

Effect of foliar application of iron (Fe) and zinc (Zn) on growth, yield and quality of strawberry (*Fragaria ananassa*) cv. winter dawn.

ABSTRACT

An experiment on strawberry (*Fragaria ananassa*) cv. winter dawn was conducted during December 2021 to April 2022, in Horticulture Research Farm of Horticulture Department, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj (U.P) India. The experiment was performed on strawberry variety of winter dawn. There are 16 treatments, viz., T₀ (water spray), T₁(Zn 0.2%+Fe 0.2%), T₂ (Zn 0.4%+Fe 0.4%), T₃ (Zn 0.6%+Fe 0.6%), T₄(Zn 0.2%+Fe 0.4%), T₅ (Zn 0.2%+Fe 0.6%) T₆(Zn 0.4%+Fe 0.2%) T₇ (Zn 0.4%+Fe 0.6%) T₈(Zn 0.6%+Fe 0.4%) T₉(Zn 0.6%+Fe 0.2%) , T₁₀ (Zn 0.2%), T₁₁(Zn 0.4%), T₁₂(Zn 0.6%) , T₁₃(Fe 0.2%), T₁₄ (Fe 0.4%), T₁₅ (Fe 0.6%) replicated thrice in Randomized Block Design (RBD). The results of the present investigation, regarding the cultivation of strawberry with different concentrations of Zinc (Zn) and Iron (Fe) found as the best option for higher productivity whereas the treatment T₃ with concentration of Zn (0.6%)+ Fe (0.6%) showed the best result in terms of plant height at 30 days to transplanting (8.1 cm), 60 days to transplanting (15.4 cm) and 90 days to transplanting (22.1 cm), Number of leaves plant⁻¹ at 30 days to transplanting (7.3), 60 days to transplanting (21.3) and 90 days to transplanting (27.4), Plant Spread (27.2 cm), runner plant⁻¹ (5.9), yield/ha (6.0 t), fruit length (4.3 cm), fruit weight (29.3 g), fruit diameter (3.4 cm), TSS (9.3° Brix), showed the best results in terms of vegetative growth, yield, quality. Hence the T₃ Zn (0.6%) + Fe (0.6%) is best suited for the farmers in terms of growth, yield, quality and net returns.

Keywords: Strawberry, Growth, Yield, Quality

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. 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). It is an herbaceous perennial plant and is adapted to different climates, and can ever be grown from tropical and sub-tropical to temperate regions of high altitudes up to 3000 meter above mean sea level with assured irrigation facility. Water is a major constituents of strawberry fruits. 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.

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. As compared to other berry fruits strawberries contain a higher percentage of vitamin C, phenolics and flavonoids (Hakkinen and Torronen, 2000). It is commercially grown in China (38.7%), USA (17.5%),

Mexico (4.9%), Turkey (4.8%), Spain (4%), total world production (Faostat, 2016). The area and production of strawberry in India during 2015-16 was reported 77 ha and 5602 mt respectively (NHB, 2016).

Iron (Fe) deficiency induces chlorosis is a major nutritional disorder in calcareous soils (Alvarez et al., 2006). The phenotype introduction by hairpin RNA i-based silencing can be heritable moreover, the transcripts of multigene families can be silenced by a single construct making this technique a powerful tool to study the loss of function phenotype of a target gene in plants with high levels of polyploidy such as strawberry (Guidrelli and Baraldi, 2015). Zinc is an important essential micronutrient for the plant. Zinc is an essential metal for normal plant growth and development since it's a structural element of proteins and enzymes in living organisms. High concentration of Zn in many soils indicated correct management methods including application of sewage sludge or animal manure (Chaturvedi et al., 2003). Therefore, the present study was conducted to study the effect of foliar application of Iron and Zinc on the growth, yield and quality of strawberry in cv. winter dawn.

MATERIALS AND METHOD

A field experiment was conducted during December 2021 to April 2022. At Departmental field of Horticulture Department, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj (U.P.). The experiment entitled "Effect of foliar application of iron and zinc on growth, yield and quality of strawberry was conducted in rabi season adapting Randomized Block Design (RBD) consisting of 16 treatments and three replications replications are showed in mentioned in Table 1. The experimental field has an even topography with a gentle slope and good drainage. The sample from each replication of experimental plot at 0-15 cm depth before sowing of the crop and a composite sample was made to determine the physical and chemical properties of soil. Normal cultural practices and plant protection measures were followed during the cultivation process. Plants were selected randomly from each plot as a representative sample for recording the data.

Iron and Zinc applied to the seedlings of strawberry manually at at 30, 60 and 90 days after transplanting days after transplanting as per treatments. Experimental data collected was subjected to statistical analysis by adopting Fisher's method of analysis of variance (ANOVA) as outlined in Panse and Sukhatme (1985). Critical difference (CD) values were calculated whenever the "F" test was significant at 5 per cent level.

Table1: Treatment details.

S.NO	Treatment Notations	Treatment Details
1.	T₀	WATER SPRAY
2.	T₁	Zn(0.2)+Fe(0.2)
3.	T₂	Zn(0.4)+Fe(0.4)
4.	T₃	Zn(0.6)+Fe(0.6)
5.	T₄	Zn(0.2)+Fe(0.4)
6.	T₅	Zn(0.2)+Fe(0.6)
7.	T₆	Zn(0.4)+Fe(0.2)
8.	T₇	Zn(0.4)+Fe(0.6)
9.	T₈	Zn(0.6)+Fe(0.4)
10.	T₉	Zn(0.6)+Fe(0.2)
11.	T₁₀	Zn(0.2)
12.	T₁₁	Zn(0.4)
13.	T₁₂	Zn(0.6)
14.	T₁₃	Fe(0.2)
15.	T₁₄	Fe(0.4)
16.	T₁₅	Fe(0.6)

RESULTS AND DISCUSSION

A. Growth parameters

Effect of iron and zinc on growth parameters on plant height (cm) at 30,60,90 DAT

The plant height (cm) was minimum at 30 days was observed with interaction of Zn and Fe (0.6%+0.6%) i.e., treatment T₃ (8.1 cm), followed by concentration of Zn and Fe (0.4%+0.6%) i.e., treatment T₇ (7.8 cm). Whereas minimum was recorded in treatment T₀ (5.4 cm) which consisted of water spray as shown in Table 2.

The maximum plant height at (60 days) was observed with interaction of Zn and Fe (0.6%+0.6%) i.e., treatment T₃ (15.4 cm), followed by concentration of Zn and Fe (0.4%+0.6%) i.e., treatment T₇ (15.1 cm). Whereas minimum was recorded in treatment T₀ (12 cm) which consisted of water spray.

The maximum plant height at (90 days) was observed with interaction of Zn and Fe (0.6%+0.6%) i.e., treatment T₃ (22.1 cm), followed by concentration of Zn and Fe (0.4%+0.6%) i.e., treatment T₇ (21.9 cm). Whereas minimum in treatment T₀ (16.9 cm) which consisted of water spray.

Zinc is a component of carbonic anhydrase as well as several dehydrogenases and auxin production which in turn enhance plant growth and iron is necessary for the biosynthesis of chlorophyll and cytochrome, leading to increase in the biosynthesis of materials and growth. Abdollahi et al., (2012) reported increased inflorescence and fruit size with ZnSO₄ application because of its important role in pollination and fruit set in strawberry, cultivar Selva. Increase in shelf life of berry might be due to the fact that zinc works as stimulant of amino acids and appears to be helpful in the process of photosynthesis.

Effect of iron and zinc on no. of leaves per plant at 30,60,90 DAT

The maximum no. of leaves at (30 days) was observed with interaction of Zn and Fe (0.6%+0.6%) i.e., treatment T₃ (7.3), followed by concentration of Zn and Fe (0.4%+0.6%) i.e., treatment T₇ (7.1). Whereas minimum was recorded in treatment T₀ (4.5) which consisted of water spray as shown in Table 2.

The maximum no. of leaves at (60 days) was observed with interaction of Zn and Fe (0.6%+0.6%) i.e., treatment T₃ (21.3), followed by concentration of Zn and Fe (0.4%+0.6%) i.e., treatment T₇ (21.0). Whereas minimum was recorded in treatment T₀ which consisted of water spray was (15.2).

The maximum no. of leaves at (90 days) was observed with interaction of Zn and Fe (0.6%+0.6%) i.e., treatment T₃ (27.4), followed by concentration of Zn and Fe (0.4+0.6) i.e., treatment T₇ (26.9). Whereas minimum was recorded in treatment T₀ which consisted of water spray was (20.2).

Effect of iron and zinc on growth parameters on plant spread and no. of fruits per plant at 90 DAT

The maximum plant spread at (90 days) was observed with interaction of Zn and Fe (0.6%+0.6%) i.e., treatment T₃ (27.2), followed by concentration of Zn and Fe (0.4%+0.6%) i.e., treatment T₇ (26.9). Whereas minimum plant spread (90 days) was recorded in treatment T₀ which consisted of water spray was (23.2) as shown in Table 2.

The maximum no. of fruits per plant at (30 days) was observed with interaction of Zn and Fe (0.6%+0.6%) i.e., treatment T₃ of (20.4), followed by concentration of Zn and Fe (0.4%+0.6%) i.e., treatment T₇ of (20.0). Whereas minimum no of fruits per plant (30 days) in treatment T₀ which consisted of water spray was (12.1).

Foliar application is based on the principle that the nutrients are quickly absorbed by leaves and transported to different parts of the plant to fulfil the functional requirement of nutrition. Foliar application of the nutrients is obviously an ideal way of evading the problems of nutrient availability. Zinc and boron have important role on pollination; fruit set and yield (Motesharezade et al., 2001) among the micronutrients.

B. Yield Parameters

The maximum yield/ha was observed with the interaction of Zn and Fe (0.6%+0.6%) i.e., treatment T₃ of (6.0), followed by concentration of Zn and Fe (0.4%+0.6%) i.e., treatment T₇ of (5.4). Whereas minimum yield/ha in treatment T₀ which consisted of water spray was (2.3) as shown in Table 3.

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., 2003)

The maximum fruit length was observed with the interaction of Zn and Fe (0.6%+0.6%) i.e., treatment T₃ of (4.3 cm), followed by concentration of Zn and Fe (0.4%+0.6%) i.e., treatment T₇ of (4.1 cm). Whereas minimum fruit length in treatment T₀ which consisted of water spray was (3.2 cm).

The maximum fruit weight was observed with interaction of Zn and Fe (0.6%+0.6%) i.e., treatment T₃ of (29.3 g), followed by concentration of Zn and Fe (0.4%+0.6%) i.e., treatment T₇ of (27.1g). Whereas minimum fruit weight in treatment T₀ which consisted of water spray was (18.6 g).

The maximum fruit diameter was observed with the interaction of Zn and Fe (0.6%+0.6%) i.e., treatment T₃ of (3.4 cm), followed by concentration of Zn and Fe (0.4%+0.6%) i.e., treatment T₇ of (3.3 cm). Whereas minimum fruit diameter in treatment T₀ which consisted of water spray was (2.6 cm).

The number of fruits per plant, mean fruit weight, diameter and volume of fruit significantly increased with the application of Zinc (0.6%) alone or with Iron (0.4%) in fruit plants. Bhambota et al., (1962).

C. Quality Parameters

The maximum TSS was observed with the interaction of Zn and Fe (0.6%+0.6%) i.e., treatment T₃ of (9.3° Brix), followed by concentration of Zn and Fe (0.4%+0.6%) i.e., treatment T₇ of (9.1° Brix). Whereas minimum TSS in treatment T₀ which consisted of water spray was (6.3° Brix) as shown in Table 3.

Foliar application of zinc increases fruit size, total soluble solids (TSS) (Dixi and Gamdagin, 1978) also increasing sugar and decreasing acidity (Abedy, 2001).

Table 2: Effect of iron and zinc on growth

Treatments	Combinations	Plant Height (cm)			No. of leaves per plant			Plant spread (cm)	No. of fruits per plant
		30 DAT	60 DAT	90 DAT	30 DAT	60 DAT	90 DAT	90 DAT	90 DAT
T0	Water Spray	5.4	12.0	16.9	4.5	15.2	20.2	23.2	12.1
T1	Zn(0.2)+Fe(0.2)	6.8	14.0	20.8	6.5	19.6	25.0	26.0	18.0
T2	Zn(0.4)+Fe(0.4)	7.3	14.8	21.7	6.8	20.6	26.0	26.6	19.1
T3	Zn(0.6)+Fe(0.6)	8.1	15.4	22.1	7.3	21.3	27.4	27.2	20.4
T4	Zn(0.2)+Fe(0.4)	7.0	14.3	21.1	6.5	19.9	25.3	26.1	18.4
T5	Zn(0.2)+Fe(0.6)	7.6	15.0	21.8	6.9	20.9	26.5	26.7	19.7
T6	Zn(0.4)+Fe(0.2)	6.4	13.7	20.1	6.2	19.1	24.3	25.6	17.0
T7	Zn(0.4)+Fe(0.6)	7.8	15.1	21.9	7.1	21.0	26.9	26.9	20.0
T8	Zn(0.6)+Fe(0.4)	7.1	14.5	21.4	6.7	20.3	25.8	26.3	18.8
T9	Zn(0.6)+Fe(0.2)	6.5	13.9	20.4	6.4	19.4	24.7	25.9	17.6
T10	Zn(0.2)	5.7	12.8	17.2	4.9	16.7	22.0	24.3	14.1
T11	Zn(0.4)	5.9	12.8	17.5	5.0	17.2	22.6	24.6	15.0
T12	Zn(0.6)	6.0	13.1	17.9	5.2	17.7	22.9	24.9	15.4
T13	Fe(0.2)	6.1	13.2	18.4	5.5	18.1	23.1	25.2	16.0
T14	Fe(0.4)	6.2	13.3	19.3	5.7	18.4	23.4	25.3	16.3
T15	Fe(0.6)	6.3	13.6	19.9	6.0	18.8	23.8	25.6	16.8
F-test		S	S	S	S	S	S	S	S
SEd (±)		0.05	0.10	0.25	0.12	0.27	0.21	0.52	0.47
C.D_{0.05%}		0.15	0.30	0.72	0.34	0.77	0.60	1.50	1.37
CV%		1.33	1.30	2.17	3.38	2.43	1.48	3.51	4.77

Table 3: Effect of iron and zinc on yield and quality

		Yield/ha	Fruit length (cm)	Fruit weight (g)	Fruit diameter (cm)	TSS
Treatments	Treatment (%)	Mean	Mean	Mean	Mean	Mean
T0	Water Spray	2.3	3.2	18.6	2.6	6.3
T1	Zn(0.2)+Fe(0.2)	4.5	3.8	24.8	3.0	8.3
T2	Zn(0.4)+Fe(0.4)	5.0	3.9	26.2	3.1	8.6
T3	Zn(0.6)+Fe(0.6)	6.0	4.3	29.3	3.4	9.3
T4	Zn(0.2)+Fe(0.4)	4.7	3.8	25.4	3.0	8.4
T5	Zn(0.2)+Fe(0.6)	5.3	4.0	26.8	3.2	8.8
T6	Zn(0.4)+Fe(0.2)	4.1	3.6	23.8	2.9	8.1
T7	Zn(0.4)+Fe(0.6)	5.4	4.1	27.1	3.3	9.1
T8	Zn(0.6)+Fe(0.4)	4.9	3.9	25.9	3.1	8.5
T9	Zn(0.6)+Fe(0.2)	4.3	3.7	24.2	2.9	8.2
T10	Zn(0.2)	2.9	3.3	20.7	2.7	6.7
T11	Zn(0.4)	3.2	3.3	21.3	2.7	7.3
T12	Zn(0.6)	3.4	3.4	21.8	2.7	7.4
T13	Fe(0.2)	3.6	3.4	22.3	2.8	7.8
T14	Fe(0.4)	3.7	3.5	23.0	2.8	7.9
T15	Fe(0.6)	3.9	3.6	23.4	2.9	8.0
F-test		S	S	S	S	S
SEd(±)		0.07	0.10	0.47	0.09	0.10
C.D _{0.05%}		0.19	0.30	1.37	0.26	0.30
CV%		8.10	4.90	3.41	5.26	2.24

CONCLUSION

Based on the results of the present investigation entitled Effect of Foliar Application of Iron (Fe) and Zinc (Zn) on growth, yield and quality of strawberry (*Fragaria ananassa*) cv. winter dawn. it is concluded that cultivation of strawberry with different concentrations of Zn & Fe found as the best for higher productivity whereas the treatment cv. winter dawn T₃ Zn (0.6%)+Fe (0.6%) showed the best results in terms of vegetative growth, yield, quality. Hence the T₃ Zn (0.6%)+ Fe(0.6%) is best suited for the farmers in terms of growth, yield, quality and net returns.

REFERENCES

- Abdollahi, M., Eshghi, S., Tafazol, E. and Moosavi, N. (2012).** Effect of paclobutrazol, boric acid and zinc sulphate on vegetative and reproductive growth of strawberry (*Fragaria × ananassa* Duch.) cv. Selva. *J. Agri. Sci. Technol.*, **14**: 357-63
- Abedy A.(2001).** Effects of zinc sulphate and citric acid spray on fruit characteristics of tomato cultivar 'Urbana'. Msc. Thesis, Shiraz University.
- Álvarez, E., Cancela, M.A. and Maceiras, R. (2006).** Comparison of rheological behaviour of sweet and salad sauces. *International Journal of Food Properties*, **7(3)**: 511–518.
- Bhambota (1962)** Study of the effect of sprays with micro nutrients of the chlorosis of citrus. *Hortic. Adv.* 1962; 6:168-172
- Boriss, H., Brunke, H., & Kreith, M. (2006).** Commodity profile: strawberries. *Agricultural Issues Center, University of California, Davis, California, USA.*
- Chaturvedi, O. P., Singh, A. K., Tripathi, V. K., & Dixit, A. K. (2003).** Effect of zinc and iron on growth, yield and quality of strawberry cv. Chandler. In VII International Symposium on Temperate Zone Fruits in the Tropics and Subtropics-Part Two 696 (pp. 237-240).
- Dixi and Gamdagin (1978).** Effect of foliar application of zinc and iron chlorosis and yield kinnow *Pro.Horti.Sci.* 10(1), 13-19
- Faostat. (2016).** Influence of genetic variability on the quality of strawberry cultivars: sensorial, physical-chemical and nutritional characterization *Acta Scientiarum. Agronomy*
- Guidarelli, M., & Baraldi, E. (2015).** Transient transformation meets gene function discovery: the strawberry fruit case. *Frontiers in plant science*, 6, 444.
- Hakkinen & torronen (2000)** Content of flavonols and selected phenolic acids in strawberries and *Vaccinium* species: influence of cultivar, cultivation site and technique. *Food Research InternationalJournal*

Motesharezade (2001) Effects of N, Zn and B sprays on photochemical efficiency of sweet cherry. Hort. Newsletter. 2001; 12:106-111

Panse, V.G. and Sukhatme, P.V. (1985) Statistical Methods for Agriculture Workers. ICAR, New Delhi, 14-