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Effect of Fertigation Treatments on Quality and Biochemical Parameters of Strawberry (*Fragaria* X *ananassa* Duch., cv. Sabrina)

S. Mounashree[1*], D. Madaiah[2], R. Praveenakumar[3], M. Dinesh Kumar[4], B. C. Dhananjaya[5] and Y. Kantharaj[2]

[1]Department of Fruit Science, College of Horticulture, Mudigere, India.
[2]Department of Post Harvest Technology, College of Horticulture, Mudigere, India.
[3]Department of Horticulture, GKVK, University of Agricultural Sciences, Bangalore, India.
[4]Department of Agriculture, College of Agriculture, Shivamogga, India.
[5] Department of Soil Science and Agriculture Chemistry, College of Agriculture, Shivamogga, India.

Authors' contributions

This work was carried out in collaboration between all authors. Author SM designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors DM, MDK, BCD and YK managed the analyses of the study. Author RP managed the literature searches. All authors read and approved the final manuscript.

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Short Communication

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ABSTRACT

The experiment was conducted at College of Horticulture, Mudigere to study the effect of fertigation on quality and biochemical parameters of strawberry fruits. The experiment consists of eight treatments, each treatment was replicated four times in Completely Randomized Design. Among the treatments, 100% recommended dose of fertilizer (RDF) through fertigation (T_8) recorded significantly higher fruit yield per plant (384-391 g) and fruit quality parameters [fruit weight (17-18 g), fruit volume (18-19 cc), fruit length (4.00-4.14 cm) and fruit diameter (4.08-4.14 cm)]. However, it was at par with T_7 (75% RDF through fertigation). With respect to biochemical parameters same treatment (T_8) has recorded significantly higher values of all the parameters *viz.,* reducing sugar

**Corresponding author: E-mail: mounashrees8@gmail.com;*

(5.87%), non reducing sugar (1.96%), total sugar (7.87%), sugars: acid ratio (10.55), ascorbic acid content (69.27 mg/100 g) and titratable acid content (0.93%). Whereas, the total soluble solids (10.27 ^{0}B) were found the maximum in the treatment supplied with 25% RDF through soil + 75% RDF through fertigation (T_6) and thus it can be concluded that T_8 was the best treatment for improving the yield, quality and biochemical parameters of strawberry fruit.

Keywords: Strawberry; fertigation; fruit quality; yield.

1. INTRODUCTION

Strawberry is one of the most favoured fruit in the world. It is a delicious small fruit widely appreciated mainly for its characteristic aroma, its bright red colour and rich in vitamin B, vitamin C, fibre, folic acid and potassium. A profitable crop production is based entirely on balanced plant nutrition with a suitable method of application. Hence, there is need to develop a suitable method of application of fertilizer, which will improve quality and productivity of the crop. Nutrients are very important mineral elements in strawberry cultivation. A proper nutrition management for the crop is important in terms of increasing yield and improvement in the quality of the produce [1]. Fertigation allows an accurate and uniform application of nutrients to the wetted area, where the active roots are concentrated. Further, it gives flexibility of fertilization which enables the specific nutritional requirements of the crop to be met at different stages of growth.

As for the quality, the taste of strawberry is one of the most important aspects. The sweet taste of this fruit is conditioned, in part, by the balance of sugar and acidity in fruit [2]. The total soluble sugars in fruits are carbohydrates of low molecular weight. They are the most soluble solids of strawberries and are related to sweetness, flavour, aroma, attractive colour and texture [3]. As the crop is being trained under a controlled environment, adoption of the fertigation system becomes easy to manage and also helpful to exploit the potentiality of the crop with desired quality. By considering these points, an experiment was conducted to study the influence of fertigation on yield, quality and biochemical parameters of strawberry under naturally ventilated poly house conditions.

2. MATERIALS AND METHODS

Considering the importance of fertigation the research was conducted during the year 2016-17 in naturally ventilated polyhouse of the Department of Fruit Science, College of Horticulture, Mudigere. The experiment was conducted by adopting Completely Randomized Design with eight treatments (T_1-100% recommended dose of fertilizer (RDF) through soil application, T_2-75% RDF through soil application, T_3-50% RDF through soil + 25% RDF through fertigation, T_4-50% RDF through soil + 50% RDF through fertigation, T_5-25% RDF through soil + 50% RDF through fertigation, T_6-25% RDF through soil + 75% RDF through fertigation, T_7-75% RDF through fertigation and T_8-100% RDF through fertigation) with four replications. Farm yard manure @ 20 t/ha was applied common to all the treatments. The recommended fertilizer dosage used in the study was 150:100:120 kg/ha. Fertigation was done at seven intervals of 25, 32, 39, 46, 53, 60 and 67 DAT. Tissue cultured plants of Sabrina variety of strawberry was planted at a spacing of 30 cm x 30 cm on raised beds with 14 plants per plot *viz.*, 7 plants of 2 rows. Analysis of fruits was done for recording quality and biochemical parameters like;

2.1 Fruit Weight

The matured fruits were harvested from the tagged plants and the weight of fruit was recorded in digital analytical balance, then average value of individual fruit was worked out and expressed in grams.

2.2 Fruit Volume

The volume of the fruits was recorded by water displacement method and expressed in Cubic Centimetre per fruit.

2.3 Fruit Length

The length from the stalk end and floral end of the fruit was measured with the help of digital vernier calipers and expressed in centimetre.

2.4 Fruit Diameter

Fruit diameter was measured with the help of digital vernier calipers at the area of maximum width and it was expressed in centimetre.

2.5 Total Soluble Solid

TSS of the juice was determined with digital refractometer at room temperature by putting a few drops of juice on the prism and expressed as degree brix (ºBrix).

2.6 Reducing Sugar

The reducing sugar content of the fruit was estimated through anthrone reagent method by pipetting out 1 ml of sample aliquot and different concentrations (0, 0.2, 0.4, 0.6, 0.8 and 1.0 ml) of glucose standard solution in different test tubes were taken and the volume was made up to 2.5 ml each with distilled water to form the standard glucose graph. All the tubes were kept in an ice bath and added 5 ml of anthrone reagent to the test tube slowly. The contents were gently stirred with a glass rod. Then the contents of test tubes were heated on boiling water bath for exactly 7.5 minutes and were cooled immediately in ice bath. After cooling, the absorbance of the solutions was measured at 630 nm against the blank. The sugar content was calculated through standard glucose curve.

$$\text{Reducing Sugar (\%)} = \frac{\text{Glucose (mg) in sample from standard curve}}{\text{Aliquot taken (ml) for test}} \times \frac{\text{Vol. made (ml) after alcohol evaporation}}{\text{Vol. taken for alcohol evaporation (ml)}} \times \frac{\text{Vol. made (ml) after sample extraction}}{\text{Sample taken for extraction (mg)}} \times 100$$

2.7 Non Reducing Sugar

The percentage of non-reducing sugars was obtained by subtracting the percentage of reducing sugars from the total sugars and expressed in percentage.

Non-reducing sugar (%) = Total sugar – Reducing sugar

2.8 Total Sugar

The total sugar content of the fruit was estimated by following the method of Ranganna [4] and expressed in percentage. The total sugar content of the fruit can be calculated by using the formula,

$$\text{Total Sugars (\%)} = \frac{\text{Glucose (mg) in sample from standard curve}}{\text{Aliquot taken (ml) for test}} \times \frac{\text{Vol. made after hydrolysis (ml)}}{\text{Vol. taken for hydrolysis (ml)}} \times \frac{\text{Vol. made after (ml) alcohol evaporation}}{\text{Vol. taken for evaporation (ml)}} \times \frac{\text{Vol. made after sample extraction (ml)}}{\text{Sample taken for extraction (mg)}} \times 100$$

2.9 Ascorbic Acid

It was estimated by using 2, 6-dichlorophenol indophenol titration method. The sample was extracted in 4 per cent of oxalic acid, filtered using Whatman No.4 paper and made up to a known volume (50 ml). The known volume of filtrate (5 ml) was pipeted out in conical flask and 5 ml of oxalic acid was added and titrated against 2, 6-Dichlorophenol-indophenol dye. The titration was carried out until an appearance of light pink colour. The dye was prepared using 50 mg of sodium salt of 2, 6-Dichlorophenol-indophenol dye in approximately 200 ml of double distilled water containing 4.2 mg of sodium bicarbonate. It was used for titration and standardizing ascorbic acid [5] and expressed in milligram per hundred grams of edible pulp.

$$\text{Ascorbic acid (mg/100 g)} = \frac{\text{Dye factor} \times \text{Titrate value} \times \text{Vol. made up}}{\text{Aliquot of extraction} \times \text{Vol. of sample taken} \times \text{Sample taken}} \times 100$$

Where, dye factor =0.5

2.10 Titratable Acidity

Twenty five grams of fruit pulp was thoroughly homogenized in an electric blender and volume was made to 250 ml. The mixture was filtered through Whatman No. 1 filter paper. 50 ml of sample was then titrated against N/10 NaOH solution using phenolphthalein as an indicator till it gave pink coloured end point. The total titratable acidity was calculated in terms of citric acid on the basis of 1 ml of N/10 NaOH equivalent to 0.0067 gram of anhydrous citric or per cent citric acid in juice (Ranganna [6]). The total titratable acidity was expressed in terms of citric acid percentage on fresh fruit weight basis.

$$\text{Titratable acidity (\%)} = \frac{\text{Titre} \times \text{Normality of Alkali} \times \text{Volume made up} \times \text{Equivalent weight of acid}}{\text{Volume of sample taken} \times \text{Volume of aliquot taken} \times 1000} \times 100$$

2.11 Sugar to Acid Ratio

The sugar to acid ratio was calculated by dividing the total sugar content by the titrable acidity.

3. RESULTS AND DISCUSSION

The results revealed that the significant differences were observed in the yield, quality and biochemical parameters of strawberry fruits with respect to eight treatments.

The total soluble solids (10.27 ^{0}B) were found maximum in T_6 followed by T_7 (10.24 ^{0}B). T_8 recorded maximum reducing sugar (5.87%), non reducing sugar (1.96%), total sugar (7.87%) and sugars: acid ratio (10.14). This increase in sugar content and TSS of fruits might be due to more absorption of nitrogen which may have further exerted the regulatory role in affecting the fruit quality. These results are in line with findings of Kachwaya [7], Rodas et al. [8], Wold and Opstad [9], Rana and Chandel [10].

Fertigation with 100 per cent and 75 per cent recommended dose of NPK significantly increased ascorbic acid content. The highest ascorbic acid content (69.27 mg/100 g) was recorded in T_8 which was at par with T_7 (68.86 mg/100 g) while the minimum was recorded in T_2 (51.18 mg/100 g). Higher ascorbic acid content with the higher levels of nitrogen might be attributed to increase in synthesis and catalytic activity of several enzymes and co-enzymes which are instrumental in ascorbic acid synthesis. The results are in accordance with Boora and Singh [11].

Titratable acid content of fruits revealed that the fruit acidity was higher (0.93%) in fruits produced by plants supplied with 100 per cent RDF through fertigation (T_8) and the minimum (0.74%) was recorded in T_2 which received 75 per cent RDF through soil application (Table 2). Present results are in line with the findings of Wold and Opstad [9], where they reported that acid content were comparatively higher in strawberry fruits harvested from fertigated treatments than those harvested from low level of fertigation treatments.

The berry weight was significantly differed for fertigation treatments of strawberry plants. The maximum berry weight (17.97 g) was recorded in T_8 (100% RDF through fertigation) which was at par with T_7 (17.96 g) and T_6 (17.95), whereas the minimum berry weight (13.40 g) was recorded in T_2 (75% RDF through soil application). Fertigation with 100 and 75 per cent with recommended dose of NPK registered a significant results with respect to fruit length, diameter and volume. The maximum fruit length of 4.14 cm, diameter of 4.14 cm and volume of 18.50 cc was recorded in T_8 (100% RDF through fertigation) which was at par with T_7 (75% RDF through fertigation) recorded fruit length of 4.12 cm, diameter of 4.10 cm and volume of 18.38 cc. It seems that uniform distribution of nutrients, coupled with its confinement in the root zone under fertigation, might have lead to the increased nutrient uptake as a result it increased the size of berries. These results are in accordance with the findings of Martinsson *et al.* [14], Kachwaya [7] and Pervin et al. [12] who observed better size and weight of strawberry under fertigation compared to common soil application.

Among different treatments, T_8 recorded higher fruit yield (390.42 g/plant) which was at par with T_7 (385.96 g/plant) and T_6 (384.75 g/plant).

Table 1. Effect of fertigation on quality parameters of strawberry fruits (cv. Sabrina)

Treatments	Fruit weight (g)	Fruit volume (cc)	Fruit length (cm)	Fruit diameter (cm)	Fruit yield/ plant (g)
T_1	15.07	16.74	3.84	3.33	292.95
T_2	13.40	14.56	2.86	2.68	221.28
T_3	13.83	15.39	3.11	2.83	232.90
T_4	16.42	16.95	3.84	3.37	328.45
T_5	14.16	15.41	3.15	2.87	250.33
T_6	17.95	18.25	4.00	4.08	384.75
T_7	17.96	18.38	4.02	4.10	385.96
T_8	17.97	18.50	4.14	4.14	390.42
S. Em ±	0.16	0.10	0.04	0.05	2.25
C. D. (P = 0.05)	0.47	0.29	0.13	0.14	6.57

Table 2. Effect of fertigation on biochemical parameters of strawberry fruits (cv. Sabrina)

Treatment	TSS (^{0} B)	AA (mg/100 g)	RS (%)	NS (%)	TS (%)	TA (%)	S:A
T_1	9.38	55.07	5.14	1.94	6.94	0.75	7.50
T_2	8.76	51.18	5.17	1.20	6.27	0.74	6.82
T_3	9.01	53.97	5.07	1.60	6.74	0.84	7.48
T_4	9.27	60.12	5.42	1.85	7.29	0.89	8.15
T_5	9.17	60.64	4.76	1.60	6.33	0.90	7.03
T_6	10.27	67.09	5.60	1.91	7.53	0.90	8.92
T_7	10.24	68.86	5.84	1.93	7.62	0.92	10.14
T_8	10.26	69.27	5.87	1.96	7.87	0.93	10.55
S Em ±	0.09	0.58	0.14	0.07	0.15	0.01	0.21
C D 5%	0.25	1.68	0.39	0.20	0.43	0.02	0.61

(TSS- Total soluble solids; AA- Ascorbic acid; RS- Reducing sugar; NS- Non reducing sugar; TS- Total sugar; TA- Titrable acidity; S: A- Sugar to acid ratio)

The minimum yield was recorded in T_2 (221.28 g/plant). Significantly higher yields under fertigation with maximum dose of fertilizers may be attributed to the improved vegetative growth, better water and nutrient utilization compared to other treatments (Table 1). Furthermore, split application of fertilizers at different intervals, such fractionated supplies might have met the nutrients requirement of strawberry at different growth stages thus leading to higher fruit yield. These results are in line with those of Kachwaya [7], Pervin et al. [12], Gutal et al. [13], Martinsson et al. [14] and Reddy et al. [15] who observed significant increase in yield of strawberry with full nutrient package through fertigation as compared to low and basal fertilizer applications.

4. CONCLUSION

The results of the present study revealed that 100 percent recommended fertilizers through drip irrigation (T_8) performed well for achieving higher yield with good quality fruits in the strawberry crop.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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