The Pharma Innovation Journal 2022; 11(4): 1590-1594

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; 11(4): 1590-1594

www.thepharmajournal.com
Received: 02-02-2022
Accepted: 09-03-2022

M Kamala Priya
M.Sc. Scholar, Department of Horticulture and Fruit Science), NAI, SHUATS, Prayagraj, Uttar Pradesh, India

Dr. Devi Singh
Associate Professor, Department of Horticulture, NAI, SHUATS, Prayagraj, Uttar Pradesh, India

Dr. Vijay Bahadur
Associate Professor, Department of Horticulture, NAI, SHUATS, Prayagraj, Uttar Pradesh, India

S Alekhya Naidu
M.Sc. Scholar, Department of Horticulture and Fruit Science, NAI, SHUATS, Prayagraj, Uttar Pradesh, India

M Bhargavi
M.Sc. Scholar, Department of Horticulture and Fruit science, NAI, SHUATS, Prayagraj, Uttar Pradesh, India

Corresponding Author:
M Kamala Priya
M.Sc. Scholar, Department of Horticulture and Fruit Science), NAI, SHUATS, Prayagraj, Uttar Pradesh, India

Influence of micro-nutrients on growth, Yeild and quality of strawberry (*Fragaria annanasa*) CV sweet Charlie under protected cultivation

M Kamala Priya, Dr. Devi Singh, Dr. Vijay Bahadur, S Alekhya Naidu and M Bhargavi

Abstract
Strawberry is a widely grown hybrid species of the genus Fragaria (*Rubiaceae family*). It is cultivated worldwide for its fruit, which is an aggregate accessory fruit widely appreciated for its characteristic aroma, bright red color, juicy texture, and flavor. Strawberry is one of the most sensitive plants in horticultural production and nutrient management is a key factor to ensure high yields and fruit quality. Furthermore, an adequate management of nutrient elements is crucial to guarantee health food safety and food quality. The aim of the present study was to evaluate the efficiency of selected micronutrients and its influence on growth, yield and quality parameters of strawberry under protected cultivation. It was started in Nov. 2019 in poly house of department of horticulture SHUATS, Naini, Prayagraj with *cv* sweet Charlie. The experiment was conducted in completely randomized block (CRD) under protected cultivation with three replications with treatments (T_0 +T_{12}).To analyse Growth parameters such as plant height, plant spread (E-W and N-S), Number of leaves per plant, Days to first flowering, Number of leaves per plant, DAS to first flowering, Number of flower per plant, DAS to first fruiting, DAS to fruit maturity, Number of runners/plant. Yield parameters such as Number of fruits per plant, fruit length (cm), fruit diameter (cm), fruit weight (g), fruit Volume (cc), Yield per plant (kg), yield(q/h). Quality attributes such as Total soluble solids(%), ascorbic acid, acidity(%), sugars(%), Total sugars (%), Reducing sugars (%), Non-reducing sugars (%), Benefit: cost ratio, statistical analysis.

Keywords: Strawberry, Micro nutrients, under protected cultivation, growth parameters, Yield parameters, Quality attributes

Introduction
Strawberry (*Fragaria x ananassa* Duch.) is one of the most important temperate fruit belongs to the family Rosaceae. It is an octoploid (8x) in nature having (x=7) basic chromosome number. Botanically it is an aggregate fruit which is highly perishable in nature. Basically, it is herbaceous, perennial and short-day plant. Among all the berries, strawberry gives the quickest return in a shortest possible time (Boriss *et al.,* 2006). Strawberry has gained the status of being one of the most important soft fruits in the world. Nutritionally, strawberry is a low calorific carbohydrate fruit. It is a rich source of Vit. A (60 IU/100 g of edible portion), Vit. C (30-120mg/100 g of edible portion), fiber and also has high pectin content (0.55%) available in the form of calcium pectate. Water is a major constituent of strawberry fruit. It contains 90% water. Ellagic acid is a naturally occurring plant phenol in its fruit.

Strawberry fruits have great demand in fresh market, in processing industries as well as in preserve and confectionaries industries. It's phenomenal increases in production during the recent years show the popularity of strawberry fruit cultivation. In India, the total area of strawberry is 1000 Ha with production of 5000 MT (Anonymous, 2015-16). Here, Maharashtra is the leading State in production of strawberry fruits. It is also commercially grown in Haryana, Punjab, Uttar Pradesh, Jammu and Kashmir, Uttarakhand and lower hills of Himachal Pradesh. The nutrition status in the strawberry plant plays a vital role in determining the growth, yield and quality of fruits since it is a very sensitive plant to nutritional balance (Mohamed *et al.,* 2011) [19]. An optimal fertilization is contributive in obtaining high yield of good quality and high biological value. Both macro and micro-nutrients are well known to ameliorate plant growth, yield and quality of fruit plants. Among various micro-nutrients, iron (Fe) and zinc (Zn) plays an important role in promoting vegetative growth, flowering, yield and quality of strawberry fruits (Chaturvedi *et al.,* 2005) [10].

Iron has many important functions in plant growth and development, such as involvement in the biosynthesis of chlorophyll, respiration, chloroplast development and improves the performance of photosystems. It is an essential part of many enzymes. Iron also participates in the oxidation process that releases energy from sugars and starches and in responses that convert nitrate to ammonium in plant. It plays an essential role in nucleic acid metabolism (Romheld and Marschner, 1991; Miller *et al.,* 1995; Eskandari, 2011; Havlin *et al.,* 2014). Zinc also plays an important role in photosynthesis and related enzymes resulting in increasing sugar and decreasing acidity. Mahnaz *et al.,* 2010 [29] claimed that ZnSO4 as a source of zinc had a positive effect in increasing leaf area, length and diameter of petiole, fresh and dry shoot ratio, yield, TSS, acidity and Vitamin-C of strawberry plant.

Many researchers have shown that plants absorb nutrients not only through roots (by soil application) but also through the foliage (by foliar spray). In fact, it has efficient organ of absorption of nutrients through foliage. The foliar spray of micro-nutrients has been very popular means of correcting micro-nutrients deficiencies in many fruit crops. Foliar feeding of micro-nutrients also plays an important role in influencing the plant growth characters, yield and yield attributing parameters and quality characters in strawberry. Application of micro-nutrients through foliar feeding is an effectual way of controlling the timing and emplacement of nutrients. This also ameliorates the micronutrient use efficiency by reducing nutrients losses from leaching, volatilization and from fixation in the soil to less available forms. For getting higher yield as well as quality produce, it is very important to bring changes in the method of nutrient management in strawberry. Some literatures are available on foliar feeding of micro-nutrients in strawberry; however, attempts are made to collect related on the aforesaid aspects. A correct balance between macronutrients and micronutrients is essential to achieve the best possible yield and quality from strawberries. A deficiency of any single nutrient is enough to limit crop yield or quality and the availability of each nutrient needs to be related to the crop requirements.

Materials and Methods

The details of the various materials used and methods adopted in laid out the experiment are given below:

Experimental site

The experiment was conducted at poly house, Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture and Technology &sciences, Prayagraj. The area is situated on the south of Prayagraj on the right bank of Yamuna at RewaRoad at a distance of about 6 km from Prayagrajcity. Itissituatedat 250.8' Nlatitudeand 810.50'Elongitudes on elevation of 98 meters from the sealevel. (UP) during 2020. All the facilities necessary for cultivation, including labour were made available in the department. The experiment was carried about 120 DAS, with Three replications under 12 treatments with control.

Experimental Details

Crop: Strawberry
Scientific name: *Fragaria ananassa* (*Fragaria vesca*)
Chromosome no: x=7, 2n=8x=56
Family: Rosaceae
Origin: France
Name of the cultivar: Sweet Charlie
Experimental design: Randomized Block design
No of replications: 3
No of treatments: 12 +0
No of plants/treatment: 12
No of plots: 39
Spacing: 30x30

Table 1: Treatment details

Sl. No	Treatments Combination	Treatment Notations
1.	RDF+CONTROL(WATER SPRAY)	T_0
2.	RDF+$ZNSO_4$ (0.15)%	T_1
3.	RDF+$FESO_4$(0.15)%	T_2
4.	RDF+BORON(0.1%)	T_3
5.	RDF+$ZNSO_4$(0.2%)	T_4
6.	RDF+$FESO_4$(0.2%)	T_5
7.	RDF+BORON(0.12%)	T_6
8.	RDF+$ZNSO_4$(0.4%)	T_7
9.	RDF+$FESO_4$(0.4%)	T_8
10	RDF+BORON(0.15%)	T_9
11.	RDF+znso4+feso4+boron(0.15+0.15+0.1%)	T_{10}
12.	RDF+znso4+feso4+boron(0.2+0.2+0.12%)	T_{11}
13.	RDF+znso4+feso4+boron(0.4+0.4+0.4%)	T_{12}

Results and Discussion

Growth parameters: The growth parameters, flowering and fruiting characteristics were recorded for the following variables namely plant height(cm), plant spread(E-W) and (N-S), number of leaves/plant, number of runners/plant, days to first flowering, number of flowers/plant, days to first fruiting, days to maturity.

Effect of foliar application of micro-nutrients showed significant differences in respect to plant height observed at 30, 60, 90 and 120 days after planting. At 30,60,90,130 DAP. The maximum plant height (9.26 cm), (18.68cm), (24.16cm), (30.88cm) was recorded under the treatment (T_{10}) and the minimum plant height (7.83), (10.43cm), (16.35cm), (22.31cm) was observed under (T_0). It is evident from the result obtained that the foliar application of micro nutrients had significantly influenced the plant height as compared to control. The increase in plant height of strawberry is might be due to the fact Zn +B +Fe promotes vegetative growth by active cell division and elongation and therefore the height must have increased. Another probable reason for the increase in plant height might be due to the osmotic uptake of water and nutrients under the influence of Zn + B + Fe. These results were in close agreement with the findings of Chaturvedi *et al.,* (2005) [10], Bakshi *et al.,* (2013a) [9] Bakshi *et al.,* (2013b) [9] and Singh *et al.,* (2015) [27] in strawberry.

The data recorded on plant spread at 30, 60, 90 and 120 DAP influenced significantly with the foliar application of micro-nutrients under the present investigation. As per data observed on E-W direction at 30,60,90,120 DAP, The treatment T_{10}obtained maximum plant spread (10.65 cm),(25.73 cm), (29.38 cm) followed by T_{11} with plant spread of 28.77 cm, (34.52 cm), followed by T_{11} with plant spread (32.09 cm).However the minimum plant spread was recorded under the treatment RDF+Control (T_0). at 30,60,90,120 DAP i.e., (8.72 cm), (12.95 cm), (16.69 cm) (20.74 cm).

At 30,60,90,120 DAP, no significant difference were observed among the treatments in respect to plant spread on N-S direction, The treatment T_{10} obtained maximum plant

spread (12.67 cm),(25.33 cm) followed by T_{11} with plant spread of 23.73 cm,(30.01 cm) followed by T $_{11}$with plant spread 28.38cm,(35.17 cm) followed by T_{11} with plant spread of 33.14cm.However the minimum plant spread was noticed under the treatment T_0 having average plant spread of (10.38 cm), (13.82 cm), (17.85 cm), (22.90 cm). It is evident from the result obtained in present investigation, the foliar application of micro-nutrients had significantly influenced the plant spread as compared to control. The increase in plant spread (E-W & N-S) of strawberry at 120 days after planting was recorded maximum (35.16& 33.14 cm) under the treatment T_{10} and T_{11}. while minimum plant spread (22.91cm) was noticed under RDF+Control (T_0). The increase in plant spread of strawberry might be due to Zn + B + Fe might have stimulated cell division and cell elongation resulting in increased plant spread would have increased in the treated plants. These results were in close agreement with the findings of Bakshi *et al.,* (2013 a) [9], Bakshi *et al.,* (2013 b) [9] and Singh *et al.,* (2015) [27] in strawberry.

The data obtained on number of leaves per plant after spraying of different plant growth regulators was recorded at 30, 60, 90 and 120 DAPno significant differences were observed among the treatments in respect to number of leaves per plant. Maximum number of leaves per plant (7.65) was observed under the treatment T_{10},(21.78),(33.46), followed by T_{11} having number of leaves per plant of 32.47,(44.01).The minimum number of leaves per plant (6.29) was recorded under the treatment T_0,(13.67),(25.05),(37.76).Among the different treatments of micro-nutrients the maximum number of leaves per plant was observed under the plants treated with T_{10} (RDF+ ZnSO4 +Boron + FeSO, @ 0.15+0.15+0.1%), while the minimum number of leaves per plant was recorded under T_0 (RDF+Control).The increase in number of leaves per plant as results of ZnSO4 + Boron + $FeSO_4$ application might be due to fact that activity of micronutrients at shoot meristem resulting is more system of nucleoprotein responsible for increasing leaf initiation and expansion. Similar observations on number of leaves per plant due to micronutrients were also reported by Chaturvedi *et al.,* (2005) [10], Bakshi *et al.,* (2013. a) Bakshi *et al.,* (2013, b) [9] and Singh *et al.,* (2015) [27] in strawberry.

The maximum number of runners per plant (8.15) was noticed under the treatment T_{10}, which was found non-significant differences with the treatments T_{11} having average number of runners per plant 7.08. The minimum number of runners per plant (4.13) was recorded under the treatment RDF+ Control (T_0).The increase in number of runners per plant as results of $ZnSO_4$ + Boron + FeSO, application might be due to fact that activity of micronutrients at shoot meristem resulting is more system of nucleoprotein responsible for increasing in runners formation. Similar results were also obtained by Chaturvedi *et al.,* (2005) [10] and Kazemi (2014) in strawberry.

Days to first flowering was significantly influenced by different treatments of micro-nutrients. Amongst the different treatments minimum days to first flowering (39.54) was noticed under the treatment T_{11}, which was recorded non-significant difference with T_{10} having days to first flowering 41.92. Maximum days to first flowering (53.38) were observed under the treatment T_0 (control), which was found statistically at par with T_{12} (52.91).Early inflorescence emergence was significantly altered by the different treatments of micro-nutrients. This might be due to reduced flowering duration, which could be attributed to enhancing effect of 1 micronutrients in enzymatic reduction, cell division as well as in growth The present findings are in close agreement with the finding of Yadlod and Kadam (2003) in banana and Singh *et al.,* (2015) [27] Mehraj *et al.,* (2015) in strawberry.

It is evident from the data that effect of micro-nutrients showed significant differences under the present investigation. The minimum days to first fruiting (47.61) was noted under the treatment T_{11} (RDF + $ZnSO_4$ + $FeSO_4$+Boron @ 0.2+0.2+0.12%), which was at par with T_{10} (RDF + $ZnSO_4$ + $FeSO_4$+Boron, @ 0.15+0.15+0.1) having days to first fruiting 48.98. The maximum days to first fruiting (61.38) was registered under the treatment T_0 (RDF + Control), which was at par with (60.32 days) T_{12}. It may be due to micro-nutrient spray especially FC. B promotes the nation of flower stimuli as hormone from the leaf to the axils of the leaves thus produces early flowering and fruiting as compare to other treatments. These findings are close agreement with the findings of Yadlod and Kadam (2003) in banana and Mehraj *et al.,* (2015) in strawberry.

Days to fruit maturity

The data pertaining to days to fruit maturity from flowering influenced significantly by different treatments. The minimum days to flowering to maturity (57.58) was observed under the treatments T_{11} (RDF + $ZnSO_4$, + $FeSO_4$,+Boron @ 0.2+0.2+0.12%). The maximum days to fruit to maturity (71.32) was recorded under the treatment T_0 (RDF+Control). The minimum days to fruit maturity was observed under the treatment T_{11} (57.59), which was followed by T_{10} (RDF+ ZnSO4+ FeSO4+Boron@ 0.15+0.15+0.1%) having days to fruit maturity 60.07. Shortened the number of days to fruit maturity might be due to the better source sink relationship and translocation of carbohydrates efficiency to the developing fruit. The present results are in conformity with the findings of those reported by Yadlod and Kadam (2003). Yadav *et al.,* (2010) in banana and Mehraj *et al.,* (2015) in strawberry.

Table 2: Mean performance of Influence of Micro-nutrients on growth, yield and quality of strawberry (*Fragaria ananassa*) cv sweet Charlie under protected cultivataion

T. No.	Treatment	Plant height (cn)				Plant spread (cm				No. of leaves				No. of runners / plant	Days to 1st flowering	No. of flowers/ plants	Day of fruiting maturity	Days to 1st fruiting
		(30D AP)	(60D AP)	(90D AP)	(12D AP)	(30D AP)	(60D AP)	(90D AP)	(12D AP)	(30D AP)	(60D AP)	(90D AP)	(12D AP)					
T_0	RDF+Control(WATER SPRAY)	7.83	10.43	16.35	22.31	10.38	13.82	17.84	29.91	6.29	13.68	25.05	37.76	4.13	53.38	34.28	f	61.38
T_1	RDF+$ZnSO_4$(0.15)%	8.45	12.42	18.47	24.67	11.16	15.92	20.86	24.92	6.53	15.77	28.24	40.04	4.54	52.57	36.99	66.98	59.64
T_2	RDF+$FeSO_4$(0.15)%	8.74	15.86	20.01	27.68	12.14	20.86	24.89	29.95	7.06	17.12	29.72	40.67	5.72	45.12	39.92	62.03	52.04

T_3	RDF+Boron(0.1%)	8.73	14.82	19.54	27.54	11.78	19.75	23.81	28.89	7.02	17.05	29.51	40.71	5.33	46.28	39.25	63.07	53.25
T_4	RDF+$ZnSo_4$(0.2%)	8.87	16.44	20.12	28.33	12.30	22.21	24.91	30.97	7.13	17.67	29.89	40.98	5.72	44.82	40.17	61.25	51.89
T_5	RDF+$FeSo_4$(0.2%)	8.67	14.47	18.71	26.41	11.43	19.12	22.84	27.88	6.94	16.54	29.06	40.56	5.05	47.02	38.88	66.12	54.00
T_6	RDF+Boron(0.12%)	8.97	17.06	20.94	29.18	12.35	23.54	26.56	32.33	7.31	18.66	31.01	41.84	6.08	44.73	41.58	60.82	51.81
T_7	RDF+$ZnSo_4$(0.4%)	8.70	14.79	19.08	27.05	11.77	19.79	23.47	28.65	6.98	16.84	29.15	40.57	5.21	46.28	39.23	65.27	53.28
T_8	RDF+$FeSo_4$(0.4%)	8.54	13.47	18.57	25.82	11.41	17.55	22.81	26.98	6.57	16.53	28.59	40.18	4.62	52.21	37.23	66.56	59.12
T_9	RDF+Boron(0.15%)	8.37	12.11	18.39	24.38	10.81	15.65	20.84	24.87	6.49	15.39	27.38	39.93	4.51	52.69	36.88	69.15	59.87
T_{10}	RDF+$ZnSo_4$+$FeSo_4$+Boron(0.15+0.15+0.1%)	9.28	18.68	27.16	30.89	12.67	25.33	30.02	35.17	7.65	21.78	33.46	44.01	8.15	41.42	42.74	60.07	48.98
T_{11}	RDF+$ZnSo_4$+$FeSo_4$+Boron(0.2+0.2+0.12%)	9.09	17.29	21.73	29.88	12.48	23.73	28.38	33.14	7.36	19.74	32.49	42.68	7.06	39.54	44.24	57.58	47.61
T_{12}	RDF+$ZnSo_4$+$FeSo_4$+Boron(0.4+0.4+0.4%)	8.26	11.54	17.25	23.68	10.43	14.22	18.41	23.01	6.34	15.08	26.68	39.02	4.18	52.91	36.38	70.07	60.32
	F Test	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
	SE (m)±	0.38	0.49	0.54	0.59	0.38	0.49	0.54	0.59	0.33	0.50	0.52	0.60	0.33	0.55	0.50	0.51	0.55
	C. D at 5%	N/A	1.44	1.60	1.72	N/A	1.44	1.60	1.72	N//A	1.47	1.52	1.77	0.98	1.61	1.48	1.50	1.61

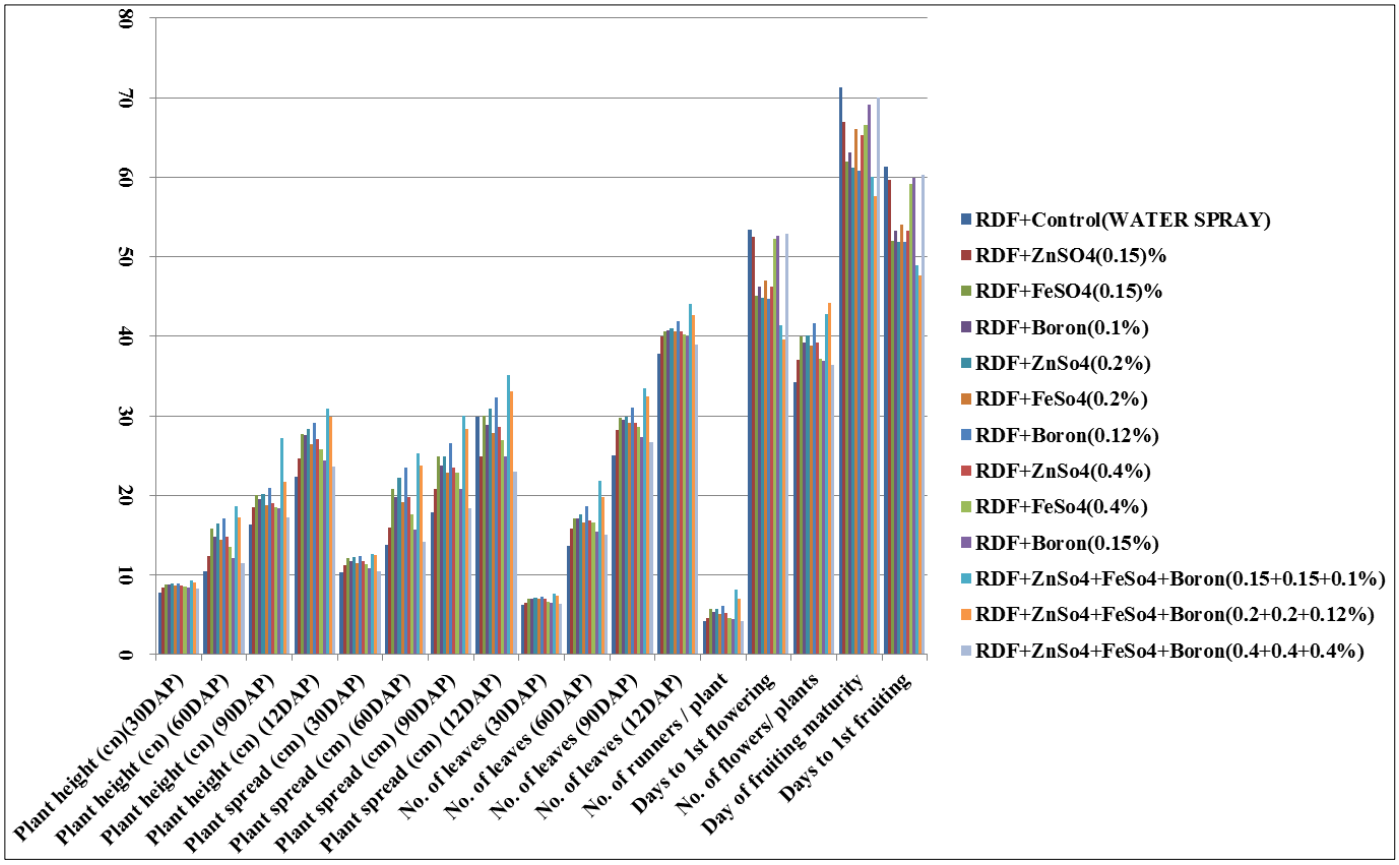

Fig 1: Influence of Micro-nutrients on Growth, yield & quality of strawberry (*Fragaria ananasa*) cv sweet Charlie under protected cultivation

Acknowledgement
The author conveys their thanks to the staff of Horticulture department Sam Higg in bottom University of Agriculture, Technology & Sciences, Prayagraj (Uttar Pradesh) India for their colossal assistance, without which the trial would not have been successful.

Conflict of Interest
As a corresponding Author, I M. Kamala Prkiya, confirm that none of the others have any conflicts of interest associated with this publication.

References
1. Albregts EE, Howard CM. Response of strawberries to soil and foliar fertilizer rates Hort Science. 1986;21:1140-1142.
2. Archbold D, MacKown C. Seasonal and cropping effects on total and fertilizer nitrogen use in June-bearing and day-neutral strawberries J Amer. Soc. Hort. Sci. 1995;120:403-408.
3. Albregts EE, Howard CM. Accumulation of nutrients by strawberry plants and fruit grown in annual hill culture J Amer. Soc. Hort. Sci. 1980;105:386-38.
4. Ayesha R, Fatima N, Ruqayya M, Qureshi KM, Hafiz IA, Khan KS. Influence of different growth media on the fruit quality and reproductive growth parameters of strawberry (*Fragaria ananassa*) J Med. Plants Res. 2011;5(26):6224-6232.
5. Alshaal T, El-Ramady H. Foliar application: From plant nutrition to biofortification. The Environ, Biodivers & Soil Secur. 2017;1:71- 83.
6. Asad. Strawberry production and marketing potentials. Advisory leaflet of MFVDP. 1997;30:1-2.
7. Breen PJ, Martin LW. Vegetative and growth responses

of three strawberry cultivars to nitrogen J Amer. Soc. Hort. Sci. 1981;106:266 272.
8. Bowling BL. The berry grower companion. Timber Press Inc., Portland, Oregon, USA. 2000.
9. Bakshi P, Jasrotia A, Wali VK, Sharma A, Akshi M. Influence of pre-harvest application of calcium and micro-nutrients on growth, yield, quality and shelf-life of strawberry cv "Chandler". Ind. J Agric. Sci. 2013;83:831-835.
10. Chaturvedi OP, Singh AK, Tripathi VK, Dixit AK. Effect of zinc and iron on growth, yield and quality of strawberry cv. "Chandler". Acta. Hort. 2005;696:237-240.
11. Cardenas-Navarro R, López-Pérez L, Lobit P, Ruiz-Corro R, Castellanos-Morales VC. Effects of nitrogen source on growth and development of strawberry plants. J. Plant Nutr. 2006;29(9):1699-1707. [Google Scholar]
12. Casierra-Posada F, Pena-Olmos JE, Ulrichs C. Basic growth analysis in strawberry plants (*Fragaria* sp.) exposed to different radiation environments. Agron. Colomb. 2012;30(1):25-33. [Google Scholar]
13. Dixit A, Shaw SS, Pal V. Effect of micronutrients and plant growth regulators on fruiting of litchi. Hort. Flora Res. Spect. 2013;2(1):77- 80.
14. Hasnain M, Chen J, Ahmed N, Memon S, Wang L, Wang Y. The effects of fertilizer type and application time on soil properties, plant traits, yield and quality of tomato. Sustainability. 2020;12(21):9065. [Google Scholar]
15. Kirsch RK. The importance of interaction effects in fertilizer and lime studies with strawberries Proc. Amer. Soc. Hort. Sci. 1959;73:181-188.
16. Kerin V, Berova MFoliar fertilization in plants. Videnov & Son, Sofia. Bulgarian. 2003.
17. Kumar SS, Pramod K, Mahesh K, Saravanan S, Choudhary ML, Sharma MC. Studies on influence of bio-fertilizers and micronutrients on growth, flowering and yield of strawberry (*Fragaria x ananassa* Duch) cv. "Chandler". Ann. Hortic. 2012;5:259-264.
18. .May GM, Pritts PM. Strawberry nutrition. Adv. Strawberry Res. 1990;9:10-24.
19. Mohamed RA, Abd El-Aal HA, Abd El- Aziz MG. Effect of Phosphorus, Zinc and their Interaction on vegetative growth characters, yield and fruit quality of Strawberry. J Hortic. Sci. Ornam. Plants. 2011;3:106-114
20. Odongo T, Isutsa DK, Aguyo JN. Effects of integrated nutrient sources on growth and yield of strawberry grown under tropical high altitude conditions. Afr. J Horticult. Sci. 2008, 1 [Google Scholar]
21. Perez AG, Olias R, Espada J, Olias JM, Sanz C. Rapid determination of sugars, nonvolatile acids, and ascorbic acid in strawberry and other fruits. J Agric. Food Chem. 1997;45:3545-3549.
22. Preusch PL, Takeda F, Tworkoski TJNP. Uptake by strawberry plants grown with composted poultry litter. Sci. Hortic. 2004;102(1):91-103. [Google Scholar]
23. Qureshi KM, Chughtai S, Qureshi US, Abbasi NA. Impact of exogenous application of salt and growth regulators on growth and yield of strawberry. Pakistan J. Bot. 2013;45(4):1179-1185.
24. Raja WH, Kumawat K, Sharma O, Sharma A, Mir J, Nabi SU. Effect of different substrates on growth and quality of Strawberry cv. chandler in soilless culture. Pharma Innov. J 2018;7:449-453. [Google Scholar]
25. Shahzad U, Ijaz M, Nauman Noor MS, Hassan Z, Kahn AA, Calica P. Variations in growing media and plant spacing for the improved production of strawberry (Fragaria ananassa cv. Chandler) Philipp. J Sci. 2018;147(4):705-713. [Google Scholar]
26. Trejo-Tellez LI, Gomez-Merino FC. Nutrient Management in Strawberry: Effects on Yield, Quality and Plant Health. Strawberries: Cultivation, Antioxidant Properties and Health Benefits. In: Malone Nathan., editor. Nova Science Publishers, 2014, 239–267. [Google Scholar]
27. Singh M, Jamwal M, Sharma N, Kumar R, Wali V. Response of iron and zinc on vegetative and reproductive growth of strawberry (*Fragaria* × *ananassa* Duch.) cv. Chandler. Bangladesh J. Bot. 2015;44(2):337-340.
28. Strik B, Righetti T, Buller G. Influence of rate, timing and method of nitrogen fertilization application on uptake and use of fertilizer nitrogen, growth and yield of June-bearing strawberry J Amer. Soc. Hort. Sci. 2004;129:165-174.
29. Swift MJ, Heal OW, Anderson JM. Decomposition in terrestrial ecosystems. Blackwell, Oxford, UK. 1979.
30. Strik B, Righetti T, Buller G. Influence of rate, timing and method of nitrogen fertilization application on uptake and use of fertilizer nitrogen, growth and yield of June-bearing strawberry J Amer. Soc. Hort. Sci. 2004;129:165-174.
31. Thakur M, Shylla B. Influence of different growing media on plant growth and fruit yield of strawberry (*Fragaria* × *ananassa* Duch.) cv. Chandler grown under protected conditions. Int. J. Curr. Microbiol. Appl. Sci. 2018;7(4):2724-2730.[Google Scholar]
32. Ulrich G, Martin L. Spring applications of nitrogen on strawberries Proc. Oregon Hort. Soc. 1987;78:142-146.
33. Vandecasteele B, Debode J, Willekens K, Van Delm T. Recycling of P and K in circular horticulture through compost application in sustainable growing media for fertigated strawberry cultivation. Eur. J Agron. 2018;96:131-145. [Google Scholar]
34. Winkler AJ, Cook JA, Kliewer WM, Lider LA. General viticulture. Univ. California Press, Los Angeles, CA. 1974.
35. Wei H, Liu C, Ryong Jeong B. An optimal combination of the propagation medium andfogging duration enhances the survival, rooting and early growth of strawberry daughter plants. Agronomy. 2020;10(4):557. [Google Scholar]
36. Zurawicz E, Stushnoff C. Influence of nutrition on cold tolerance of 'Readcoat' strawberries J Amer. Soc. Hort. Sci. 1977;102:342-346.