International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2019; 7(5): 1058-1060

Received: 25-07-2019
Accepted: 26-08-2019

Monika G
PhD Scholar, Department of Fruit Science, Horticultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India

RM Vijayakumar
Professor (Horticulture), Department of Fruit Science, Horticultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India

K Soorianathasundaram
Professor (Horticulture), Department of Fruit Science, Horticultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India

D Keisar Lourdusamy
Associate Professor and Head (Horticulture), Horticultural Research Station (HRS), Vijayanagaram, Ooty, Tamil Nadu, India

D Vasanthi
Professor, Department of Soil Science and Agricultural Chemistry, Agricultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India

Correspondence
RM Vijayakumar
Professor (Horticulture), Department of Fruit Science, Horticultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India

Influence of fertigation on the biochemical and quality parameters of strawberry cv. Nabila under polyhouse condition

Monika G, RM Vijayakumar, K Soorianathasundaram, D Keisar Lourdusamy and D Vasanthi

Abstract
This study was conducted to find out the relationship between mineral nutrition and fruit quality in strawberry. The experiment involved three levels of fertilizers as treatments based on the recommended dose of fertilizers 150: 100: 120 kg NPK /ha (Kachwaya, 2014) *viz.*, T_1 -75% RDF, T_2 -100% RDF and T_3 -125% RDF with seven replications in randomized block design. The fertilizers were applied at critical stages *viz.*, vegetative stage, flowering stage and fruiting stage through fertigation. Significant differences in the content of TSS (°Brix), sugar to acid ratio, ascorbic acid (mg/ 100 g) and anthocyanin (mg/ 100 g) were observed by the application of nutrients during two years of study while other parameters such as titratable acidity (%), total sugars (%), reducing sugars (%) and non-reducing sugars (%) were not affected.

Keywords: Strawberry, fertigation, nutrients, fruit quality

Introduction
Strawberry (*Fragaria x annanasa* Duch.) is one of the highly nutritious fruits being cultivated in areas confined to Hilly Tracts of Himachal Pradesh, Uttaranchal, parts of Uttar Pradesh, Punjab, Haryana, Kashmir valley, Meghalaya, Sikkim, Mizoram, Karnataka and parts of Tamil Nadu. Strawberry cultivation is highly profitable due to the quick returns in the shortest possible period. An array of factors like mineral nutrition, cultivar, climatic conditions, cultural practices and irrigation influence the quality of strawberry fruit (Nestby *et al*., 2005) [10].
Application of nutrients is always a necessary need at critical stages of a crop to increase the fruit size, yield and quality. It is a herbaceous crop with shallow roots and hence the requirement of nutrients is continuous at vegetative, flowering and fruit production stages. The nutrients when applied through drip irrigation system, helps in more accurate and timely crop nutrition than broadcasting. It is the most accurate method to deliver proper nutrition at the root zone of plants saving 70% of water than the conventional methods. It was reported that nutrient use efficiency could be as high as 90% compared to 40 - 60% in conventional methods. The amount of fertilizer lost through leaching can be as low as 10% in fertigation whereas 50% in the conventional methods (Solaimalai *et al*., 2005) [12].
Hence, it is important to apply nutrients at critical stages of crop growth in small doses, at shorter intervals, to minimize the loss of nutrients and cost of production to achieve higher yield and good quality fruits. Nutrient application on fruit quality may have a direct or indirect effect. Nestby *et al*. (2005) [10] reported that N, P, K and B are accumulated more in the harvested fruit than other plant organs indicating the importance of these nutrients in fruit quality.
In this background, this study was taken up to identify the effect of nutrients at each critical stage *viz*., vegetative stage, flowering stage and fruiting stage of strawberry crop through fertigation to improve fruit quality parameters under polyhouse condition.

Materials and Methods
A field trial was conducted at farmer’s field in Thambatty village, Nilgiris Dt. to assess the ‘stage-wise application of nutrients for strawberry cv. ‘Nabila’ under polyhouse condition at a latitude of 11°35’ N and longitude 76°69’ E with an altitude of 6510 ft above mean sea level during the month of february at both 2018 and 2019. Soil type of the experimental field was

sandy clayey loam with pH and EC of 6.6 and 0.41 dS/m respectively. The initial status of available N, P, K in the experimental field was 384 kg/ha, 102 kg/ha and 423 kg/ha respectively. The study involved three treatments based on the recommended dose of nutrients 150: 100: 120 kg/ha (Kachwaya, 2014) [7] *viz*., T_1 -75% RDF, T_2 -100% RDF and T_3 -125% RDF with seven replications in randomized block design applied at each stage as per the following nutrient scheduling (Table 1):

Table 1: Nutrient scheduling at each critical stage

Nutrients	Vegetative stage (5 weeks) (%)	Flowering stage (4 weeks) (%)	Fruiting stage (20 weeks) (%)	Total (%)
N	30	20	50	100
P	20	30	50	100
K	10	20	70	100

Strawberry runner plants were purchased from Channarayapatna region of Mysore. Beds were prepared inside the polyhouse with a width of 60 cm, height of 30 cm width and bed to bed spacing of 30 cm. Mulching of beds was done with 50 mm thickness sheet and drip system was installed at 30 cm intervals. Strawberry plants were planted in two rows alternatively with a spacing of 30 X 30 cm in each bed. Regular cultural operations were followed as per the farmer's practices. Fertigation treatments were given as per the nutrient schedule at weekly intervals at each growth stages.

Data analysis was carried out using STAR package (Statistical tools for Agricultural Research developed by IRRI, Phillipines) to calculate the significant differences among the treatments under the statistical design as randomised block design (RBD). The data taken are the average of seven replications and were statistically significant at 5% level. Data were recorded for two years for the following quality and biochemical parameters.

- Total Soluble Solids (°B): Total Soluble Solids in the fruits was determined using an 'ERMA' Hand Refractometer, make ERMA®, Japan. Readings were recorded in °Brix.
- Titratable acidity (%): Titratable acidity (%) was determined as per the method suggested by AOAC (1960) [1]. The freshly extracted fruit juice was titrated against N/10 NaOH solution and expressed as gram of citric acid per 100 g of fruit pulp
- TSS to acid ratio: The ratio was determined between TSS and acidity.
- Total sugars (%): Total sugars were determined by the method of Hedge and Hofreiter (1962) [5] and are expressed in percentage.
- Reducing sugars (%): Reducing sugar content of the fruit was estimated by anthrone method given by Somogyi (1952) [13] and is expressed in percentage.
- Non-reducing sugars (%): The percentage of non-reducing sugars was obtained by subtracting the percentage of reducing sugars from the total sugars and expressed in percentage.
- Ascorbic acid (mg/100g): Ascorbic acid was estimated by using 2, 6-dichlorophenol indophenol titration method. Ascorbic acid (mg/100 g) content of the fruit was estimated as per the method of Rosenberg (1945) [11] and expressed in milligram per hundred grams of edible pulp.
- Anthocyanin (mg/100g): Total anthocyanin content was estimated as per the method suggested by Harborne (1973) [4] and is expressed in mg/100 g.

Results and Discussion

The data recorded on TSS (°Brix), titratable acidity (%), sugar to acid ratio, total sugars (%), reducing sugars (%), non-reducing sugars (%), ascorbic acid (mg/ 100 g) and anthocyanin (mg/ 100 g) content due to fertigation are discussed.

Analysis of variance values for the content of TSS (°Brix), sugar to acid ratio, ascorbic acid (mg/ 100 g) and anthocyanin (mg/ 100 g) revealed that these parameters were significantly influenced by the application of nutrients during both the years of study.

Higher TSS of 6.35 °B and 6.21 °B were observed during 2018 and 2019 respectively (Table 2) in 125% RDF (187.5: 125: 150 kg/ha) treatment. Increased TSS in higher dose may be due to the sufficient amount of nitrogen and potassium available during the fruiting stage to increase the fruit quality. Joshi *et al*. (1990) [6] also reported that increase in nitrogen content helped in increasing the sugar content with higher carbohydrate production through transformation of starch to sugars.

Application of 125% RDF increased the TSS-acid ratio (6.90 and 6.27 during both the years 2018 and 2019 respectively) (Table 2). TSS- acid ratio is a very significant factor that imparts flavor of the fruit which is due to the increased total soluble solids and low titratable acidity with their respective concentrations (Valero and Altisent, 1998) [15].

Higher ascorbic acid was found in 100% RDF (150: 100: 120 kg/ha) (52.34 mg/100g and 52.56 mg/100g during 2018 and 2019 respectively) (Table 4). This might be attributed to the optimum levels of nitrogen content involved in increase in the synthesis and catalytic activity of enzymes and co-enzymes for the synthesis of ascorbic acid as reported by Boora and Singh (2000) [2] and Kachwaya (2015) [8].

Reports have also showed that the quality improvement might be due to the involvement of potassium in carbohydrate synthesis, breakdown and translocation of starch, synthesis of protein and neutralisation of physiologically important organic acids (Tisdale and Nelson, 1966) [14] and its requirement for the activity of the enzyme, starch synthase (Greenberg and Preiss, 1965) [3]. Reduction in ascorbic content may be due to the increasing rates of nitrogen concentrations of alpha-amino acid-N and tended to raise concentrations of polyphenols and reduce those of ascorbic acid content (Nestby *et al*., 2005) [10].

Anthocyanin content was found to be higher (44.65 mg/100g and 43.55 mg/100g) in 125% RDF (187.5: 125: 150 kg/ha) during 2018 and 2019 respectively (Table 4). This might be due to the nutrients involved in the physiological and biochemical processes especially the phenylalanine ammonia lyase (PAL) activity, which is the primary cause in increasing the red pigment and red colour in the strawberry fruits as reported by Martinez *et al*. (1996) [9] and Kachwaya (2015) [8]. It was also reported that anthocyanin synthesis in strawberry fruits may be reduced by lower application of nitrogen (Yoshida *et al*., 2002) [16]. This substantiates the role of nitrogen in the accumulation of anthocyanin.

Though the above quality attributes had significance by fertigation other parameters such as titratable acidity (%), total sugars (%), reducing sugars (%) and non-reducing sugars (%) (Table 3) were not significantly influenced by the application of nutrients during both the years.

Conclusion

Application of the recommended dose of fertilizers (150: 100: 120 kg/ha) at 100% and 125% levels at three critical stages *viz.*, vegetative stage, flowering stage and fruiting stages had an influence on the physico-biochemical properties of strawberry fruits.

Acknowledgement

We acknowledge for the support and assistance rendered by the Strawberry District Private limited, Thambatty village, The Nilgiris to raise the experimental plot in their area.

Table 2: Influence of fertigation on total soluble solids (°B), titratable acidity (%) and sugar: acid ratio in strawberry cv. Nabila

Treatments	TSS (°B)			Titratable acidity (%)			TSS to acid ratio		
	2018	2019	Pooled mean	2018	2019	Pooled mean	2018	2019	Pooled mean
75% RDF	6.12	6.01	6.07	0.95	1.11	1.03	6.44	5.41	5.93
100%RDF	6.23	6.12	6.18	0.99	1.01	1.01	6.29	6.06	6.18
125%RDF	6.35	6.21	6.28	0.92	0.99	0.96	6.90	6.27	6.59
Pooled mean	6.23	6.11	6.17	0.95	1.04	1.00	6.55	5.92	6.23
SE d			0.043			-			0.067
C.D (0.05)			0.087			NS			0.136

Table 3: Influence of fertigation on total sugars (%), reducing sugars (%) and non-reducing sugars (%) in strawberry cv. Nabila

Treatments	Total Sugars (%)			Reducing Sugars (%)			Non- Reducing Sugars (%)		
	2018	2019	Pooled mean	2018	2019	Pooled mean	2018	2019	Pooled mean
75% RDF	5.08	5.11	5.10	4.35	4.47	4.41	0.73	0.64	0.69
100%RDF	5.12	5.14	5.13	4.79	4.89	4.97	0.33	0.25	0.29
125%RDF	5.23	5.25	5.24	4.95	4.98	4.84	0.28	0.27	0.28
Pooled mean	5.14	5.17	5.16	4.70	4.78	4.74	0.45	0.39	0.42
SE d			-			-			-
C.D (0.05)			NS			NS			NS

Table 4: Influence of fertigation on ascorbic acid (mg/100g) and anthocyanin (mg/100g) in strawberry cv. Nabila

Treatments	Ascorbic Acid (mg/100g)			Anthocyanin (mg/100g)		
	2018	2019	Pooled mean	2018	2019	Pooled Mean
75% RDF	50.56	48.27	49.42	42.22	41.13	41.68
100%RDF	52.34	52.56	52.45	43.75	42.95	43.35
125%RDF	51.14	50.97	51.06	44.65	43.55	44.10
Pooled mean	51.35	50.60	50.97	43.54	42.54	43.04
SE d			0.517			0.366
C.D (0.05)			1.039			0.738

Reference:

1. AOAC. Official Methods of Analysis. Published by A.O.A.C., Washington, D.C, 1960.
2. Boora RS, Singh D. Effect of NPK on growth, yield and quality of sapota (Manilkara achras (Mill.) Forberg) cv. Cricket Ball. Haryana Journal of Horticultural Sciences. 2000; 29(3/4):188-189.
3. Greenberg E, Preiss J. Biosynthesis of bacterial glycogen. II. Purification and properties of the adenosine diphosphoglucose-glycogen transflucosylase of *Arthrobacter* species. J. Biol. Chem. 1965; 240:2341-2348.
4. Harborne JB. *A guide to modern techniques of plant analysis*. Chapman and Hall, 1973.
5. Hedge JE, Hofreiter BT. In: Carbohydrate Chemistry 17 (Eds. Whister R.L and Be Miller, J.N.) Academic Press. Newyork, 1962.
6. Joshi VK, Bhutani VP, Sharma RS. The effect of dilution and addition of nitrogen source on chemical, mineral and sensory qualities of wild apricot. Am. J. Enol. Vitic. 1990; 41(3):229-231.
7. Kachwaya DS. Studies on drip irrigation and fertigation in strawberry (*Fragaria* x *ananassa* Duch.) Ph.D. thesis submitted to Dr Yashwant Singh Parmar University of Horticulture and Forestry, Naun, 2014.
8. Kachwaya DS, Chandel JS. Effect of fertigation on growth, yield, fruit quality and leaf nutrients content of strawberry (Fragaria× ananassa) cv Chandler. Indian J. Agric. Sci. 2015; 85:1319-1323.
9. Martinez GA, Chaves AR, Anon MC. Effect of exogenous application of gibberellic acid on color change and phenylalanine ammonia-lyase, chlorophyllase, and peroxidase activities during ripening of strawberry fruit (Fragaria x ananassa Duch.). Journal of Plant Growth Regulation. 1996; 15(3):139.
10. Nestby R, Lieten F, Pivot D, Lacroix CR, Tagliavini M. Influence of mineral nutrients on strawberry fruit quality and their accumulation in plant organs: a review. International Journal of Fruit Science. 2005; 5(1):139-156.
11. Rosenberg SR. Chemistry and Physiology of Vitamins. Inter Science Publishers, New York, 1945.
12. Solaimalai A, Baskar M, Sadasakthi A, Subburamu K. Fertigation in high value crops - a review. Agric. Rev. 2005; 26(1):1-13.
13. Somogyi M. Notes on sugar determination. J. Biol. Chem. 1952; 200:245-247.
14. Tisdale SL, Nelson WN. Soil fertility and fertilizers, Mc Millen Co., London, 1966, 81.
15. Valero Ubierna C, Ruiz-Altisent M. Measuring equipment of organoleptic quality in fruits. Professional fruitgrowing. 1998; 95:38-45.
16. Yoshida Y, Goto T, Hirai M, Masuda M. Anthocyanin accumulation in strawberry fruits as affected by nitrogen nutrition. Acta Hort. 2002; 567:357-360.