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Effect of spacing and mulching on vegetative growth, fruit yield and quality of strawberry cultivars (*Faragria*× *ananassa* Duch.)

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Abstract
The present study was carried out at Fruit Research Farm , Guru Kashi University Talwandi Sabo, Bathinda, during the period 2016- 2017. The experiment was performed to find out the most suitable cultivar and the best spacing and mulching material for Punjab conditions. The experiment was laid out split-split plot design with four replication. The treatment comprised of three main treatment as cultivar (Chandler, Camarosa and Winterdown), three sub treatment as spacing (30×15 cm, 30×20 cm and 30×30 cm) and two sub-sub treatment as mulching (paddy straw mulch and without mulch).On the basis of statistical data, it is concluded that cv. Chandler with spacing 30×30 cm was found to be best in terms of plant growth *viz*., plant height, number of leaves, plant spread, mean fruit weight and number of days required for flowering, fruit set and ripening, mean fruit yield / plant, fruit length and diameter, quality parameters TSS, Acidity and TSS / Acid ratio. The highest yield / ha was recorded with spacing 30×15 due to increasing number of plants per unit. Paddy straw mulching had significant effect on all over characters.

Keywords: Strawberry, mulching, spacing

Introduction
Strawberry (*Faragria* × *ananassa* Duch.) is one of the most important cultivated fruit crop in the world. It is hybridization of two wild American octaploid species *F. Chiloensis* and *F. Virginian* it resulted in *Faragria* × *ananassa*, it belongs to the family Rosaceous and genus Faragria. Strawberry is exclusive amongst all the cultivated fruits. It is a delicious and short duration crop and has a specific demand in processing industry for making various products and it is eaten as fresh fruit. Fruit colour, texture, aroma and the balance between sweetness and sourness have been identified as important determinants of overall quality parameters of strawberry fruit (Shamila *et al.* 1992) [15] that give commercial value to the fruits in general.
The fruit plants are covered with straw mulch during time of fruiting to avoid soil and spoilage of fruits due to moisture. Runners are planted in the month of October and fruiting ends in April, under Punjab conditions due to short growing period under sub-tropical climate the growth of strawberry is also restricted and yield is poor account of sudden rise in temperature soon after the commencement of fruiting in March. Work on this aspect in our country is scanty, especially under Punjab conditions but much work has been done on the establishment of strawberry plants and runner production at abroad.
In strawberry cultivation there is considerable variation among different cultivars regarding their adaptability to a particular set of agro-climatic conditions (Sharma and Thakur 2008) [16]. The effect of environmental factors on strawberry characteristics has already been reported by many authors (Faedi *et.al.* 2002, Pelayo-Zaldivar *et al.*2005) [4, 14]. All three photoperiod types, short day (SD), long day (LD), and day-neutral (DN) exist in Faragria, Although the most of the commercial octaploid cultivars are grown either SD or DN (Hancock 1999) [6].
Mulching is an important cultural practice in strawberry for conservation of soil moisture, control of weeds and regulation of soil temperature for quality production of strawberry. Mulching with black polythene improved the quality of the fruit in cv. Tioga in Himachal Pradesh and increased the yield by 56-60% (Gupta and Acharaya, 1993) [5]. The exact growth and development requirement have restricted the commercial cultivation of this fruits to the

specific areas of the worlds. The principal strawberry growing areas of our country fall in the hilly regions of Kashmir, Himachal Pradesh, Dehradun, valley of Uttar Pradesh and Mahabaleshwer in Bombay and Cooner in South. The commercial cultivation of strawberry in Haryana, Uttar Pradesh and Punjab is picking up fast due to its remunerative prices. Under north Indian conditions, the crop has to be protected from the frost and high temperature injuries during winter and summer respectively. Because of the high prospects of strawberry cultivation in this region, there is an urgent need of standardization of cultural practices and evaluation of different cultivars.

Material and Method

The present investigations entitled "Effect of spacing and mulching on vegetative growth, fruit yield and quality of strawberry cultivars *(Fragaria* × *ananassa* Duch.)" under condition of Punjab were undertaken in department of fruit science, Guru Kashi University, Talwandi Sabo during 2016-2017 which situated at 29º57'latitude and 75º7'longitude and altitude 213 meters above sea level. Total 18 treatment combinations of three main plot treatments of different cultivars viz. chandler, Winterdown and Camarosa, three spacing viz. 30×15cm, 30×20cm and 30×30cm in sub plot and two mulching treatments as sub- sub plot viz. straw mulch and without mulch were laid out in split – split plot design with four replications. The uniform strawberry plants cv. Chandler were procured from Gurdaspur, cv. Camarosa and cv. Winterdown from (Solan) Himachal Pradesh. The plot was divided into 4 blocks of equal size with height of 25 cm at distance of 30 cm. Soil was thoroughly ploughed up and well rotten FYM @25 t/ ha was mixed well in the soil. At the time of bed preparation half dose of nitrogen and phosphorus, and complete dose of potash were also added and remaining dose was applied at time of flowering. Planting was done on 5th October (Chandler, Camarosa and Winterdown) at different spacing 30×15 cm (12 Plants/bed), 30×20 cm (8 plants/bed) and 30×30 cm (6 plants/bed). The roots of the runners were well pressed in the soil and immediate irrigation was given. Observations were recorded on plant height (cm), no. of leaves, plant spread (cm), number of fruits, fruit length (cm), fruit breath (cm), fruit weight (gm), yield per plant (gm). Total soluble solid (brix) measured with the help of refractrometer and titratable acidity was determined as per standard procedure of AOAC, 1970.

Results and Discussion

Effect of cultivars: On the basis of present investigations of different spacing and mulching on vegetative growth, yield and quality of different strawberry cultivars and observed data was shown in form of tables. Data presented in table no. 1 clearly revealed that the maximum vegetative growth viz. plant height (12), maximum number of leaves (18.26), plant spread in both directions viz. n-s and e-w (16.42 cm and 16.85 cm) was recorded in chandler. Chandler also took lesser number of days from planting to first flower initiation (72.55), planting to fruit set (81.65), fruit set to harvest (31.81), maximum fruit weight (11.89 gm), fruit length and diameter (3.66 cm and 2.76), TSS (9.32 brix), acidity (1.0%) and TSS/Acid ratio (8.71%). Different strawberry cultivars showed significant variation among themselves with respect to total soluble solid and it ranged from 9.26 in 'Catskill' to 14.02 in 'Pajaro' and 'Selva' (Sharma *et.al.* 2014) [16]. Beniwal *et al*. (1989) [2] reported that gens are responsible for variation in cultivars. Sahu and Chandel (2014) [18] found that cv. Festival and Camarosa were the best in plant height and leaf area. Different environmental factors were responsible for differences in plant height and plant spread among various cultivars. Gupta (1998) [7] studied on cv. Chandler under mid hills of Himachal Pradesh and found higher fruit weight of chandler.

Effect of spacing: The growth and yield of strawberry cultivars were significantly affected by plant spacing (Table 1). The wider spacing (30×30 cm) gave best results in terms of plant height (11.39 cm), maximum number of leaves (18.37), plant spread in both directions viz. n-s and e-w (16.96 cm and 16.52 cm) as well as took lesser no of days from planting to fruit set (81.89). Yield and quality parameters viz. maximum fruit weight (10.15 gm), fruit length and diameter (3.36 cm and 2.64 cm), yield per plant (104.97 gm), TSS (9.11 brix), acidity and TSS/Acid ratio (1.03% and 8.94%) also found best with wider spacing. Plants grown at the highest spacing required the longest growing period. But the lowest spacing (30 cm x 15cm) significantly produced the maximum yield per hector. The plants grown under minimum spacing produced more yields which might have been due to the higher number of plants accommodated in per hector. Perez *et al*. (2004) [12] suggested that plant spacing increased growth and development in strawberry. Wright and Sandrang (1993) [19] reported that the earliest flowering start when plants grown at a medium density (25 plants/m^2) and produced highest number of flowers per inflorescence.

Effect of mulching: Mulching had also significant effect on all over parameters viz. growth, yield and quality as compared to without mulching. Mulching improved plant growth and development. Swenson *et al*. (2004), miller *et al*. (2002) [9] reported that mulching was Improved the water infiltration and higher water retention. Mulching was also increase in growth characteristics also been reported by Dobbelaere (2000). The present investigation established the fact that mulching improves the vegetative growth in strawberry (Table no. 1, 2). Similar results have also been reported by Moor *et al.* (2004) [10]. Lamarre *et al.* (1996) [8] reported increase in fruit size and yield with mulching in cv. Tribute, sites in Canada. Similar observations in cv. Chandler have also been reported by Probosco *et al.* (1994) [13].

Interaction effect: Interaction effect of different cultivars × spacing × mulching was found to be significant on growth, yield and quality. Respectively, It has been presented in table no. 3, 4, 5. The maximum number of leaves (19.36), fruit diameter (2.92 cm) and TSS/Acid ratio (9.67%) were recorded in chandler with spacing 30×30 cm (table no.3). Fruit diameter (2.81 cm) and TSS/Acid (9.82%) also influenced in spacing 30×30 cm with straw mulch (table no.4). Interaction effect of cultivar and mulching were also significant in all aspect of growth. Chandler with straw mulch took lesser number of days for planting to fruit set (80.97), fruit set to harvest (30.55) and the maximum fruit length and diameter (3.68 cm and 2.89 cm) was also recorded with this combination (table no.5).

Conclusion

From the above mentioned results it can be indicated that cv. Chandler with spacing 30×30 cm is the most promising among the three cultivars because of the highest yield and better quality attributes. Cv. Winterdown may promise for its fruit quality characters which are important as far as

economics concerned. Spacing 30×15 cm was the best due to increased number of plants per unit area leading to the highest yield/ was also increased. Mulching is the most desirable which increased the yield and improved the quality of the fruits over without mulch treatment in all cultivars

Table 1: Effect of spacing and mulching on growth and flowering parameters of different strawberry cultivars

Treatment	Plant height (cm)	No. of leaves	Plant spread (cm)		Days for planting to First flowering	Days for Planting to fruit set	Days for fruit set to harvest
			N – S	E -W			
Main plot : Cultivar (T)							
T1 = Chandler	12.00	18.26	16.42	16.85	72.55	81.65	31.81
T2 =Camarosa	10.66	17.51	14.92	14.32	80.52	83.85	33.44
T3 = Winterdown	11.30	16.92	16.17	14.54	79.41	82.93	34.98
CD at 5%	0.89	0.66	0.69	0.51	2.86	NS	1.96
Sub plot : Spacing (S) cm							
S1 = 30 × 15 cm	11.19	16.33	15.11	14.28	79.41	84.83	32.08
S2 = 30× 20 cm	11.38	18.04	15.44	14.92	79.04	82.93	33.53
S3 = 30 × 30 cm	11.39	18.37	16.96	16.52	77.16	81.89	34.62
CD at 5%	NS	0.85	0.89	1.16	NS	2.45	NS
Sub sub plot : Mulching (M)							
M_1 = Mulching	11.45	17.68	16.11	15.30	75.95	82.06	33.61
M_0 = Without mulch	11.19	17.48	15.57	15.18	79.03	83.55	33.21
CD at 5%	NS	NS	NS	NS	1.09	2.67	NS
Interaction							
Cultivar× spacing	NS	1.47	NS	NS	NS	NS	NS
C cultivar× mulching	NS	NS	NS	NS	NS	2.67	2.02
spacing× mulching	NS	NS	NS	NS	NS	NS	NS
Cultivar × spacing × mulching	NS	NS	NS	NS	NS	NS	NS

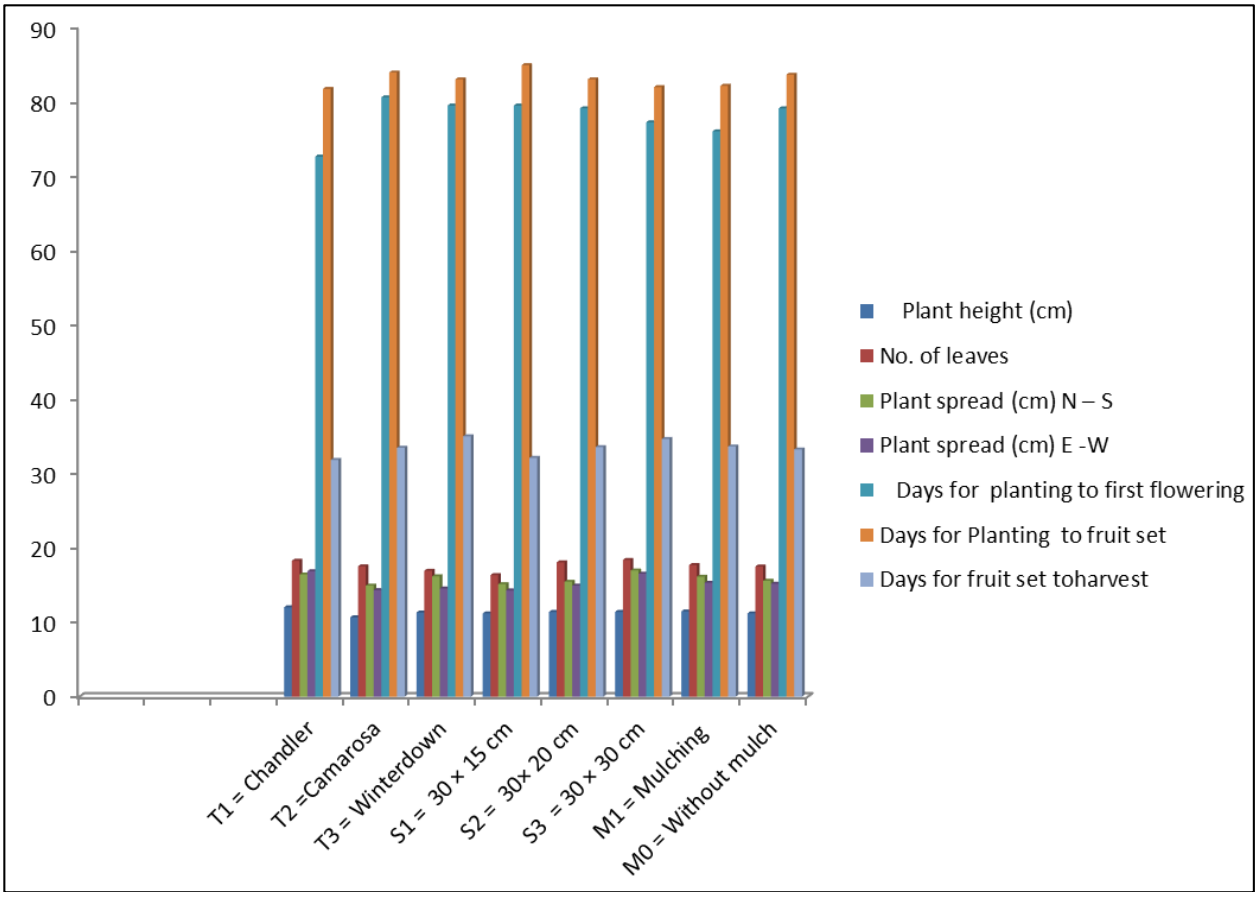

Fig 1: Effect of spacing and mulching on growth and flowering parameters of different strawberry cultivars

Table 2: Effect of spacing and mulching on yield and quality parameters of different strawberry cultivars

Treatment	Fruit Length (cm)	Fruit Diameter (cm)	Mean fruit weight (gm)	Mean yield / plant (gm)	TSS (%)	Acidity (%)	TSS / Acidity (%)
Main plot: Cultivar (T)							
T1 = Chandler	3.66	2.76	11.89	104.97	9.32	1.0	8.71
T2 =Camarosa	2.96	2.46	8.31	32.41	9.02	1.3	7.27
T3 = Winterdown	3.00	2.55	9.49	28.02	8.69	1.1	7.88
CD at 5%	0.29	0.18	2.24	13.65	NS	0.09	0.85
Sub plot: Spacing (S) cm							
S1 = 30 × 15 cm	3.11	2.53	9.62	49.85	9.10	1.22	7.54
S2 = 30× 20 cm	3.14	2.59	9.91	56.31	8.82	1.25	7.39
S3 = 30 × 30 cm	3.36	2.64	10.15	59.25	9.11	1.03	8.94
CD at 5%	NS	NS	NS	NS	NS	NS	0.80
Sub sub plot: Mulching (M)							
M_1 = Mulching	3.22	2.63	10.27	58.18	9.02	1.09	8.34
M_0 = Without mulch	3.19	2.55	9.52	52.09	9.00	1.25	7.57
CD at 5%	NS	NS	NS	NS	NS	NS	0.57
Interaction							
Cultivar× spacing	NS	0.37	NS	NS	NS	NS	1.40
Cultivar× mulching	0.37	0.31	NS	NS	NS	NS	NS
spacing× mulching	NS	0.31	NS	NS	NS	NS	0.99
Cultivar × spacing × mulching	NS	NS	NS	NS	NS	NS	NS

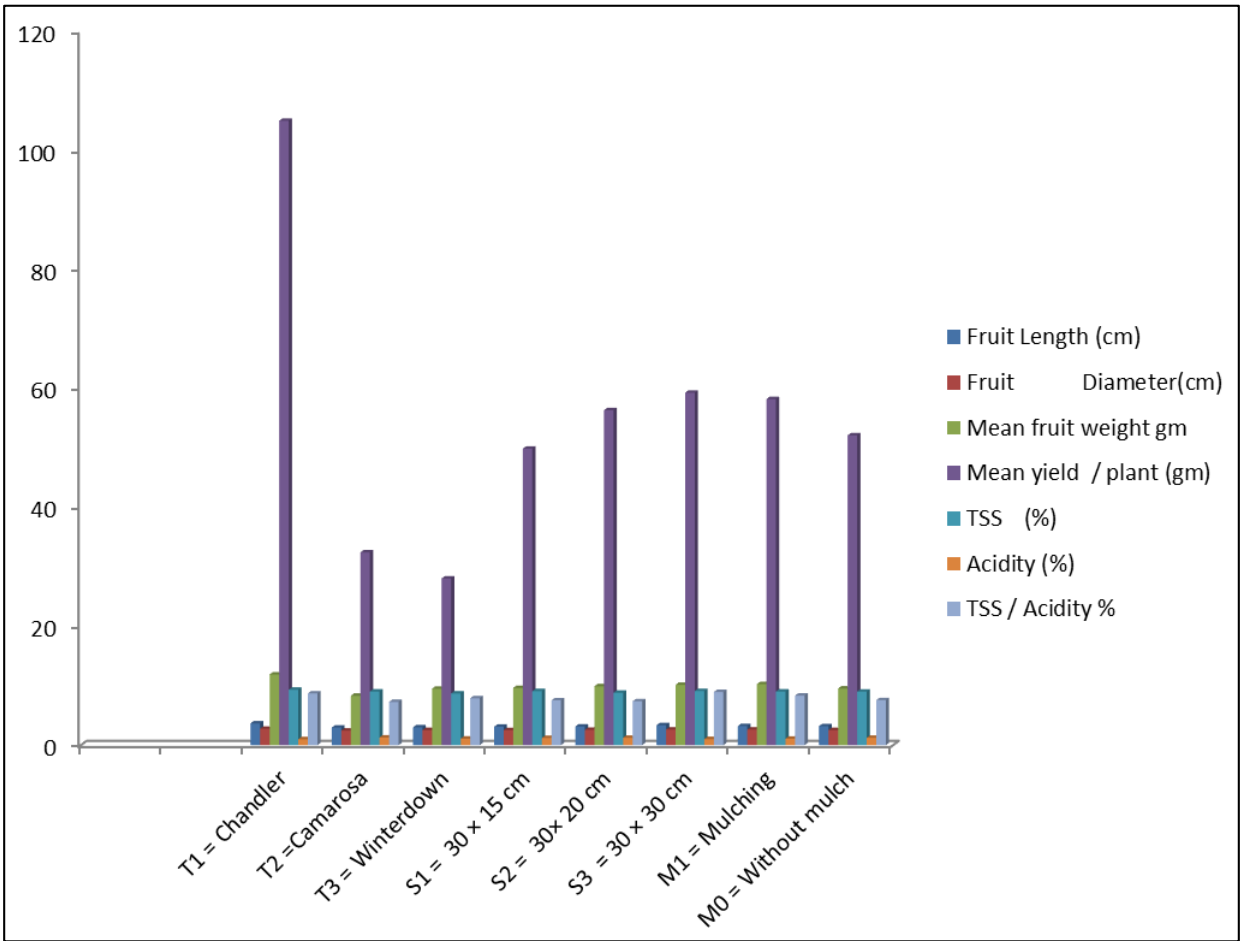

Fig 2: Effect of spacing and mulching on yield and quality parameters of different strawberry cultivars

Table 3: Interaction effect in different cultivars and spacing on no. of leaves, fruit diameter and TSS/Acid ratio

Cultivar / Spacing	No. of leaves	diameter (cm)	TSS / Acid
chandler = 30×15 cm	17.62	2.57	7.36
30×20 cm	17.80	2.79	6.62
30×30 cm	19.36	2.92	9.67
Camarosa = 30×15 cm	17.65	2.59	6.56
30×20 cm	18.88	2.77	6.35
30×30 cm	16.01	2.68	8.90
Winterdown = 30×15 cm	15.37	2.10	8.71
30×20 cm	18.42	2.71	9.19
30×30 cm	17.11	2.17	8.24
CD at 5%	1.47	0.37	1.40

Table 4: Interaction Effect in different mulching and spacing on fruit diameter and TSS/Acid

Mulching / Spacing	Fruit Diameter (cm)	TSS /Acid
Straw mulch = 30×15 cm	2.70	7.68
30×20 cm	2.78	7.80
30×30 cm	2.81	9.82
Without mulch = 30×15 cm	2.48	7.41
30×20 cm	2.69	9.68
30×30 cm	2.48	8.06
CD at 5%	0.31	0.99

Table 5: Interaction effect in different cultivars and mulching flowering and fruiting parameters

Cultivar / mulching	Days required for Planting to fruit set	Days required for fruit set to harvest	Fruit Length (cm)	Fruit Diameter (cm)
chandler= straw mulch	80.97	30.55	3.68	2.89
Without mulch	82.32	33.07	3.66	2.63
camarosa= straw mulch	81.74	33.91	3.14	2.57
Without mulch	85.95	32.97	2.78	2.35
Winterdown=straw mulch	83.72	34.08	2.77	2.35
Without mulch	82.14	35.17	3.23	2.48
CD at 5%	2.67	2.02	0.37	0.31

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References

1. Ali, Angrej, Gaur GS. Effect of different mulches on growth, flowering, yield and quality on strawberry (*Fragaria ×ananassa* duch.) cv. Sweet Charlie. The Asian Journal of Horticulture, 2007; 2(1):149.
2. Beniwal LS, Daulta BS, Bisla SS. Evaluation of different strawberry (*Fragaria ananassa*) cvs. Under Hisar conditions. 2. Yield and fruit quality characters. Haryana. J Hortic. Sci. 1989a; 18(1, 2):56-60.
3. Dobbelaere S, Croonenboghs A, Thys A, Ptacek D, Vanderleyden J *et al*., Responce of agronomically important crops to inoculation with Azospirilium. Aust. J Plant Physiol. 2001; 28:871-879.
4. Faedi W, Mourgues F, Rosati C. Strawberry Breeding and Varieties: Situation and Perspectives. Acta Hort. 2002; 567:51- 59.
5. Gupta R, Acharya CL. Effect of mulch induced hydrothermal regime on root growth, water use efficiency, yield and quality of strawberry. J Ind. Soc Sci. 1993; 41(1):17-25.
6. Honcock JF. Strawberries. CAB International, Wallingfer, UK, 1999.
7. Gupta U. Description and evaluation of strawberry cultivars under mid hills of H.P. Thesis, M.Sc. Dr. YSPUHF, Solan (HP), India, 1998.
8. Lamarre M, Lareau MJ, Payette S, Fortin C. Influence of nitrogen fertilization, row covers and cultivars on the production of day-neutral strawberries in Quebec. Canad. J Soil Sci. 1996; 76(1):29-36.
9. Miller, Chang. Hydrological properties of clay laom soil after long- term cattle manure application. J environ. 2002; 31:989-996.
10. Moor U, Karp K, Poldma P. Effect of mulching and fertilization on the quality of strawberries. Agric. Food Sci. 2004; 13:256-267.
11. Nicoll MF, Gallatta GJ. variations in growth and flowering habits of june bearing. J Amer. Soc. Hort. Sci. 1987; 95:120-22.
12. Perez DE, Camacaro ME, Camacaro GJ, Hadley P, Dennett MD, Battey NH *et al*. Effect of plant density and initial crown size on growth, development and yield in strawberry cultivars 'Elsanta' and 'Bolero'. J Hort. Sci. Biotech. 2004; 79(5):739-46.
13. Probasco PR, Garrison SA, Fiola JA. Annual strawberry production on plastic mulch. In: 25th National Agricultural Plastics Congress. Proc. Conf. held in Lexington, k Y., USA, @#-27 September, 1994(ed. By Jones, T.T.) St. Augustine, USA, Am. Soc. For Plasticulture. 1994, 215-220.
14. Pelayo-Zaldivar C, Ebeler bSE, Kader AA. Cultivar and harvest date effects on flavor and other quality attributes of California strawberries. J Food Quality. 2005, 28.
15. Shamaila M, Baumann TE, Eaton GW, Powrie WD, Skura BJ. Quality attributes of strawberry cultivars grown in british Columbia. J Food Sci. 1992; 57(3):696-99.
16. Sharma G, Yadav A, Thakur M. studies on growth and flowering attributes of different strawberry cultivars in Himachal Pradesh. Asian J Adv. Basic Sci. 2014; 13(1):1-4
17. Sharma, Thakur MS. Evaluation of different Strawberry cultivars for yield and quality Characters in Himachal Paradesh) Evaluation of some Strawberry cultivation under Jammu plains. Indian J Plant Genetic Res. 2008; 15:64-66.
18. Sahu A, Chandel JS. Studies on the performance of strawberry cultivars under mid- hill conditions of north-western Himalayas. Indian. J Hort. 2014; 71: 330-34
19. Wright CJ, Sandrang AK. Density effects on vegetative and reproductive development in strawberry cv. Hapil. J Hort. Sci. 1993; 68(2):231-236.