Biological Forum – An International Journal **13(4): 344-348(2021)**

ISSN No. (Print): 0975-1130
ISSN No. (Online): 2249-3239

Influence of Micronutrient on Growth, Fruit Yield and Quality of Strawberry (*Fragaria × ananassa* Duch.) cv. Winter Star under Protected Cultivation

Saurav Kumar[1*] and Devi Singh[2]

[1]M.Sc. Scholar, Department of Horticulture, NAI, SHUATS, Prayagraj, (Uttar Pradesh), India.
[2]Assistant Professor, Department of Horticulture, NAI, SHUATS, Prayagraj, (Uttar Pradesh), India.

(Corresponding author: Saurav Kumar)*
(Received 19 August 2021, Accepted 21 October, 2021)
(Published by Research Trend, Website: www.researchtrend.net)

ABSTRACT: The present investigation entitled was carried out during the year 2020-2021 in the Department of Horticulture, Sam Higginbottom University of Agriculture Technology & Sciences Prayagraj in the months of December 2020 to March 2021. The experimental field was brought to fine tilth by ploughing and harrowing by tractor. The experimental site was divided into small plots of 1.8m × 1.2m dimensions with 30 cm bunds between the plots. Between the rows of 60 cm and between the plants of 30 cm spacing was maintained and plants were planted in the evening. The experiment was laid out in RBD design having thirteen treatment and three replications. The result revealed that treatment T12 RDF (100:80:40) + Copper 250ppm + Manganese 200ppm was found to be best in terms of maximum plant height (24.51cm), plant spread (cm) (32.56cm), number of leaves per plant (18.38cm), petiole length (cm) (14.85cm), number of flower per plant (8.63), Number of fruit per plant (9.07), fruit weight (13.86g), fruit length (3.94cm), fruit diameter (3.12cm), specific gravity (1.61), Fruit yield per plant (574.26g), fruit yield (45.08t ha^{-1}), juice content (94.49%), Vitamin C (62.38mg/100g fruit pulp), acidity (0.57%), Total soluble solids (7.53°Brix). As strawberry is one of the most liked fruit of India it has a great economic value as compared to other fruits. Using micronutrients in the field of strawberry increases the yield and quality considerably, which makes it one of best for strawberry cultivation.

Keywords: Growth, fruit yield, quality, Strawberry, (*Fragaria* × *ananassa* Duch.), Winter star and micronutrient.

INTRODUCTION

The contemporary cultivated strawberry (*Fragaria* × *ananassa* Duch) is a hybrid between two largely dioecious octaploid species, *Fragaria chiloensis* and *Fragaria verginiana*. *Fragaria* species belong to the family Rosaceae, with basic chromosome number of x=7. However the cultivated strawberry, (*Fragaria* × *ananassa*, is an octaploid having chromosome number. of 2n=56. In addition to *Fragaria xananassa* the genus *fragaria* includes atleast 17 other species including diploids, tetraploids, octaploids and a hexaploids.

Strawberry is nutritionally a low calorie carbohydrate fruit but a very rich source of vitamin A (60 IU/100 g of edible portion), vitamin C (30-120mg/100g of edible portion) and fiber and also has high pectin (0.55%), available in the form of calcium pectate. Water is a major component of strawberry fruit nearly (90%). The strawberry fruit take in (5%) of total sugar and 0.90 to 1.85% acids the prominent being citric acid, succinic acid and malic acid, with small amount of glycolic, glyceric, quinic and oxalo acetic acid (Sharma, 2002). Ripe strawberries accomplish alluring red colour on sudden rise in temperature after beginning of fruiting in February. The fruits are scrumptious and attractive, having pleasant aroma and a dainty flavour.

In strawberry ellagic acid is a naturally occurring plant phenol, it has been found to inhibit the cancer disease (Daniel *et al.* 1989); (Wang *et al.*, 1990). Regular consumption of strawberry fruit controls asthma.

The total world area and production of strawberry was 2.6 lakh and 3.61 MT respectively. Europe producing the about 1/3rd of total production strawberries of the world (Sharma, 2002). Strawberries are grown in most of the parts of United State, Canada, European countries including France, Italy, United Kingdom, Bulgaria, Poland, Southern and Eastern Africa, New Zealand, Australia and also in Japan.

In India, strawberry got introduced by National Bureau of Plant Genetic Resources, regional Research station, Shimla (Himachal Pradesh) and Kashmir valley but with the introduction of Floridian cultivar like

Chandler, Douglas fern etc. Its cultivation spread to tropical and sub tropical zone also. It is now being grow in Shimla, Solan, Bilaspur, Kangra, Kullu, Palampur, (Himachal Pradesh), Anantnag, Srinagar, (J&K), Dehradun, Saharanpur, (Uttarakhand), Muzaffarnagar, Meerut, Gaziabad, (U.P.), Hoshiarpur, Gurdaspur, Ludhiana, Jalandhar, Patiala (Punjab), Pune, Mahabalweshwar (Maharashtra) in a small scale (Sharma *et al.,* 1974). The yield and quality of fruits depends on different factors which are closely related with nutrient uptake by the plant. The application of nutrients to the plants should be in a balanced way, ensuring not to give excess or under fertilizer. In addition to NPK, micronutrients play a vital role in influencing the yield attributes and fruit production. Micronutrients are involved in nearly all metabolic and cellular functions of the plant. Micronutrients are vital and equally important as macronutrients to have better growth, yield and quality in plants. In the past years, there was no requirement of micronutrients because these trace elements were naturally supplied by soil. But due to intensive cultivation and excessive use of agricultural land, increase in soil pH and soil salinity in most of soils, these nutrients are present but are not available to plants (Ahmad *et al.,* 2010). As we all know, Copper is essential for photosynthesis and mitochondrial respiration, for carbon and nitrogen metabolism. Iron act as catalyst in synthesis of chlorophyll molecule and helps on the absorption of other elements. It is a key element in various redox reactions of respiration, photosynthesis and reduction of nitrates and sulphates (Wallihan *et al.,* 1958; Zende, 1996).

MATERIALS AND METHODS

The present investigation was carried out during the year 2020-2021 in the Department of Horticulture, Sam Higginbottom University of Agriculture Technology & Sciences Prayagraj in the month of December 2020 to March 2021. The experiment was conducted on strawberry cv. Winter star. All the facilities necessary for cultivation, including labour were made in the department.

Climatic condition of experimental site: The Prayagraj District comes under subtropical belt in the southeast of U.P. which experience extremely hot summer and fairly cold winter. During the winter months (Dec.-Jan) temperature falls 2-5°C or even low, while in summer months (May-June) it reaches as high as 49°C. Hot blowing winds are regular feature during the summers and an occasional spell of frost may be during winters. Most of the rainfall is received in the middle of July to end of September after which the intensity of rainfall decreases. The mean annual rainfall is about 850-1100mm. However, occasional precipitation is also not uncommon during winter months. All the data recorded at SHUATS Prayagraj during the observatory period.

RESULTS AND DISCUSSION

During the present investigation, observations on various plant characteristics were recorded to evaluate the Influence of micronutrient on growth, fruit yield and quality of Strawberry (*Fragaria* × *ananassa* Duch.) cv. Winter star under protected cultivation. The tabulated data were statistically analyzed with a view to find out the significant effect of different factors which are present in the appendix. The data present in the tabular forms shows the relevant standard error of mean deviation S. (±) and the critical difference (C.D.) at 5% level of significance, wherever necessary. The results emanating from the present studies are presented under appropriate heading.

There was significant different between the treatments at all successive stages of growth. There was significant difference between the treatment 30, 50, 70, 90 and 110 DAT among the treatments applied T_{12}RDF (100:80:40) + Copper 250 ppm + Manganese 200ppm produced significantly better plant height (9.45, 13.31, 15.85, 21.03 and 24.51cm) followed by T_{11}RDF (100:80:40)+ Molybdenum 200ppm+ Copper 150ppm and T_{10}RDF (100:80:40) + Molybdenum 100ppm+ Manganese 150ppm and where the minimum plant height (6.25, 9.32, 11.79, 14.37 and 18.76) was recorded in T_0RDF (100:80:40) Control. There was significant difference between the treatments at all successive stages of growth. There was significant difference between the treatment 30, 50, 70, 90 and 110 DAT among the treatments applied T_{12}RDF (100:80:40) + Copper 250ppm+ Manganese 200 ppm produce significantly better plant spread (cm) (9.95, 14.65, 20.28, 27.12 and 32.56 cm) followed by T_{11}RDF (100:80:40) + Molybdenum 200ppm + Copper 150ppm and T_{10}RDF (100:80:40) + Molybdenum 100ppm+ Manganese 150ppm and where the minimum plant spread (cm) (6.62, 10.75, 14.57, 19.45 and 25.01) was recorded in T_0RDF (100:80:40) Control.

There was significant different between the treatments at all successive stages of growth. There was significant difference between the treatment 30, 50, 70, 90 and 110 DAT among the treatments applied T_{12}RDF (100:80:40) + Copper 250ppm + Manganese 200ppm produced significantly better number of leaves per plant (3.80, 5.62, 8.65, 13.76, 18.38cm) followed by T_{11}RDF (100:80:40) + Molybdenum 200ppm + Copper 150ppm and T_{10}RDF (100:80:40) + Molybdenum 100ppm+ Manganese 150ppm and where the minimum number of leaves per plant (cm) (2.15, 3.38, 5.85, 8.84 and 14.83) was recorded in T_0RDF (100:80:40) Control. These increases may be due to application of micronutrients. There was significant different between the treatments at all successive stages of growth. There was significant difference between the treatment 30, 50, 70, 90 and 110 DAT among the treatments applied T_{12}RDF (100:80:40) + Copper 250ppm + Manganese 200ppm produced significantly better petiole length (cm) (6.56,

8.71, 18.86, 12.84 and 14.85cm) followed by T_{11}RDF (100:80:40) + Molybdenum 200ppm + Copper 150ppm and T_{10}RDF (100:80:40)+ Molybdenum 100ppm+ Manganese 150ppm and where the minimum petiole length (cm) (4.09, 6.16, 7.87, 9.49 and 10.60) was recorded in T_0RDF (100:80:40) Control.

There was significant different between the treatments at all successive stages of growth. The treatments 60, 75, 90, 105, 120 and 135 DAT among the treatments applied T_{12}RDF (100:80:40) + Copper 250ppm + Manganese 200ppm produced significantly better number of flower per plant (1.55, 3.83, 4.87, 7.75, 9.84, 8.63) followed by T_{11}RDF (100:80:40) + Molybdenum 200ppm + Copper 150ppm and T_{10}RDF (100:80:40) + Molybdenum 100ppm + Manganese 150ppm and where the minimum number of flower per plant (0.81, 2.11, 3.20, 5.75, 7.75 and 6.75) was recorded in T_0RDF (100:80:40) Control. These increases may be due to application of micronutrients. There was significant different between the treatments at all successive stages of growth. The treatment 60, 75, 90, 105, 120 and 135DAT among the treatments applied T_{12}RDF (100:80:40) + Copper 250ppm + Manganese 200ppm produced significantly better Number of fruit per plant (1.56, 2.86, 3.74, 6.82, 8.49 and 9.07) followed by T_{11}RDF (100:80:40) + Molybdenum 200ppm + Copper 150ppm and T_{10}RDF (100:80:40) + Molybdenum 100ppm + Manganese 150ppm and where the minimum Number of fruit per plant (0.71, 1.05, 3.16, 4.38, 6.15, 6.64) was recorded in T_0RDF (100:80:40) Co maximum fruit length (3.94cm) was recorded with T_{12} RDF (100:80:40) + Copper 250ppm + Manganese 200ppm followed by T_{11} RDF (100:80:40) + Molybdenum 200ppm + Copper 150ppm and T_{10} RDF (100:80:40) + Molybdenum 100ppm + Manganese 150ppm and the minimum fruit length (2.16cm) was found in treatment T_0RDF (100:80:40) Control These increases may be due to application of micthat maximum fruit diameter (3.12cm) was recorded with T_{12} RDF (100:80:40)+ Copper 250ppm + Manganese 200ppm followed by T_{11} RDF (100:80:40) + Molybdenum 200ppm + Copper 150ppm and T_{10} RDF (100:80:40) + Molybdenum 100ppm + Manganese 150ppm and the minimum fruit diameter (2.19cm) was found in treatment T_0RDF (100:80:40) Control These increases may be due to application of micronutrient.

Maximum specific gravity (1.61) was recorded with T_{12} RDF (100:80:40) + Copper 250ppm + Manganese 200 ppm followed by T_{11} RDF (100:80:40) + Molybdenum 200ppm+ Copper 150ppm and T_{10} RDF (100:80:40)+ Molybdenum 100ppm + Manganese 150ppm and the minimum specific gravity (1.07) was found in treatment T_0RDF (100:80:40) control.

However, better qualities of fruits obtained from the cultivar during winter season may be attributed due to application of different micronutrients. Fruit yield per plant (574.26g) was recorded with T_{12} RDF (100:80:40) + Copper 250ppm + Manganese 200ppm followed by T_{11} RDF (100:80:40) + Molybdenum 200ppm + Copper 150ppm and T_{10} RDF (100:80:40) + Molybdenum 100ppm + Manganese 150ppm and the minimum fruit yield per plant (283.68g) was found in treatment T_0RDF (100:80:40) control maximum fruit yield (45.08t ha^{-1}) was recorded with T_{12} RDF (100:80:40) + Copper 250ppm + Manganese 200ppm followed by T_{11} RDF (100:80:40) + Molybdenum 200ppm + Copper 150ppm and T_{10} RDF (100:80:40) + Molybdenum 100ppm+ Manganese 150ppm and the minimum fruit yield (25.08t ha^{-1}) was found in treatment T_0RDF (100:80:40) Control. These increases may be due to application of micronutrients.

The maximum juice content (94.49%) was recorded with T_{12} RDF (100:80:40) + Copper 250ppm + Manganese 200ppm followed by T_{11} RDF (100:80:40) + Molybdenum 200ppm + Copper 150ppm and T_{10} RDF (100:80:40) + Molybdenum 100ppm+ Manganese 150ppm and the minimum juice content (81.87%) was found in treatment T_0RDF (100:80:40) Control. The results were in agreement with Ekka *et al.*, (2018); Saha *et al.*, (2019).

Table 1: Variable cost and total cost of cultivation for different treatments of strawberry (*Fragaria* × *annanasa* Duch.) cv. winter star.

Treatment		NPK				Micronutrient (Three time spray)			Molybdenum(Three time spray)			Total Amount
		Qty.	Rate	Amount		Qty.	Rate	Amount	Qty.	Rate	Amount	
		kg	Rs kg^{-1}	Rs.		g	Rs g^{-1}	Rs.	g	Rs g^{-1}	Rs.	
T_0	Control	Urea=217 ha^{-1} SSP=500 ha^{-1} MOP=66kg ha^{-1}	Rs. 10 kg^{-1} Rs. 15 kg^{-1} Rs. 8 kg^{-1}	2170 7500 528								10198
T_1	Molybdenum 150ppm	Urea=217 ha^{-1} SSP=500 ha^{-1} MOP=66kg ha^{-1}	Rs. 10 kg^{-1} Rs. 15 kg^{-1} Rs. 8 kg^{-1}	2170 7500 528					247.5	10	2475	12673
T_2	Manganese 200ppm	Urea=217 ha^{-1} SSP=500 ha^{-1} MOP=66kg ha^{-1}	Rs. 10 kg^{-1} Rs. 15 kg^{-1} Rs. 8 kg^{-1}	2170 7500 528		330	12	3960.00				13158
T_3	Copper 250ppm	Urea=217 ha^{-1} SSP=500 ha^{-1} MOP=66kg ha^{-1}	Rs. 10 kg^{-1} Rs. 15 kg^{-1} Rs. 8 kg^{-1}	2170 7500 528		412.5	9	3712.50				13910
T_4	Molybdenum 200ppm	Urea=217 ha^{-1} SSP=500 ha^{-1} MOP=66kg ha^{-1}	Rs. 10 kg^{-1} Rs. 15 kg^{-1} Rs. 8 kg^{-1}	2170 7500 528					330	10	3300	13498
T_5	Manganese 250ppm	Urea=217 ha^{-1} SSP=500 ha^{-1} MOP=66kg ha^{-1}	Rs. 10 kg^{-1} Rs. 15kg^{-1} Rs. 8 kg^{-1}	2170 7500 528		412.5	12	4950.00				15148
T_6	Copper 300ppm	Urea=217 ha^{-1} SSP=500 ha^{-1} MOP=66kg ha^{-1}	Rs. 10 kg^{-1} Rs. 15 kg^{-1} Rs. 8 kg^{-1}	2170 7500 528		495	9	4455.00				14653
T_7	Molybdenum 250ppm	Urea=217 ha^{-1} SSP=500 ha^{-1} MOP=66kg ha^{-1}	Rs. 10 kg^{-1} Rs. 15 kg^{-1} Rs. 8 kg^{-1}	2170 7500 528					412.5	10	4125	14323
T_8	Manganese 300ppm	Urea=217 ha^{-1} SSP=500 ha^{-1} MOP=66kg ha^{-1}	Rs. 10 kg^{-1} Rs. 15 kg^{-1} Rs. 8 kg^{-1}	2170 7500 528		495	12	5940.00				16138
T_9	Copper 350ppm	Urea=217 ha^{-1} SSP=500 ha^{-1} MOP=66kg ha^{-1}	Rs. 10 kg^{-1} Rs. 15 kg^{-1} Rs. 8 kg^{-1}	2170 7500 528		577.5	9	5197.50				15395
T_{10}	Molybdenum 100ppm+ Manganese 150ppm	Urea=217 ha^{-1} SSP=500 ha^{-1} MOP=66kg ha^{-1}	Rs. 10 kg^{-1} Rs. 15 kg^{-1} Rs. 8 kg^{-1}	2170 7500 528		247.5	12	2970.00	165	10	1650	14818
T_{11}	Molybdenum 200ppm+ Copper 150ppm	Urea=217 ha^{-1} SSP=500 ha^{-1} MOP=66kg ha^{-1}	Rs. 10 kg^{-1} Rs. 15 kg^{-1} Rs. 8 kg^{-1}	2170 7500 528		247.5	9	2227.50				12425
T_{12}	**Copper 250ppm+ Manganese 200ppm**	Urea=217 ha^{-1} SSP=500 ha^{-1} MOP=66kg ha^{-1}	Rs. 10 kg^{-1} Rs. 15 kg^{-1} Rs. 8 kg^{-1}	2170 7500 528		412.5 330	9 12	4950.00 3960.00				20108

Table 2: Economics of different treatments and benefit cost ratio of Strawberry (*Fragaria* × *annanasa* Duch.) cv. Winter star.

Treatment No.	Treatment	Cost of cultivation	Fruit Yield	Selling Rate	Gross return	Net return	Benefit cost ratio
		Rs. ha^{-1}	t ha^{-1}	Rs. t^{-1}	Rs. ha^{-1}	Rs. ha^{-1}	
T_0	Control	368754.00	25.08	35000.00	877800.00	509046.00	2.38
T_1	Molybdenum 150 ppm	371229.00	39.70	35000.00	1389500.00	1018271.00	3.74
T_2	Manganese 200 ppm	371714.00	36.83	35000.00	1289050.00	917336.00	3.47
T_3	Copper 250 ppm	372466.00	32.53	35000.00	1138550.00	766084.00	3.06
T_4	Molybdenum 200ppm	372054.00	41.00	35000.00	1435000.00	1062946.00	3.86
T_5	Manganese 250ppm	373704.00	36.38	35000.00	1273300.00	899596.00	3.41
T_6	Copper 300ppm	373209.00	34.62	35000.00	1211700.00	838491.00	3.25
T_7	Molybdenum 250 ppm	372879.00	40.61	35000.00	1421350.00	1048471.00	3.81
T_8	Manganese 300p pm	374694.00	38.34	35000.00	1341900.00	967206.00	3.58
T_9	Copper 350 ppm	373951.00	35.33	35000.00	1236550.00	862599.00	3.31
T_{10}	Molybdenum 100 ppm + Manganese 150 ppm	373374.00	29.69	35000.00	1039150.00	665776.00	2.78
T_{11}	Molybdenum 200 ppm + Copper 150 ppm	370981.00	43.29	35000.00	1515150.00	1144169.00	4.08
T_{12}	**Copper 250 ppm + Manganese 200ppm**	378664.00	45.08	35000.00	1577800.00	1199136.00	4.17

CONCLUSION

From the present investigation, it is concluded that treatment combination T_{12} RDF (100:80:40) + Copper 250ppm + Manganese 200 ppm is found to be the best treatment in growth, yield and fruit quality of strawberry and the maximum benefit cost ratio was (1:4.17).

FUTURE SCOPE

Using micronutrients enhanced the yield and quality of strawberry which was also examined by the research in the field condition. Micronutrients can play a vital role in increasing the yield of strawberry in the coming future, hence there is need to aware the farmers about the uses of micronutrients in adequate quantity. This fruit has a great potential of increasing the farmers income.

Conflict of Interest. None.

REFERENCES

Ahmad, I., Khan, M. A., Qasim, M., Ahmad, R., & Randhawa, M. A. (2010). Growth, yield and quality of Rosa hybrida L. as influenced by various micronutrients. *Pak. J. Agric. Sci., 47*(1): 5-12.

Daniel, B. S.; Kumar, R., & Singh, D. (1989). Effect of zinc sulphate, cytozyme and 2, 4-D on fruit retention and quality of Kinnow a mandarin hybrid. *Haryana J. Hort. Sci., 15*(1-2): 14-17.

Ekka, R. A., Kerketta, A., Lakra, S., & Saravanan, S. (2018). Effect of Zn, B, Cu and Fe on vegetative growth, yield and quality of strawberry (*Fragaria* × *ananassa* Duch.) cv. *Chandler. Int. J. Curr. Microbiol. App. Sci., 7*, 2886-2890.

Saha T., Ghosh B., Debnath S., & Bhattacharjee A. (2019). Effect of micronutrients on growth, yield and quality of strawberry (*Fragaria* × *ananassa* Duch.) cv. Winter Dawn in the Gangetic Alluvial Region of West Bengal. *Journal of Crop and Weed, 15*(1): 92-95.

Sharma, R. R. (2002). Growing strawberries 1st Ed. *International Book Distributing Co.India*.

Sharma, B. B., Singh, R., & Sharma, H. C. (1974). Response of Sweet Orange (*Citrus Sinensis* Osbeck.) Plants To Zinc, Urea and Dbcp. *Indian Journal of Horticulture, 31*(1): 38-44.

Wallihan, E.F., Embleton, T. W., & Wilma, P. (1958). Zinc deficiency in avocado. Califgric, *12*(6): 4-5.

Wang, S.V., Mass, T. L., Daniall, E. M., & Galleta, G. J. (1990). Improved HPCL resolutnd Qualification of ellagic acid from strawberry, blackberry and cranberry (*Abst*), *Hort. Science, 25*: 1078.

Zende, G. K. (1996). Integrated nutrient supply in relation to micronutrients for sustainable agriculture. *Micronutrient News, 10*(11): 1-9.

How to cite this article: Kumar, S. and Singh, D. (2021). Influence of Micronutrient on Growth, Fruit Yield and Quality of Strawberry (*Fragaria* × *ananassa* Duch.) cv. Winter Star under Protected Cultivation. *Biological Forum – An International Journal, 13*(4): 344-348.