Original Research Article

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 the "Effect of foliar application of Iron (Fe) and zinc (Zn) on growth, yield and quality of 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 results o the present investigation, regarding the cultivation of Strawberry with different concentrations of Zin (Zn) and Iron (Fe) found as the best option for higher productivity whereas the treatment wit concentration of Fe(0.6%)+ Fe (0.6%) showed the best result in terms of plant height at 30 DAT (8.1cm 60 DAT (15.4 cm) and 90 DAT (22.1cm), Number of leaves plant^{-1} at 30 DAT(7.3), 60 DAT(21.3) an 90 DAT(27.4), Plant Spread (27.2 cm), runner plant^{-1} (5.9), yield/ha (6.0 t), fruit length (4.3 cm), fru weight (29.3 g), fruit diameter (3.4 cm), TSS (9.3^{o} Brix), B:C ratio (3:8:1) showed the best results i terms of vegetative growth, yield, quality, economic returns and B:C ratio. Hence the T_3Zn (0.6%) (0.6%) is best suited for the farmers in terms of growth, yield, quality and net returns.

Keywords: *Strawberry, Growth, Yield and Quality*

INTRODUCTION

Strawberry (*Fragaria x ananassa duch.*) is one of the most important temperate fruit belongs t the family Rosaceae. It is an octoploid (8x) in nature having (x=7) basic chromosome number. t 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 even 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. Strawberry is a low calorific carbohydrate fruit. It is a rich source of Vit. A (60 IU/100 g of edible portion), Vit. C (30-120 mg/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. 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).

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).

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Iron (Fe) deficiency induces chlorosis is a major nutritional disorder in calcareous soils (Alvarez et al., 2006). The phenotype introduced by hairpin RNAi-based silencing can be heritable, moreover th 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. Zinc is an important essential micronutrient for plant. Zinc is an essential metal fo normal plant growth and development since it's a structural element of proteins and enzymes in living organisms. High concentrations of Zn in many soils indicated correct management methods including application of sewage sludge or animal manure. Therefore, present study was conducted to study th effect of foliar application of Iron and zinc on growth, yield and quality of strawberry in cv. Winte dawn.

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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 (*Frageria ananassa*) cv. Winter dawn" was conducted in rabi season adapting Randomized Block Design (RBD) consisting of 16 treatments and three replications. The treatments are T_0 (water spray),T_1(Zn 0.2%+Fe 0.2%),T_2 (Zn 0.4%+Fe 0.4%),T_3 (Zn 0.6%+Fe 0.6%),T_4(Zn 0.2%+Fe 0.4%),T_5 (Zn 0.2%+Fe 0.6%)T_6(Zn 0.4%+Fe 0.2%)T_7 (Zn 0.4%+Fe 0.6%)T_8(Zn 0.6%+Fe0.4%)T_9(Zn 0.6%+Fe 0.2%) ,T_{10} (Zn 0.2%),T_{11}(Zn 0.4%),T_{12}(Zn 0.6%) ,T_{13}(Fe 0.2%),T_{14} (Fe 0.4%),T_{15} (Fe 0.6%).The experimental field has an even topography with a gentle slope a good drainage. The sample were drownfrom 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 representative sample for recordin the data.

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Iron and zinc applied to the seedlings of strawberry manually at of 30, 60 and 90 days after transplanting (DAT) as per treatments. Experimental data collected was subjected to statistical analysis 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

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Table 1: Treatment details

S.NO	Treatment Notations	Treatment Details
1.	T_0	WATER SPRAY
2.	T_1	Zn(0.2%)+Fe(0.2%)
3.	T_2	Zn(0.4%)+Fe(0.4%)
4.	T_3	Zn(0.6%)+Fe(0.6%)
5.	T_4	Zn(0.2%)+Fe(0.4%)
6.	T_5	Zn(0.2%)+Fe(0.6%)
7.	T_6	Zn(0.4%)+Fe(0.2%)
8.	T_7	Zn(0.4%)+Fe(0.6%)
9.	T_8	Zn(0.6%)+Fe(0.4%)
10.	T_9	Zn(0.6%)+Fe(0.2%)
11.	T_{10}	Zn(0.2%)

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12.	**T_{11}**	**Zn(0.4%)**
13.	**T_{12}**	**Zn(0.6%)**
14.	**T_{13}**	**Fe(0.2%)**
15.	**T_{14}**	**Fe(0.4%)**
16.	**T_{15}**	**Fe(0.6%)**

RESULTS AND DISCUSSION

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The results revealed that strawberry had the following performance.

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 T_3 (8.1 cm), followed by concentration of Zn and Fe (0.4%+0.6%) i.e., treatment T_7 (7.8 cm). Whereas minimum was recorded in treatment T_0 (5.4 cm) which consisted of water spray.
The maximum plant height at (60 days) was observed with interaction of Zn and Fe (0.6%+0.6%) i.e., treatment T_3 (15.4 cm), followed by concentration of Zn and Fe (0.4%+0.6%) i.e., treatment T_7 (15.1 cm). Whereas minimum was recorded in treatment T_0 (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 T_3 (22.1 cm), followed by concentration of Zn and Fe (0.4%+0.6%) i.e., treatment T_7 (21.9 cm). Whereas minimum in treatment T_0 (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 growth parameters 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 T_3 (7.3), followed by concentration of Zn and Fe (0.4%+0.6%) i.e., treatment T_7 (7.1). Whereas minimum was recorded in treatment T_0 (4.5) which consisted of water spray.
The maximum no. of leaves at (60 days) was observed with interaction of Zn and Fe (0.6%+0.6%) i.e., treatment T_3 (21.3), followed by concentration of Zn and Fe (0.4%+0.6%) i.e., treatment T_7 (21.0). Whereas minimum was recorded in treatment T_0 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 T_3 (27.4), followed by concentration of Zn and Fe (0.4+0.6) i.e., treatment T_7 (26.9). Whereas minimum was recorded in treatment T_0 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 T_3 (27.2), followed by concentration of Zn and Fe (0.4%+0.6%) i.e., treatment T_7 (26.9). Whereas minimum plant spread (90 days) was recorded in treatment T_0 which consisted of water spray was (23.2).

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 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).

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)

The maximum fruit length was observed with 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 interaction of Zn and Fe (0.6%+0.6%) i.e., treatment of (3.4 cm), followed by concentration of Zn and Fe (0.4%+0.6%) i.e., treatment $T_7$of (3.3 cm). Whereas minimum fruit diameter in treatment T_0which 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 interaction of Zn and Fe (0.6%+0.6%) i.e., treatment T3 of (9.3 o Brix) followed by concentration of Zn and Fe (0.4%+0.6%) i.e., treatment T7 of (9.1 o Brix). Whereas minimum TSS in treatment T0 which consisted of water spray was (6.3 o Brix).

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 parameters

		Plant Height (cm)			No. of leaves per plant			Plant spread (cm)	No. of fruits per plant
Treatments	**Combinations**	**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

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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 parameters

		Yield/ha	**Fruit length (cm)**	**Fruit weight (g)**	**Fruit diameter (cm)**	**TSS**
Treatments	**Treatment Combinations(%)**	**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, economic returns and B:C ratio. Hence the T3 Zn (0.6%)+ Fe(0.6%) is best suited for the farmers in terms of growth, yield, quality and net returns.

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