RESEARCH ARTICLE

EFFECT OF PLANTING TIME ON YIELD AND QUALITY OF STRAWBERRY CV CHANDLER IN SUBTROPICAL REGION OF PUNJAB

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ARTICLE INFO	ABSTRACT
	An investigation was carried out in the Department of Horticulture, Khalsa College, Amritsar during the year 2016-17 to study the effect of planting time on yield and fruit quality of strawberry cv. Chandler in subtropical region of Punjab. The runners of strawberry cv Chandler were planted at 30x40 cm apart on the raised beds on seven times of planting i.e.1st September,15th September,1st October 15th October,30th October, 15th November and 30th November 2017 respectively. The experiment was laid out in Randomised Block Design (RBD). The results of the study revealed that out of the various planting times the planting time of 15th October proved to be the most effective in increasing the yield (310.10 g/plant) and improving the quality of the fruits with maximum fruit length(5.08 cm), breadth(3.39 cm) and fruit weight(15,60 g). Among biochemical characteristics, maximum TSS(8.30° Brix), total sugars(6.53%), reducing sugars(4.80%) and ascorbic acid(68.49mg/100g) were also generated from the plants planted on 15th October respectively.

INTRODUCTION

Strawberry (*Fragaria ananassa*) is a widely grown hybrid species of the genus *Fragaria* belonging to the family Rosaceae. It is one of the most popular soft fruit and is cultivated in plains as well as in the hills. Strawberry is an aggregate accessory fruit meaning that the fleshy part is derived not from the plant ovaries but from the receptacle that holds the ovaries of the flower with a seed inside it (Dhillon 2013).It occupies a significant place in the fruit growing areas of the world, since it can be cultivated in plains as well as in the hills upto an elevation of 300 m in humid and dry regions. India is the second largest producer of strawberry fruit in the world, after China (Sharma and Sharma, 2004). Undoubtedly, Strawberry is mainly grown in the hilly regions of Kashmir, Himachal Pradesh, Uttrakhand and Uttar Pradesh particularly between 1200 and 2100 mm above msl and also is successfully cultivated under subtropical climate of Punjab and other adjoining irrigated regions with certain environmental modifications (Dhillon 2005). The fresh strawberries are deep red in colour with a unique shape. They are highly perishable fruits with a pleasant flavor, taste, fresh use, freezing and processing purposes. It is refreshing and nutritious fruit with a distinct Tantalizing aroma (Kaur 2010).

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Strawberry fruit is regarded as a valuable food in the diet of millions of people around the globe. It is eaten fresh and is in a special demand by fruit processing and cosmetic industries. Due to its wide adaptability to climate and soils, the strawberry is available fresh from the tropics to sub-arctic, around the year. (Asrey and Singh 2004). The successful strawberry industry depends on good quality runner production, induction of early maturity and prolonged period of harvest. The early harvested fruit sells at a premium under sub-tropical conditions of Punjab. Season and date of planting varied from place to place depending upon the climate of the area, so the optimization of time is of great importance. According to Anna *et al* (2003) for successful strawberry cultivation, time of planting plays a very significant role and its optimization is pre-requisite. Furthermore, higher profitability and productivity of strawberry is being taken in many countries through manipulation of planting time. However, turning of planting time are the important ways to achieve higher yield of strawberries (Rahman 2014).Hence the present investigation was conducted to study the interactive effect of planting time of strawberry under subtropical conditions of Punjab.

MATERIALS AND METHODS

The research study was conducted in the nursery of Horticulture Department, Khalsa College, Amritsar. Runners of strawberry cv. Chandler were planted on seven dates

viz.,T_1(1st September);T_2(15th September);T_3(1st October);T_4(15th October); T_5(30th October); T_6(15th November); T_7(30th November) during 2016-2017with planting distance of 30x40cm,replicated thrice. The fruit characters of the plants were recorded in terms of fruit length, breadth, weight, TSS, acidity, TSS: acid ratio, sugars, ascorbic acid, yield per plant and yield per hectare The data were statistically analysed by the method of analysis of variance using RBD.

cv. Chandler. The data on fruit weight revealed that the maximum fruit weight 15.60 g was observed under treatment T_4(15th October) which was found to be highly significant to all treatments. The treatments T_3 and T_5 were found at par with each other. Minimum fruit weight (11.20 g)was observed under the plantation of end of November, this might be due to the prevalence of high temperature during the month of October which led to the formation of good amount of

Table 1. Effect of planting time on physical characters of fruits of strawberry cv. Chandler

Treatments	Fruit length (cm)	Fruit breadth (cm)	Fruit weight (g)
T_1 1st September	Nil	Nil	Nil
T_2 15th September	4.45	3.26	13.33
T_3 1st October	4.61	3.37	14.59
T_4 15th October	5.08	3.39	15.60
T_5 30th October	4.58	2.89	14.43
T_6 15th November	4.11	2.65	12.09
T_7 30th November	4.03	2.39	11.20
CD (5%)	0.48	0.38	0.56

Table 2. Effect of planting time on bio-chemical characters of fruits of strawberry cv. Chandler

Treatments	TSS (°Brix)	Titratable acidity (%)	TSS/acid ratio	Reducing sugars (%)	Total sugars (%)	Non-reducing sugars (%)	Ascorbic acid (mg/100 g)
T_1 1st September	Nil	Nil	Nil	Nil	Nil	Nil	Nil
T_2 15th September	7.56	0.30	25.20	3.86	6.52	2.66	57.22
T_3 1st October	8.08	0.31	26.06	4.18	6.19	2.01	61.55
T_4 15th October	8.30	0.24	34.58	4.80	6.53	1.74	68.49
T_5 30th October	8.18	0.29	28.21	4.52	6.38	1.86	65.57
T_6 15th November	7.42	0.30	24.73	3.61	6.10	2.52	65.08
T_7 30th November	7.12	0.41	17.37	3.57	5.92	2.35	65.00
CD (5%)	0.43	0.03	0.09	0.05	0.51	0.02	0.35

Table 3. Effect of planting time on yield parameters of strawberry cv. Chandler

Treatments	Yield/plant (g)	Yield/hectare (q)
T_1 1st September	Nil	Nil
T_2 15th September	144.52	7.22
T_3 1st October	200.32	10.01
T_4 15th October	310.10	15.50
T_5 30th October	299.70	14.98
T_6 15th November	134.77	6.73
T_7 30th November	131.09	6.55
CD (5%)	0.26	0.01

RESULTS AND DISCUSSION

Maximum fruit length 5.08 cm was found in the plants under treatment T_4(15th October)which was highly significant over all the treatments followed by the treatments T_3,T_5,T_2 and T_6 with length of 4.45 cm,4.61 cm,4.58 cm,4.11 cm , 4.03 cm and 0 cm respectively which were found at par with each other. Minimum fruit length (4.03 cm) were recorded in the plants planted on end of November. Maximum fruit breadth 3.39 cm was recorded in the plants under treatment T_4 (15th October) which was found to be at par with all other treatments. The other treatments T_1,T_2,T_3 and $T_4,$ were having 3.37 cm,3.26 cm,2.89 cm and 2.65 cm breadth respectively. Minimum fruit breadth (2.39 cm) was recorded in the plants under plantation of end November. The increase in fruit size in the month of October plantation as compared to November plantation might be due to congenial temperature conditions. Higher temperature in the month of October might have produced more photosynthates leading to good formation of berries with prominent berry size as compared to the late plantation. Mawkhiew and Pereira (2015) conducted a research study whose results are in agreement with the present results. Singh (2007) and Kaur (2010) also reported the same in strawberry

carbohydrates leading to more berry weight as compared to the late planted plants which generated berries with lesser fruit weight as they had less time for optimize vegetative growth which might be the reason for lesser fruit weight. the findings of Menzil and Smith (2011) and Mawkhiew and Pereira (2015) are in support with the present results. Kaur (2010) also reported the same in strawberry cv. Chandler. The data clearly showed that the total soluble solids of fruits was affected by the different planting time and the maximum TSS of 8.3 per cent were found in the fruits produced by plants under treatment T_4 followed by T_5,T_3,T_2 and T_6 with 8.18,8.08,7.56 and 7.42 per cent TSS respectively. The fruits of the plants planted on the end of November generated minimum (7.12%)TSS level .The fruits of early planted plants in the month of October contained more TSS than late planted plants which might be due to the more exposure of these plants to favourable environment and they got enough time for sugar and acid accumulation which resulted in high TSS than those of late planted plants .Rahman *et al* (2014) stated that fruits of early planted plants contained more TSS due to exposure under favourable environment. The fruits of late planted plants were more exposed to temperature conditions obstructed TSS which had negative effect on fruit quality in strawberry

(Hassan *et al* 2005). The findings of Rahman (2014) and Kaur (2010) are also in support with the present study. There was a slight variation in the acidity level of the fruits of the plants planted on various dates. Minimum acidity of 0.24 per cent and 0.29 per cent was obtained from the fruits of the plants planted in the month of October while the maximum acidity of 0.41 per cent was from the end November plantation. These results are in agreement with the findings of Kaur (2010) and Mawkhiew and Pereira (2015) in strawberry cv.Chandler. TSS:acid ratio was maximum in the plants under treatment T_4 with 34.58 followed by plants under treatment T_5, T_3, T_2 and T_6 with TSS:acid ratio of 28.21,26.06,25.20 and24.73.The minimum TSS:acid ratio was in treatment T_7 with 17.37.This might be due to the fact that increased metabolites in berry due to the favourable climatic conditions led to enhancement in the TSS:acid ratio .Kaur (2010) and Mawkhiew and Pereira (2015) also reported the same in strawberry cv. Chandler.

Results of the study showed that plants under treatment T_4 yielded fruits with maximum reducing sugars of 4.80 per cent which proved to be significantly higher than all other treatments. It was followed by T_5 and T_3 with 4.52 and 4.18 per cent. Minimum reducing sugars (3.57 %) were in T_7. These findings are confirmed by Kaur (2010) and Mawkhiew and Pereira (2015) in strawberry cv. Chandler. This might be attributed to the better vegetative growth and better accumulation of sugars in berries due to the favourable climatic conditions prevailing at that time Rahman (2014) also reported the same in strawberry plants. The total sugars increased rapidly with advanced planting time. It was noted that the plants under T_4 yielded fruits with maximum total sugars of 6.53 per cent which were found at par with T_2 with 6.52 per cent. It was followed by other treatments with T_5, T_2 and T_6 with 6.38,6.19 and 6.10 per cent total sugars .Minimum total sugars (5.92 per cent) were recorded from the planting of end November .It might be due to the reason that early planting of strawberry exhibited better plant growth, flowering, fruiting and accumulated better sugars in the berries whereas the late planting resulted in lesser sugars due to the highest number of flowers and fruits competing for nutrition, water and light. Similar trials with different planting dates for assessing the quality of fruits were conducted by Jahangeera *et al* (2010), Menzel and Smith (2011) and Rahman *et al* (2014) who also reported the same. The findings of Kaur (2010) are also in line with the present research.

It was noted that plants under treatment T_4 yielded fruits with minimum non reducing sugars of 1.74 per cent which proved to be significantly higher than all other treatments followed by T_5, T_6, T_7, T_3, T_2 and T_1 with 2.32,2.52,2.35,2.01,2.01 and 0 per cent non-reducing sugars respectively. Zero results were recorded under treatment T_1 reason being none of the plant survived due to unfavourable climatic conditions present at that time. The positive results were recorded under T_4 reason being favourable weather conditions present at that time. The results are in accordance with Kaur (2010) she studied that the maximum results of non-reducing sugars were recorded under mid October planting than other treatments like end October and mid November planting time. Maximum ascorbic acid content (68.49 mg/100g pulp) was found in the fruits produced by plants under treatment T_4 which proved to be significantly higher than all other treatments .It was followed by the plants under treatment T_5, T_6, T_7, T_3 and T_2 with 65.57,65.08,65.00,61.55 and 57.22 mg/100 g pulp

respectively. All these treatments were found to be highly significant with each other The fruits of October planting plants contained more ascorbic acid than late planted plants which might be due to the fact that early planted plants had more exposure to favourable environment and got enough time for sugar acid accumulation which resulted in higher ascorbic acid content than those of late planted plants. These results are in accordance with the findings of Rahman *et al* (2014) who stated that the early planted plants contained more ascorbic acid due to exposure under favourable environment. The fruits of late planted plants had negative effect on fruit quality in strawberry due to temperature variation Hassan *et al* (2000).These results are in conformation with the findings of Rahman (2014) and Kaur (2014) in strawberry plants. The data on fruit yield per plant as affected by different planting depicted that the maximum fruit yield per plant was noted in the plants under T_4 treatment with 310.10 g/plant which proved to be significantly higher than all other treatments followed by the plants under treatment T_5, T_3, T_2, T_6 and T_7 which generated fruit yield of 299.70,200.32,144.55,134.77 and 131.02 g/plant respectively. All the treatments were found to be highly significant over each other. Zero results were obtained from T_1 treatment being none of the plant survived due to very high temperature present at that time. Planting date affected yield in nearly all cases. Cropping was generally best when the stock was planted in early to mid October. he 15th October planted plants produced higher fruit yield than the plants planted in November which might be due to the fact that October planted plants acquired more favourable growing conditions before fruiting. On the other hand September planted plants require more days for flowering than the October plants due to unfavourable temperature which led to produce large number of leaves during the reproductive phase these leaves acted as sink, while November planted plants got less time for optimum vegetative growth, which might have led to less yield. This statement was supported by Menzel and Smith (2011) in strawberry cv.Festival. Rahman (2014) also reported the same in strawberry cultivars. These findings are also in conformation with the research study of Kaur (2010) in strawberry cv. Chandler. Maximum fruit yield per hectare was noted in the plants under treatment T_4 with 14.01 q/ha which proved to be significantly higher than all the treatments while the minimum yield (6.55 q/ha) was in the treatment T_7.All the treatments were found to be highly significant with each other. These results are in accordance with the findings of Menzel and Smith (2011) and Rehman (2014) in strawberry plants. Kaur (2010) also reported the same in strawberry cv. Chandler.

Conclusion

From the results of the present experiment, planting of strawberry cv. Chandler on 15th October appears to be more beneficial in the improvement of fruit characters. It also increased the yield and improved the quality attributes of the fruits. It was also noted that number of fruits, yield and productivity of plants that were planted on 15[th]October were at par with those planted on October 30.Hence October 15-30 can be considered the best planting time for strawberry cv. Chandler in sub tropical areas of Punjab.

REFERENCES

Anna, D., Tapichino, G. and Incalcalerra, G. 2003. Influence of planting time and runner order on strawberry plug plant grown under plastic tunnel. *Acta Hort* 614:123-129.

Asrey, R. and Singh, R. 2004. Evaluation of strawberry varieties under semi-arid irrigation region of Punjab. *Ind J of Hort* 61: 122-124.

Dhillon, A. S. 2005. Effect of bio-regulators on growth and cropping in strawberry under sub tropical conditions of Punjab. *M.Sc. Thesis,GNDU.*

Dhillon, W. S. 2013. Fruit production in India 631-646. *Narendra Publishing House New Delhi.*

Hassan, G. L., Godara, A. K., Jitender, K., Huchche, A. D. and Kumar, J. 2005. Effect of different mulches on the yield and quality of 'oso Grande' strawberry (Fragaria×ananassa). *Ind. J Agric Sci* 70:184-185.

Jahangeera, B., Kher, R., Bakshi, P. and Wah, V. K. 2010. Effect of planting time and mulching material on quality of strawberry. *J Res SKUAST-J* 9:54-62.

Kaur, A. 2010. Cultivation of strawberry under protected conditions in sub tropical regions of Punjab. Ph.D. *Thesis GNDU.*

Mawkhiew, A. and Pereira, L. S. 2015. Effect of planting time on yield and quality of strawberry in west garo hills, Meghalaya. *J Agric technol* 22: 44-48.

Menzil, C. M. and Smith, L. 2011. Effect of time of planting, plant size and nursery-growing environment on the performance of strawberry in a sub-tropical environment. *Hort Tech* 21: 56-66.

Rahman, M. M. 2014. Interact to influence of planting date and cultivar on growth, yield and quality of strawberry (Fragaria×Ananassa Dutch.) *J hort fores* 6:31-37.

Rahman, M. M., Rahman, M. M., Hossain, M. M., Khaliq, Q. A. and Moniruzzamam, M. 2014. Effect of planting time and genotypes on growth, yield and quality of strawberry. *Sci Hort* 167: 56-62.

Sharma, R. R. and Sharma, V. P. 2004. Planting time is important for partitioning the assimilates, which directly influence the growth and yield of strawberry. *J of Hort and Fores.*

Singh, R., Sharma, R. R. and Goyal, R. K. 2007. Effect of planting time and mulching on Chandler strawberry. *Scientia Hort* 111: 344-351.

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