Research Article

INFLUENCE OF INTEGRATED NUTRIENT MANAGEMENT PRACTICES ON PHYSIO-CHEMICAL ATTRIBUTES IN STRAWBERRY (*FRAGARIA* × *ANANASSA* DUCH.) CV. SWEET CHARLIE

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ABSTRACT
The study was conducted so as to identify most suitable integrated nutrient management (INM) practice for enhancing the physio-chemical properties of strawberry (*Fragaria* × *ananassa* duch.) fruits of variety Sweet Charlie with 21 treatments and different combinations of organic and microbial sources of nutrients (Compost, Poultry Manure, Vermicompost, FYM, *Azotobacter* and PSB) replicated thrice with 18 plants per 2x2 m plot size in Randomized Block Design. . The study revealed that INM comprising application of vermicompost 5t/ha+ poultry manure 2.5t/ha+ *Azotobacter* + phosphorus solubilizing bacteria (PSB) was the best to obtain a maximum fruit yield (112.63 g plant^{-1}), fruit weight (12.86 g), in terms of length and breadth, fruit with maximum specific gravity and highest shelf life (5.69 days),. This was much significantly higher as compared to that of the control. A similar trend was observed in the fruit bio-chemical attributes like Total Soluble Solids (7.05 °B), titratable acidity (0.64%), ascorbic acid content (53.42 mg/100 g fruit pulp), and pH (2.66) content of the harvested fruits. Hence, it can be considered the integrated application of vermicompost 5t/ha+ poultry manure 2.5t/ha +*Azotobacter* + PSB is most suitable INM practice for enhancing physio-chemical properties of strawberry cv. Sweet Charlie fruits as grown under Allahabad conditions.

INTRODUCTION

Strawberry (Fragaria × ananassa Duch.) is an aggregate fruit, occupies a significant place in fruit growing in India. Since, it can be cultivated in plains as well as in hills, it has gained the status of being one of the most important soft fruit of the worlds after grapes. Its popularity can be judged from the very fact that total area and production of the world had increased considerably over the past decade. It occupies on an area of 2, 43,907 ha with a total production 43, 66,662 tones (FAO, 2010). It is cultivated to a limited extent is plains and sub mountainous areas of Himachal Pradesh, Uttarakhand, Uttar Pradesh, Maharashtra, Karnataka, Punjab, Haryana Madhya Pradesh and Meghalaya, wherever, irrigation facilities are available in India. Among the various factors which contribute to the growth and yield of strawberry, nutrition is an important aspect of crop production that accounts for about one third of the total cost of production (Bhatt, 1999; Nazir, 2005). A balanced form of fertilizer is a pre- requisite to higher yields. However, these chemical fertilizers are costlier and also pollute the environment through the process of denitrification, volatilization and leaching. The surest means to tide over the challenge is through environmentally sustainable farming methods. To sustain the fertility status of the soil, maintenance of appropriate status of microflora, to make safe the produce and for realizing the additional yields, Integrated Nutrient Management (INM) is a certain answer. To combat this problem, use of organic manures and bio fertilizers are probably the best way to maintain a sustained food production pattern. Since the need is to ensure that the physio chemical properties of the fruits are enhanced, hence an effort had been made so as to determine the most suitable INM practice that can positively influence the fruit physiochemical properties.

MATERIALS AND METHODS

Experimental site

Strawberry plants were planted by transplanting method with 60 x 30 cm spacing. Cultural practice had used manually with the help of labours, water supply provided by hazara on an alternate days and in term of pest management practice use trap card. Strawberry fruits were harvested in fresh conditions during morning hours. The fruits were cleaned properly with water. It was ensured that the fruits harvested were free from blemishes and spots. Then the fruits were analysed physio-chemically in Post graduate Lab, Department of horticulture, SHUATS, Allahabad.

Design used in this experiment

The design of the experiment was Randomized Block Design (RBD) with 21 treatments replicate thrice time with 2 x 2 m plot size.

Treatment details

T_0-Control (N- 100kg/ha, p-80kg/ha and k-80kg/ha)
T_1-Compost (7 t ha $^{-1}$)
T_2-Poultry Manure (5 t ha $^{-1}$)
T_3-Vermicompost (10 t ha $^{-1}$)
T_4-FYM (10 t ha $^{-1}$)
T_5-Vermicompost (5 t ha $^{-1}$) + Poultry Manure (2.5 t ha $^{-1}$)
T_6-Poultry Manure (2.5 t ha $^{-1}$) + Compost (3.5 t ha $^{-1}$)
T_7-FYM (5 t ha $^{-1}$) + Vermicompost (2.5 t ha $^{-1}$)
T_8-Poultry Manure (2.5 t ha $^{-1}$) + FYM (5 t ha $^{-1}$)
T_9-Vermicompost (5 t ha $^{-1}$) + Compost (3.5 t ha $^{-1}$)
T_{10}-Compost (3.5 t ha $^{-1}$) + FYM (5 t ha $^{-1}$)
T_{11}-Compost (7 t ha $^{-1}$) + *Azotobacter* + PSB
T_{12}-Poultry Manure (5 t ha $^{-1}$) + *Azotobacter* + PSB
T_{13}-Vermicompost (10 t ha $^{-1}$) + *Azotobacter* PSB
T_{14}-FYM (10 t ha $^{-1}$) + *Azotobacter* + PSB
T_{15}-Vermicompost (5 t ha $^{-1}$) + Poultry Manure (2.5 t ha $^{-1}$) + *Azotobacter* + PSB
T_{16}-Poultry Manure (2.5 t ha $^{-1}$) + Compost (3.5 t ha $^{-1}$) + *Azotobacter* + PSB
T_{17}-FYM (5 t ha $^{-1}$) + Vermicompost (2.5 t ha $^{-1}$) + *Azotobacter* + PSB
T_{18}-Poultry Manure (2.5 t ha $^{-1}$) + FYM (5 t ha $^{-1}$) + *Azotobacter* + PSB
T_{19}-Vermicompost (5 t ha $^{-1}$) + Compost (3.5 t ha $^{-1}$) + *Azotobacter* + PSB
T_{20}-Compost (3.5 t ha $^{-1}$) + FYM (5 t ha $^{-1}$) + *Azotobacter* + PSB

Application of manures and bio fertilizers

Recommended amount of manures *viz.* farm yard manure, vermicompost, poultry manure, compost were applied before transplanting as per the treatment and mixed thoroughly in the soil and bio fertilizers were applied as Slurry of 200 ml of the lignite based culture of PSB and *Azotobacter* were prepared in 15 liter of water individually and combinations of both 100 ml *Azotobacter* and 100 ml PSB culture were prepared in 15 liter of water.

Parameters studied

Physical parameters

Fruit diameter (cm)

The average fruit diameter of mature berries was also measured by vernier calipers and expressed in centimeter.

Fruit length (cm)

The average fruit length was measured treatment wise with the help of vernier calipers and expressed in centimeter.

Fruit weight (g)

The fruit weight was determined electronically by electronic weighing balance

Specific gravity

The specific gravity of fruit was calculated by dividing the average fruit weight to average volume of water displaced by fruit (ml).

$$\text{Specific gravity} = \frac{\text{Weight of fruit (g)}}{\text{Volume of water displaced by fruit (ml)}}$$

Chemical parameters

Total Soluble Solids (ºBrix)

The total soluble solids of fruit were estimated with the help of hand refractometer and expressed in degree Brix.

Acidity (%)

The acidity of the fruit juice was estimated by titrating against standard alkali solution (0.1 N NaOH) using the phenolphthalein indicator and is expressed in mg. (Rangana, 1977).

pH of juice

The pH of the fruit samples were determined by digital pH meter manufactured by UTech.

Ascorbic acid (mg /100g of pulp)

Ascorbic acid content of fruits was estimated based on the oxidation of ascorbic acid to dehydro ascorbic acid and then to diketogluconic acid followed by coupling with 2,4 DNPH and expressed as mg per 100 g fruit pulp (Rangana, 1977).

Total Sugar

The reducing sugar content were estimated with the help of freshly made mixture containing equal volumes of Fehling's solution A & B by copper reducing method (A.O.A. C, 1984) using methylene blue as an indicator and was expressed in mg (Mazumdar and Majumder, 2003).

Shelf life of fruit

Shelf life of fruit was assessed under ambient conditions at temperature 7-13ºC by recording the days taken from harvesting stage to rotting in the harvested fruits.

RESULTS AND DISCUSSION

Results revealed that the plants which are being nourished with T_{15} (vermicompost + poultry manure + Azotobacter + PSB) recorded the highest fruit yield per plant (112.6 g), average fruit weight of (12.26 g) which was found at par with T_{17} (FYM + vermicompost + Azotobacter + PSB) (12.23 g). However, plants treated with T_0 (Recommended dose of nutrients through chemical fertilizers) exhibited least fruit weight (7.94 g). Maximum fruit diameter (2.99 cm) was recorded in T_{15} (vermicompost + poultry manure+ Azotobacter + PSB) which was significantly higher to other treatments but it was at par with T_{17} (FYM + vermicompost+ Azotobacter + PSB) (2.98 cm) and T_{18} (poultry manure + FYM +Azotobacter + PSB) (2.94 cm). Least fruit diameter (2.42 cm) was obtained in T0 (recommended dose of nutrients through chemical fertilizers). T_{15} (vermicompost + poultry manure + Azotobacter + PSB) was recorded highest average fruit length of (5.25 cm) followed by T_{17} (FYM + vermicompost + Azotobacter + PSB) (4.61 cm). However, plants treated with T_0

(recommended dose of nutrients through chemical fertilizers) exhibited least fruit length (3.06 cm). Specific gravity of fruits was found maximum in T_{17} (FYM + Vermicompost + Azotobacter + PSB) which is 1.86. However T_{15} (vermicompost + poultry manure + Azotobacter + PSB) was found at par with T_{17}. T_0 (control) showed least specific gravity of the fruits (1.13). The shelf life of fruits as stored under ambient conditions was observed maximum in T_{15} (vermicompost + poultry manure + Azotobacter + PSB) which was (4.51) and minimum in T_0 (control) which was (2.53). The increase may be due to balanced availability of macro and micro nutrients and growth promoting hormones produced by different bio-fertilizers applied in different treatment combinations. This may be attributed to better fillings of fruits due to more balanced uptake of nutrients which may have lead to better metabolic activities in the plant ultimately lead to high protein and carbohydrate synthesis (Singh *et al.,* 1970). Beside nitrogen fixing abilities of the microbial inoculants, the capacity to releasing phyto-hormones especially gibberellins should be regarded which increases the fruit size. Also the different partitioning of photosynthesis towards the sink by *Azotobacter* inoculation increased the fruit size and weight (Rana and Chandel, 2003). The increased in yield enhanced uptake of nutrients and water caused to higher photosynthesis leading to an increase of the assimilation rates. The generation of Co_2 during compost decomposition has also been found responsible for increasing yield (Lieten, 1996). Brown *et al.,* (1993) showed that among various organic sources, poultry manure had the most important role followed by FYM that is in agreement with the result of this study. A similar finding was found in (Ahmad and Mohammad, 2012).

Table 1. Physical properties and shelf life of harvested fruits

Treatments	Fruit yield plant^{-1}	Fruit weight (g)	Fruit diameter (cm)	Fruit length (cm)	Specific gravity	Shelf life
T_0	51.61	7.94	2.42	3.08	1.13	2.53
T_1	67.70	8.97	2.54	3.58	1.23	3.14
T_2	70.33	9.18	2.47	3.37	1.48	3.13
T_3	80.88	10.63	2.75	3.84	1.43	4.07
T_4	66.25	9.89	2.54	3.57	1.38	3.18
T_5	100.7	11.71	2.89	4.55	1.81	4.46
T_6	97.87	11.59	2.76	3.92	1.60	4.24
T_7	105.3	11.94	2.89	3.89	1.70	4.4
T_8	92.45	11.28	2.83	4.27	1.66	4.41
T_9	86.11	11.28	2.73	3.67	1.67	4.25
T_{10}	77.52	10.84	2.77	3.35	1.45	3.89
T_{11}	77.03	10.38	2.53	3.62	1.54	3.82
T_{12}	79.36	10.40	2.76	3.66	1.76	3.94
T_{13}	81.24	10.51	2.80	3.73	1.59	4.10
T_{14}	81.40	10.50	2.75	3.71	1.59	4.28
T_{15}	112.6	**12.26**	**2.99**	**5.25**	**1.84**	**4.51**
T_{16}	98.65	11.89	2.77	3.72	1.53	4.36
T_{17}	109.5	12.23	2.98	4.61	**1.86**	4.48
T_{18}	105.4	12.11	2.94	4.14	1.80	4.42
T_{19}	88.29	11.37	2.85	3.83	1.74	4.45
T_{20}	87.81	11.67	2.83	3.50	1.75	4.21
F-test	**S**	**S**	**S**	**S**	**S**	**S**
SE.d (+)	1.817	0.076	0.053	0.285	0.220	0.334
CD (0.5%)	3.673	0.153	0.107	0.576	0.445	0.675

Table 2 clearly shows that the total soluble solids, acidity, ascorbic acid and pH were significantly influenced by the organic manure application. The maximum total soluble solids (7.05 °B) and ascorbic acid (53.42 mg/100g of pulp) were recorded with treatment T_{15} (vermicompost + poultry manure + *Azotobacter* + PSB) followed by total soluble solids (6.51°B) and ascorbic acid (52.86 mg/100g of pulp) with T_{17} (vermicompost + FYM +*Azotobacter*

+PSB) respectively and while the minimum total soluble solids (5.31°B) and ascorbic acid (49.38 mg/100g of pulp) were observed in T_0 (recommended dose of nutrients through chemical fertilizers) and minimum acidity (0.64 %) and pH (2.63) was found in T_{15} (vermicompost + poultry manure +*Azotobacter* + PSB) followed by acidity (0.66%) and (0.66%) and pH (2.69) and (2.78) T_{17} (vermicompost+ FYM +*Azotobacter* + PSB) and T_5 (vermicompost + poultry manure) respectively and maximum acidity (0.72%) and pH (3.90) in T_0 (Recommended dose of nutrients through chemical fertilizers). Increased TSS and ascorbic acid at higher levels of nitrogen might have resulted due to the fact that absorption of nitrogen may be exerted regulatory role as an important and during ripening of fruits the carbohydrate reserves of the roots and stem are drawn upon heavily by fruits which might have resulted into higher TSS and ascorbic acid in fruits. Increased TSS, ascorbic acid in fruits and decreased acidity and pH are in agreement with the findings of EI-Hamid *et al.,* 2006 who reported that that application of PSB on strawberry resulted increase in TSS, total sugar, ascorbic acid and juice percentage and Singh *et al.,* 2008 who reported that the fruit harvested from plant receiving vermicompost were TSS and ascorbic acid increases, acidity decreased and color more attractive. A similar trend was also observed in T_{15} (vermicompost + poultry manure + Azotobacter + PSB) which yielded fruits with a higher content of total sugar. However, the least total sugar content was observed in T_7 (5.41).Poultry manure contains essential plant nutrients that play significant role in improving quality as reported by Prabakaran and Pichal (2003).

Table 2. Bio-chemical properties of harvested fruits

Treatment	TSS (°B)	Titratable acidity (%)	pH	Ascorbic acid (mg/100g pulp)	Total sugar
T_0	5.31	0.64	3.90	49.38	5.86
T_1	5.56	0.71	3.79	49.79	6.17
T_2	5.51	0.71	3.69	51.66	6.19
T_3	6.08	0.68	3.12	51.28	5.94
T_4	5.74	0.69	3.10	51.42	6.33
T_5	6.59	0.66	2.78	52.78	5.77
T_6	6.06	0.67	3.29	52.16	6.37
T_7	6.08	0.70	3.60	52.26	5.41
T_8	5.98	0.68	3.41	52.12	6.00
T_9	5.58	0.69	3.23	51.95	5.98
T_{10}	5.50	0.69	3.21	52.16	6.30
T_{11}	5.38	0.66	3.49	50.31	5.90
T_{12}	5.35	0.68	3.32	50.22	6.21
T_{13}	5.38	0.70	3.30	51.98	6.44
T_{14}	5.57	0.69	3.21	51.76	6.22
T_{15}	**7.05**	**0.72**	**2.63**	**53.42**	**6.51**
T_{16}	6.30	0.69	3.13	52.35	6.44
T_{17}	6.51	0.71	2.69	52.86	6.23
T_{18}	6.84	0.70	2.98	52.58	6.30
T_{19}	6.10	0.69	3.28	52.49	6.46
T_{20}	5.66	0.70	3.37	50.91	6.43
F-test	**S**	**S**	**S**	**S**	**S**
SE.d (±)	0.237	0.009	0.107	0.222	0.156
CD (0.5%)	0.479	0.019	0.217	0.449	0.316

SUMMARY AND CONCLUSION

Soil applied with T_{15} (Vermicompost (5 t ha $^{-1}$) + Poultry Manure (2.5 t ha $^{-1}$) + *Azotobacter* + PSB) yielded fruits with maximum length, breadth, weight and specific gravity. The shelf life was also found to be more with T_{15}(Vermicompost (5 t ha $^{-1}$) + Poultry Manure (2.5 t ha $^{-1}$) + *Azotobacter* + PSB) . Biochemical properties of the fruits like TSS, Total sugar, acidity, pH and ascorbic acid content were also found higher with T_{15} (Vermicompost) (5 t ha $^{-1}$) + Poultry Manure (2.5 t ha $^{-1}$) + *Azotobacter* + PSB). Hence, it can be considered the T_{15} (Vermicompost (5 t ha $^{-1}$) + Poultry Manure (2.5 t ha $^{-1}$) + *Azotobacter* + PSB) is the most suitable INM practice for enhancing physio-chemical properties of strawberry cv. Sweet Charlie fruits as grown under Allahabad conditions.

REFERENCES

Ahmad Dadashpour and Mohammad Jouki. 2012. Impact of Integrated Organic nutrient handling on fruit yields and quality of strawberry cv. Kurdistan in Iran. *J. Orntl. & Hortic. Plants*, **2**(4): 25.

Artira Kumar Mukharjee, Sajal Pati, Aninesh Ghosh Bag, Nitin Chatterje, Biplab Pal and Dhaneshwar Padhan. 2017. Integrated Nutrient management for sustainable agriculture. Innovative Farming. **2**(1): 37-40.

Bhat, N.H. 1999. Response of strawberry cultivars to varied levels of organic manure. MSc Thesis, SK University of Agricultural Sciences and Technology of Kashmir, Srinagar, J& K, India.

Brown, J.E., C.H. Gilliam, R.L. Shumack and D.W. Porcch. 1993. Commercial snapbean response to fertilization with broiler litter. *J. Hort. Sci*. **28**(1): 29-31.

EI-Hamid, A.S. Aza, A.A. Abbou, S.A.A. Mansour and A.A.A. EI. Sayed. 2006. Effect of some biofertilizers on the yield, and fruit quality of strawberry. *Annual Agricultural. Science*, **44**(10): 251-264.

FAO. 2010. Statistical Database of the Food and Agricultural Organization, Rome. www.fao.org.Accesses.

Lieten, F. 1996. Effect of Co_2 enrichment on greenhouse grows strawberry. Acta Hort. **439**(2): 583-587.

Nazir, N. 2005. Studies on organic farming techniques for production of quality strawberry (*Fragaria x ananassa* Duch.). MSc Thesis, SK University of Agricultural Sciences and Technology of Kashmir, Srinagar, J & K, India. **4**(2): 61-67.

Prabakaran, C. and G.J. Pichal. 2003. Effect of different organic nitrogen sources on pH, total soluble solids, titrable acidity, crude protein, reducing and non-reducing sugars and ascorbic acid content of tomato fruits. *Journal of Soil Crops*. **13**(1): 172-175.

Rana, R.K. and J.S. Chandel. 2003. Effect of biofertilizer and nitrogen on growth, yield and fruit quality of strawberry. *Prog. Hort*. **35**(1): 25-30.

Ranganna, S. 1977. Manual of Analysis of Fruits and Vegetable products. Tata McGraw-Hill.

Singh, R. and V.P. Sharma. 1970. Prospects of growing strawberry under plains. *Ind. Hort*. **15**(3): 13-15.

Singh, R., R.R. Sharma, S.I. Kumar, R.K. Gupta and R.T. Patil. 2008. Vermicompost substitution influence growth, physiological disorders, fruit yield and quality of strawberry. *Biological Research and Technology*, **99**: 8507-8511.

Yadav and Singh. 2016. Effect of Integrated Nutrient Management on yield, protein content, nutrient content and uptake of sorghum (*sorghum bicolour* (L.) Moench. Innovative Farming, **1**(2):30-34.

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