Plant Archives Vol. 24, No. 2, 2024 pp. 1943-1950 e-ISSN:2581-6063 (online), ISSN:0972-5210

Plant Archives

Journal homepage: http://www.plantarchives.org

DOI Url : https://doi.org/10.51470/PLANTARCHIVES.2024.v24.no.2.279

EFFECT OF FOLIAR APPLICATION OF MICRO NUTRIENTS ON GROWTH, YIELD AND QUALITY OF STRAWBERRY (*FRAGARIA* × *ANANASSA* DUCH.) CV. WINTER DAWN

Shubham Krishna*, Annjoe V. Joseph and Akhilesh Kumar

Department of Horticulture, Sam Higginbottom University of Agriculture, Technology & Sciences, Prayagraj-211 007 (U.P.), India.

*Corresponding author E-mail : shubhamkrishna90@gmail.com

(Date of Receiving-25-05-2024; Date of Acceptance-16-08-2024)

ABSTRACT

The present investigation entitled "Effect of foliar application of micro nutrients on growth, yield and quality of strawberry (*Fragaria* × *ananassa* Duch.) cv. Winter Dawn" was carried out during the year 2022-2024 in the Department of Horticulture, Sam Higginbottom University of Agriculture Technology & Sciences Prayagraj in the months of October 2023 to February 2024. The experiment was conducted on strawberry cv. Witner Dawn. . The experiment was laid in completely randomized block design with 11 treatments and was replicated three times. Based on the results of present investigation, it can be concluded that combined foliar application of micronutrients of Zinc Sulphate (0.5%) + Copper sulphate (0.5%) + Borax sulphate (0.5%) + Ferrous sulphate (0.5%) was beneficial for increasing vegetative growth, early flowering and fruiting, fruit development, fruit yield and quality of strawberry cv. Winter dawn.

Key words : Micronutrients, Growth, Yield, Quality and Strawberry.

Introduction

Strawberry (*Fragaria* × *ananassa* Duch.) is one of the most fascinating fruits of the world. It is a cross between two species of wild strawberry: A large fruited species, *Fragaria chiloensis* originally from Chile and *Fragaria virginiana*, originally from Virginia, USA. The chromosme no. of strawberry is 2n=2x= 56. Strawberry belongs to the family Rosaceae. The commercially cultivated strawberry is an octaploid species. The United States is the world's largest producer of strawberries accounting for about 30 percent of the world strawberry production (Morgan, 2012).

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 (Kamala *et al*., 2022).

Micronutrients, forming constituent part of plant are considered essential for the growth of plants. Proper supply of these nutrients is sure to yield positive effect on crop production. Foliar application of different micronutrients at proper stage helps in improving fruit yield and physiochemical characteristics of strawberry. It also helps in correcting micronutrients deficiency. For growth and development of strawberry is necessary micronutrients are (Shukla *et al*., 2009).

Materials and Methods

The present investigation entitled "Effect of foliar application of micro nutrients on growth, yield and quality of strawberry (*Fragaria* × *ananassa* Duch.) cv. Winter Dawn" was carried out during the year 2023-2024 in the Department of Horticulture, Sam Higginbottom University of Agriculture Technology & Sciences, Prayagraj in the months of October 2023 to February 2024. All the facilities necessary for cultivation, including labour were made in the department.

The experiment was conducted in Randomized Block Design (RBD) with 11 treatments in three replications via T_0 – Control, T_1 - Zinc Sulphate (0.5%), T_2- Copper sulphate (0.5%), T_3 - Ferrous sulphate (0.5%), T_4 - Borax (0.5%), T_5 - Zinc Sulphate (0.5%) + Copper sulphate (0.5%), T_6 - Zinc sulphate (0.5%) +Ferrous sulphate (0.5%), T_7 - Zinc sulphate (0.5%) + Borax sulphate (0.5%), T_8 - Copper sulphate (0.5%) + Ferrous sulphate (0.5%), T_9 - Ferrous sulphate (0.5%) + Borax sulphate (0.5%), T_{10} - Zinc Sulphate (0.5%) + Copper sulphate (0.5%) +Borax sulphate (0.5%)+ Ferrous sulphate (0.5%). The leaf area of strawberry was measured using leaf area meter (Biovis PSML2000). The fruit firmness and total soluble solid (TSS) content of strawberry fruit were determined using digital fruit firmness tester and digital refracto meter. The harvested fruits under each treatment were categorised in marketable and non-marketable fruits (fruits having weight < 10 g or malformed (Misshapen) or disease infected). The titratable acidity, ascorbic acid and sugar content of fruits were determined following the standard procedures (AOAC, 1980). The anthocyanin content of the strawberry fruits was determined following the method described by Srivastava and Kumar (2001). The data were analysed for the variance and least significant differences were calculated to compare significant effects at 5% level (Snedecor and Cochran, 1967).

Results and Discussion

Growth parameters

Plant height

It is evident from the data that significantly superior plant height at 120 days (35.69 cm) was found in foliar application of Zinc Sulphate (0.5%) +Copper sulphate (0.5%) + Borax sulphate (0.5%) + Ferrous sulphate (0.5%), which was statistically at par with application of Zinc sulphate (0.5%) + Ferrous sulphate (0.5%) and Zinc sulphate (0.5%) + Borax sulphate (0.5%) as shown in Table 1. However, minimum plant height (23.6 cm) was observed in T_0 (Control). [The increase in plant growth

Table 1 : Effect of foliar application of micronutrients on vegetative growth parameters of Strawberry (*Fragaria* x *ananassa* Duch.) cv. Winter dawn.

Treatment	Treatment combination	Plant height (cm) (120 DAT)	Number of leaves (120 DAT)	Plant spread (cm) (120 DAT)	Petiole length (cm) (120 DAT)
T_0	Control	23.67	26.43	30.48	9.31
T_1	Zinc Sulphate (0.5%)	31.00	31.18	35.89	12.38
T_2	Copper sulphate (0.5%)	30.24	31.51	36.06	11.65
T_3	Ferrous sulphate (0.5%)	29.21	30.90	34.84	11.35
T_4	Borax (0.5%)	31.29	32.61	37.60	12.28
T_5	Zinc Sulphate + Copper sulphate (0.5%)	32.70	35.16	40.62	13.19
T_6	Zinc sulphate (0.5%) + Ferrous sulphate (0.5%)	34.38	36.21	41.28	13.27
T_7	Zinc sulphate (0.5%) + Borax sulphate (0.5%)	34.53	36.94	41.68	13.50
T_8	Copper sulphate (0.5%) + Ferrous sulphate (0.5%)	31.59	36.24	37.63	11.47
T_9	Ferrous sulphate (0.5%) + Borax sulphate (0.5%)	30.93	31.95	34.59	12.29
T_{10}	Zinc Sulphate (0.5%) + Copper sulphate (0.5%) + Borax sulphate (0.5%) + Ferrous sulphate (0.5%)	35.69	38.46	42.51	13.74
F - Test		S	S	S	S
S. Ed.		0.600	0.744	0.432	0.741
CD at 0.5%		1.252	1.553	0.902	1.574
CV		2.343	2.427	1.585	1.855

during research may be due to used of micronuitrients. The enhancement of plant height with the application of Zinc sulphate (0.5%) + Copper sulphate (0.5%) + Borax sulphate (0.5%) + Ferrous sulphate (0.5%) may be due to improved nutrient availability for longer period throughout the crop growth which resulted in better photosynthetic activities and ultimately high biomass production (Singh *et al.*, 2015). The results of present investigation in terms of plant growth are in concordance with the findings reported earlier by Ekka *et al.* (2003), Chaturvedi *et al.* (2005), Li *et al.* (2017) and Yadav *et al.* (2021) in strawberry.

Plant spread

It is evident from the data that significantly superior plant spread at 120 days (38.46 cm) was found in foliar application of Zinc Sulphate (0.5%) +Copper sulphate (0.5%) + Borax sulphate (0.5%) + Ferrous sulphate (0.5%), which was statistically at par with application of Zinc sulphate (0.5%) + Ferrous sulphate (0.5%), Zinc sulphate (0.5%) + Borax sulphate (0.5%) and Copper sulphate (0.5%) + Ferrous sulphate (0.5%) as shown in Table 1. However, minimum plant spread (26.43 cm) was observed in T_0 (Control).

Numbers of leaves

It is evident from the data that significantly superior number of leaves per plant (42.51) at 120 DAT was found in foliar application of Zinc sulphate (0.5%) + Copper sulphate (0.5%), + Borax sulphate (0.5%). + Ferrous sulphate (0.5%), which was statistically at par with application of Zinc sulphate + Ferrous sulphate (0.5%) and Zinc sulphate (0.5%), + Borax sulphate (0.5%). However, minimum number of leaves per plant (30.48) was observed in T_0 (Control) (Table 1).

Petiole length

It is evident from the data that significantly superior petiole length of (13.74 cm) at 120 DAT was found in foliar application of Zinc sulphate (0.5%) + Copper sulphate (0.5%) + Borax sulphate (0.5%) +Ferrous sulphate (0.5%), which was statistically at par with application of Borax (0.5%) and Zinc sulphate (0.5%). However, minimum petiole length of (9.31cm) was observed in T_0 (Control) as shown Table 1.

Flowering parameters

Days to first flowering

The perusal of data revealed that earlier days to first flowering was observed in Zinc sulphate (0.5%) + Copper sulphate (0.5%) +Borax sulphate (0.5%) + Ferrous sulphate (0.5%) with 40.40 days, which was statistically at par with application of Zinc Sulphate (0.5%) + Copper sulphate (0.5%) and Zinc sulphate (0.5%) + Ferrous sulphate (0.5%) as shown in Table 2. While, in control the maximum days to first flowering of 56.60 days was recorded. Present findings were also in agreement with the earlier report by Singh *et al.* (2015), who inferred that precocious amount of boron and Zinc and also their synergism improved vegetative growth, fruit quality as well as yield of strawberry. In a previous research study, Ekka *et al.* (2018) demonstrated that boron, zinc, iron and copper application prior to flower initiation of strawberry plant boosted vegetative growth which ultimately enhanced quality and shelf life in cv. "Chandler"

Days to first fruiting

The perusal of data revealed that earlier days to first fruiting was observed in Zinc sulphate (0.5%) + Copper sulphate (0.5%) + Borax sulphate (0.5%) + Ferrous sulphate (0.5%) with 47.55 days, which was statistically at par with application of Zinc sulphate (0.5%) + Ferrous sulphate (0.5%). While control noted maximum days to first fruiting with 66.04 days as shown in table -2 . Present findings were in agreement with the earlier report by Singh *et al.* (2015).

Number of flowers per plant

It is evident from the data that the number of flower per plant as affected by foliar application of micronutrients was found significant. The maximum number of flower per plant (36.82) was recorded with treatment Zinc sulphate (0.5%) + Copper sulphate (0.5%) +Borax sulphate (0.5%) + Ferrous sulphate (0.5%) and minimum number of flower per plant (24.79) was recorded in treatment control in Table 2. However, Zinc sulphate (0.5%) + Ferrous sulphate (0.5%) was found statistically at par to Zinc sulphate (0.5%) + Copper sulphate (0.5%) +Borax sulphate (0.5%) + Ferrous sulphate (0.5%).

Number of fruits per plant

It is evident from the data that the number of fruit per plant as affected by foliar application of micronutrients was found significant. The maximum number of fruit per plant (20.25) was recorded with treatment Zinc sulphate (0.5%) + Copper sulphate (0.5%) + Borax sulphate (0.5%) + Ferrous sulphate (0.5%) and minimum number of fruit per plant (13.29) was recorded in treatment Control in (Table 2). However, Zinc sulphate (0.5%) + Ferrous sulphate (0.5%) are found statistically at par to Zinc sulphate + Copper sulphate + Borax sulphate + Ferrous sulphate (0.5%). The Present findings were also in agreement with the earlier report by Singh *et al.* (2015), who reported increased number of flower fruits by application of micronutrients.

Table 2 : Effect of foliar application of micronutrients on flowering parameters of Strawberry (*Fragaria* x *ananassa* Duch.) cv. Winter dawn.

Treatment	Treatment Combination	Days to 1st flowering	Days to 1st fruiting	Number of flower per plant	Number of fruit per plant
T_0	Control	56.60	66.04	24.79	13.29
T_1	Zinc Sulphate (0.5%)	51.18	59.63	30.47	16.66
T_2	Copper sulphate (0.5%)	47.43	55.65	27.31	17.28
T_3	Ferrous sulphate (0.5%)	53.52	62.15	29.58	16.00
T_4	Borax (0.5%)	45.10	52.73	31.18	17.25
T_5	Zinc Sulphate +Copper sulphate (0.5%)	43.38	50.83	33.50	17.80
T_6	Zinc sulphate (0.5%) + Ferrous sulphate (0.5%)	42.11	49.74	34.93	19.04
T_7	Zinc sulphate (0.5%) + Borax sulphate (0.5%)	51.50	59.65	27.30	16.10
T_8	Copper sulphate (0.5%) + Ferrous sulphate (0.5%)	53.84	62.09	30.27	17.01
T_9	Ferrous sulphate (0.5%) + Borax sulphate (0.5%)	53.28	61.72	27.97	15.95
T_{10}	Zinc Sulphate (0.5%) + Copper sulphate (0.5%) + Borax sulphate (0.5%) + Ferrous sulphate (0.5%)	40.40	47.55	36.82	20.25
F - Test		S	S	S	S
S. Ed.		0.741	1.044	0.544	0.455
CD at 0.5%		1.547	2.177	1.135	0.949
CV		1.591	2.232	2.194	3.283

Fruit development parameters

Fruit length (cm)

It is evident from the data that the fruit length as affected by foliar application of micronutrients was found significant. The maximum fruit length (3.65) (cm) was recorded with treatment T_{10} which consisted of Zinc sulphate (0.5%) + Copper sulphate (0.5%) + Borax sulphate (0.5%) + Ferrous sulphate (0.5%) and minimum fruit length (1.80) cm was recorded in treatment Control as discussed in Table 3. However, Zinc sulphate (0.5%) + Ferrous sulphate (0.5%) and Zinc sulphate (0.5%) + Copper sulphate (0.5%) are found statistically at par to application of Zinc sulphate (0.5%) + Copper sulphate (0.5%) + Borax sulphate (0.5%) + Ferrous sulphate (0.5%).

Fruit girth (cm)

It is evident from the data that the fruit girth as affected by foliar application of micronutrients was found significant. The maximum fruit girth (2.74) cm was recorded with treatment T_{10} Zinc sulphate (0.5%) + Copper sulphate (0.5%) + Borax sulphate (0.5%) + Ferrous sulphate (0.5%) and minimum fruit girth (1.26) cm was recorded in treatment Control as discussed in Table 3. However, Zinc sulphate (0.5%) are found statistically at par to application of Zinc sulphate (0.5%) +Copper sulphate (0.5%) +Borax sulphate (0.5%) +Ferrous sulphate (0.5%). The present is in agreement with the earlier report by Singh *et al.* (2015), who reported that synergism olf micronutrient improved fruit character inferred that.

Fruit weight (gm)

It is evident from the data that the fruit weight (gm) as affected by foliar application of micronutrients was found significant. The maximum fruit weight (gm) (28.74) was recorded with treatment Zinc sulphate + Copper sulphate + Borax sulphate + Ferrous sulphate 0.5% foliar application of micronutrients and minimum fruit weight (gm) (20.14) was recorded in treatment Control as

Table 3 : Effect of foliar application of micronutrients on fruit development parameters of Strawberry (*Fragaria* x *ananassa* Duch.) cv. Winter dawn.

Treatment	Treatment Combination	Fruit length (cm)	Fruit width (cm)	Fruit weight (g)
T_0	Control	1.80	1.26	20.14
T_1	Zinc Sulphate (0.5%)	3.21	2.46	24.33
T_2	Copper sulphate (0.5%)	2.67	2.22	21.68
T_3	Ferrous sulphate (0.5%)	2.82	2.34	24.47
T_4	Borax (0.5%)	3.30	2.53	27.44
T_5	Zinc Sulphate +Copper sulphate (0.5%)	3.43	2.55	27.84
T_6	Zinc sulphate (0.5%) +Ferrous sulphate (0.5%)	3.54	2.63	28.46
T_7	Zinc sulphate (0.5%) +Borax sulphate (0.5%)	3.08	2.09	24.76
T_8	Copper sulphate (0.5%) +Ferrous sulphate (0.5%)	3.15	2.17	25.71
T_9	Ferrous sulphate (0.5%) +Borax sulphate (0.5%)	3.39	2.12	23.99
T_{10}	Zinc Sulphate (0.5%) +Copper sulphate (0.5%) + Borax sulphate (0.5%) +Ferrous sulphate (0.5%)	3.65	2.74	28.74
F - Test		S	S	S
S. Ed.		0.069	0.132	0.670
CD at 0.5%		0.143	0.274	1.397
CV		2.716	7.059	3.251

discussed in Table 3. However, Borax 0.5% and Zinc sulphate + Copper sulphate 0.5% are found statistically at par to Zinc sulphate + Copper sulphate + Borax sulphate + Ferrous sulphate 0.5%.

Fruit yield parameters of Strawberry

Fruit per plant (g)

It is evident from the data that the fruit per plant (g) as affected by foliar application of micronutrients was found significant. The maximum fruit per plant (g) (581.89) was recorded with treatment Zinc sulphate + Copper sulphate +Borax sulphate + Ferrous sulphate 0.5% foliar application of micronutrients and minimum fruit per plant (g) (267.68) was recorded in treatment Control as discussed in Table 4. However, Zinc sulphate + Ferrous sulphate 0.5% are found statistically at par to Zinc sulphate + Copper sulphate +Borax sulphate + Ferrous sulphate 0.5%. Our findings were also in agreement with the earlier report by Singh *et al.* (2015). Higher count of total fruit on single plant was documented by Mohsen (2013) in tomatoes by the usage of micronutrients through foliar dose. Similar outcomes were mentioned by Bakshi *et al.* (2013), who reported efficient number of fruit per plant applying calcium, iron and zinc in combinations.

Fruit per plot (kg)

It is evident from the data that the fruit per plot (kg) as affected by foliar application of micronutrients was found significant. The maximum fruit per plot (kg) (2.33) was recorded with treatment Zinc sulphate + Copper sulphate + Borax sulphate + Ferrous sulphate 0.5% foliar application of micronutrients and minimum fruit per plot (kg) (1.07) was recorded in treatment Control as discussed in Table 4. However, Zinc sulphate + Ferrous sulphate 0.5% are found statistically at par to Zinc sulphate + Copper sulphate +Borax sulphate +Ferrous sulphate 0.5%.

Fruit yield t ha^{-1}

It is evident from the data that the fruit yield t ha^{-1} as affected by foliar application of micronutrients was found significant. The maximum fruit yield t ha^{-1} (23.28) was recorded with treatment Zinc sulphate + Copper sulphate +Borax sulphate + Ferrous sulphate 0.5% foliar application of micronutrients and minimum fruit yield t ha^{-1} (10.71) was recorded in treatment Control as discussed in Table 4. However, Zinc sulphate + Ferrous sulphate 0.5% are found statistically at par to Zinc sulphate + Copper sulphate +Borax sulphate +Ferrous sulphate 0.5%. Our findings were also in agreement with the earlier report by Singh *et al.* (2015), who inferred that precocious amount of boron and Zinc and also their synergism improved vegetative growth, fruit quality as well as yield of strawberry.

Table 4 : Effect of foliar application of micronutrients on fruit yield parameters of Strawberry (*Fragaria* x *ananassa* Duch.) cv. Winter dawn.

Treatment	Treatment combination	Fruit yield per plant (g)	Fruit yield (t ha^{-1})
T_0	Control	267.68	10.71
T_1	Zinc Sulphate (0.5%)	405.46	16.22
T_2	Copper sulphate (0.5%)	375.42	15.02
T_3	Ferrous sulphate (0.5%)	391.38	15.66
T_4	Borax (0.5%)	473.40	18.94
T_5	Zinc Sulphate +Copper sulphate (0.5%)	495.60	19.82
T_6	Zinc sulphate (0.5%) +Ferrous sulphate (0.5%)	541.70	21.67
T_7	Zinc sulphate (0.5%) +Borax sulphate (0.5%)	398.69	15.95
T_8	Copper sulphate (0.5%) +Ferrous sulphate (0.5%)	437.60	17.50
T_9	Ferrous sulphate (0.5%) +Borax sulphate (0.5%)	382.39	15.30
T_{10}	Zinc Sulphate (0.5%) +Copper sulphate (0.5%) +Borax sulphate (0.5%) +Ferrous sulphate (0.5%)	581.89	23.28
F - Test		S	S
S. Ed.		35.708	0.685
CD at 0.5%		17.118	1.429
CV		4.854	4.854

Fruit quality parameters

T.S.S.

It is evident from the data that the TSS ^{0}Brix as affected by foliar application of micronutrients was found significant. The maximum TSS 0Brix (9.76) was recorded with treatment Zinc sulphate +Copper sulphate + Borax sulphate +Ferrous sulphate 0.5% foliar application of micronutrients and minimum TSS ^{0}Brix (7.28) was recorded in treatment Control as discussed in Table 5. However, Ferrous sulphate 0.5%, Borax 0.5%, Zinc sulphate + Copper sulphate 0.5% and Zinc sulphate + Ferrous sulphate 0.5% are found statistically at par to Zinc sulphate + Copper sulphate + Borax sulphate + Ferrous sulphate 0.5%.

Acidity (%)

It is evident from the data that the Acidity (%) as affected by foliar application of micronutrients was found significant. The minimum acidity (%) (0.47) was recorded with treatment Zinc sulphate + Copper sulphate + Borax sulphate + Ferrous sulphate 0.5% foliar application of micronutrients and maximum acidity (%) (1.09) was recorded in treatment Control as discussed in Table 5. However, Zinc sulphate + Ferrous sulphate 0.5% are found statistically at par to Zinc sulphate + Copper sulphate + Borax sulphate + Ferrous sulphate 0.5%.

Ascorbic acid (mg/100g)

It is evident from the data that the ascorbic acid (mg/100g) as affected by foliar application of micronutrients was found significant. The maximum ascorbic acid (mg/100g) (58.47) was recorded with treatment Zinc sulphate + Copper sulphate +Borax sulphate +Ferrous sulphate 0.5% foliar application of micronutrients and minimum ascorbic acid (mg/100g) (49.96) was recorded in treatment Control as discussed in Table 5. However, Zinc sulphate + Ferrous sulphate 0.5% are found statistically at par to Zinc sulphate + Copper sulphate + Borax sulphate +Ferrous sulphate 0.5%.

Specific gravity

It is evident from the data that the specific gravity as affected by foliar application of micronutrients was found significant. The maximum specific gravity (1.46) was recorded with treatment Zinc sulphate + Copper sulphate + Borax sulphate + Ferrous sulphate 0.5% foliar application of micronutrients and minimum specific gravity (1.06) was recorded in treatment Control as discussed in Table 5. However, Zinc sulphate + Ferrous sulphate 0.5% are found statistically at par to Zinc sulphate + Copper sulphate + Borax sulphate + Ferrous sulphate 0.5%.

Juice content (%)

It is evident from the data that the juice content (%) as affected by foliar application of micronutrients was found significant. The maximum juice content (%) (93.69) was recorded with treatment Zinc sulphate + Copper sulphate + Borax sulphate + Ferrous sulphate

Table 5 : Effect of foliar application of micronutrients on fruit quality parameters of Strawberry (*Fragaria* x *ananassa* Duch.) cv. Winter dawn.

Treatment	Treatment combination	TSS ^{0}Brix	Acidity (%)	Ascorbic acid (mg/100g)	Specific gravity	Juice content (%)
T_0	Control	7.28	1.09	49.96	1.06	82.69
T_1	Zinc Sulphate (0.5%)	8.45	0.87	52.98	1.18	92.12
T_2	Copper sulphate (0.5%)	8.60	0.91	52.06	1.19	91.05
T_3	Ferrous sulphate (0.5%)	9.10	0.91	52.00	1.16	87.81
T_4	Borax (0.5%)	9.39	0.70	54.48	1.32	91.62
T_5	Zinc Sulphate +Copper sulphate (0.5%)	9.55	0.64	56.51	1.35	92.51
T_6	Zinc sulphate (0.5%) + Ferrous sulphate (0.5%)	9.71	0.53	57.52	1.40	93.21
T_7	Zinc sulphate (0.5%) + Borax sulphate (0.5%)	8.55	0.72	51.99	1.19	90.52
T_8	Copper sulphate (0.5%) + Ferrous sulphate (0.5%)	8.30	0.72	52.04	1.22	90.12
T_9	Ferrous sulphate (0.5%) + Borax sulphate (0.5%)	8.44	0.83	52.45	1.24	91.07
T_{10}	Zinc Sulphate (0.5%) + Copper sulphate (0.5%) + Borax sulphate (0.5%) + Ferrous sulphate (0.5%)	9.76	0.47	58.47	1.46	93.69
F - Test		S	S	S	S	S
S. Ed.		0.128	0.051	0.588	0.023	0.804
CD at 0.5%		0.268	0.106	1.226	0.047	1.676
CV		1.779	8.171	1.342	2.219	1.087

0.5% foliar application of micronutrients and minimum juice content (%) (82.69) was recorded in treatment Control as discussed in Table 5 . However, Zinc sulphate + Copper sulphate 0.5% are found statistically at par to Zinc sulphate + Copper sulphate +Borax sulphate + Ferrous sulphate 0.5%.

Conclusion

Based on the results of present investigation, it can be concluded that combined foliar application of micronutrients of Zinc sulphate + Copper sulphate + Borax sulphate + Ferrous sulphate 0.5% was beneficial for increasing vegetative growth, early flowering and fruiting, fruit development, fruit yield and quality of strawberry cv. Winter dawn with gross return, net return and benefit cost ratio (1:5.08)

Acknowledgement

The author is thankful to the Advisor and Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture Technology and sciences, Prayagraj (U.P.), India for providing necessary facilities to undertaken this research. This manuscript has not received any grant from any sources.

Competing interests

Authors have declared that no competing interests exist.

References

Chaturvedi, O.P., Singh A.K., Tripathi V.K. and Dixit A.K. (2005). Effect of zinc and Iron on growth yield and quality of strawberry. *Acta. Hort.*, **696**, 237-240.

Ekka, R.A., Singh R.K., Saravanan S. and Kasera S. (2018). Foliar application of micronutrients influenced vegetative growth, yield and quality traits of strawberry (*Fragaria x ananassa* Duch.) cv. Chandler. *J. Pharmacog. Phytochem.*, **SP1**, 2030 - 2032.

Ekka, Roshni Aradhana, Kerketta Anita, Lakra Sandeep and Saravanan S. (2018). Effect of Zn, B, Cu and Fe on Vegetative Growth, Yield and Quality of Strawberry (*Fragaria x ananassa* Duch.) cv. Chandler. *Int. J. Curr. Microbiol. App. Sci.*, **Special Issue-7**, 2886-2890.

Kumar, Ashish Patel and Singh Devi (2021). Effect of foliar spray of zinc and boron on plant growth, yield and quality of guava (*Psidium guajava* L.) cv. Allahabad safeda under high density planting in Prayagraj region. *J. Pharmacog. Phytochem*., **10(1)**, 2487-2489.

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. *Biolog. Forum – An Int. J*., **13(4)**, 344-348.

Kumari, Usha and Prahlad Deb (2018). Effect of Foliar Application of Zinc and Boron on the Physical Parameters of Pineapple cv. Mauritius. *Int. J. Curr. Microbiol. App. Sci*., **Special Issue-7**, 397-402

Singh, S., Gautam D.K. and Singh A. (2015). Effect of micronutrient (zinc, boron) and different combination with apsa -80 on growth, yield and quality and economic of strawberry (*Fragaria x ananassa* Duch.). *Res. Environ. Life Sci*., **8(3)**, 416-418 .

Singh, Sharas, Singh J.P., Singh Jyoti and Bajeli Jyoti (2019). Effect of Spray of Specific Concentration of Boron and Zinc on Growth, Yield and Quality of Tomato (*Solanum lycopersicum* Mill.). *Int. J. Curr. Microbiol. App. Sci*., **8(05)**, 1198-1206.

Singh, D.K, Ghosh S.K, Paul P.K. and Suresh C.P. (2010). Effect of different micronutrients on growth, yield and quality of papaya (*Carica papaya* L.). *Acta Hort*., **851**, 351-356.

Yadav, Rinku, Roy Sapna, Kumar Naveen, Kumar Manish Singh, Kumar Sudhir Mishra and Tiwari Prashant (2021). Effect of micro nutrients on vegetative growth, flowering and yield related traits of strawberry (*Fragaria x ananassa* Duch.) cv. Sweet Charlie. *The Pharma Innov. J*., **10(2)**, 247-250.