

Impact of Integrated Nutrient Management on Physico-Chemical Attributes in Strawberry (*Fragaria × ananassa* Duch.) cv Chandler

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Received 20 March 2016; Accepted 25 April 2016; Published online 8 May 2016

Abstract Field experiment was conducted during 2013-14 and 2014-15 to study the impact of integrated nutrient management on physico-chemical attributes in Strawberry (*Fragaria × ananassa* Duch.) cv Chandler. The experiment was laid out in randomized block design with twelve treatments and three replications. The maximum fruit size [length (33.50 mm) and width (25.14 mm)], weight (11.06g), volume (10.46cc) and specific gravity (1.067) were recorded in the plants treated with 75% NPK + Vermicompost+*Azotobacter* +PSB followed by 75% NPK+FYM+ *Azotobacter* + PSB and minimum found in untreated (control). However the maximum TSS (12.54 °Brix), reducing sugar (4.92%), non reducing sugar (4.22%), total sugar (9.16%), pH (4.95) and TSS/Acid ratio (20.36%) contents were recorded in the berries produced from the plants treated with 50% NPK + Vermicompost + *Azotobacter* + PSB followed by 50% NPK + FYM + *Azotobacter* + PSB treatment. The minimum acidity (0.61%) was recorded in 50% NPK + Vermicompost +

Azotobacter + PSB treated plants, whereas, the highest acidity (0.83%) were recorded in control. The highest ascorbic acid (69.82%) was recorded in the untreated i.e. control whereas, the minimum amount of ascorbic acid (53.65%) content was recorded in 50% NPK+Vermicompost + *Azotobacter* + PSB treated plants. The lowest values of these nutrients were recorded in control.

Keywords Strawberry cultivar, Physico-chemical characters, Fertilizers, Organic manures, Biofertilizers.

Introduction

Strawberry (*Fragaria × ananassa* Duch.) belongs to the family Rosaceae. The cultivated strawberry (*Fragaria × ananassa* Duch.) was originated from the hybridization of two American species viz., *Fragaria chilioensis* Duch. and *Fragaria virginiana* Duch. All the cultivated varieties of strawberry are octaploid ($2n = 8x = 56$) yet Indian strawberry (*Fragaria × vesca* Duch.) is diploid ($2n=28$) in nature. It is herbaceous crop with prostrate growth habit, which behaves as an annual in sub-tropical region and perennial in temperate region. Strawberry is used as fresh fruit being rich in vitamin C and ellagic acid, which has anti cancerous property. It is a valuable food in the diet of millions of people around the globe. It is worthy to note that among all the fruits, strawberry gives high returns in the short time. The strawberry is a fruit characterized by an excellent aroma

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Table 1. Physical characteristics of strawberry fruits cv Chandler (mean data of two year).

Treatments	Fruit length (mm)	Fruit width (mm)	Fruit weight (g)	Fruit volume (cc)	Specific gravity
Control	21.80	14.55	5.07	5.37	0.943
100% NPK	22.63	15.02	5.56	5.66	0.980
75% NPK + FYM + <i>Azotobacter</i> + PSB	31.19	23.76	9.90	9.45	1.047
75% NPK + Vermicompost + <i>Azotobacter</i> + PSB	33.50	25.14	11.06	10.46	1.067
75% NPK + Town compost + <i>Azotobacter</i> + PSB	29.53	19.30	7.50	7.30	1.026
75% NPK + Neem cake + <i>Azotobacter</i> + PSB	25.31	16.42	6.74	6.69	1.006
75% NPK + Poultry manure + <i>Azotobacter</i> + PSB	24.58	16.04	6.26	6.24	1.002
50% NPK + FYM + <i>Azotobacter</i> + PSB	27.08	18.27	7.23	7.08	1.020
50% NPK + Vermicompost + <i>Azotobacter</i> + PSB	30.05	20.51	9.09	8.83	1.028
50% NPK + Town compost + <i>Azotobacter</i> + PSB	25.84	17.13	6.98	6.98	0.999
50% NPK + Neem cake + <i>Azotobacter</i> + PSB	24.11	15.57	6.02	6.02	0.999
50% NPK + Poultry manure + <i>Azotobacter</i> + PSB	23.11	15.13	5.88	5.86	1.002
CD at 5%	0.559	0.256	0.181	0.250	0.023

and a sweet taste. Fruits are attractive with distinct pleasant aroma and flavour, consumed as dessert and also have a special demand by the fruit processing units for the preparation of jams, ice cream, syrups etc. The taste of fruit mainly depends on three different compounds viz. sugars, acids and aromatic compounds. The strawberry fruit contains 0.55% total sugar and 0.90% to 1.85% acidity the prominent being mallic and citric acid. As reported by Aykroyd et al. (1966) 100g fruit edible portion (96%) contents moisture (87.8%), protein (0.7%), fat(0.2%), fibre (1.1%), carbohydrate (9.8%), minerals (0.4%), vitamin A (30 IU/100 g), Thiamine (0.03 mg/100 g), Riboflavin (0.07 mg/100 g), Nicotinic acid (0.2 mg/100 g), ascorbic acid (55/100 g) and calories (44/100 g).

Materials and Methods

Field experiment was conducted during 2013-14 and 2014-15 at the Horticulture Research Farm, analyzed in the Laboratory Department of Horticulture, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi. Impact of integrated nutrient management on physico-chemical attributes in Strawberry (*Fragaria × ananassa* Duch.) cv Chandler. The experiment was laid out in randomized block design with twelve treatments and three replications. Five fruit were randomly harvested from each treatment of strawberry having uniform shape and size. Five morphological or physical characters of fruits (Table 1)

were used to characterizes and describe the 12 treatment of strawberry. Eight chemical attributes constituents were studies of fruit.

Physico-chemical analysis

Total soluble solids (^oBrix)

Pulp of three fruits was randomly taken from composite sample and crushed for extracting the juice. TSS was estimated with the help of a hand refractometer (0-32 range) and expressed as degree brix (^oBrix).

Titrateable acidity (%)

Total titrateable acidity was determined by methods given as described by (1). Titrateable acidity was determined by titration in terms of citric acid with NaOH 0.1 N where 10 mL. of the sample was taken and dissolved to make up the volume to 100 mL with water and filtered through muslin cloth. 10 mL of this aliquot was titrated against 0.1 N NaOH using few drops of 1% phenolphthalein indicator till the pink color (end-point persists).

Ascorbic acid (mg/100 g)

Ascorbic Acid was determined by using 2, 6-dichlorophenol-indophenol through visual titration method 10 g sample was taken and volume was made up to 100 mL. with 3% metaphosphoric acid and fil-

Table 2. Chemical characteristics of strawberry fruits cv Chandler (mean data of two year).

Treatments	TSS (°Brix)	Acidity (%)	Ascorbic acid (mg/ 100g)	Redu- cing sugar (%)	Non reducing sugar (%)	Total sugar (%)	pH	TSS/ Acid ratio (%)
Control	6.18	0.83	69.82	2.51	2.07	4.59	3.88	7.41
100% NPK	9.97	0.79	68.41	2.66	2.20	4.86	4.08	12.59
75% NPK + FYM + <i>Azotobacter</i> + PSB	11.58	0.71	57.51	4.08	3.73	7.82	4.73	16.14
75% NPK + Vermicompost + <i>Azotobacter</i> + PSB	12.07	0.67	56.35	4.41	3.92	8.33	4.8	17.87
75% NPK + Town compost + <i>Azotobacter</i> + PSB	10.20	0.69	58.41	3.48	3.18	6.67	4.64	14.75
75% NPK + Neem cake + <i>Azotobacter</i> + PSB	7.75	0.76	67.76	2.91	2.46	5.37	4.44	10.19
75% NPK + Poultry manure + <i>Azotobacter</i> + PSB	7.03	0.73	65.68	2.69	2.38	5.04	4.32	9.53
50% NPK + FYM + <i>Azotobacter</i> + PSB	12.23	0.64	54.94	4.66	4.11	8.79	4.86	19.04
50% NPK + Vermicompost + <i>Azotobacter</i> + PSB	12.54	0.61	53.65	4.92	4.22	9.16	4.95	20.36
50% NPK + Town compost + <i>Azotobacter</i> + PSB	11.16	0.67	57.76	3.81	3.43	7.25	4.58	16.52
50% NPK + Neem cake + <i>Azotobacter</i> + PSB	9.04	0.72	62.66	3.23	2.94	6.09	4.28	12.41
50% NPK + Poultry manure + <i>Azotobacter</i> + PSB	8.41	0.69	60.32	3.04	2.77	5.82	4.24	12.17
CD at 5%	0.326	0.012	0.577	0.162	0.097	0.240	0.102	0.697

tered with filter paper. 10 mL of this aliquot extract of the sample was titrated with the standard dye to the pink end-point which persisted for 15 seconds.

Sugars (%)

Sugars were estimated by Fehling 'A' and 'B' solution 10 g fruit pulp was macerated with small amount of distilled water and filtered muslin cloth and volume was made up to 100 mL. The total sugar was estimated by adding reducing sugar (%) and non reducing sugar (%) and expressed as percent of total sugar.

Reducing sugar (%)

An aliquot of 5 mL diluted fruit juice was taken from 100 mL as above for titration and mixed with 10 mL of Fehling 'A' and 'B'. This was titrated against 1.0% glucose in boiling solution using ethylene blue as indicator. A blank with 10 mL of Fehling 'A' and 'B' was also run. They result were expressed as per cent of reducing sugar.

Non reducing sugar (%)

Non reducing sugar was calculated by deducting the quantity of reducing sugar from total invert sugars and multiplied by factor 0.95. The result was expressed as percent of non reducing sugar.

Results and Discussion

Physical characters of the fruits

The physical characters of strawberry fruits, fruit size in treatment were mean data recorded (Table 1). Fruit length range from 21.80 to 33.50 mm. Maximum fruit length was observed in the plants treated with 75% NPK + Vermicompost + *Azotobacter* + PSB (33.50 mm), followed by 75% NPK + FYM + *Azotobacter* + PSB (31.19 mm). The minimum fruit length was recorded in untreated i.e. control (21.80 mm). Fruit width range from 14.55 to 25.14 mm. Maximum fruit width was observed in the plants treated with 75% NPK + Vermicompost + *Azotobacter* + PSB (25.14 mm), followed by 75% NPK + FYM + *Azotobacter* + PSB (23.76mm). The minimum fruit width was recorded in untreated i.e. control (14.55mm). Fruit weight range from 5.07 to 11.06g. Maximum fruit weight was observed in the plants treated with 75% NPK + Vermicompost + *Azotobacter* + PSB (11.06g), followed by 75% NPK + FYM + *Azotobacter* + PSB (9.90 g). The minimum fruit weight was recorded in control (5.07g). Fruit volume range from 5.37 to 10.46cc. Maximum fruit volume was observed in the plants treated with 75% NPK + Vermicompost + *Azotobacter* + PSB (10.46cc), followed by 75% NPK + FYM + *Azotobacter* + PSB (9.45cc). The minimum fruit volume was recorded in untreated i.e. control (5.37cc). Fruit specific gravity range from 0.94 to 1.06. Maximum fruit spe-

cific gravity was observed in the plants treated with 75% NPK + Vermicompost + *Azotobacter* + PSB (1.067), followed by 75% NPK + FYM + *Azotobacter* + PSB (1.047). The minimum fruit specific gravity was recorded in untreated i.e. control (0.94). Similar results were obtained earlier [1, 2].

Chemical attributes of the fruits

The total soluble solids, acidity, ascorbic acid, sugars (reducing sugar, non-reducing sugar and total sugar), pH and TSS/Acid ratio constitute the important chemical constituents for assessing fruit quality of different treatment strawberry cultivars (Table 2).

The total soluble solids ranged from 6.18 to 12.54 °Brix. The maximum total soluble solids was recorded in 50% NPK + Vermicompost + *Azotobacter* + PSB (12.23 °Brix) and 75% NPK + Vermicompost + *Azotobacter* + PSB (12.07 °Brix), while minimum total soluble solids was recorded in control (6.18 °Brix). The acidity ranged from 0.61 to 0.83%. The minimum acidity was recorded in 50% NPK + Vermicompost + *Azotobacter* + PSB (0.61%) treated plant. While maximum acidity was recorded in control (0.83%) which was at par with 100% NPK (0.79%). Ascorbic acid, the major constituent of strawberry ranged from 53.65 to 69.82 mg/100 g of fruit pulp. The maximum amount of ascorbic acid was recorded in untreated i.e. control (69.82 mg/100 g) followed with treated 100% NPK (68.41). The minimum amount of ascorbic acid was observed in 50% NPK + Vermicompost + *Azotobacter* + PSB (53.65 mg/100 g). The similar results regarding total soluble solids, acidity and ascorbic acid were also reported earlier [3–6].

Sugar percentage which is mainly found as the regarding reducing sugar range from 2.51 to 4.92%. The maximum amount of reducing sugar percentage was recorded in 50% NPK + Vermicompost + *Azotobacter* + PSB (4.92%), followed by 50% NPK + FYM + *Azotobacter* + PSB (4.66%) and 75% NPK + Vermicompost + *Azotobacter* + PSB (4.41%). The minimum was observed in control (2.51%). The maximum amount of non reducing sugar percentage was recorded in 50% NPK + Vermicompost + *Azotobacter* + PSB (4.22%), followed by 50% NPK + FYM + *Azotobacter* + PSB (4.11%) and 75% NPK + Vermicompost

+ *Azotobacter* + PSB (3.92%). The minimum was observed in control (2.07%). Total sugar percentage which is mainly found as the range from 4.59 to 9.16%. The maximum amount of total sugar percentage was recorded in 50% NPK + Vermicompost + *Azotobacter* + PSB (9.16%), followed by 50% NPK + FYM + *Azotobacter* + PSB (8.79%) and 75% NPK + Vermicompost + *Azotobacter* + PSB (8.33%). The minimum was observed in control (4.59%). The results are in accordance with earlier report [6–8]. The pH range of strawberry fruit 3.88 to 4.95. The maximum pH range of strawberry fruit 3.88 to 4.95. The maximum pH range was recorded in 50% NPK Vermicompost + *Azotobacter* + PSB (4.95), followed by 50% NPK + FYM + *Azotobacter* + PSB (4.86) and 75% NPK + FYM + *Azotobacter* + PSB (4.80). The minimum amount of pH was recorded in control (3.88). TSS/Acid ratio ranged from 7.41 to 20.36%. The maximum TSS/Acid ratio was recorded in 50% NPK + Vermicompost + *Azotobacter* + PSB (20.36%), followed by 50% NPK + FYM + *Azotobacter* + PSB (19.04%) and 75% NPK + Vermicompost + *Azotobacter* + PSB (17.87%). The minimum TSS/Acid ratio was recorded in untreated i.e. control (7.41%). The results are in accordance with earlier report [9].

The mean data recorded as significance between the various physical and chemical characters of fruit were established during 2013-2014 to 2014-2015.

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