Effect of Chitosan application on growth, yield and quality of Strawberry (*Fragaria* × *ananassa* Duch.) cv. Winter Dawn

ABSTRACT

Strawberry is a sweet and fragrant fruit that is popular all over the world. It belongs to the genus *Fragaria* and is known for its bright red colour, juicy texture, and characteristic aroma. The present investigation was laid out on the experimental site of Department of Horticulture, Sam Higginbottom University of Agriculture Technology & Sciences, Naini, Prayagraj (UP), during 2022-2023. The experiment consisted of 10 treatments with different combinations of RDF and chitosan replicated thrice with 4 plants per replication in Randomized Block Design. Observations were recorded for vegetative growth, yield and quality of strawberry variety Winter Dawn.The statistical analysis indicated significant variation among the different treatments in terms of growth parameters. The treatment labeled as T_{10} (RDF + Chitosan spray 4g/L at 45, 90, and 120 DAP) demonstrated the highest values for vegetative parameters such as the number of leaves (26.50), plant height (18.10 cm), and plant spread in both east-west and north-south directions (26.15). Similarly, T_{10} also exhibited the maximum values for fruit characteristics, including fruit length (5.63 cm), fruit diameter (3.95 cm), and fruit weight (30.23 g). In terms of yield, T_{10} recorded the highest yield (341.25 g) among all the treatments, followed by T_9 (RDF + Chitosan spray 3g/L at 45, 90, and 120 DAP).

Keywords: *Chitosan, RDF,Genus, Strawberry.*

INTRODUCTION

Strawberries, scientifically known as *Fragaria* × *ananassa* (Duch), are a hybrid species widely cultivated around the world for their delicious fruit. Belonging to the Fragaria genus, strawberries are cherished for their vibrant red colour, sweet taste, juicy texture, and distinctive aroma. They are consumed in various forms, including fresh fruit, as well as in jams, juices, pies, ice cream, milkshakes, and even chocolate. The flavour and scent of strawberries are also replicated in artificial strawberry products like candies, soaps, lip glosses, perfumes, and many others. The garden strawberry, the result of a crossbreeding between *Fragaria virginiana* from eastern North America and *Fragaria chiloensis* from Chile, was first developed in Brittany, France, during the 1750s (Anonymous, 2010). Cultivars of *Fragaria* × *ananassa* have replaced, in commercial production, the woodland strawberry (*Fragaria vesca*), which was the first strawberry species cultivated in the early 17th century.Strawberry is a unique fruit in the temperate region, being the quickest plant to bear fruit from the time of planting and the earliest to come to the market in the spring (Jackson *et al*., 2011). Greenhouses produce a small number of strawberries during the off season. The strawberry, regardless of its appearance, is classified as a dry, not a fleshy fruit. Botanically, it is not a berry; it is an aggregate-accessory fruit, the latter term meaning the fleshy part is derived not from the plant's ovaries but from the receptacle that holds the ovaries. Numerous dry achenes are attached to the outside of the fruit-flesh; they appear to be seeds but each is an ovary of a flower, with a seed inside Strawberry is an octoploid self-pollinated plant species with chromosome number 2n=8x=56 (Folta and Barbey, 2019). Strawberries are a remarkably versatile fruit plant that can thrive in diverse climatic zones, spanning from temperate to Mediterranean and sub-tropical regions. This adaptability can be attributed to the fruit's genetic diversity, high heterozygosity, and broad range of environmental adaptations. In India, strawberries are commercially cultivated on a large scale across multiple

states, including Himachal Pradesh, Uttarakhand, Uttar Pradesh, Punjab, Haryana, Karnataka, Tamil Nadu, and Maharashtra. These regions offer favorable climatic conditions for strawberry cultivation, and the fruit is grown in various locations within each state. The widespread cultivation of strawberries in India showcases the fruit's popularity and underscores its significant economic value in the country (*Source:NHB,* Ministry of Agriculture & Farmers Welfare, Government of India, 2021-22). Chitosan is a biopolymer that occurs naturally and is derived from chitin, a substance found in the exoskeletons of crustaceans and insects. It is a linear polysaccharide consisting of glucosamine and N-acetylglucosamine units, which are connected by beta-1, 4 glycosidic bonds. Chitosan is formed through the deacetylation of chitin, a process that involves the removal of acetyl groups from the N-acetylglucosamine units. As a result, chitosan gains a positively charged amino group, which imparts unique properties to this substance. Many studies have reported the antimicrobial activities of chitosan against various phytopathogens (Sakif *et al*., 2016), and its ability to enhance the storability and preservation of anthocyanin content in coated strawberry fruits (Malerba and Cerena, 2018). Chitosan has been widely used to stimulate plant defence (Hadwiger *et al*., 2002; and Naeem *et al*., 2010) and has shown promising results in promoting growth, development, and productivity in various vegetable and fruit crops, including cucumber (Shehata *et al*., 2012), tomato (El-Tantawy, 2009), and strawberry (Rahman *et al*., 2018). In fact, foliar spray of chitosan has been shown to increase vegetative growth, yield, and biochemical contents in plants. Given these benefits, chitosan is an attractive natural compound for use in agriculture as a potential alternative to synthetic pesticides and fertilizers.

MATERIAL AND METHODS

The present investigation was done to understand the effect of chitosan and different RDF doseson yield and quality of strawberry variety Winter dawn. The experiment was carried out at Horticultural Research Farm (HRF), Department of Horticulture, Naini Agricultural Institute SHUATS, Prayagraj, U.P., during the *Rabi* season of 2022-23.Thedifferent combination doses of chitosan and RDF mentioned in table 1 and replicated thrice.Observations were recorded at different stages of growth periods. The data were statistically analysed by the method suggested by Fisher and Yates, 1963**.**

Table 1 Details of different doses of Chitosan and RDF.

Notation	Treatment Details	Notation	Treatment Details
T_1	RDF	T_6	RDF + Chitosan Spray 3g/L at 45 and 90 DAP
T_2	RDF + Chitosan spray 2g/L at 45 DAP	T_7	RDF + Chitosan Spray 4g/L at 45 and 90 DAP
T_3	RDF+ Chitosan spray 3g/L at 45DAP	T_8	RDF + Chitosan spray 2g/L at 45, 90 and 120 DAP
T_4	RDF + Chitosan spray 4g/L at 45 DAP	T_9	RDF + Chitosan spray 3g/L at 45, 90 and 120 DAP
T_5	RDF + Chitosan spray 2g/L at 45 and 90 DAP	T_{10}	RDF + Chitosan spray 4g/L at 45, 90 and 120 DAP

RESULTS AND DISCUSSION

Table 2 Performance of different treatment combinations of chitosan and RDFon number of leaves and plant heightof strawberry.

Treatment symbol	Treatment Details	No of leaves (30DAP)	No of leaves (60DAP)	No of leaves (90 DAP)	No of leaves (120DAP)	Plant height (30DAP) (cm)	Plant height (60DAP) (cm)	Plant height (90DAP) (cm)	Plant height (120DAP) (cm)
T_1	RDF	2.83	4.41	6.67	10.00	4.33	6.05	9.72	13.41
T_2	RDF + Chitosan spray 2g/L at 45 DAP	5.92	9.5	10.75	18.00	5.12	7.93	11.90	14.09
T_3	RDF+ Chitosan spray 3g/L at 45DAP	6.67	9.5	11.50	19.08	5.50	8.05	12.25	13.85
T_4	RDF + Chitosan spray 4g/L at 45 DAP	6.33	10.4	14.83	23.33	6.52	8.48	12.17	15.00
T_5	RDF + Chitosan spray 2g/L at 45 and 90 DAP	6.67	11	13.67	20.00	5.67	7.46	11.27	14.63
T_6	RDF + Chitosan Spray 3g/L at 45 and 90 DAP	6.08	10	11.00	19.50	5.03	7.33	11.93	13.60
T_7	RDF + Chitosan Spray 4g/L at 45 and 90 DAP	7.25	13.5	16.92	24.50	7.43	10.15	12.48	16.63
T_8	RDF + Chitosan spray 2g/L at 45, 90 and 120 DAP	6.83	10.4	13.75	20.33	7.32	8.79	12.27	15.47
T_9	RDF + Chitosan spray 3g/L at 45, 90 and 120 DAP	7.50	14.9	18.67	25.50	7.83	10.40	12.82	17.17
T_{10}	RDF + Chitosan spray 4g/L at 45, 90 and 120 DAP	8.92	15.6	19.58	26.50	8.52	11.38	13.75	18.10
F-Test		**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**
S.E.(m) (±)		**0.39**	**0.64**	**0.62**	**0.50**	**0.21**	**0.22**	**0.55**	**0.49**
C.D. (5%)		**1.16**	**1.89**	**1.83**	**1.48**	**0.62**	**0.64**	**1.65**	**1.44**
C.V.		**10.44**	**10.09**	**7.77**	**4.17**	**5.68**	**4.34**	**7.96**	**5.54**

Abbreviations used: **RDF**: Recommended doses of Fertilizers

Table 3 Performance of different treatment combinations of chitosan and RDF on plant spread of strawberry.

Treatment symbol	Treatment Combination	Plant spread (30 DAP) (cm)		Plant spread (60 DAP) (cm)		Plant spread (90 DAP) (cm)		Plant spread (120 DAP) (cm)	
		E-W	N-S	E-W	N-S	E-W	N-S	E-W	N-S
T_1	RDF	6.42	6.28	9.05	8.98	14.10	14.02	18.55	18.39
T_2	RDF + Chitosan spray 2g/L at 45 DAP	7.63	7.48	9.78	10.38	15.38	15.70	19.53	19.76
T_3	RDF+ Chitosan spray 3g/L at 45DAP	8.24	7.93	10.62	10.82	16.88	16.70	20.50	20.47
T_4	RDF + Chitosan spray 4g/L at 45 DAP	10.53	10.67	12.68	12.38	18.00	17.78	21.85	21.60
T_5	RDF + Chitosan spray 2g/L at 45 and 90 DAP	8.85	7.99	10.82	10.34	16.74	16.58	18.70	18.65
T_6	RDF + Chitosan Spray 3g/L at 45 and 90 DAP	9.20	9.91	12.82	12.83	17.76	17.37	19.38	19.26
T_7	RDF + Chitosan Spray 4g/L at 45 and 90 DAP	11.03	10.80	14.22	14.12	18.93	18.91	21.46	21.98
T_8	RDF + Chitosan spray 2g/L at 45, 90 and 120 DAP	10.66	10.23	15.84	16.63	19.25	19.20	24.82	24.52
T_9	RDF + Chitosan spray 3g/L at 45, 90 and 120 DAP	12.73	12.76	16.62	17.08	21.07	21.13	25.15	25.30
T_{10}	RDF + Chitosan spray 4g/L at 45, 90 and 120 DAP	13.83	13.67	17.23	17.49	22.58	22.31	26.15	26.15
F-Test		**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**
S.E.(m) (±)		**0.12**	**0.12**	**0.11**	**0.10**	**0.48**	**0.38**	**0.18**	**0.19**
C.D. (5%)		**0.35**	**0.37**	**0.32**	**0.30**	**1.43**	**1.13**	**0.52**	**0.55**
C.V.		**2.07**	**2.19**	**1.43**	**1.32**	**4.59**	**3.65**	**1.41**	**1.49**

Abbreviations used: **RDF**: Recommended doses of Fertilizers

Table 4 Performance of different treatment combinations of chitosan and RDF on yield parameters of strawberry.

Treatment symbol	Treatment Details	Days from flower bud initiation to flowering (days)	Days to first flowering (days)	Days to first fruiting (days)	Flowering to harvest duration (days)	Fruit Length (cm)	Fruit Diameter (cm)	Fruit Weight (g)	No of flowers /plant	No of fruits /plant	Total fruit production/plant (g)
T_1	RDF	22.17	62.17	83.67	35.50	3.26	2.63	11.75	12.08	11.67	183.81
T_2	RDF + Chitosan spray 2g/L at 45 DAP	21.17	60.58	81.08	34.00	3.56	3.19	18.25	15.08	14.58	225.03
T_3	RDF+ Chitosan spray 3g/L at 45DAP	20.58	60.17	80.75	32.58	3.77	3.48	22.29	16.58	16.17	244.45
T_4	RDF + Chitosan spray 4g/L at 45 DAP	18.75	54.67	76.00	31.17	4.25	3.78	26.11	19.25	18.67	301.93
T_5	RDF + Chitosan spray 2g/L at 45 and 90 DAP	20.33	59.00	79.58	33.75	3.54	3.57	23.28	16.33	16.25	259.84
T_6	RDF + Chitosan Spray 3g/L at 45 and 90 DAP	19.75	56.67	77.00	32.33	3.88	3.63	25.97	17.42	17.50	274.11
T_7	RDF + Chitosan Spray 4g/L at 45 and 90 DAP	18.75	53.33	74.00	30.67	4.29	3.70	27.61	18.08	18.50	301.92
T_8	RDF + Chitosan spray 2g/L at 45, 90 and 120 DAP	18.42	53.83	73.92	30.58	4.73	3.71	27.12	19.25	19.50	319.66
T_9	RDF + Chitosan spray 3g/L at 45, 90 and 120 DAP	17.75	49.33	69.50	28.75	5.27	3.86	29.08	20.33	20.50	332.08
T_{10}	RDF + Chitosan spray 4g/L at 45, 90 and 120 DAP	16.17	48.00	68.08	27.67	5.63	3.95	30.23	20.92	20.75	341.25

F-Test	S	S	S	S	S	S	S	S	S	S
S.E.(m) (±)	0.15	0.21	0.27	0.09	0.06	0.02	0.19	0.34	0.30	2.22
C.D. (5%)	0.45	0.64	0.80	0.27	0.17	0.07	0.56	1.00	0.90	6.61
C.V.	1.35	0.67	0.61	0.51	2.29	1.21	1.35	3.10	3.00	1.38

Abbreviations used: **RDF**: Recommended doses of Fertilizers

Table 5 Performance of different treatment combinations of chitosan and RDF on quality parameters of strawberry.

Treatment symbol	Treatment Details	TSS (°Brix)	Acidity (%)	shelf life of fruits at ambient conditions (Days)
T_1	RDF	8.13	0.96	2.33
T_2	RDF + Chitosan spray 2g/L at 45 DAP	8.40	0.94	3.33
T_3	RDF+ Chitosan spray 3g/L at 45DAP	8.57	0.91	4.33
T_4	RDF + Chitosan spray 4g/L at 45 DAP	10.33	0.71	6.33
T_5	RDF + Chitosan spray 2g/L at 45 and 90 DAP	9.30	0.82	5.00
T_6	RDF + Chitosan Spray 3g/L at 45 and 90 DAP	9.63	0.78	5.33
T_7	RDF + Chitosan Spray 4g/L at 45 and 90 DAP	10.50	0.73	6.00
T_8	RDF + Chitosan spray 2g/L at 45, 90 and 120 DAP	10.83	0.63	6.33
T_9	RDF + Chitosan spray 3g/L at 45, 90 and 120 DAP	11.00	0.61	6.67
T_{10}	RDF + Chitosan spray 4g/L at 45, 90 and 120 DAP	11.87	0.58	7.33
F-Test		**S**	**S**	**S**
S.E.(m) (±)		**0.06**	**0.01**	**0.27**
C.D. (5%)		**0.17**	**0.02**	**0.80**
C.V.		**1.01**	**1.53**	**8.82**

Abbreviations used: **RDF**: Recommended doses of Fertilizers

A) Growth Parameters

Data from the table 2 and 3 depicts the growth parameters observed for strawberry.

1. Total Number of leaves per plant

Maximum No of Leaves [8.92 (30DAP), 15.60 (60 DAP), 19.58 (90 DAP), 26.50 (120 DAP)] was recorded in treatment T_{10}(RDF + Chitosan spray 4g/L at 45,90 and 120 DAP) and Minimum was recorded in Treatment T_1 (Control) [2.83 (30 DAP), 4.41 (60 DAP), 6.67 (90 DAP), 10.00 (120 DAP)].The probable increase in number of trifoliate leaves per plant is due to increased nutrient absorption and the foliar application of chitosan stimulate molecular signals which served as plant growth promoters that induced higher rate of cell division and cell elongation in sub apical meristems of strawberry shoots might leads to production of a greater number of trifoliate leaves per plant (Hadwiger *et al*. 2002). The similar results were also obtained by Abdel-Mawgoud *et al*. (2010) on strawberry.

2. Plant height

Maximum plant Height [8.52 (30 DAP), 11.38 (60 DAP), 13.75 (90 DAP), 18.10 (120 DAP)] was recorded in treatment T_{10} (RDF + Chitosan spray 4g/L at 45,90 and 120 DAP) and Minimum was recorded in Treatment T_1 (Control) [4.33 (30 DAP), 6.05 (60 DAP), 9.72 (90 DAP), 13.41 (120 DAP)].The probable reason for stimulating effect of chitosan on plant growth might be attributed to increased availability and uptake of water and essential nutrients through adjusting cell osmotic pressure and reducing the accumulation of harmful free radicals by increasing antioxidants and enzyme activities. Further, it may be attributed to increased enzymatic activities of nitrogen metabolism (nitrate reductase, glutamine synthetase and protease), improved transportation of nitrogen to functional leaves and increased photosynthesis which enhanced growth and development of plants. (Mondal *et al*. 2012) In addition, chitosan enhanced auxin biosynthesis pathways via tryptophan-independent pathway might enhanced the height of plants (Uthairatanakij*et al*. 2007). The results obtained from the study are in line with results of Chibu and Shibayama, (2003), Gornik*et al*. (2008) and Abdel-Mawgoud*et al*. (2010).

3. Plant spread (cm)

Maximum Plant Spread [E-W= 13.83 cm] [N-S=13.67 cm] (30 DAP)] was recorded in treatment T_{10} (RDF + Chitosan spray 4g/L at 45, 90 and 120 DAP) and Minimum was recorded in Treatment T1 (Control) E-W= 6.42 cm] [N-S= 6.28 cm] (30 DAP)]. Effect of treatment T_{10} (RDF + Chitosan spray 4g/L at 45,90 and 120 DAP) recorded the maximum plant spread [E-W= 17.23] [N-S=17.49] (60DAP), [E-W= 22.58 cm] [N-S=22.31 cm] (90 DAP) [E-W= 26.15 cm] [N-S=26.15 cm] (120 DAP) over all other treatments where-as Treatment T_1 (Control) [E-W= 9.05] [N-S= 8.98](60 DAP), [E-W= 14.10 cm] [N-S= 14.02 cm] (90 DAP), [E-W= 18.55 cm] [N-S= 18.39 cm](120 DAP)was found having significantly minimum plant spread. The increased plant spread in chitosan sprayed treatment may be attributed to increased length and upright growth of petioles led to leaning outwards resulting in higher plant spread and chitosan stimulates enzyme activities of nitrogen metabolism (nitrate reductase, glutamine synthetase and protease) and improved the transportation of nitrogen in the functional leaves which enhanced plant spread of strawberry (Mondal *et al*., 2012). These results are in line with the findings of Gornik*et al.* (2008) and Abdel-Mawgoud *et al.* (2010).

B) Phenological characters

Data from the table 4 depicts the phenological characters observed for strawberry.

1. Days from flower bud initiation to flowering and Days to first flowering

Minimum number of days for flower bud initiation to flowering (16.17 days) was recorded in T_{10} (RDF + Chitosan spray 4g/L at 45, 90 and 120 DAP) which was significantly superior to all other treatments. Maximum number of days for flower bud initiation to flowering (22.17 days) was recorded in T_1 (RDF). Minimum number of days for first flower appearance (48.0 days) was recorded in T_{10} (RDF + Chitosan spray 4g/L at 45, 90 and 120 DAP) which was significantly superior to all other treatments. Maximum number of days for first flower appearance (62.17 days) was recorded in T_1 (RDF).

2. Days to first fruiting and Days from Flowering to harvest duration

Minimum number of days for first fruit appearance (68.08 days) was recorded in T_{10} (RDF + Chitosan spray 4g/L at 45, 90 and 120 DAP) which was significantly superior to all other treatments. Maximum number of days for first fruit appearance (83.67 days) was recorded in T_1 (RDF). Minimum number of days for first flowering to harvest duration (27.67 days) was recorded in T_{10} (RDF + Chitosan spray 4g/L at 45, 90 and 120 DAP) which was significantly superior to all other treatments. Maximum number of days for first flowering to harvest duration (35.50 days) was recorded in T_1 (RDF). Chitosan and RDF can promote early flowering in plants by providing essential nutrients, natural plant growth hormones, beneficial microorganisms, and stress mitigation. Nutrient availability of essential nutrients such as nitrogen, phosphorus, and potassium stimulate early flowering. Hormones like auxins and cytokinin in organic manures and bio capsules promote the production of flower buds. Beneficial microorganisms enhance nutrient uptake and hormone synthesis in plants, leading to early flowering. Finally, stress mitigation helps to cope with unfavourable environmental conditions, promoting early flowering. Similar findings were reported by Mondal *et al.*, (2012). These results are in line with the findings of Gornik*et al.* (2008) and Abdel-Mawgoud*et al*. (2010).

C) Yield parameter

Data from the table 4 depicts the yield characters observed for strawberry.

1. Fruit length, Fruit diameter and Fruit weight

Maximum Fruit Length (5.63 cm) was recorded in Treatment T_{10} (RDF + Chitosan spray 4g/L at 45, 90 and 120 DAP) which was significantly superior to all other treatments. Minimum Fruit Length (3.26 cm) was recorded in T_1 (RDF). Maximum Fruit Diameter (3.95 cm) was recorded in T_{10} (RDF + Chitosan spray 4g/L at 45, 90 and 120 DAP) which was significantly superior to all other treatments. Minimum Fruit Diameter (2.63 cm) was recorded in T_1 (RDF). Maximum Fruit Weight (30.23 g) was recorded in T_{10} (RDF + Chitosan spray 4g/L at 45, 90 and 120 DAP) which was significantly superior to all other treatments. Minimum Fruit Weight (11.75 g) was recorded in T_1 (RDF). The increase in fruit length, diameter and weight might be due to oscillation of physio-chemical status of plant and production of more photosynthates due to maximum vegetative growth of plants as influenced by foliar application of chitosan. The current results are in accordance with the works of Abdel-Mawgoud*et al*. (2010) on strawberry.

2. Number of flowers/plant and number of fruits/plants

Maximum No. of flowers / plant (20.92) was recorded in T_{10} (RDF + Chitosan spray 4g/L at 45, 90 and 120 DAP). Minimum No. of flowers / plant (12.08) was recorded in T_1 (RDF). Maximum No of fruits / plant (20.75) was recorded inT_{10} (RDF + Chitosan spray 4g/L at 45, 90 and 120 DAP). Minimum was recorded in (11.67) was recorded in T_1 (RDF). The probable reason for increase in number of fruits per plant might be since chitosan stimulates biosynthesis of gibberellins that causes the production of a greater number of crowns per plant, flowers per plant and rapid elongation of reproductive parts thereby increasing flowering duration and fruit set percentage which increased the number of fruits per plant. While frequent foliar application of water creates moisture stress which affects the physiological processes of plants. The current results are in accordance with the works of Abdel-Mawgoud *et al*. (2010) on strawberry.

3. Total production per plant

Maximum Total fruit Production / plant (341.25g) was recorded in T_{10} (RDF + Chitosan spray 4g/L at 45, 90 and 120 DAP) which was significantly superior to all other treatments. Minimum Total fruit Production / plant (183.81g) was recorded in T_1 (RDF). The increase in Total fruit productionper plant in treatment receiving chitosan spray may be due to its effects in stimulating physiological processes, improving vegetative growth, followed by active translocation of photo assimilates from source to sink tissues thereby increase in number of flowers per plant, fruit length, fruit volume, and fruit diameter. While frequent foliar application of water creates moisture stress which affects the physiological processes of plants, including uptake and translocation of nutrients results in hormonal imbalance which causes drop of flowers and incidence of more pest and diseases which accounts for reduction of yield per plant in RDF treatment. The current results are in conformity with the findings of Ghoname *et al*. (2010).

D) Quality parameter

Data from the table 5 depicts the quality characters observed for strawberry.

1. TSS, Acidity and Shelf life

Higher TSS content (11.87 ^{0} Brix) was recorded with T_{10} (RDF + Chitosan spray 4g/L at 45, 90 and 120 DAP). Lesser TSS content (8.13 ^{0} Brix) was recorded in T_1 (RDF) which was significantly superior to all other treatments. Minimum acidity score (0.58) was recorded in Treatment T_{10} (RDF + Chitosan spray 4g/L at 45, 90 and 120 DAP). Maximum acidity score (0.96) was recorded in T_1 (RDF). Longest Shelf life of fruits at ambient conditions (7.33 days) was recorded in T_{10} (RDF + Chitosan spray 4g/L at 45, 90 and 120 DAP). Shortest Shelf life of fruits at ambient conditions (2.33 days) was recorded in T_1 (RDF). This increase in TSS could reflect the cell wall disassembly (Cordenusi *et al*. 2005) and decrease in respiration rate and increase in dry matter contents due to water loss. The lower TSS values might reflect dilution of sugars by spray of water during fruit ripening stage. Similar result was also obtained by Petriccione *et al*. (2015).

Conclusion

Based on this experiment, maximum growth, yield, quality parameters and BC ratio was recorded in Treatment T_{10} (RDF + Chitosan spray 4g/L at 45, 90 and 120 DAP). The present study on effect of chitosan application on growth, yield and fruit quality of strawberry (*Fragaria* × *ananassa* Duch.) cv. Winter Dawn, suggested that cultivation of strawberry with application of chitosan thrice at RDF + Chitosan spray 4g/L at 45, 90 and 120 DAP was found more effective to increase growth, yield and quality. Henceforth, it can also be suggested to farmers the benefits of getting high yield of strawberry by using Chitosan spray @ 4g/L along with RDF.

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