variations were observed in the percentages of total sugar, reducing sugar and non reducing sugar among the varieties. The highest value of total sugar (7.01% and 5.43%), reducing sugar (3.81% and 2.96%) and non reducing sugars (3.88% and 2.63%) were observed in Sweet Charlie (T_4) in both open and 50 per cent shade net conditions. The variation in sugar

contents might be due to the varied rates of hydrolysis of starch into soluble sugars such as glucose, sucrose and fructose. The results are in line with the experiments of Jami *et al.,* (2015). In addition, sugar content in strawberries differ not only due to cultivar, but also depends on cultivation conditions, such as irrigation (which is particularly important in blossoming phase and fruit setting phase), fertilization (mainly NPK), as well as the health condition of the plantation from the Table 5, 6 and 7 it is clearly evident that there are significant differences among the different dates of planting.

Table 4: Effect of date of planting and strawberry varieties on sscorbic acid (mg/100 g) content.

Treatments	Open condition					50% Shade net condition				
	S_1	S_2	S_3	S_4	Mean	S_1	S_2	S_3	S_4	Mean
T_1	27.89	29.24	29.10	24.93	27.79	24.16	25.95	26.00	22.22	24.58
T_2	28.55	28.77	28.51	24.20	27.51	23.89	25.06	25.42	21.49	23.97
T_3	29.62	29.55	29.79	30.11	29.77	25.06	25.78	25.51	22.81	24.79
T_4	25.59	25.72	25.10	22.67	25.24	19.78	19.28	19.01	21.36	19.96
T_5	30.21	31.59	30.91	28.43	30.29	26.96	27.55	27.45	22.79	26.19
T_6	29.79	31.27	31.25	27.63	29.98	23.94	24.33	24.17	21.51	23.49
T_7	29.85	31.21	30.35	24.56	28.52	24.37	24.68	24.23	21.79	23.66
T_1	28.79	29.62	29.29	26.08		24.02	24.66	24.54	21.99	
			SEd (±)	**CD (P=0.05)**				**SEd (±)**	**CD (P=0.05)**	
V × S			1.49	3.00				0.59	1.19	
V at the same level of S			1.35	2.72				0.24	0.48	
S at the same or different levels of V			1.05	2.12				0.20	0.40	

Table 5: Effect of date of planting and strawberry varieties on total sugars (%) content.

Treatments	Open condition					50% Shade net condition				
	S_1	S_2	S_3	S_4	Mean	S_1	S_2	S_3	S_4	Mean
T_1	5.19	6.04	5.93	4.60	5.44	4.11	4.54	4.30	3.66	4.16
T_2	5.48	6.57	6.45	5.35	5.96	4.29	4.73	4.35	3.83	4.30
T_3	5.24	6.26	6.07	4.51	5.52	3.83	4.08	4.02	3.33	3.82
T_4	5.52	7.01	6.69	5.07	6.07	3.97	5.43	5.19	3.79	4.60
T_5	4.84	5.97	5.83	4.59	5.31	3.53	4.44	4.33	3.42	3.93
T_6	4.52	6.07	5.92	4.32	5.21	3.48	4.19	3.97	3.60	3.81
T_7	4.97	6.31	5.88	4.51	5.42	3.49	4.40	4.11	3.84	3.96
Mean	5.11	6.32	6.11	4.71		3.81	4.55	4.32	3.64	
			SEd (±)	**CD (P=0.05)**				**SEd (±)**	**CD (P=0.05)**	
V × S			0.59	1.18				0.58	1.17	
V at the same level of S			0.16	0.32				0.15	0.29	
S at the same or different levels of V			0.18	0.37				0.11	0.23	

Table 6: Effect of date of planting and strawberry varieties on non-reducing sugar (%).

Treatments	Open condition					50% Shade net condition				
	S_1	S_2	S_3	S_4	Mean	S_1	S_2	S_3	S_4	Mean
T_1	2.25	3.29	2.63	2.52	2.67	2.09	2.33	2.26	2.10	2.20
T_2	2.16	3.44	2.83	2.44	2.72	2.23	2.47	2.34	2.11	2.29
T_3	2.22	3.08	2.74	2.38	2.61	2.08	2.11	2.03	1.67	1.97
T_4	2.55	3.88	3.63	3.00	3.26	2.46	2.63	2.20	2.36	2.41
T_5	2.49	3.00	2.85	2.58	2.73	2.16	2.42	2.20	2.01	2.20
T_6	2.49	2.97	2.81	2.39	2.66	2.01	2.26	2.03	1.85	2.04
T_7	2.48	2.97	2.78	2.35	2.64	2.06	2.30	2.04	1.96	2.09
Mean	2.38	3.23	2.90	2.52		2.16	2.36	2.16	2.01	
			SEd (±)	**CD (P=0.05)**				**SEd (±)**	**CD (P=0.05)**	
V × S			0.58	1.17				0.58	1.16	
V at the same level of S			0.12	0.24				0.07	0.15	
S at the same or different levels of V			0.11	0.22				0.09	0.18	

Table 7: Effect of date of planting and strawberry varieties on reducing sugar (%).

Treatments	Open condition					50% Shade net condition				
	S_1	S_2	S_3	S_4	Mean	S_1	S_2	S_3	S_4	Mean
T_1	2.97	3.19	2.93	2.22	2.83	2.02	2.22	2.01	1.56	1.95
T_2	2.97	3.02	3.09	2.08	2.79	2.06	2.26	1.97	1.72	2.00
T_3	3.08	3.24	2.82	2.07	2.80	1.74	1.93	1.99	1.66	1.83
T_4	3.22	3.81	3.26	2.83	3.28	1.50	2.96	2.80	1.43	2.17
T_5	2.35	2.97	2.94	2.07	2.58	1.70	2.02	2.13	1.55	1.85
T_6	2.02	3.07	3.07	1.93	2.52	1.47	1.93	1.90	1.75	1.76
T_7	2.50	3.11	3.34	2.16	2.78	1.40	2.10	2.06	2.06	1.91
Mean	2.73	3.20	3.06	2.19		1.70	2.18	2.14	1.68	
			SEd (±)	**CD (P=0.05)**				**SEd (±)**	**CD (P=0.05)**	
V × S			0.59	1.19				0.58	1.17	
V at the same level of S			0.21	0.41				0.15	0.29	
S at the same or different levels of V			0.19	0.39				0.14	0.29	

The mean values for total sugar, non-reducing and reducing sugar contents were significantly higher in S_2 (15th of November) in both open conditions (6.32%; 3.23% and 3.20%) and 50 per cent shade net conditions (4.55%, 2.36% and 2.18%) respectively. Whereas, lowest values for total sugars and reducing sugars are recorded by S_4 and for non reducing sugars S_1 is found to record lowest in case of open conditions. On the part of 50% shade net, it was for S_4 which recorded the lowest values of all the three sugar parameters. The variation in total sugar content might be due to the exposure of the plants to sunlight in as sunlight is necessary for hydrolysis of starch into sugars. The findings are in agreement with the results of Singh *et al.,* (2008).

CONCLUSION

Finally it can be concluded that the variety Sweet Charlie was found to have the best results followed by Winter Dawn in terms of biochemical parameters when grown both in open conditions as well as under 50 percent shade net conditions. Moreover, the best date of planting was found to be the S_2 *i.e* 15th of November which sowed encouraging results in comparison to the other dates. Thus, the variety Sweet Charlie can be considered the best variety and preferably 15th of November should be the time of planting Strawberry runners under Assam conditions.

Conflict of inetrest: None.

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