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Effect of integrated nutrient management on physico-chemical attributes and B:C ratio of strawberry (*Fragaria* × *ananassa* Duch.)

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ABSTRACT

The field experiment was conducted during 2017-18 and 2018-19 at the Horticulture Research Farm, Babasaheb Bhimrao Ambedkar University, Lucknow (UP), on Strawberry (Fragaria × ananassa Duch.) The runners were planted with a spacing of 30 x 15cm. Twelve treatment combinations were evaluated in randomized block design with three replications. The results indicated that the application of organics (FYM and MSWC), bio-inoculant (PSB) and mulch (Paddy straw) significantly influenced the physico-chemical attributesoffruit and B:C ratio. The maximum fruit length (3.80 cm), fruit diameter (2.72cm), fruit size (9.68 cm^2), fruit weight (13.03g) and B:Cratio (23.12:1) were recorded with 75% NPK+MSWC + mulch + PSB, which was significantly superior over control. The minimum values were recorded in control treatment. The maximum pH (4.9), total soluble solids (12.21 ^oBrix), TSS/Acid ratio (18.82%) were recorded with 75% NPK + FYM + mulch + PSB followed by 75% NPK+MSWC + mulch + PSB, while minimum under control in both the years.

Key words: Strawberry, Organics, PSB, physico-chemical attributes.

INTRODUCTION

Strawberry (*Fragaria* x *ananassa* Duch.) is one of the most appealing and refreshing fruit in the world. The cultivated strawberry belongs to the family Rosaceae. It was arisen in Europe in the 18th century as a chance cross between two American native diploid species viz., *Fragaria chilioensis* Duch. and*Fragaria verginiana* Duch (Singh *et al.,* 2015). In India it was introduced during the early sixties and has become favourite fruit among growers because of its remunerative prices and higher profitability. (Pandey *et.al.,* 2016). It is herbaceous crop with prostate growth habit, which behaves as an annual in sub-tropical region and perennial in temperature region (Beer *et al.,* 2017). 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. Fruits are attractive with distinct pleasant aroma and flavour and a sweet taste, deliciousness, softness and rich source of vitamins, minerals and nutrients. Fruits are consumed as dessert and also have a special demand by the fruit processing industries for preparation of canned strawberries, jam, jelly, ice-cream and beauty products. The application of chemical fertilizers has improved yield manifold per unit area but these fertilizers are expensive and hamper the ecological balance of the soil. Excessive and unbalanced use of chemical fertilizers leads to degradation of physico-chemical properties and microbial status of soil. The balanced application of organic manures, bio-fertilizers and inorganic fertilizers will enable to higher production of quality berries and runners. Therefore, an alternate source of nutrition is needed to sustain productivity of land (Beer *et al.,* 2017). Biofertilizers are one of the best modern tools for agriculture and are used to improve the fertility and quality of the soil. It offers an economically attractive and ecologically sound route for augmenting nutrient supply that enables to plant growth and development of strawberry (Singh *et al.,* 2015). Among various production practices, mulching is considered as an important cultural practice as its plays an important role in soil moisture conservation, weed control, regulation of soil-hydrothermal regime, besides keeping the delicate fruit neat and clean (Tarara, 2000). In view of above facts, the present experiment was conducted to ascertain the effect of organics and bio-ioculant on physico-chemical attributes and B: C ratio of strawberry.

MATERIALS AND METHODS

The present experiment was carried out during the winter season of 2017-18 and 2018-2019 at the Horticulture Research Farm,

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Babasaheb Bhimrao Ambedkar University, Vidya Vihar, Rae Bareli Road, Lucknow (UP), India. Twelve treatments with three replications were tested in randomized block design. The treatments were : T_0 - Control (Without fertilizers, Organics, Bio-inoculant and mulching), T_1 - 100% NPK + mulch, T_2-75% NPK + + mulch, T_3 - 50% NPK + + mulch, T_4 - 75% NPK + FYM + + mulch, T_5 - 75% NPK + MSWC + + mulch, T_6 - 50% NPK + FYM + + mulch, T_7- 50% NPK + MSWC + + mulch, T_8 - 75% NPK + FYM + mulch + PSB, T_9 - 75% NPK + MSWC + mulch + PSB, T_{10} - 50% NPK + FYM + mulch + PSB and T_{11} - 50% NPK + MSWC + mulch + PSB. The di-ammonium phosphate, urea and muriate of potash were used to supply the recommended dose (100:120:80 kg. ha^{-1}) of NPK. Full dose of P_2O_5 and K_2O and half dose of nitrogen were applied as a basal dose and remaining nitrogen was applied in two equal splits as a top dressing after one and two months of transplanting. The FYM (20 t ha^{-1}), and municipals solid waste compost (MSWC) (10 t ha^{-1}) were applied before fifteen days of runners planting. Runners were inoculated with PSB ((10^9 cfu/ml) prior to planting. Treated runners were planted at spacing of 30 x 15cm during the month of November 2017 and 2018. Uniform mulching with paddy straw was done in the plots as per treatments. The observations viz., length of fruits, diameter of fruits, size of fruit, fresh fruit weight, dry fruit weight, volume of fruit, specific gravity, were recorded on five fruits. Bio-chemical attributes viz. pH of fruit juice was measured with a digital pH meter, total soluble solids (^{o}Brix) was estimated with the help of a digital hand refractometer (0-32 range). TSS/Acid ratio was calculated by dividing total soluble solids (TSS ^{o}Brix) by titratable acidity. Titratable acidity was determined by titration in terms of citric acid with 0.1 N NaOH and using few drops of 1% phenolphthalein indicator. Ascorbic Acid was determined by using 2, 6-dichlorophenol-indophenol through visual titration method. Anthocyanin was determined by the method as suggested by Rangana (1997). B:C ratio was also recorded as per method of Saini *et.al.* (2001).

RESULTS AND DISCUSSION

Physical characters of the fruits

The fruit length, fruit diameter, fruit size, fresh fruit weight, dry fruit weight, fruit volume and specific gravity are constituents for assessing physical characters of the fruits of strawberry. Fruit length ranged from 2.23 to 3.80 cm and maximum (3.80 cm) fruit length was recorded with 75% NPK+ MSWC + mulch + PSB followed by 75% NPK + FYM + mulch + PSB (3.57cm). The minimum (2.23 cm) fruit length was recorded in control (Table1). Fruit diameter ranged from 1.46 to 2.72 cm and maximum valueb (2.72 cm) was recorded with 75% NPK+MSWC + mulch + PSB followed by 75% NPK + FYM + mulch + PSB (2.62 cm). The minimum fruit diameter was recorded under control (1.46 cm). Similar result was reported by Tripathi *et al.* (2011) regarding fruit length,

Table 1: Effect of integrated nutrient management on physico-chemical attributes of strawberry (pooled data of 2 years)

Treatments	length of fruits (cm)	diameter of fruits (cm)	Size of fruit (cm^2)	Fresh fruit weight (g)	Dry fruit weight (g)
T_0 Control	2.23	1.46	3.25	5.90	0.56
T_1:100% NPK + Mulch	3.55	2.53	9.16	9.35	0.89
T_2: 75% NPK + Mulch	3.50	1.99	7.22	8.92	0.85
T_3:50% NPK + Mulch	3.01	1.87	5.64	8.19	0.78
T_4:75% NPK + FYM + Mulch	3.18	2.27	7.21	10.25	0.98
T_5 :75% NPK + MSWC + Mulch	3.22	2.36	7.59	10.68	1.02
T_6 :50% NPK + FYM + Mulch	2.93	2.21	6.46	9.35	0.90
T_7:50% NPK + MSWC + Mulch	2.92	1.85	5.51	8.89	0.85
T_8: 75% NPK + FYM + Mulch + PSB	3.57	2.62	8.79	12.65	1.21
T_9 : 75% NPK+MSWC + Mulch + PSB	3.80	2.72	9.68	13.03	1.24
T_{10} : 50% NPK+ FYM + Mulch + PSB	3.28	2.20	7.21	11.96	1.14
T_{11} : 50% NPK+MSWC+ Mulch + PSB	3.43	2.09	7.17	12.49	1.19
SEm±	0.23	0.21	0.91	0.65	0.06
CD (P= 0.05)	0.68	0.61	2.69	1.93	0.18

width, weight, volume, TSS (^{o}Brix), total sugars, ascorbic acid with minimum titratable acidity in strawberry. Fruit size ranged from 3.25 to 9.68 cm^2 and maximum value (9.68 cm^2) was found with 75% NPK+MSWC + mulch + PSB (Umar *et al.* 2010). The minimum fruit size was recorded in control (3.25 cm^2). Fresh fruit weight ranged from 5.90 to 13.03g and maximum value (13.03g) was found with 75% NPK+MSWC + mulch + PSB and minimum in control (5.90g). Similar trends were recorded in dry fruit weight. Jain *et al.* (2016) reported similar results.Fruit volume ranged from 6.23 to 12.65mm and maximum value was observed with 75% NPK+MSWC + mulch + PSB (12.65mm) and minimum in control (6.23 cc). Specific gravity ranged from 0.946 to 1.040 and maximum value (1.040) was recorded with 75% NPK + FYM + mulch followed by 50% NPK + MSWC + mulch + PSB. The minimum value (0.946) was recorded under control. The improvement in physical properties of fruits due to integrated nutrient management may be attributed to increased availability of plant nutrients and moisture. Similar results were reported by Nowsheen *et al.* (2015) regarding fruit length, fruit diameter, volume of fruit, fruit weight and chemical characters viz. total sugars, total soluble solids, acidity and TSS: acid ratio in strawberry.

Bio-chemical attributes of the fruits

The pH ranged from 3.83 to 4.93 and maximum value (4.93) was recorded in 75% NPK + FYM + mulch + PSB followed by 75% NPK+MSWC + mulch + PSB (4.69). The minimum value of pH was recorded under control (3.83). The total soluble solids ranged from 6.25 to 12.21^{o}Brix and maximum value (12.21^{o}Brix) was recorded with 75% NPK + FYM + mulch + PSB and minimum under control (6.25^{o}Brix). An enhanced TSS with INM and inorganic fertilizers was reported byKumar *et al.*(2015)**.** The titratable acidity ranged from 0.65 to 0.82% and minimum value (0.65%) was recorded in 75% NPK + FYM + mulch + PSB, while maximum (0.82%) was recorded under control (Table 2). Similar result was reported by Tripathi and Mishra (2011) on TSS, total sugars, ascorbic acid in strawberry. The TSS/acid ratio ranged between 7.59 and 18.82% and maximum value (18.82%) was recorded with 75% NPK + FYM + mulch + PSB and minimum (7.59 %) under control. Ascorbic acid is the major constituent of strawberry fruit and ranged from 54.36 to 69.56mg/100g and maximum (69.56mg/100g) amount was recorded under control. The minimum amount was observed in 75% NPK + FYM + mulch + PSB (54.36mg/100g). Anthocynin, the major component of strawberry fruit, ranged from 31.02 to 45.86mg/100 g and maximum (45.86mg/100g) value was recorded with 75% NPK + MSWC + mulch. The minimum (31.02 mg/100 g) was recorded under Control.

Table 2: Effect of integrated nutrient management on physico-chemical attributes of strawberry (pooled data of 2 years)

Treatments	Volume of fruit (mm)	Specific gravity	pH of juice	TSS (^{o}Brix)	Titratable acidity (%)
T_0 Control	6.23	0.946	3.8	6.25	0.82
T_1:100% NPK + Mulch	9.87	0.948	4.2	9.78	0.77
T_2: 75% NPK + Mulch	8.74	1.020	4.0	9.74	0.77
T_3:50% NPK + Mulch	7.92	1.034	4.0	9.53	0.79
T_4:75% NPK + FYM + Mulch	9.85	1.040	4.5	10.12	0.67
T_5 :75% NPK + MSWC + Mulch	10.34	1.033	4.3	10.47	0.72
T_6 :50% NPK + FYM + Mulch	9.23	1.013	4.0	9.26	0.78
T_7:50% NPK + MSWC + Mulch	8.63	1.030	4.1	9.35	0.77
T_8: 75% NPK + FYM + Mulch + PSB	12.27	1.031	4.9	12.21	0.65
T_9 : 75% NPK+MSWC + Mulch + PSB	12.65	1.030	4.6	11.63	0.66
T_{10} : 50% NPK+ FYM + Mulch + PSB	11.62	1.029	4.6	11.15	0.69
T_{11} : 50% NPK+MSWC+ Mulch + PSB	12.08	1.034	4.5	10.42	0.74
SEm±	0.62	0.01	0.15	0.38	0.01
CD (P= 0.05)	1.84	0.02	0.46	1.14	0.03

B : C ratio

Benefit cost ratioranged from 7.19:1 to 23.12:1 and maximum (23.12:1) was noted with 75% NPK+MSWC + mulch + PSB followed by 75% NPK + FYM + mulch + PSB (22.35:1). The minimum (7.19:1) value of this ratio was recorded under control (Table 3). The increase in B : C ratio may be ascribed due to improved environment of root media and higher productivity of fruits due to integrated nutrient management (Singh *et al.* 2015).

Table 3: Effect of integrated nutrient management on bio-chemical attributes and B:C ratio of strawberry (pooled data of 2 years)

Treatments	TSS/Acid ratio	Ascorbic acid/(mg/100g)	Anthocyanin (mg/ 100 g)	B:C ratio
T_0 Control	7.59	69.56	31.02	7.19:1
T_1:100% NPK + Mulch	`12.65	68.37	34.83	16.76:1
T_2: 75% NPK + Mulch	12.68	64.67	35.55	15.14:1
T_3:50% NPK + Mulch	12.03	65.06	31.83	11.69:1
T_4:75% NPK + FYM + Mulch	15.09	58.04	41.43	19.05:1
T_5:75% NPK + MSWC + Mulch	14.50	59.80	45.86	20.13:1
T_6:50% NPK + FYM + Mulch	11.88	65.43	36.14	16.49:1
T_7:50% NPK + MSWC + Mulch	12.17	63.25	36.41	16.56:1
T_8: 75% NPK + FYM + Mulch+PSB	18.82	54.36	42.94	22.35:1
T_9: 75% NPK+MSWC + Mulch+PSB	17.67	56.09	42.47	23.12:1
T_{10}: 50% NPK+ FYM + Mulch+PSB	16.21	54.96	41.04	21.39:1
T_{11}: 50% NPK+MSWC+ Mulch+PSB	14.19	58.49	38.88	22.01:1
SEm±	0.58	1.14	0.95	-
CD (P= 0.05)	1.71	3.37	2.81	-

It may be concluded from the present investigation that application of 75% NPK+MSWC + mulch + PSB has proved beneficial under Lucknow conditions for achieving better quality of fruits and productivity.

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