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Study on morpho-physico traits of strawberry (*Fragaria ananasa* Duch.) cultivars under open and protected condition

[1]Bhoirab Gogoi, [2]Shourov Dutta, [3]Puja Basumatary and [4]Sanjoy Barthakur

[1]Krishi Vigyan Kendra, Jorhat, Assam Agricultural University, Teok, Assam, India

[2]Krishi Vigyan Kendra, Karbi Anglong, Assam Agricultural University, Diphu, Assam, India

[3]Krishi Vigyan Kendra, Kokrajhar, Assam Agricultural University, Gossaigaon, Assam, India

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Corresponding Author: Sanjoy Barthakur

Abstract

Strawberry is one of the most important crops which gained attention and popularized within a short period of time due to its attractive colour, aroma and taste. But due to insufficient information regarding its growing conditions, varieties and other essential cultivation practices farmers were not been able to come out with encouraging results. Keeping this in view, an experiment has been undertaken to evaluate the performance of various Strawberry cultivars 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 percent shade net conditions. Results revealed that the variety Winter Dawn has been found to have the maximum value for Plant height (17.00 cm and 16.17 cm), Number of leaves at flowering (14.25 and 11.50), Leaf area (64.67 sq. cm and 62.33 sq.cm), Number of crowns per plant (3.25 and 3.00), Number of fruits per plant (12.92 and 11.25), Fruit weight (14.69g and 13.49g), Fruit diameter (3.57 cm and 3.45 cm), Fruit length (3.82 cm and 3.68 cm) and Fruit production (231.33 g per plant and 207.83 g per plant) in open conditions as well as in 50 percent shade net conditions. In addition, the variety Winter Dawn took least number of days to first flowering (22.25 days and 27.75 days) and days from flowering to maturity of fruits (26.00 days and 27.08 days) in both the growing conditions. Whereas, the best planting time found was the 15th of November with maximum values of all the parameters.

Keywords: Chandler, strawberry, sweet Charlie, winter dawn, morpho-physico characters

Introduction

Strawberry (*Fragaria ananasa* Duch.) is one of the most attractive and popular fruit all over the world due to its tantalizing aroma (Sharma and Yamdagni, 2000), eye-catching colour, nutrient compositions and worthy pharmaceutical properties (Rahman *et al*., 2015) [16]. It belongs to the family Rosaceae and is native of America. Strawberry basically, is a temperate fruit plant. However, in recent years, increase in area and production has been observed in tropical and subtropical plains of India (Sharma and Sharma, 2004) [21]. Strawberry consists of proteins, fats, carbohydrates and vitamins. It can also be processed for preparing jams, jellies, squashes, ice creams, canned strawberry, wine and other soft drinks (Joshi *et al*., 2005) [10]. It is grown in various parts of the country like Himachal Pradesh, Uttrakhand, Maharashtra, West Bengal, Delhi, Punjab, Haryana Rajsthan and Nilgiri hills (Chadha, 2001) [5].

Along with the other north eastern states, Assam also found to have a good results pertaining to Strawberry farming which projects future prospect for the crop in the region. But, the available information for the suitable cultivars, planting time and performance of the crop in open and protected conditions in Assam conditions are very scanty whereas, choice of cultivars is of paramount importance for successful strawberry cultivation (Asrey and Singh, 2004; Ahsan *et al.* 2014) [2, 1]. Under these circumstances, an experiment has been undertaken to evaluate the best cultivar, date of planting and growing environment on the basis of performance of morpho-physico characters in Assam conditions.

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). The soil of the experimental plot was a sandy loam having pH of 5.06. The study was conducted with 07 (seven) treatments *viz.* V1- Sabrina, V2- Winter Dawn, V3- Chandler, V4- Sweet Charlie, V5- Cristal, V6- Selva, V7- Camarosa and 04 (four) planting dates *viz.* S1-1st November, S2-15th November, S3-1st December, S4-15th 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 x 60 cm. The experimental area (open condition and 50 per cent shade net house) was thoroughly ploughed followed by

harrowing and levelling. Each treatment contained three number of replication accommodating nine plants in each plot. All the cultivation practices were carried out according to the Package of Practices, Assam Agricultural University. Five uniformly grown plants in each plot were selected to record the observations on some morpho-physico parameters like Plant height (cm), Number of leaves at flowering (no.), Leaf area (sq. cm), Number of crowns per plant (no.), Days to first flowering (days), Days from flowering to maturity of fruits (days), Number of fruits per plant (no.), Fruit weight (g), Fruit length (cm) Fruit diameter (cm), Fruit production (g/plant). Observations were recorded at proper time during the entire crop period.

Results and Discussion

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

Table 1: Plant height (cm) of different cultivars of strawberry

Variety / Days of Planting	Open Condition					50% Shade Net Condition				
	S_1	S_2	S_3	S_4	Mean	S_1	S_2	S_3	S_4	Mean
V_1: Sabrina	16.00	18.17	14.17	13.00	15.33	16.67	18.00	13.67	12.33	15.17
V_2: Winter Dawn	19.00	20.00	15.83	13.17	17.00	17.33	18.67	15.33	13.33	16.17
V_3: Chandler	14.00	17.17	10.83	10.17	13.04	13.00	14.67	11.00	10.50	12.29
V_4: Sweet Charlie	15.83	18.50	13.17	11.00	14.63	13.67	16.67	12.33	10.83	13.38
V_5: Cristal	15.50	17.83	12.00	10.83	14.75	17.00	17.67	12.67	11.67	14.04
V_6: Selva	16.17	18.00	14.00	11.50	14.92	15.83	16.33	11.00	10.33	13.38
V_7: Camarosa	15.17	18.00	13.00	10.50	14.17	14.33	15.67	12.67	11.50	13.54
Mean	15.95	18.24	13.29	11.45		15.40	16.81	12.67	11.50	
V X S			SEd(±)	CD(P =0.05)				SEd(±)	CD(P =0.05)	
			0.91	NS				0.79	NS	
V at the same level of S			0.93	NS				0.77	NS	
S at the same or different levels of V			0.69	NS				0.56	NS	

From the Table 1, among the varieties, growth in terms of plant height, the Winter Dawn (V_2) was found more vigorous (17.00 cm and 16.17 cm) than the rest of the varieties in both open and 50 per cent shade net condition. On the other hand, minimum plant height (13.04 cm and 12.29 cm) in both open and per cent shade net condition was found in Chandler (V_3). The varieties and time of planting did not have significant influence on plant height. The data also revealed that the effect of interaction between the varieties and planting time on plant height was found to be non-significant. However, higher plant height was recorded in S_2 (15^{th} of November) whereas lower plant height was recorded in S_4 (15^{th} of December) in both the growing conditions. It might be due to the prevalent environmental conditions which influenced the growth of strawberry cultivars. Varietal differences in plant height were also noted by Singh *et al*. (2008) [22] in Meghalaya which supports the present observation. Results of present investigation regarding plant height were in partial agreement with the findings of Rahman *et al.* (2013) [15], Rahman (2011) [17], and Asrey and Singh (2004) [2]. Riyaphan *et al*. (2005) [19] also obtained no significant variation in plant height of strawberry plants in Thailand, which ranged from 10 to 20 cm at mid-harvesting time.

Table 2: Number of leaves at flowering of different cultivars of strawberry

Variety / Days of Planting	Open Condition					50% Shade Net Condition				
	S_1	S_2	S_3	S_4	Mean	S_1	S_2	S_3	S_4	Mean
V_1: Sabrina	12.00	14.67	14.00	11.00	12.92	11.00	11.33	10.33	9.67	10.58
V_2: Winter Dawn	14.00	15.33	16.00	11.67	14.25	12.00	12.33	11.67	10.33	11.50
V_3: Chandler	11.33	12.33	12.67	12.33	12.17	10.67	11.67	10.67	10.00	10.75
V_4: Sweet Charlie	14.00	14.33	15.67	12.33	14.08	10.33	12.00	11.67	10.00	10.83
V_5: Cristal	10.67	12.33	12.00	11.67	11.67	11.33	11.33	10.33	8.67	10.58
V_6: Selva	9.33	13.00	11.67	12.67	11.67	10.33	11.67	11.33	9.67	10.83
V_7: Camarosa	9.33	11.33	10.67	11.00	10.58	9.67	10.67	10.00	8.33	9.67
Mean	11.52	13.33	13.24	11.81		10.81	11.52	10.86	9.52	
V X S			SEd(±)	CD(P =0.05)				SEd(±)	CD(P =0.05)	
			1.08	NS				0.75	NS	
V at the same level of S			1.10	NS				0.71	NS	
S at the same or different levels of V			0.82	NS				0.57	NS	

From the data presented in the Table 2, it is evident that no significant differences were found among the varieties, planting time and the interaction effect of both the factors in response to the number of leaves at flowering. Strawberries have compound leaves in which the blade (flattened part of the leaf) is divided into 3 separate leaflets, called a "trifoliate". Leaves are the main sites of photosynthesis. Farooq *et al.* (2009) [8] mentioned that development of optimal leaf area is important towards photosynthesis and dry matter yield.

It was observed in the present investigation that the maximum number of leaves (14.25 and 11.50) at flowering was counted in Winter Dawn variety (V_2) and the minimum number of leaves (10.58 and 9.67) was produced by Camarosa variety (V_3) in open condition and 50 per cent shade net condition. The present finding is in conformity

with the results of Rao and Lal (2010) [18] where they justified that the number of leaves produced by the plants of different varieties differed mainly due to the inherent characters of the varieties. In both the planting condition open and 50 per cent per cent shade net condition, highest number of leaves (13.33 and 11.52) was recorded in S_2 planting time (15th of November). Variation with respect to number of leaves at flowering could be attributed to the fact that different cultivars may react differently to photoperiod, light, temperature, nutrient status of soil, available metabolites and their allocation to the above ground plant parts (Tanaka and Mizuta, 1974; Strik, 1988) [24, 23]. The highest value of number of leaves per plant was found in open condition (16.00) whereas lowest value was found in 50 per cent shade net condition (8.33). It might be due to exposure of the plants to the direct sunlight and precipitation and better air movement availed in open condition.

Treatment combination of V_2S_2 (Winter Dawn) in open condition helped the plants to produce highest number of leaves at flowering while (V_2S_2) Winter Dawn at 15th November planting time in 50 per cent net house condition exhibited maximum number of leaves but less than the open condition. This might be due to the influence of inherent genetic characters as well as environmental conditions where they were planted. The present result might be supported by the findings of Awang and Atherton (1995) [3] who remarked that shading reduced total leaf growth and observed that plants in open condition produced 26 per cent more leaves than those grown under shaded conditions.

Table 3: Leaf area (sq. cm) of different cultivars of strawberry

Variety / Days of Planting	Open Condition					50% Shade Net Condition				
	S_1	S_2	S_3	S_4	Mean	S_1	S_2	S_3	S_4	Mean
V_1: Sabrina	61.00	63.67	63.67	63.00	62.83	60.33	63.00	62.00	60.33	61.42
V_2:Winter Dawn	62.00	66.00	65.67	65.00	64.67	61.67	64.00	63.00	60.67	62.33
V_3: Chandler	32.67	35.00	35.00	34.67	34.33	31.00	34.00	34.00	32.00	32.75
V_4: Sweet Charlie	54.00	60.67	59.33	60.00	58.50	54.00	56.33	56.00	54.33	55.17
V_5: Cristal	57.33	59.00	58.67	57.33	58.08	55.33	58.00	57.67	56.33	56.83
V_6: Selva	55.67	61.00	60.33	59.67	59.17	58.00	59.67	56.00	58.67	58.08
V_7: Camarosa	59.00	61.00	61.00	59.67	60.17	58.33	59.00	58.33	58.00	58.42
Mean	54.52	58.05	57.67	57.05		54.10	56.29	55.29	54.33	
V X S			SEd(±)	CD(P =0.05)				SEd(±)	CD(P =0.05)	
			1.19	NS				1.09	NS	
V at the same level of S			1.18	NS				1.11	NS	
S at the same or different levels of V			0.89	NS				0.83	NS	

Data from the Table 3 revealed that there were no any significant differences among the varieties and in planting time for leaf area. In open condition the highest leaf area (64.67 cm^2) was found in V_2 (Winter Dawn) and in S_2 (15th of November) planting time with 66.00 cm^2. On the other hand in 50 per cent shade net condition the highest leaf area (64.00 cm^2) was found in V_2S_2 (Winter Dawn at 15th of November). The higher leaf area in these varieties might be due to more available metabolites and their allocation to the above ground parts of the plants through roots and genetic attributes of respective cultivars. Tanaka and Mizuta (1974) [24] also reported that variation with respect to leaf area among different cultivars could be attributed to influence of different photoperiod, temperature and soil nutrient status.

Table 4: Number of crowns per plant (no.) of different cultivars of strawberry

Variety / Days of Planting	Open Condition					50% Shade Net Condition				
	S_1	S_2	S_3	S_4	Mean	S_1	S_2	S_3	S_4	Mean
V_1: Sabrina	3.00	3.33	3.00	2.00	2.83	3.00	3.67	3.33	1.33	2.83
V_2: Winter Dawn	3.33	4.00	3.67	2.00	3.25	3.00	3.67	3.33	2.00	3.00
V_3: Chandler	2.00	2.00	2.00	1.67	1.92	1.67	2.33	2.00	1.00	1.75
V_4: Sweet Charlie	3.67	3.33	3.00	2.00	3.00	3.00	3.67	3.33	1.33	2.83
V_5: Cristal	2.67	3.33	2.67	1.33	2.50	2.33	3.00	2.67	1.33	2.33
V_6: Selva	2.67	3.33	3.00	1.67	2.67	2.67	3.33	2.67	1.67	2.58
V_7: Camarosa	3.00	2.67	3.00	2.33	2.75	2.67	3.33	2.33	1.33	2.42
Mean	2.67	3.29	2.86	1.52		2.86	3.05	2.90	1.81	
V X S			SEd(±)	CD(P =0.05)				SEd(±)	CD(P =0.05)	
			0.69	NS				0.65	NS	
V at the same level of S			0.58	NS				0.47	NS	
S at the same or different levels of V			0.51	NS				1.63	NS	

The basal portion of a strawberry plant from which the basal shoot and leaves arise is referred to as crown of a strawberry plant. This is the central "trunk" of the strawberry plant from which all other parts grow. In the present investigation, the varieties did not significantly differ in relation to crown number per plant.

Maximum number of crown per plant (4.00 and 3.67) was produced by Winter Dawn at 15th November planting time (V_2S_2) and minimum number of crown (1.67 and 1.00) was produced by the variety Chandler (V_3S_4) among all the varieties in both open and 50 per cent shade net condition. The present finding is more or less in conformity with the results of Rahman *et al.* (2013) [15] who reported that there was significant variation in terms of number of crowns per

plant among different varieties of strawberry and they reported that this variation among the varieties might be due to genetic reason.

In S_2 (15th November), the number of crowns per plant was higher (3.29 and 3.05) while the minimum (1.52 and 1.81) was found in S_4 (15th December) in both open and 50 per cent shade net condition. Increased number of crowns in open condition might be due to increased growth of the plant in the form of height and number of leaves, synthesizing more photosynthates and thereby increased crowns. Among the various treatment combinations, there was no significant difference in relation to production of crown per plant. The present finding is in conformity with the results of Kumar *et al.* (2015) [12] and Kher *et al.* (2010) [11].

Table 5: Days to first flowering (days) of different cultivars of strawberry

Variety / Days of Planting	Open Condition					50% Shade Net Condition				
	S_1	S_2	S_3	S_4	Mean	S_1	S_2	S_3	S_4	Mean
V_1: Sabrina	25.67	27.67	21.00	18.67	23.25	30.67	33.67	31.00	24.67	29.92
V_2: Winter Dawn	24.00	27.00	20.67	17.33	22.25	28.67	30.67	27.00	24.33	27.75
V_3: Chandler	29.33	33.33	22.67	19.33	26.17	39.00	39.00	36.33	30.67	36.25
V_4: Sweet Charlie	31.00	33.33	25.00	20.33	26.42	41.33	41.67	37.67	32.67	38.33
V_5: Cristal	25.67	29.67	21.67	19.33	24.08	30.00	31.00	29.00	26.00	29.00
V_6: Selva	27.00	30.33	24.33	18.67	26.08	32.33	34.00	32.00	29.33	31.92
V_7: Camarosa	24.00	30.00	22.67	18.33	23.75	31.00	31.00	29.67	27.67	29.83
Mean	26.67	30.19	22.57	18.86		33.29	34.43	31.81	27.90	
V X S			SEd(±)	CD(P =0.05)				SEd(±)	CD(P =0.05)	
			0.81	1.63				1.35	2.7	
V at the same level of S			0.81	1.63				1.28	2.57	
S at the same or different levels of V			0.58	1.17				0.88	1.78	

The phenological parameters such as days to first flowering, days from flowering to maturity are considered as very much important parameters as these are related to duration of fruit production. Significant variations among the varieties as well as in planting time in relation to days to first flowering were observed in the present investigation.

In open condition the maximum number of days (26.42 days) taken to produce first flower was observed in Sweet charlie (V_4) and the minimum days was observed in Winter Dawn (V_2) among the seven varieties of strawberry. Again in 50 per cent shade net condition maximum number of days (41.67 days) taken to produce first flower was observed in Sweet charlie (V_4) and the minimum (27.75 days) was observed in Winter Dawn (V_2). It is more or less in agreement with the findings of Riyaphan *et al.* (2005) [19]. Asrey and Singh (2004) [2] found a significant variation in days to flowering, which is also in consonant with the present findings. The variation in the time of flowering among strawberry cultivars might be due to the fact that different cultivars differ widely in their chilling requirement and plants of these cultivars were capable of growing and producing early flowers without a prolonged chilling period (Craig and Brown, 1977; Nicoll and Galletta, 1987) [6, 14].

Table 6: Days from flowering to maturity of fruits (days)

Variety / Days of Planting	Open Condition					50% Shade Net Condition				
	S_1	S_2	S_3	S_4	Mean	S_1	S_2	S_3	S_4	Mean
V_1: Sabrina	39.33	45.00	20.67	16.33	30.33	35.00	48.67	23.67	18.33	31.42
V_2: Winter Dawn	32.33	34.67	20.33	16.67	26.00	30.00	36.67	23.33	18.33	27.08
V_3: Chandler	36.00	39.67	21.33	18.33	28.75	32.67	40.00	24.00	18.33	28.83
V_4: Sweet Charlie	37.67	41.67	22.00	16.00	29.33	36.00	46.00	26.00	18.33	31.58
V_5: Cristal	32.67	38.33	18.67	16.00	26.42	33.33	39.67	22.00	18.67	28.42
V_6: Selva	31.67	36.67	22.00	17.33	26.92	30.33	41.00	22.00	19.00	28.08
V_7: Camarosa	34.67	42.00	22.67	17.33	29.17	35.00	42.00	27.33	20.67	31.25
Mean	34.90	39.71	21.10	16.86		33.19	42.00	24.05	18.81	
V X S			SEd(±)	CD(P =0.05)				SEd(±)	CD(P =0.05)	
			1.34	2.78				1.58	3.21	
V at the same level of S			1.87	3.78				1.07	2.18	
S at the same or different levels of V			1.36	2.74				1.33	2.69	

From the data presented in the Table 6 it is evident that significant differences were found among the varieties and planting time in relation to the flowering to maturity. Moreover, significant differences were also found in the interaction effect between varieties and planting time. In open condition days from flowering to maturity of fruits was recorded highest (29.33 days) in Sweet Charlie (V_4) while minimum days (26.00 days) taken from flowering to maturity of fruits was recorded in Winter Dawn (V_2) among the seven varieties of strawberry. Again in 50per cent shade net condition highest days from flowering to maturity of fruits were recorded highest (31.58 days) in Sweet Charlie (V_4) while minimum days (27.08 days) taken from flowering to maturity of fruits were recorded in Winter Dawn (V_2).

In open condition days from flowering to maturity of fruits was recorded highest (29.33 days) in Sweet Charlie (V_4) while minimum days (26.00 days) taken from flowering to

maturity of fruits was recorded in Winter Dawn (V_2) among the seven varieties of strawberry. Again in 50per cent shade net condition highest days from flowering to maturity of fruits were recorded highest (31.58 days) in Sweet Charlie (V_4) while minimum days (27.08 days) taken from flowering to maturity of fruits were recorded in Winter Dawn (V_2). It might be due to genetic makeup of the varieties. Jami *et al*. (2015) [9] reported that days required from planting to flowering and flowering to fruit maturity were observed to have significant variation but there was no considerable variation with regard to days required from flowering to fruit set. The results are also in conformity with the findings of Dwivedi *et al.* (2004) [7] Sharma and Sharma (2006) [20] and Verma *et al.* (2022) [25].

Table 7: Number of fruits per plant of different cultivars of strawberry

Variety / Days of Planting	Open Condition					50% Shade Net Condition				
	S_1	S_2	S_3	S_4	Mean	S_1	S_2	S_3	S_4	Mean
V_1: Sabrina	9.33	15.33	13.67	4.67	10.75	10.00	13.67	11.00	7.33	10.50
V_2: Winter Dawn	10.00	19.00	14.00	8.67	12.92	10.33	15.67	11.33	7.67	11.25
V_3: Chandler	8.00	13.67	10.67	5.00	9.33	8.00	11.33	9.00	3.67	8.00
V_4: Sweet Charlie	10.67	19.00	13.00	8.67	12.83	10.00	14.00	11.33	7.67	10.75
V_5: Cristal	9.33	12.67	11.00	8.67	10.42	10.67	13.00	9.67	5.33	9.67
V_6: Selva	9.33	16.33	12.67	8.33	11.67	10.33	13.33	10.33	4.00	9.50
V_7: Camarosa	9.67	14.00	11.00	8.67	10.83	9.00	11.00	9.33	7.67	9.25
Mean	9.48	15.71	12.29	7.52		9.76	13.14	10.29	6.19	
V X S			SEd(±)	CD(P =0.05)				SEd(±)	CD(P =0.05)	
			1.33	2.69				0.86	1.74	
V at the same level of S			1.27	2.56				0.88	1.78	
S at the same or different levels of V			0.88	1.78				0.68	1.38	

The number of fruits per plant was significantly influenced by variety and planting time in both the planting conditions. In open condition the number of fruits per plant was highest (19.00) in Winter Dawn (V_2S_2) and in 50 per cent shade net condition the number of fruits per plant was also maximum (15.67) in Winter Dawn variety at 15th date of planting (V_2S_2). The present finding had a close proximity with the findings of Awang and Atherton (1995) [3] who reported that plants grown under open condition produced more number of fruits than those under shade conditions. Insufficient sunlight and poor air circulation in the protected condition (50 per cent shade net house) might have led to the poor vegetative growth resulting in poor production of flowers and thereby lesser production of fruits.

Table 8: Fruit weight (g) of different cultivars of strawberry

Variety / Days of Planting	Open Condition					50% Shade Net Condition				
	S_1	S_2	S_3	S_4	Mean	S_1	S_2	S_3	S_4	Mean
V_1: Sabrina	11.05	12.10	10.75	7.77	10.42	10.65	10.99	10.71	6.83	9.79
V_2: Winter Dawn	16.08	17.49	16.68	8.50	14.69	15.52	15.74	14.55	8.14	13.49
V_3: Chandler	9.00	9.35	8.09	6.18	8.15	7.05	8.15	7.88	6.37	7.36
V_4: Sweet Charlie	13.33	14.64	14.13	7.95	12.51	11.78	12.48	10.98	8.18	10.86
V_5: Cristal	11.68	13.48	13.02	6.01	11.05	10.88	11.29	10.03	8.99	10.30
V_6: Selva	8.55	9.26	7.83	7.76	8.35	9.37	9.02	9.20	5.10	8.17
V_7: Camarosa	11.08	11.74	10.62	10.05	10.87	11.41	11.90	11.25	6.24	10.20
Mean	11.42	12.40	11.85	6.85		11.07	11.55	10.40	8.02	
V X S			SEd(±)	CD(P =0.05)				SEd(±)	CD(P =0.05)	
			0.72	1.45				0.62	1.24	
V at the same level of S			0.65	1.32				0.36	0.73	
S at the same or different levels of V			0.75	1.51				0.25	0.50	

The different varieties studied in the present experiment showed significant variation in their fruit weight which had positive effect on fruit yield. In open condition the variety Winter Dawn at 15th November planting time (V_2S_2) produced maximum fruit weight (17.49 g) followed by Sweet Charlie (14.64 g) whereas minimum fruit weight (6.01) was exhibited by Cristal (V_5S_4). In 50 per cent shade net condition Winter Dawn (V_2S_2) showed highest fruit weight (15.75 g) followed by 12.48 g in Sweet Charlie at 15th November planting time (V_4S_2). Significant variation was noticed in case of fruit weight in different planting time. In both the planting time highest fruit weight was observed in S_2 (15th of November). This might be due to maximum interception of sunlight help in higher production of photosynthates enabling the plants to produce bigger fruits in open condition.

Table 9: Fruit length (cm) of different cultivars of strawberry

Variety / Days of Planting	Open Condition					50% Shade Net Condition				
	S_1	S_2	S_3	S_4	Mean	S_1	S_2	S_3	S_4	Mean
V_1: Sabrina	3.86	3.96	3.66	3.14	3.66	3.49	3.91	3.40	3.09	3.48
V_2: Winter Dawn	3.88	4.11	3.82	3.45	3.82	3.93	4.02	3.63	3.21	3.68
V_3: Chandler	1.89	2.13	1.71	1.54	1.82	1.69	1.92	1.69	1.53	1.71
V_4: Sweet Charlie	3.82	4.01	3.82	3.34	3.75	3.82	3.93	3.77	2.75	3.59
V_5: Cristal	2.91	3.08	2.84	2.56	2.85	2.61	2.62	2.54	2.20	2.49
V_6: Selva	3.25	3.31	3.10	2.59	3.06	2.77	3.07	2.83	2.60	2.82
V_7: Camarosa	3.93	3.33	3.03	2.60	3.23	3.04	3.18	2.68	2.22	2.78
Mean	3.33	3.33	3.07	2.66		3.09	3.33	3.01	2.60	
V X S			SEd(±)	CD(P =0.05)				SEd(±)	CD(P =0.05)	
			0.58	1.18				0.58	1.17	
V at the same level of S			0.16	0.32				0.12	0.25	
S at the same or different levels of V			0.21	0.43				0.16	0.32	

Significant differences also noticed in terms of fruit length in different cultivation situations. Longest fruit (4.11 cm and 4.02 cm) was observed in both open and 50 per cent shade net condition was in Winter Dawn at 15th November planting time (V_2S_2) and shortest fruit (1.54 cm and 1.53 cm) was observed in both open and 50 per cent shade net house condition was in Chandler at 15th December planting time (V_3S_4).

Table 10: Fruit diameter (cm) of different cultivars of strawberry

Variety / Days of Planting	Open Condition					50% Shade Net Condition				
	S_1	S_2	S_3	S_4	Mean	S_1	S_2	S_3	S_4	Mean
V_1: Sabrina	3.19	3.78	3.23	3.14	3.34	3.24	3.23	3.34	2.84	3.16
V_2: Winter Dawn	3.60	3.81	3.53	3.36	3.57	3.77	3.74	3.45	2.85	3.45
V_3: Chandler	1.76	1.84	1.41	1.25	1.56	1.47	1.54	1.28	1.27	1.39
V_4: Sweet Charlie	3.32	3.43	3.28	3.27	3.33	3.70	3.36	3.33	2.63	3.26
V_5: Cristal	2.59	2.77	2.46	2.39	2.55	2.28	2.27	2.04	1.78	2.09
V_6: Selva	2.85	3.08	2.82	2.09	2.71	2.43	2.54	2.51	2.37	2.46
V_7: Camarosa	2.75	2.95	2.67	2.61	2.75	2.18	2.65	2.81	2.02	2.42
Mean	2.82	2.88	2.74	2.21		2.77	2.98	2.71	2.63	
V X S			SEd(±)	CD(P =0.05)				Sed(±)	CD(P =0.05)	
			0.59	1.18				0.58	1.17	
V at the same level of S			0.17	0.35				0.10	0.20	
S at the same or different levels of V			0.17	0.35				0.12	0.25	

The value of fruit diameter was significant in different cultivation situations and planting time where variety Winter Dawn (V_2) showed the highest diameter (3.57 cm and 3.45 cm) in open conditions as well as in 50 per cent shade net condition.

Table 11: Fruit production (g/plant) of different cultivars of strawberry

Variety / Days of Planting	Open Condition					50% Shade Net Condition				
	S_1	S_2	S_3	S_4	Mean	S_1	S_2	S_3	S_4	Mean
V_1: Sabrina	176.33	188.67	181.33	166.00	178.08	165.67	175.33	172.00	162.00	168.75
V_2: Winter Dawn	225.33	249.67	237.00	213.33	231.33	202.67	216.67	211.67	200.33	207.83
V_3: Chandler	100.33	112.00	104.00	99.67	104.00	100.67	111.33	102.00	98.00	103.00
V_4: Sweet Charlie	200.33	211.67	205.33	193.33	202.67	180.67	199.33	196.00	180.67	189.17
V_5: Cristal	169.00	177.33	170.33	160.00	169.17	156.33	164.00	157.67	156.00	158.50
V_6: Selva	173.33	182.00	180.33	170.33	176.50	165.67	176.00	173.33	162.00	169.25
V_7: Camarosa	148.00	155.33	152.00	145.33	150.17	154.00	157.00	141.67	128.33	145.25
Mean	171.24	182.62	174.29	161.57		159.95	171.14	166.38	157.76	
V X S			SEd(±)	CD(P =0.05)				SEd(±)	CD(P =0.05)	
			2.01	3.75				2.47	3.99	
V at the same level of S			1.70	3.43				1.86	2.02	
S at the same or different levels of V			1.20	2.42				1.15	2.31	

The fruit production (g/plant) was significantly influenced by different varieties and planting time. Among the varieties, in open condition the variety Winter Dawn produced the highest number of fruits (231.33 g/plant) while the lowest fruit production was observed in Chandler (104.00 g/plant). Again in 50 per cent shade net condition the variety Winter Dawn produced the highest number of fruits (207.83 g/plant) while the lowest fruit production was observed in Chandler (103.00 g/plant). In open condition, the fruit production (g/plant) is considerably higher as compared to cultivation of strawberry in shade net house. The highest fruit production (g/plant) in open condition

could be attributed to the higher production of fruits per plant, heavier individual fruit production, longer and broader fruits recorded in open condition in the present investigation. The present findings are in conformity with Bai *et al*. (2023) [4] observations while it was reported otherwise by Menzel (2025) [13].

Conclusion

It may be concluded that in terms of Morpho phsico characteristics of the crop, the best results have been found in case of Variety Winter Dawn when grown both in open conditions as well as under 50 percent shade net conditions. In addition, the best time of planting has been found to be the S_2 *i.e* 15th of November. Thus, the variety Winter Dawn can be considered the best variety and preferably 15th of November should be the time of planting Strawberry runners for quality morpho physico characters under Assam conditions.

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