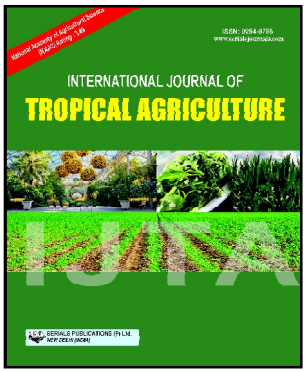

INTERNATIONAL JOURNAL OF TROPICAL AGRICULTURE

ISSN : 0254-8755

available at http: www.serialsjournals.com

Volume 37 • Number 2 • 2019

Strawberry Cultivation is a Profitable Proposition in the Hills

K. K. Pramanick, A. K. Shukla, Santosh Watpade, Jeetender Kumar and Dipak Negi

ICAR-I.A.R.I. Regional Station (CHC), Amartara Cottage, Shimla-171004, E-mail: kallolpramanick@gmail.com

Abstract: The cultivated strawberry has commanded a premier position in the world fruit market due to its attractive fruit and distinctive flavour. The strawberry plant performs equally well from regions that are characteristically temperate, or the sub-tropical plains and even in high altitude regions of the tropical zone. In spite of attractive fruits and pleasing flavor strawberry cultivation is still in its infancy in India primarily because of its perishable nature. Farmers in the sub-tropics in the vicinity of urban centres have been profitably cultivating strawberries during the winter months obtaining their planting material from hill states of India. Strawberry growers in the hills thus have a two pronged earning potential from strawberry cultivation. A number of large fruited, high yielding varieties viz., Chandler, Pajaro, Etna, Sweet Charlie, Selva, Douglas, Confictura, Dana, Belrubi, Gorella, Dilpasand, Torrey, Seascape and Addie have been introduced into the country from Europe and North America. Some of the day-neutral cultivars are Selva, Majestic, Phenomenal, Brighton, Etna, Fern, Sweet Charlie are very promising. Farmers from tropical & sub-tropical area have been profitably cultivating strawberries during the winter months obtaining their planting materials from the hills. Besides, the income from strawberry fruits, growers in the hills thus can also earn by producing planting material for winter plantings in the plains.

INTRODUCTION

The cultivated strawberry (*Fragaria X ananassa* Duch.) has commanded a premier position in the world fruit market due to its attractive fruit and pleasant distinctive flavor. It has adapted well to highly varying climatic conditions. It is today commercially cultivated in regions that are characteristically temperate to sub-tropical plains to high altitudes in tropical regions and even in the desert-like areas of Israel. Being a shallow rooted crop, both crop damage and plant mortality can occur during dry seasons. Strawberry cultivation recently received some impetus in India with large business houses setting up a number of agro based establishments primarily aimed at large scale production of strawberry fruits. Being an herbaceous annual fruit crop, it can also be

grown easily in kitchen gardens, roof-top gardens, pots etc. It is regarded as a valuable food in the diet of millions of people around the globe and is in special demand by the fruit processing industries for preparing the jams, ice cream, candy, toffee, juices, shake and other products especially used in medical sciences. A number of large fruited, high yielding varieties (e.g. 'Chandler', 'Pajaro', 'Etna', 'Sweet Charlie', 'Selva', 'Douglas', 'Confictura', 'Dana', 'Belrubi', 'Gorella', 'Dilpasand', 'Torrey', 'Seascape' and 'Addie') have been introduced into India from Europe and North America. Some of the day-neutral cultivars (e.g. 'Selva', 'Majestic', 'Phenomenal, 'Brighton', 'Etna, 'Fern') may be adapted for different Indian climate. Farmers in the vicinity of Delhi, Haryana and Uttar Pradesh a sub-tropical area have been profitably cultivating strawberries during the winter months obtaining their planting materials from the hills of Himachal Pradesh / Uttarakhand. Besides, the income from strawberry fruits, growers in the hills thus can also earn by producing planting material for winter plantings in the plains. Hemelrick (1982) showed that plants grown on black polythene produce more runners and fruits than with bare soil. Different workers have reported beneficial effects of mulches on strawberry production (Rebandel and Przysiccka, 1981, Badiyala and Aggarwal, 1981, Hassan et al., 2000, Lille et al., 2003). Keeping this in view, the study was conducted to test the performance of the promising genotypes under hilly conditions in India.

MATERIAL AND METHODS

Eighteen strawberry cultivars **(Table 1)**, representing diverse fruit and plant characteristics constituted the material for the present study. The investigation was carried out at the ICAR-IARI Regional Station (CHC), Shimla, during 2017-2018. The observations were recorded from randomly selected five plants from each cultivar in each replication. Observations were recorded for plant height, No. of leaves, petiole length, date of flowering, date of full bloom, date of fruit set, date of harvest, fruit weight, fruit length, fruit width, T.S.S., No. of fruits per plant, runner production, disease reaction(leaf spot), yield per plant and yield per hectare from both in open condition and low tunnel condition.

The *Mcoysphaerella fragariae* leaf spot severity was recorded in nursery as well as in pots by selecting 50 leaves at random and categorizing them into 0-5 scale and percent disease intensity was computed according to McKinney (1923). All the disease ratings were further utilized for calculation of disease severity on the individual genotype.

The strawberry plants were planted at a distance of 30 cm apart in rows that were 45 cm apart. Ten plants were planted in a bed of 150 x 60 cm. All runners were removed as soon as they appeared for better fruit production. In the same experiments, five other beds were kept for fruit production as well as runner production. There were three replications with five beds of each cultivar in each replicate. Other recommended agronomic, drip-irrigation and plant protection measures as well as organic mulches were followed for successful strawberry cultivation.

Table 1
List of Strawberry Cultivars / lines

1)	Chandler
2)	Pajaro
3)	Etna
4)	Sweet Charlie
5)	Selva
6)	Douglas
7)	Confictura
8)	Dana
9)	Belrubi
10)	Gorella
11)	Addie
12)	Majestic
13)	Phenomenal
14)	Brighton
15)	Fern
16)	Dilpasand
17)	Torrey
18)	Sea Scape

RESULTS AND DISCUSSION

Performance of strawberry genotypes in the hills is presented in Tables 2 and 3 for fruit and plant characteristics.

Observation on the trial for the evaluation of eighteen cultivars / lines was continued. Comparisons were made among the cultivars / lines for their height, No. of leaves, petiole length, date of flowering, date of full bloom, date of fruit set, date of harvest, fruit weight, fruit length, fruit width, T.S.S., No. of fruits per plant, yield per plant and yield per hectare (Table 2 and Table 3).

The fruit weight varied from 2.37g in Phenomenal to 24.78g in Etna. The large fruited varieties were Etna, Chandler, Selva, Douglas, Dana, Belrubi, Confictura, Brighton, Pajaro, Fern, Adie, Gorilla, Sweet Charlie, Sea Scape, etc. Maximum fruit length was exhibited by Selva (38.95mm) followed by Gorella (37.85mm), Douglas (35.98mm), Etna (34.68mm) where as minimum was recorded in Majestic (19.75mm) followed by Dilpasand (19.92mm). The fruit length varied from 19.75mm to 38.95mm. Maximum fruit width was observed in Etna (35.77mm) followed by Douglas (30.93mm), Chandler (29.97mm) etc., where as minimum was recorded in Majestic (14.89mm) followed by Phenomenal (16.59mm). According to Nitsch (1950), Janick & Eggert (1968) and Moore *et al.* (1970), these differences in fruit size were primarily due to plant vigour, competition among fruits in the inflorescence, number & size of developed achenes, climatic condititions, irrigation & plant nutrient status. Sea Scape exhibited maximum T.S.S. ^{0}brix (11.95) followed by Sweet Charlie (11.91), Belrubi (11.55) etc., where as minimum T.S.S. ^{0}brix was recorded in Chandler (8.01) followed by Etna (8.21), Selva (8.52) etc. These results are in agreement with the findings of Veazie (1995) who reported that TSS content varies from 4^{o} to 12^{o} Brix in strawberry. According to Shaw (1990), environmental conditions rather than genetic inheritance during production influenced the soluble solids content.The maximum number of fruits per plant was harvested from Pajaro (23.01) followed by Sweet Charlie (22.05), where as minimum was recorded in Etna (10.09), followed by Selva (10.05), Douglas(12.08) etc. Yield per plant depending on the cultivar / line varied a lot (41.23g to 243.80g). The maximum yield was observed in Etna followed by Sweet Charlie (232.19g), Chandler (225.01g), Belrubi (213.20g), Douglas (196.44g), Sea Scape (180.88g), Selva (175.01g) etc. whereas minimum was recorded in Phenomenal followed by Majestic (50.01g), Torrey (52.95g) etc. These variations in yielding potential may be ascribed to the fact that strawberry yields are markedly influenced by environmental parameters like photoperiod, temperature & light intensities (Avidov, 1986).

The data on variations in plant characteristics (plant height, number of leaves and petiole length) is prescribed in **Table 3**. The plant remained dormant from end of December' 2017 to end of February'2018. So plant height remained almost constant during the period. It attained maximum during August—September 2018. The plant height varied from19.05cm in Phenomenal to 29.01cm in Pajaro. Grewal et al.(1988) also observed significant differences in plant height & spreads. Number of leaves also remained to some extent constant during the dormant period but maximum number of leaves was exhibited by Belrubi (33.66) during August—September '2018 followed by Adie (33.48), etc where as the minimum was recorded during the period in Chandler (12.85) followed by Douglas (13.95), Etna (14.66) etc. Beniwal *et al.* (1989) also found similar observations. Petiole length varied from 11.34 cm to 24.01 cm. Maximum petiole length was observed in Torrey (24.01 cm), Majestic (20.66cm) where as the minimum was recorded in Brighton followed by Belrubi (11.51 cm), Etna (12.01 cm), Gorella (12.67 cm), etc. The plant spread varied from 18.83cm in Douglas to 29.47cm in Sea Scape. The results of present investigations are in conformity with those

obtained by Sanford et al.(1982) & Stahler et al.(1995) who reported long & moderate petioles in 'Honeyoye' & 'Red Crest' strawberries. These variation in petiole lengths could be attributed to differences in cultivar's response to photoperiodism & light intensity (Darrow,1966).

Variations were also recorded in the date of first flower appearance, date of full bloom and length of harvest period (Table 4) both in open as well as low tunnel condition. Gast and Pollard (1991) found that row covers could enhance yield of marketable fruits in Earliglow strawberry but not the number of flowers. Yield increase was primarily due to increase in development of tertiary berries in trusses. 'Darrow', 'Earliglow', and 'Sparkle' strawberries grown under spun-bounded polypropylene, polyester, polyamide or silted polyethylene films, flowered 13 days earlier and their fruits were ready for harvest 10 days earlier than uncovered plants (Pollard *et al.,* 1989). Fruiting in plastic-covered 'Rahnyaya' and 'Redgauntlet' strawberries was hastened by 20 days (Kopylov, 1991).

Covering the strawberry bed with mini-plastic tunnels induced early cropping and total yield by 22 per cent and considerably reduced winter injury (Table 4). During summers (in the hills) the plastic sheets of the tunnels were replaced by plastic anti-hail nets / anti bird nets which resulted in higher yields and better fruit quality. The adoption of protected systems for strawberry production in Brazil must be carefully evaluated and implemented, since a number of reports mention the occurrence of higher temperatures under protected environments in relation to field conditions, especially with regard to maximum temperatures (Montero et al., 1985), this condition could be adverse for strawberry production (Iuchi, 1993), requiring an adaptation of cultural practices. Iuchi also observed smaller *strawberry* vegetative growth under protected cultivation, when compared to open field conditions.

Large scale runner production were undertaken by establishing runner beds even on fields prone to spring frosts as damage to the flowers does not matter. Generally a production of 5.99 to 26.56 runners were obtained per plant. Phenomenal produced the maximum number of runners per plant (26.56) followed by Torrey (21.58), Seascape (19.63) etc. whereas, the minimum was recorded in Douglas (5.99), followed by Selva (6.98), Fern (7.47) etc. The data is presented in Table 5.

Strawberry cultivars were evaluated for their disease reaction to leaf spot (c.o. *Mycosphaerella fragariae*) under natural disease pressure during the period under report (Table 6). Large fruited varieties were more susceptible than small to medium fruited varieties. Protected cultivation has been used for strawberry cultivation in order to protect plants from harsh weather and for a better control of diseases (Passos, 1997).

Considering all these factors it may be concluded that the genetic stock of strawberry used in these investigation had a wide range of variability of fruit and yield characters. As such, there is enough scope for improvement of these characters by selection / breeding.

CONCLUSION

Considering all these factors it may be concluded that the genetic stock of strawberry used in these investigation had a wide range of variability of fruit, plant and yield characters. As such, there is enough scope for improvement of these characters by selection / breeding.

Covering the strawberry beds with mini plastic tunnels induced one month early cropping and increased total yields by 22%. Winter injury and consequent mortality was also appreciably reduced. During summers (in the hills) the plastic sheets of the tunnels were replaced by plastic anti-hail nets or anti-bird nets which resulted in higher yields and better fruit quality. Black polyethylene mulching

Table 2
Fruit Characteristics of Strawberry Cultivars / Lines

Cultivar	*Fruit Wt(g)*	*Fruit Length (mm)*	*Fruit Width (mm)*	*T.S.S. (° brix)*	*No. of Fruits / Plant*	*Yield / Plant (g)*	*Yield / ha (qt)*
Chandler	15.01	36.11	29.97	08.01	15.01	225.01	150.76
Pajaro	06.75	26.69	22.53	09.24	23.01	155.25	104.02
Etna	24.78	34.88	35.77	08.21	10.09	243.80	163.35
Sweet Charlie	10.53	30.04	27.62	11.91	22.05	232.19	155.56
Selva	17.50	38.95	26.85	08.52	10.05	175.01	117.26
Douglas	16.37	35.98	30.93	10.03	12.08	196.44	131.62
Confictura	13.01	30.58	27.77	09.55	15.07	195.15	130.75
Dana	08.50	26.35	25.10	10.01	20.68	170.01	113.90
Belrubi	10.66	33.27	22.94	11.55	20.04	213.20	142.84
Gorella	06.10	37.85	18.05	09.01	18.08	109.80	73.57
Addie	07.01	26.50	22.36	09.01	15.06	105.15	70.45
Majectic	02.50	19.75	14.89	08.55	20.05	50.01	33.51
Phenomenal	02.37	20.82	16.59	09.75	19.01	41.23	27.69
Brighton	07.50	24.42	21.67	10.05	18.02	135.01	90.46
Fern	08.09	29.52	21.85	09.50	17.05	136.01	91.13
Dilpasand	03.53	19.92	18.95	09.25	22.03	77.66	52.03
Torrey	03.53	28.55	17.29	10.13	15.07	52.95	44.19
Sea Scape	10.01	33.36	25.76	11.95	18.07	180.88	121.19

Table 3
Plant Characteristics of Strawberry Cultivars

Sl. No.	*Cultivars*	*Plant height (cm)*	*No. of leaves per Plant 15 March*	*No. of leaves per Plant 15 Sept*	*Petiole length (cm)*	*Plant Spread (cm)*
1.	Chandler	19.66	5.67	12.85	15.01	25.30
2.	Pajaro	29.01	7.11	31.33	19.51	22.75
3.	Etna	19.66	4.85	14.66	12.01	26.67
4.	Sweet Charlie	25.48	7.01	30.03	13.05	20.60
5.	Selva	21.91	4.01	15.66	13.51	19.53
6.	Douglas	21.95	4.11	13.95	16.67	18.83
7.	Confictura	24.66	5.68	29.33	19.34	20.19
8.	Dana	25.66	4.67	20.41	16.51	22.80
9.	Belrubi	23.83	6.67	33.66	11.51	24.33
10.	Gorella	21.83	5.33	25.66	12.67	23.10
11.	Addie	26.66	6.66	33.48	20.40	25.33
12.	Majestic	25.33	5.66	18.15	20.66	21.03
13.	Phenomenal	19.05	5,17	13.85	16.87	25.70
14.	Brighton	27.01	7.02	30.66	11.34	22.56
15.	Fern	22.33	5.67	28.32	17.10	22.27
16.	Dilpasand	25.01	5.81	22.66	17.41	24.87
17.	Torrey	25.51	5.67	28.78	24.01	20.70
18.	Sea Scape	24.68	5.87	28.58	13.63	29.47

Table 4
Flowering and Harvest Periods of Strawberry Cultivars Under Open Field and Polythene Cover Conditions

S.No	Cultivars	Open Field			Polythene Cover		
		1st Flower Appearance	Date of Full Bloom	Harvest Period (Days)	1st Flower Appearance	Date of Full Bloom	Harvest Period (Days)
1.	Chandler	1/3/18	11/3/18	95	15/1/18	9/2/18	90
2.	Pajaro	1/3/18	3/4/18	74	6/2/18	1/3/18	73
3.	Etna	4/3/18	26/3/18	101	8/2/18	28/2/18	99
4.	Sweet Charlie	27/2/18	17/3/18	103	17/1/18	15/2/18	101
5.	Selva	28/2/18	3/4/18	91	20/1/18	10/2/18	90
6.	Douglas	2/3/18	13/4/18	78	23/2/18	28/3/18	77
7.	Confictura	2/3/18	16/3/18	110	1/2/18	15/2/18	109
8.	Dana	13/4/18	27/4/18	39	1/3/18	26/3/18	38
9.	Belrubi	3/4/18	12/4/18	90	17/1/18	1/3/18	90
10.	Gorella	9/3/18	26/3/18	49	18/1/18	1/3/18	45
11.	Addie	28/2/18	12/4/18	83	19/2/18	12/3/18	82
12.	Majestic	2/3/18	16/4/18	56	29/1/18	10/3/18	56
13.	Phenomenal	1/3/18	1/4/18	71	21/1/18	4/3/18	70
14.	Brighton	6/3/18	5/4/18	86	27/1/18	20/2/18	85
15.	Fern	1/3/18	5/4/18	74	10/2/18	2/3/18	74
16.	Dil Pasand	24/3/18	6/4/18	45	5/2/18	4/3/18	45
17.	Torrey	2/3/18	20/4/18	51	22/2/18	20/3/18	50
18.	Sea Scape	1/3/18	31/3/18	93	12/1/18	28/2/18	93

Table 5
Propagation Potential (Runners) in Different Strawberry Cultivars / Lines

Sl.No.	Cultivars / Lines	No.of runners /plant
1.	Chandler	9.69
2.	Pajaro	14.77
3.	Etna	12.23
4.	Sweet Charlie	16.53
5.	Selva	6.98
6.	Douglas	5.99
7.	Confictura	12.43
8.	Dana	15.57
9.	Belrubi	17.33
10.	Gorella	12.03
11.	Addie	10.77
12.	Majestic	12.54
13.	Phenomenal	26.56
14.	Brighton	14.57
15.	Fern	7.47
16.	Dilpasand	8.82
17.	Torrey	21.58
18.	Sea Scape	19.63

Table 6
Reaction of strawberry cultivars to leaf spot diseases

Genotype	Disease severity
Chandler	35
Pajaro	39
Etna	53
Sweet Charlie	49
Selva	47
Douglus	41
Confictura	53
Dana	55
Belrubi	59
Gorella	43
Addie	39
Majestic	31
Phenomenal	34
Brighton	33
Fern	32
Dilpasand	55
Torrey	37
Sea scape	41

resulted in a better soil moisture regime and considerably reduced weed growth.

Farmers from tropical & sub-tropical area have been profitably cultivating strawberries during the winter months obtaining their planting materials from the hills. Besides, the income from strawberry fruits, growers in the hills thus can also earn by producing planting material for winter plantings in the plains. The growers in the plains cannot produce their own disease free planting material as these plants do not survive in the extreme summer, even if they do so, they are prone to various diseases, particularly those transmitted by aphids or other insect pests.

REFERENCES

Avidov, H.A., (1986). Strawberry. In: Handbook of Fruitset and Development (Ed.Monselise, S.P.). Florida, CRC Press, Inc.

Badiyala, S.D. and G.C. Aggarwal. (1981). Note on the effect of mulches on strawberry production. Ind. J. Agric. Sci. 51:832-34.

Beniwal, L. S., Daulta, B. S. and Bisla, S. S., (1989). Evaluation of different strawberry cvs. Under Hisar conditions II-yield,fruit and quality characters. Haryana J. Hort. Sci., 18(1-2): 56-60.

Darrow, G. M., (1966). The Strawberry. New York: Holt, Rinehart and Winston.

Gast K.L.B. and J.E. Pollard. (1991). Row covers enhance reproductive and vegetative yield components in strawberries. Hort Science 26:1467-69.

Grewal, G. P. S., Dhaliwal, G. S. and Grewal, S. S., (1988). Evaluation of strawberry varieties for vegetative and fruiting characters under submountain zone. Punjab Hort. J., 28 (1&2): 87-90.

Hassan, G.I., A.K. Godara, Jitender Kumar, and A.D. Huchche. (2000). Effect of different mulches on the yield and quality of 'Oso Grande' strawberry (Fragaria x ananassa). Ind. J. Agric. Sci. 70: 184-85.

Hemelrick, D.G. (1982). Effect of polyethylene mulch colour on soil temperatures and strawberry plant response. Adv. Strawberry Prod., 1:15-16.

Iuchi, T. (1993). Crescimento da planta e do fruto de morangueiro (*Fragaria* x *ananassa* Duch.) em diferentes regimes hídricos. Viçosa: UFV, 187p. (Tese - Doutorado).

Iuchi, T. (1993). Plant growth and fruit of strawberry (Fragaria x *ananassa* Duch.) in different water regimes. Viçosa: UFV, 187p. (Thesis - Ph.D.).

Janick, J. and Eggert, D. A., (1968). Factors affecting fruit size in the strawberry. Proc. Amer. Soc. Hort. Sci., 93: 311-316.

Kopylov, L.I. (1991). Early strawberry crop under plastic covers. Sadovodstvo vinogradarstvo 3:25-26.

Lille, T., K. Karp, and R. Varnik. (2003). Profitability of different technologies of strawberry cultivation. Agronomy Research, 1:75-83.

McKinney, H.H. (1923). Influence of soil temperature and moisture on infection of wheat seedlings by *Helminthosporium sativum*. J. Agric. Res. 26: 195-217.

Montero, J.I., N. Castilla, E. Gutierrez de rave, and F. Bretones. (1985). Climate under plastic in the Almeria area. Acta Horticulturae, n.170, p. 227-234.

Moore, J. N., Brown, G. R. and Brown, E. D., (1970). Comparison of factors influencing fruit size in large-fruited and small fruited clones of strawberry. J. Amar. Soc. Hort. Sci. 95(6): 827-831.

Nitsch, J. P., (1950). Growth and morphogenesis of the strawberry in relation to auxin. Amer. J. Bot. 37: 211-215.

Passos, F.A. (1997). Influência de alguns sistemas de cultivo na cultura do morango (*Fragaria* x *ananassa* Duch.). Piracicaba: USP/ESALQ, 1997. 106p. (Tese - Doutorado).

Pollard, J.E., K.L.B. Gast, and C.M. Chundari. (1989). Overwinter row covers increase yield and earliness in strawberry. Acta Horticulturae 265: 229-34.

Rebandel, Z. and M. Przysiccka. (1981). Evaluation of the suitability of some organic materials in strawberry cultivation. Informator o hadaniach prowadzonych w Zakladzie Sadownictwa Akadernii Rolniczej w Poznaniu. pp. 113-18.

Sanford, J. C., Durecky, D. K., Reich, J. E. and Aldwinckle, H.S., (1982). Honeyoye and Canoga strawberries. Hort. Sci. 17(6): 982-984.

Shaw, D., (1990). Response to selection and associated changes in genetic variance for soluble solids and titrable acid contents in strawberries. J. Amer. Soc. Hort. Sci. 115: 839-843.

Stahler, M. M., Lawrence, F. J., Martin, L. W., Moore, P. P., Daubeny, H.A., Sheets, W.A. and Varseveld, G. W., 1995. Rederest Strawberry. Hort. Sci. 30(3): 635-636.

Veazie, P. P., (1995). Growth and ripening of strawberry fruit. In: Horticultural Reviews. Vol. 17. (Ed. Jules Janick). John Wiley and Sons Pub. Inc.