Agriculture Association of Textile Chemical and Critical Reviews Journal (2022) 35-44

AATCC Review

29 July 2022: Received
26 August 2022: Revised
08 October 2022: Accepted
30 October 2022: Available Online

http://aatcc.peerjournals.net/

Research Article

Open Access

Assessment of Strawberry to Integrated Nutrient Management for Different Physico-Chemical Attributes

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Abstract

Strawberry is the well-known crop in Dehradun (Uttarakhand) and is highly appreciated by the consumers in this region. The problem is to get qualitative yield. The present study was conducted to improve quality of the fruits regarding this an experiment was conducted at the main experiment station, DCAST, Dehradun during the years 2018-19 and 2019-20 for the optimization of physico-chemical characteristics of strawberry fruit through organic manure and inorganic fertilizers with the aid of bio-fertilizers. The experiment was statistically conducted in a completely Randomized Block Design (CRBD) with three replications having nine treatments with different doses of NPK, FYM, Azotobacter and PSB either single or in combination.The data noted for different physico-chemical characters vizFruit size, Weight of berry and Volume of berryTSS, Acidity, Ascorbic acid, Reducing sugar, Non-reducing sugars, Total sugars, and Anthocyanin were found significantly superior with soil application of T5- 100% FYM+NPK (25:120:80) kg/hac+Azotobacter (20kg/ha)+PSB (20kg/ha) during both the year of experimentation 2018-19 and 2019-20 whereas all the treatment were noted better result for the different characters while the treatment T1-50 ton FYM/ha was noted lowest result among all other treatments.

Keywords: *Organic manure, In-organic fertilizers, Bio-fertilizer, strawberry, INM, Azotobacter, PSB.*

Introduction

Strawberry (*Fragariax ananasa* Duch.) comes under the family rosaceae is a man-made hybrid developed through the cross between *Fragariachiloensis* and *Fragariaverginiana*in France in the 17th century. This is a fruit most demanded in world due to its delicious quality and test which has attained a premier position in the world fruit market as fresh fruit as well as in the processing industries [1]. In the early stage of cultivation, the strawberry was cultivated under the temperate zone of the country but as time is passing its cultivation becomes possible in sub-tropical zones as well with the introduction of day-neutral cultivar [2]. In India, the strawberry is extensively cultivated under Haryana, Mizoram, Meghalaya, Kerala, Madhya Pradesh, and Himachal Pradesh, Tamil Nadu, Uttar Pradesh, Uttarakhand. During the year 2018-19 in India, an average production of 5000 MT of strawberry fruit was noted from an area of 1000 ha[3]. Strawberry is a fine source of Vitamin-C (30-120mg/100g edible portion), Vitamin-A (60 IU/100g edible portion), protein (0.67g) and different minerals *viz.* calcium, potassium, iron and phosphorus [4]. Regular use of strawberries will be helpful to inhibit cancer disease and asthma in human due to the presence of natural occurring plant phenol, ellagic acid (antimutagenic and anticarcinogenic plant pherol) [5]. There are several cultivars and hybrids viz. Chandler, Bangalore, Pusa early dwarf, Majestic, Sujata, Sweet charlie, Pajaro, etc are commercially cultivated and preferred by different growers of India. Among these varieties Chandler is an exceptionally high dessert quality with outstanding color, resistant to physical damage due to rain, and tolerant to the virus, fruit large, flesh and skin firm and flavor excellent, suitable for fresh market and processing [6].

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DOI: https://doi.org/10.58321/AATCCReview.2022.10.03.35

As suggested by [7], nutrition is one of the most important factors which maintains plant growth and development and provides better returns. The increasing demands of foods the growers are willing to excessive use of chemical fertilizers. These chemicals fertilizers are killing the fertility of the soil by disturbing the soil structure which will be the cause of low and bad quality production also creating bad effect on human health. Hence keeping such problems the practice of Integrated Nutrient Management is a better solution for economy, environment friendly and maintenance of soil health. The concept of Integrated Nutrient Management includes the balanced supply of organic manure and inorganic fertilizer with the aid of bio-fertilizers to maintain the eco-friendly relationship among soil health, plant health and human health in most efficient manner. Thus judicious application of different organic and inorganic nutrients with aid of bio-fertilizers may help in enhancing physico-chemical attributes of strawberry [8]as well as sustainable soil health [9]. In strawberry the practice of Integrated Nutrient Management is more essential to realize quality fruit and higher yield. Hence the present investigation is subjected to develop proper nutrient management for strawberry cultivation regarding different treatment combination of organic manure, inorganic fertilizer and bio-fertilizer.

Material and Methods

The present study entitled "Assessment of strawberry to Integrated Nutrient Management for different physico-chemical attributes" was carried out at Main Experimental Station, Horticulture, Doon (PG) College of Agriculture Science and Technology, Camp Road, Selaqui, Dehradun during the years 2018-19 and 2019-20 at 30.3165° N, 78.0322° E and 447 MSL. It is sunny in the months of October to May, generally receiving an average of eight hours of sunshine per day. The temperature during hot weather commences by about end of February and ends by about the middle of June. The monsoon is warm and moderately humid. It commences in the middle of June and ends in the middle of September. In this region, monsoon is often erratic and uncertain, in respect of total rainfall and its distribution. The soil of the Dehradun medium and the plant growth is bound to affect profoundly the rate of growth of plants and ultimately the final yield through its properties. Therefore, an attempt was made to assess the physical and chemical properties of the soil of the experimental field. To evaluate the initial soil fertility status of soil, samples were collected from the experimental field before sowing of crop taken randomly from different parts up to a depth of 0-30 cm, and a composite sample was prepared which was subjected to mechanical and chemical analysis as per the procedure.The sapling of strawberry cultivar Chandler was taken from a private nursery of Chandigarh, Haryana. This cultivar is most suited under Dehradun climatic conditions and gives a better response in view of quality fruit production.

There were nine treatment combinations of different organic manure, inorganic fertilizer and bio-fertilizers. All the nine treatments as T_1- Control (50ton FYM/ha), T_2- NPK (100:120:80) kg/hac, T_3- 50% FYM+NPK (50:120:80) kg/hac, T_4- 50% FYM+NPK (50:120:80) kg/hac+ *Azotobacter* (20kg/ha)+PSB (20kg/ha), T_5- 100% FYM+NPK (25:120:80) kg/hac+*Azotobacter* (20kg/ha)+PSB (20kg/ha), T_6- 6ton/ha *Vermicompost*, T_7- 50% *Vermicompost* +NPK (50:120:80) kg/ha, T_8- 50% *Vermicompost* +NPK (50:120:80) kg/ha+*Azotobacter* (20kg/ha)+PSB (20kg/ha) and T_9- 100% *Vermicompost* +NPK (25:120:80) kg/ha+*Azotobacter* (20kg/ha)+PSB (20kg/ha) were replicated three times with Completely Randomized Block Design (CRBD) suggested by [10].The experiment was conducted to ascertain the impact of different organic manure, inorganic fertilizer and bio-fertilizers on Fruit length, Fruit width, Weight of berry, Volume of berry, Total Soluble Solids (TSS), Acidity, Ascorbic acid, Reducing sugar, Non-reducing sugars, Total sugars, and Anthocyanin.

Result and Discussion

Physical parameters

Data recorded for fruit length of strawberry presented in the table-1, showed significant response during both the year of experimentation 2018-19 and 2019-20. The maximum (4.68cm and 4.95cm)fruit length was recorded under the treatment T_5-100% FYM+NPK (50:120:80) kg/hac+Azotobactor(20kg/ha) +PSB (20kg/ha) followed by the treatment T_4-50% FYM+NPK (50:120:80) kg/hac +Azotobactor (20kg/ha) +PSB (20kg/ha) during both the year of experimentation (2018-19 and 2019-20). The treatment T_1 which keeps only FYM @ 50ton per ha showed lowest (3.32cm and 3.70cm) fruit length.The fruit width of strawberry was significantly affected with soil application of different organic manure and inorganic fertilizers during both the years of experimentation (2018-19 and 2019-20). The width of

Table-1: Effect of Integrated Nutrient Management on fruit length and width of strawberry

Treatments	Fruit length (cm)		Fruit width (cm)	
	2018-19	2019-20	2018-19	2019-20
T_1:Control (50ton FYM/ha)	3.32±0.06[g]	3.70±0.07[h]	3.32±0.08[d]	3.34±0.11[c]
T_2:NPK (100:120:80) kg/hac	3.68±0.07[ef]	3.90±0.08[fg]	3.33±0.12[d]	3.37±0.12[c]
T_3:50% FYM+NPK (50:120:80) kg/hac	3.84±0.05[d]	4.05±0.11[de]	3.38±0.18[cd]	3.43±0.16[bc]
T_4:50% FYM+NPK (50:120:80) kg/hac+Azoto(20kg/ha each)+PSB (20kg/ha each)	4.44±0.06[b]	4.70±0.07[b]	3.66±0.06[ab]	3.75±0.04[a]
T_5:100% FYM+NPK (50:120:80) kg/hac+Azoto(20kg/ha each)+PSB (20kg/ha each)	4.68±0.08[a]	4.95±0.06[a]	3.74±0.12[a]	3.84±0.03[a]
T_6:6 ton/ha VC	3.58±0.07[f]	3.82±0.05[gh]	3.32±0.09[d]	3.37±0.13[c]
T_7:50% VC+NPK (50:120:80) kg/ha	3.76±0.06[de]	3.96±0.07[ef]	3.34±0.03[d]	3.41±0.23[c]
T_8:50% VC+NPK (50:120:80) kg/ha+Azoto(20kg/ha each)+PSB (20kg/ha each)	3.87±0.05[d]	4.12±0.06[d]	3.38±0.03[cd]	3.45±0.08[bc]
T_9:100% VC+NPK (50:120:80) kg/ha+Azoto(20kg/ha each)+PSB (20kg/ha each)	4.18±0.11[c]	4.45±0.07[c]	3.55±0.09[bc]	3.65±0.12[ab]
S. Em±	**0.044**	**0.046**	**0.062**	**0.077**
CD(p=0.05)	**0.133**	**0.139**	**0.188**	**0.231**

Table-2: Effect of Integrated Nutrient Management on weight of berry and volume of berry

Treatments	Weight of berry (g)		Volume of berry (cm^3)	
	2018-19	2019-20	2018-19	2019-20
T_1:Control (50ton FYM/ha)	8.18±0.33[e]	8.20±0.31[e]	7.70±0.21[g]	7.90±0.24[f]
T_2:NPK (100:120:80) kg/hac	8.50±0.40d[e]	8.56±0.34[de]	8.10±0.13[ef]	8.35±0.26[de]
T_3:50% FYM+NPK (50:120:80) kg/hac	8.84±0.51[bcde]	8.85±0.52[cde]	8.40±0.23[cde]	8.62±0.11[cd]
T_4:50% FYM+NPK (50:120:80) kg/hac+Azoto(20kg/ha each)+PSB (20kg/ha each)	9.50±0.42[ab]	9.58±0.39[ab]	8.80±0.13[ab]	9.05±0.16[ab]
T_5:100% FYM+NPK (50:120:80) kg/hac+Azoto(20kg/ha each)+PSB (20kg/ha each)	10.18±0.40[a]	10.20±0.39[a]	8.95±0.11[a]	9.20±0.22[a]
T_6:6 ton/ha VC	8.36±0.28[de]	8.40±0.60[e]	7.80±0.15[fg]	8.05±0.24[ef]
T_7:50% VC+NPK (50:120:80) kg/ha	8.62±0.45[cde]	8.65±0.34[cde]	8.25±0.17[de]	8.50±0.27[d]
T_8:50% VC+NPK (50:120:80) kg/ha+Azoto(20kg/ha each)+PSB (20kg/ha each)	9.11±0.40[bcd]	9.20±0.52[bcd]	8.50±0.28[bcd]	8.72±0.15[bcd]
T_9:100% VC+NPK (50:120:80) kg/ha+Azoto(20kg/ha each)+PSB (20kg/ha each)	9.30±0.45[bc]	9.35±0.39[bc]	8.70±0.13[abc]	8.95±0.19[abc]
S. Em±	**0.250**	**0.241**	**0.109**	**0.127**
CD(p=0.05)	**0.750**	**0.721**	**0.327**	**0.380**

strawberry was noted maximum (3.74cm and 3.84cm) under the treatment T_5-100% FYM+NPK (50:120:80) kg/hac + Azotobactor (20kg/ha) +PSB (20kg/ha) which was closely related with the treatment T_4-50% FYM+ NPK (50:120:80) kg/hac +Azotobactor (20kg/ ha) +PSB (20kg/ha). All the treatments applied for the evaluation of strawberry plants, showed better results while the treatment T_1having FYM @ 50ton per ha noted minimum (3.32cm and 3.34cm)width of strawberry fruit for both the years (2018-19 and 2019-20). Data presented in the table-2, recorded for weight of berry of strawberry. The maximum (10.18g and 10.20g) weight of berry was recorded under the treatment T_5-100% FYM+ NPK (50:120:80) kg/ hac + Azotobactor (20kg/ha) +PSB (20kg/ha) followed by T_4-50% FYM+ NPK (50:120:80) kg/hac +Azotobactor (20kg/ha) +PSB (20kg/ha). In comparison to all other treatments the T_1 FYM @ 50ton was recorded lowest (8.18g and 8.20g) weight of berry during both the year of experimentation (2018-2019 and 2019-20). It is confined from the data presented in the table-2 that all treatments were recorded significantly superior results regarding volume of berry whereas the treatment T_5 which keeps 100% FYM+ NPK (50:120:80) kg/ ha + Azotobactor (20kg/ha) +PSB (20kg/ha) recorded maximum (8.95cm^3 and 9.20cm^3)

Table-3: Effect of Integrated Nutrient Management on fruit yield and TSS of strawberry

Treatments	Fruit Yield (q/ha)		TSS (^{0}Brix)	
	2018-19	2019-20	2018-19	2019-20
T_1: Control (50ton FYM/ha)	106.40±1.13^i	108.36±1.13^h	9.50±0.22^f	9.60±0.11^f
T_2: NPK (100:120:80) kg/hac	112.83±0.91^g	117.25±1.39^f	9.80±0.16^e	9.90±0.11^e
T_3: 50% FYM+NPK (50:120:80) kg/hac	120.02±1.33^e	121.27±1.47^e	10.25±0.17^{cd}	10.37±0.06^{cd}
T_4: 50% FYM+NPK (50:120:80) kg/hac+Azoto(20kg/ha each)+PSB (20kg/ha each)	139.61±1.15^b	143.48±1.20^b	10.70±0.19^{ab}	10.80±0.013^{ab}
T_5: 100% FYM+NPK (50:120:80) kg/hac+Azoto(20kg/ha each)+PSB (20kg/ha each)	152.47±1.19^a	155.87±1.42^a	10.80±0.17^a	10.90±0.11^a
T_6: 6 ton/ha VC	109.67±1.15^h	111.87±1.61^g	9.54±0.09^{ef}	9.63±0.04^f
T_7: 50% VC+NPK (50:120:80) kg/ha	115.57±1.27^f	119.76±1.41^{ef}	10.10±0.18^d	10.17±0.10^d
T_8: 50% VC+NPK (50:120:80) kg/ha+Azoto(20kg/ha each)+PSB (20kg/ha each)	125.79±1.22^d	128.39±1.17^d	10.30±0.09^{cd}	10.38±0.17^c
T_9: 100% VC+NPK (50:120:80) kg/ha+Azoto(20kg/ha each)+PSB (20kg/ha each)	131.99±1.15^c	133.81±1.49^c	10.50±0.14^{bc}	10.60±0.12^b
S. Em±	**0.719**	**0.840**	**0.099**	**0.069**
CD(p=0.05)	**2.155**	**2.519**	**0.296**	**0.206**

Table-4: Effect of Integrated Nutrient Management on acidity and ascorbic acid of strawberry

Treatments	Acidity (%)		Ascorbic acid (mg/100g pulp)	
	2018-19	2019-20	2018-19	2019-20
T_1: Control (50ton FYM/ha)	0.81±0.03^a	0.86±0.01^a	50.66±0.27^f	51.50±0.34^g
T_2: NPK (100:120:80) kg/hac	0.76±0.02^{abc}	0.78±0.03^{bc}	51.20±0.22^{def}	51.70±0.18^f
T_3: 50% FYM+NPK (50:120:80) kg/hac	0.71±0.03^{cde}	0.74±0.03^{cd}	52.00±0.01^{bcd}	52.50±0.21^d
T_4: 50% FYM+NPK (50:120:80) kg/hac+Azoto(20kg/ha each)+PSB (20kg/ha each)	0.64±0.02^{fg}	0.67±0.02^{ef}	52.80±0.15^b	53.30±0.25^b
T_5: 100% FYM+NPK (50:120:80) kg/hac+Azoto(20kg/ha each)+PSB (20kg/ha each)	0.61±0.02^g	0.63±0.02^f	53.80±0.20^a	54.35±0.21^a
T_6: 6 ton/ha VC	0.78±0.03^{ab}	0.81±0.02^b	50.80±0.84^{ef}	51.30±0.23^{fg}
T_7: 50% VC+NPK (50:120:80) kg/ha	0.74±0.03^{bcd}	0.76±0.02^{bc}	51.60±0.19^{cde}	52.10±0.22^e
T_8: 50% VC+NPK (50:120:80) kg/ha+Azoto(20kg/ha each)+PSB (20kg/ha each)	0.69±0.03^{def}	0.71±0.02^{de}	52.40±0.26^{bc}	52.90±0.09^c
T_9: 100% VC+NPK (50:120:80) kg/ha+Azoto(20kg/ha each)+PSB (20kg/ha each)	0.67±0.03^{ef}	0.69±0.03^{de}	52.50±0.24^b	53.00±0.16^{bc}
S. Em±	**0.018**	**0.017**	**0.281**	**0.133**
CD(p=0.05)	**0.056**	**0.050**	**0.843**	**0.397**

berry volume. Treatment T_4 having 50% FYM+ NPK (50:120:80) kg/hac +Azotobacter (20kg/ha) +PSB (20kg/ha) was found closely related with treatment T_5. The minimum (7.70cm^3 and 7.90cm^3) volume of berry was recorded under the treatment T_1- FYM @ 50ton/ha.The soil application of different organic manure and inorganic fertilizers gives the superior response regarding different physiological parameters of strawberries during the experimentation years (2018-19 and 2019-20).

The data presented in the table-3 and Fig-5 revealed that the organic and inorganic nutrients leave the significant effect on yield of fruit with the aid of bio-fertilizers. The maximum yield per hectare was recorded under the treatment T_5-100% FYM+ NPK (50:120:80) kg/ hac + Azotobacter (20kg/ha) +PSB (20kg/ha) followed by T_4-50% FYM+ NPK (50:120:80) kg/hac +Azotobacter (20kg/ha) +PSB (20kg/ha) whereas the treatment T_1 having FYM @ 50ton/ha lonely gives the lowest yield among all other treatments during both the years of experimentation (2018-19 and 2019-20).The reason behind highest yield may be due to the increased berry size fruit,and weight and also may be due to the fact that nitrogen fixers and phosphorus solubilizes not only increased the availability of nitrogen and phosphorus to the plants but also increased their translocation from root to flower through plant foliage [11].

The reason for better physical characteristics of strawberry fruits under the treatment T_5 is may be due to sufficient and increased availability of nutrients at the early stage of fruit development by NPK and then by organic manure (100% FYM) and also application of biofertilizers (Azotobacter and PSB). These are the nutrients basically organic and biofertilizers helping in the improvement of soil's physical condition, especially under light textured soil which led to better metabolic activities in the plant and ultimately led to high protein and carbohydrate synthesis [12].The superiority of treatment $T_5$for gaining better physical characters of fruit is may be due to highest growth and reproductive capacity of plants as influenced by a mixture of organic manure, inorganic fertilizer and bio-fertilizers applied as treatment. Hence the findings are accordance with those of [13] [14]in strawberry. The results regarding physical parameters are in close conformity with study of [15] in strawberry.[16], [17] and [18]and [19] also noted the same result while working on strawberry crops with different organic manure and inorganic fertilizers. [20] have also reported the better performance of strawberry fruits with the use of FYM compared with triple phosphate fertilizer. [21], [22], [23] and [7] also recorded better physical parameters of strawberry fruits working with organic manure and inorganic fertilizers.

Quality parameters

The soil application of different organic manure and inorganic fertilizers showed a significant response to different quality parameters of strawberries during both the year of experimentation (2018-19 and 2019-20). The data noted for Total Soluble Solids (TSS) are presented in Table3 and Fig-3. The maximum (10.80 ^{0}Brix and 10.90 ^{0}Brix) TSS of strawberry fruit was noted under the treatment T_5 which keeps 100% FYM+ NPK (50:120:80) kg/ ha + Azotobactor (20kg/ha) +PSB (20kg/ha) followed by the treatment T_9- 100% VC+NPK (50:120:80) kg/ha+ Azotobactor (20kg/ha)+PSB (20kg/ha) whereas the treatment T_4-50% FYM+ NPK (50:120:80) kg/hac +Azotobactor (20kg/ha) +PSB (20kg/ha) was found at par with the treatment T_5. The rise in TSS in each of the treatments was recorded while the treatment T_1- FYM @ 50ton/ha was noted lowest (9.50^{0}Brix and 9.60 ^{0}Brix) TSS in strawberry fruit.It is revealed from the data presented in the table-5 & 6 and Fig-5 showed the significant response regarding sugars percentage in the strawberry fruit. All the treatments were influenced with the use of different organic manure and inorganic fertilizers whereas the maximum reducing sugar, non-reducing sugars, and total sugars were noted under the treatment T_5-100% FYM+ NPK (50:120:80) kg/ ha + Azotobactor (20kg/ha) +PSB (20kg/ha) followed by the treatment T_4-50% FYM+ NPK (50:120:80) kg/hac +Azotobactor (20kg/ha) +PSB (20kg/ha). The treatment T_1 which keeps only FYM @ 50ton/ha was noted minimum percentage of different types of sugars in the fruit of strawberry during both the years of experimentation 2018-19 and 2019-20.[24] reported that the absorption of nitrogen may have exerted a regulatory role as an important constituent of endogenous factors in affecting the quality of fruits in which carbohydrate reserves of the roots and stem are drawn upon heavily by fruits which might have resulted in higher TSS and total sugar content and also may be due to the application of Azotobacter and PSB which attributed to the quick metabolic transformation of starch and pectin into soluble compounds and rapid translocation of sugars from leaves to the developing fruits. These results are in close conformity by [23], [20]. The results are confirmed with the work of [25] and [26] on strawberry with Integrated Nutrient Management.[27] reported maximum TSS, ascorbic acid, and total sugar with use of organic, inorganic, and bio-fertilizers on a strawberry while [17] noted the same results with the Combined application of mineral, organic and bio-fertilizer.

The acidity percentage in strawberry fruit was decreases as the ripening of fruit is increases. The minimum (0.61% and 0.63%) acidity percentage in fruit was noted under the treatment T_5 which keeps 100% FYM+ NPK (50:120:80) kg/ ha + Azotobactor (20kg/ha) +PSB (20kg/ha) followed by T_4-50% FYM+ NPK (50:120:80) kg/hac +Azotobactor (20kg/ha) +PSB (20kg/ha). The maximum (0.81% and 0.86%) acidity percentage was noted under the treatment T_1- FYM @ 50ton/ha among all other treatments. The decreased level of acidity might be due to the conversion of the organic acids and photosynthates into sugar during fruit ripening by applying bio-fertilizers and further utilization of acids as a substrate for respiration during ripening and neutralization of organic acids due to potassium in tissues [28].

The level of Vitamin C as ascorbic acid was increased with the use of Integrated Nutrient Management on strawberry fruit. The maximum (53.80mg/100g pulp and 54.35mg/100g pulp)level of ascorbic acid was noted under the treatment T_5-100% FYM+

Table-5: Effect of Integrated Nutrient Management on reducing and non-reducing sugars of strawberry

Treatments	Reducing sugar		Non- reducing sugars	
	2018-19	2019-20	2018-19	2019-20
T_1: Control (50ton FYM/ha)	4.80±0.14^{e}	4.82±0.15^{d}	1.75±0.07^{d}	1.72±0.04^{e}
T_2: NPK (100:120:80) kg/hac	4.90±0.19^{cde}	4.93±0.17^{cd}	1.77±0.04^{d}	1.79±0.04^{cde}
T_3: 50% FYM+NPK (50:120:80) kg/hac	5.10±0.18^{bcde}	5.15±0.20^{bcd}	1.83±0.04^{cd}	1.82±0.06^{cd}
T_4: 50% FYM+NPK (50:120:80) kg/hac+Azoto(20kg/ha each)+PSB (20kg/ha each)	5.38±0.25^{ab}	5.41±0.29^{ab}	1.93±0.04^{ab}	1.91±0.05^{ab}
T_5: 100% FYM+NPK (50:120:80) kg/hac+Azoto(20kg/ha each)+PSB (20kg/ha each)	5.53±0.20^{a}	5.55±0.29^{a}	1.96±0.04^{a}	1.92±0.04^{a}
T_6: 6 ton/ha VC	4.84±0.13^{de}	4.87±0.20^{d}	1.75±0.04^{d}	1.75±0.04^{de}
T_7: 50% VC+NPK (50:120:80) kg/ha	5.08±0.22^{bcde}	5.13±0.21^{bcd}	1.80±0.03^{cd}	1.81±0.04^{cd}
T_8: 50% VC+NPK (50:120:80) kg/ha+Azoto(20kg/ha each)+PSB (20kg/ha each)	5.15±0.18^{bcd}	5.21±0.20^{abcd}	1.83±0.05^{cd}	1.83±0.04^{bcd}
T_9: 100% VC+NPK (50:120:80) kg/ha+Azoto(20kg/ha each)+PSB (20kg/ha each)	5.24±0.17^{abc}	5.27±0.17^{abc}	1.86b±0.03^{c}	1.86±0.04^{abc}
S. Em±	**0.116**	**0.132**	**0.029**	**0.027**
CD(p=0.05)	**0.349**	**0.397**	**0.086**	**0.081**

Table-6: Effect of Integrated Nutrient Management on total sugar and anthocyanin of strawberry

Treatments	Total sugar		Anthocyanin (mg/100g)	
	2018-19	2019-20	2018-19	2019-20
T_1: Control (50ton FYM/ha)	6.55±0.06^{e}	6.54±0.05^{f}	16.80±0.65^{e}	17.20±0.17^{g}
T_2: NPK (100:120:80) kg/hac	6.67±0.07^{e}	6.72±0.05^{e}	17.50±0.50^{cde}	17.70±0.17^{ef}
T_3: 50% FYM+NPK (50:120:80) kg/hac	6.93±0.07^{d}	6.97±0.07^{d}	18.00±0.30^{bc}	18.10±0.18^{de}
T_4: 50% FYM+NPK (50:120:80) kg/hac+Azoto(20kg/ha each)+PSB (20kg/ha each)	7.31±0.07^{b}	7.32±0.07^{b}	18.70±0.45^{ab}	18.90±0.32^{b}
T_5: 100% FYM+NPK (50:120:80) kg/hac+Azoto(20kg/ha each)+PSB (20kg/ha each)	7.49±0.12^{a}	7.47±0.07^{a}	19.30±0.36^{a}	19.50±0.19^{a}
T_6: 6 ton/ha VC	6.59±0.07^{e}	6.62±0.05^{ef}	17.20±0.43^{de}	17.50±0.30^{fg}
T_7: 50% VC+NPK (50:120:80) kg/ha	6.88±0.06^{d}	6.94±0.09^{d}	17.70±0.36^{cd}	17.90±0.35^{def}
T_8: 50% VC+NPK (50:120:80) kg/ha+Azoto(20kg/ha each)+PSB (20kg/ha each)	6.98±0.07^{cd}	7.04±0.08^{cd}	18.20±0.36^{bc}	18.20±0.18^{cd}
T_9: 100% VC+NPK (50:120:80) kg/ha+Azoto(20kg/ha each)+PSB (20kg/ha each)	7.10±0.07^{c}	7.13±0.07^{c}	18.50±0.40^{b}	18.60±0.18^{bc}
S. Em±	**0.047**	**0.043**	**0.259**	**0.148**
CD(p=0.05)	**0.140**	**0.130**	**0.777**	**0.445**

NPK (50:120:80) kg/ ha + Azotobactor (20kg/ha) +PSB (20kg/ha) which was closely related with the treatment T_4-50% FYM+ NPK (50:120:80) kg/hac +Azotobactor (20kg/ha) +PSB (20kg/ha). All other treatments were also showed an increment in ascorbic acid content while the treatment T_1- FYM @ 50ton/ha noted minimum (50.66mg/100g pulp and 51.50mg/100g pulp)level of ascorbic acid during both the year of experimentation (2018-19 and 2019-20). The quality of strawberry fruit is known best with the presence of sufficient percentage of sugar and acid. As organic fertilizers are hydrophilic in nature and absorb moisture and nutrients which persist longer thus improving the soil structure and indirectly enhancing fruit quality and ascorbic acid contents in the fruits. Hence these findings are following those of [29], [30] and [23].

The percent increase in anthocyanin level in the strawberry fruit was noted maximum (19.30% and 19.50%) with soil application of T_5-100% FYM+ NPK (50:120:80) kg/ ha + Azotobactor (20kg/ha) +PSB (20kg/ha) followed by T_4-50% FYM+ NPK (50:120:80) kg/hac +Azotobactor (20kg/ha) +PSB (20kg/ha) during both the years of experimentation (2018-19 and 2019-20). Treatment T_1- which keeps only FYM @ 50ton/ha was a noted a minimum (16.80% and 17.20%) level of anthocyanin in the

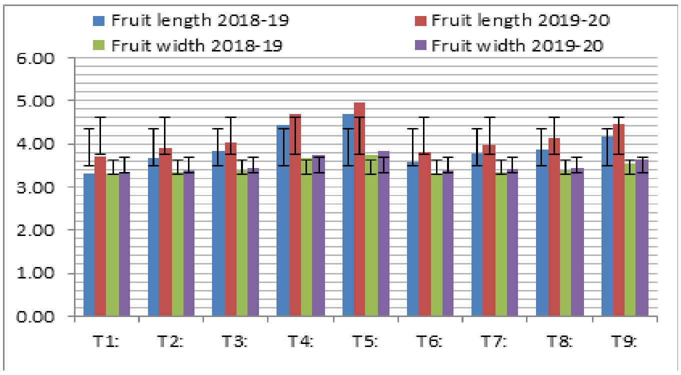

Fig-1: Effect of INM on length and width of strawberry fruit

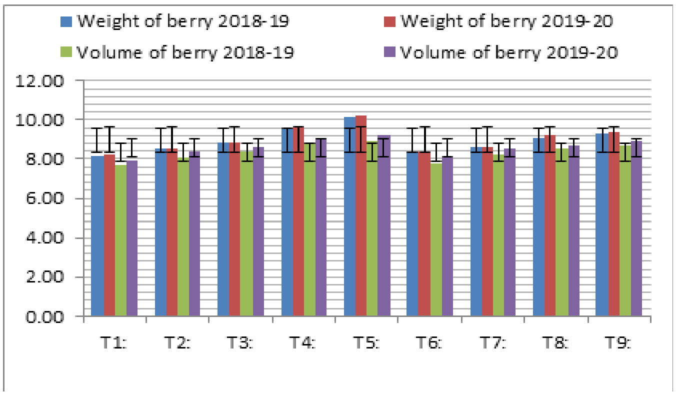

Fig-2: Effect of INM on weight and volume of strawberry fruit

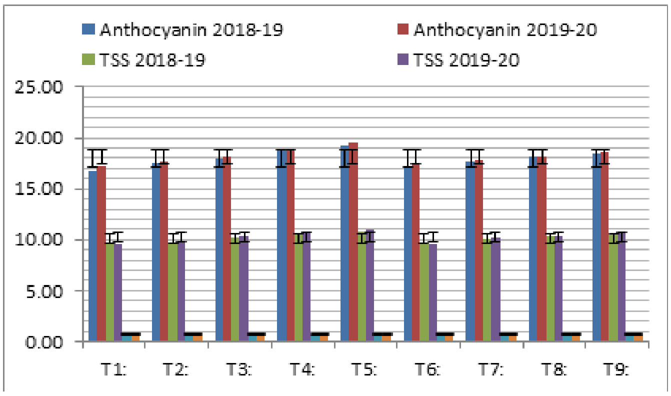

Fig-3: Effect of INM on anthocyanin and TSS of strawberry fruits

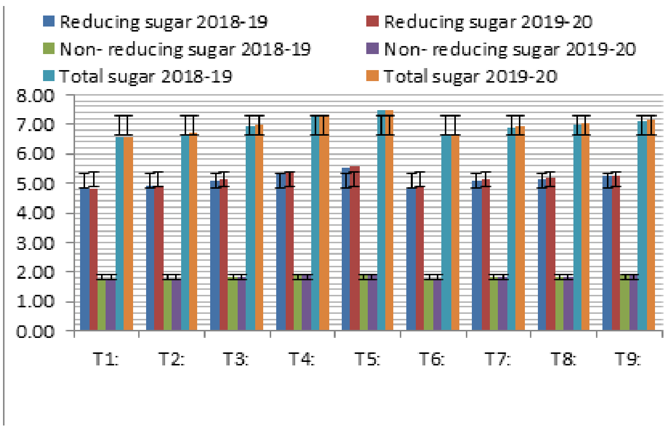

Fig-4: Effect of INM on Sugars in strawberry fruits

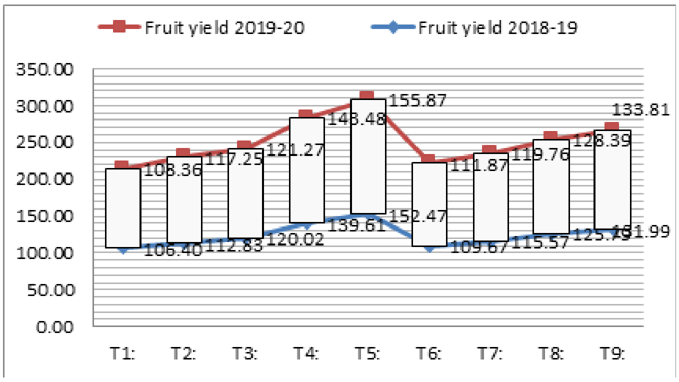

Fig-5: Effect of INM on fruit yield of strawberry

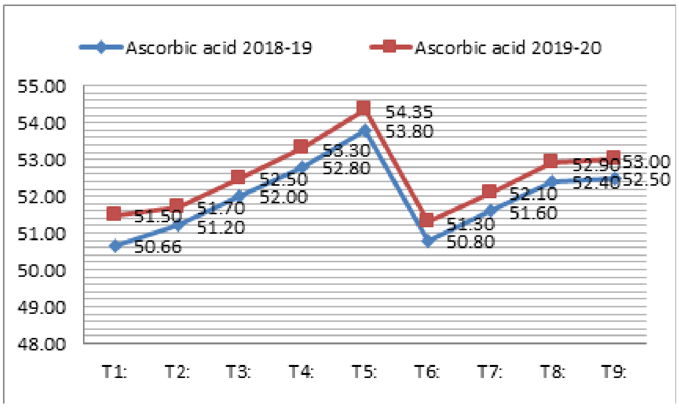

Fig-6: Effect of INM on ascorbic acid in strawberry fruit

fruit.According to [31] anthocyanin are a class of flavonoids and important plant pigments. They attract the insect to pollinate flowers, protect plants from Ultra violet irradiation and act as antimicrobial agents against herbivores and pathogens.Soluble solids and sugars decreased as the harvest season progressed, while Titrable acidity, Ascorbic acid content, and anthocyanin increased[32].[33] reported that the application of INM on strawberry gives significant results regarding different quality characteristics of the fruit. [34] and [35] were also suggested the use of different organic and inorganic nutrients for the quality improvement of strawberry fruits.

Strawberry plants grown with compost yielded fruits with high levels of phenolics, flavonol and anthocyanin content. The free radical absorbance capacities for peroxyl, superoxide, hydrogen peroxide, hydroxyle, and singlet oxygen in strawberries increased significantly with increasing compost use [36]. Also compost significantly increased levels of organic acid (Malic and Citric acid), sugars (Fructose, Glucose, and Total sugars), soluble solids content and Titrable acidity content [29].[37] reported a significant increment in TSS, total sugars and acidity in strawberry fruits which may be due to the synergistic effect by the application of a different combination of organic manure, inorganic fertilizer and bio-fertilizers.[38] found superior result for anthocyanin in strawberry fruit by the use of organic manure with aid of bio fertilizers while [39] noted maximum TSS content in fruit with the combined use of different organic manures.

Future scope: This research work will be helpful for the strawberry grower in Uttarakhand. With the present study's help, the fruit quality can be improved.

Conflict of interest: The authors declare that there is no conflict of interest.

Acknowledgment

The author is very grateful and thankful to Head of Department, Horticulture and other members whosoever helps me to conclude this task.

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