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Effect of micro-nutrients as a foliar spray on the performance of Zinnia (*Zinnia elegans* L.) Cv. Lilliput mix

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Abstract
An experiment was carried out at Navjeevan Kisan P.G. College, Mawana, Meerut, (UP). Among the treatments applied in the study, The maximum height of plant, number of leaves per plant, diameter of stem, number of shoots per plant and length of longest leaf were obtained under F_3Z_3 (1500ppm Iron +1500ppm Zinc) treatment combination, but the maximum time taken to first flower bud appearance after transplanting was observed under F_1Z_1(500ppm Iron+500ppm Zinc) treatment. While; the maximum number of flower, diameter of flower was recorded under F3Z3(1500ppm Iron +1500ppm Zinc). The maximum time taken to full opening of flower bud appearance was obtained under F_0Z_0(0ppm Iron+0ppm Zinc).

Keywords: *Zinnia spp.*, micro-nutrients

Introduction
Zinnia (*Zinnia elegans* L.) is a popular flowering plant and belongs to the family **composite**. It is a annual and perennial plant in north and south America but in India it is grown mostly as a summer and rainy season annual. Zinnia was originated from the Mexico and Central America. The leading Zinnia growing countries America, England, Holland, Brajeel, France and Japan. In India, U.P, Punjab, M.P., Gujarat, Maharastra and Karnatka etc are the leading Zinnia growing states (Singh 1985) [9]. In India, Zinnia was first introduced in 1958 from France.
Zinnia is cultivated for exhibition purpose, garden display, homes decoration and flower arrangement all over the world. In India, Zinnia is suitable for growing in beds, border, pots. The Dwarf varieties are ideal for widow-Boxes, edgings and beds. The cut flowers are commonly used in flower arrangement. Zinnia flowers adorn the hairs of ladies particularly in south India. All types of Zinnia are favorites as exhibits by cynosure is the "Giant" whose flowers measured over 25.4 Cm. across.
The flower of Zinnia have wide range of colour fours an size, dark red, orange scarlet, pink and all other colours are available in the Zinnia. Bicolour Zinnias are probably most beautiful than their counterpart in other flowers. Zinnia flowers in full in glory for over four months at a stretch in many parts of vast plains and at different times in the different climates. Zinnia flowers in summer and rainy season in the plains. The seed of Zinnia is sown from February to March in the plains. The transplanting is done at a distance of 40 Cm X 30 cms. When the seedlings attain the height of about 5 cms. Flowering occurs after about 50 days of transplanting.
There is a general feeling that either the climate is not favourable for growth and development of seasonal plants like 'Zinnia' or deficiency of some micro-nutrients do not permit it to grow normally. The later possibility is considered to be most important. Besides the nitrogen, phosphorus and potassium, micro nutrients like Zinc and Iron also have the great influence on the growth and flowering of seasonal plants.
Keeping all the above factors in mind the present experiment entitled "The effect of micro-nutrients as a foliar spray on the performance of Zinnia Spp. Cv. Lilliput mix." Was carried out at the Horticultural Research farm Navjeevan Kisan P.G. College, Mawana, Meerut-U.P. (India) with the following objective;
To find out the optimum concentration of Zn and Fe in the form of foliar spray for obtaining the best growth and quality off Zinnia flowers.

Material and Methods

The experiment was carried out under the field conditions of the Horticultural Research farm Navjeevan Kisan P.G. College, Mawana, Meerut The soil of experimental plot was sandy loam having good moisture holding and good heat absorbing capacity. The soil was well drained**.** Meerut is situated at 20.01 N latitude and 77.43 longitude at an elevation of about 222 meters above the mean sea level. Meerut region has a typical climate of semiarid with the extremes of weather conditions. The average annual precipitation about 700 mm. Bulk of which nearly 7070 is received between June and September. The climate is hot in summer season and cold with frost in winter season. Maximum and minimum temperature range between 44 °C and 3 °C. Preparation of micro-nutrient solution Zinc sulphte ($ZnSO_4.7H_20$) and Ferrous sulphate ($FeS0_2.7H_20$) containing 22.5% used for zinc and iron. 250 ml solution of each micro-nutrient was prepared. The respective doses of chemicals are as Z_0 (0mg) Zinc sulphate, Z_1 (555mg) Zinc sulphate, Z_2 (1110mg) Zinc sulphate, Z_3 (1665mg) Zinc sulphate and F_0 (0mg) Ferrous sulphate, F_1 (625 mg) Ferrous sulphate, F_2 (1250 mg) Ferrous sulphate, F_3 (1875mg) Ferrous sulphate. Method of application for four concentrations (0, 500, 1000, 1500 ppm) each of Iron and Zinc were sprayed on 15th and 30th days after transplanting. In control the water was sprayed alone. The sixteen treatments and in this experiment the design adopted was simple R.B.D. with three replications. The treatment consisted of all possible combination of two, micro-nutrients viz. Zinc and Iron with four concentrations treatment F_0(0 ppm), F_1(500 PPm), F_2 (1000 ppm), F_3 (1500 ppm), Z_0 (0 ppm), Z_1 (500 ppm), Z_2 (1000 ppm) Z_3 (1500 ppm).the experiment was Analysis of variance (ANOVA) test was performed for different plant parameters in different treatments.

Result and Discussion

(A) Growth characters

1. Height of the plant

The maximum height of plant (43.50 cm) was obtained under F_3Z_3 treatment. However; the minimum height of plant (40.23 cm) was recorded under F_0Z_1 treatments and control (38.80 cm.) after 60 days of transplanting (Table-1).

Table 1: Height of the plant (cm)

Treatment combination	15 DAT	30 DAT	45 DAT	60 DAT
F_0Z_0	17.00	4.30	29.59	38.80
F_0Z_1	17.63	24.84	29.87	40.23
F_0Z_2	17.66	25.75	30.47	40.60
F_0Z_3	18.27	26.33	30.75	41.35
F_1Z_0	18.12	25.33	29.86	40.83
F_1Z_1	18.12	26.41	30.47	42.03
F_1Z_2	18.53	26.50	30.74	42.14
F_1Z_3	18.86	27.04	30.87	43.18
F_2Z_0	18.26	25.74	29.87	40.86
F_2Z_1	18.44	26.43	30.47	41.82
F_2Z_2	19.03	26.82	30.92	42.24
F_2Z_3	18.84	27.31	31.03	43.16
F_3Z_0	18.62	26.12	29.97	41.00
F_3Z_1	19.09	27.35	30.73	42.22
F_3Z_2	19.17	27.95	31.03	42.71
F_3Z_3	19.42	27.99	31.38	43.50
C.D.at 5%	N.S.	.083	.83	.18

DAT- Days after transplanting, N.S- Non significant.

2. Number of leaves per plant

The maximum number of leaves (18.10) was recorded under F_3Z_3 treatment. While the minimum number of leaves (16.86) was noted under F_1Z_0 treatment and control (16.12) after 60 days of transplanting (Table-2).

Table 2: Number of leaves per plant

Treatment combination	15 DAT	30 DAT	45 DAT	60 DAT
F_0Z_0	5.3	9.89	12.65	16.12
F_0Z_1	6.7	11.57	13.83	16.86
F_0Z_2	7.0	12.45	14.15	17.23
F_0Z_3	7.0	12.45	14.41	17.76
F_1Z_0	6.7	10.23	12.43	15.88
F_1Z_1	6.7	11.62	13.86	16.86
F_1Z_2	6.7	12.10	14.60	17.43
F_1Z_3	7.8	12.28	15.65	17.70
F_2Z_0	6.0	10.34	13.60	16.23
F_2Z_1	7.0	12.12	15.05	17.27
F_2Z_2	6.7	12.61	15.80	17.48
F_2Z_3	6.7	12.45	16.12	17.90
F_3Z_0	7.0	11.33	13.67	16.40
F_3Z_1	7.0	12.50	15.20	17.06
F_3Z_2	8.0	12.49	16.02	17.73
F_3Z_3	7.67	12.56	16.18	18.10
C.D.at 5%	N.S.	.23	.60	.058

3. Diameter of stem

The maximum diameter of stem (1.89cm) was observed under F_3Z_3 treatment. While; the minimum diameter of stem (1.55cm) was observed under F_1Z_0 treatment and control (16.12) after 60 days of transplanting (Table-3).

Table 3: Diameter of stem (cm)

Treatment combination	15 DAT	30 DAT	45 DAT	60 DAT
F_0Z_0	.68	.84	1.03	1.33
F_0Z_1	.65	.91	1.13	1.55
F_0Z_2	.72	.97	1.22	1.64
F_0Z_3	.74	1.00	1.26	1.81
F_1Z_0	.64	.88	1.10	1.36
F_1Z_1	.69	.94	1.22	1.56
F_1Z_2	.72	1.05	1.27	1.76
F_1Z_3	.78	1.14	1.28	1.84
F_2Z_0	.72	.89	1.15	1.41
F_2Z_1	.73	1.01	1.20	1.71
F_2Z_2	.77	1.08	1.21	1.79
F_2Z_3	.81	1.13	1.34	1.87
F_3Z_0	.75	.93	1.17	1.47
F_3Z_1	.79	1.14	1.25	1.63
F_3Z_2	.83	1.21	1.32	1.82
F_3Z_3	.89	1.23	1.34	1.89
C.D.at 5%	N.S.	.001	.002	.001

4. Number of shoots per plant

The maximum number of shoots per plant (9.33) was noted under F_3Z_3 treatment. While; the minimum number of shoots per plant (8.18) was observed under F_1Z_0 treatment and control (8.05) after 60 days of transplanting (Table-4).

Table 4: Number of Shoots per plant

Treatment combination	15 DAT	30 DAT	45 DAT	60 DAT
F_0Z_0	6.0	6.83	7.83	8.05
F_0Z_1	5.94	7.32	8.00	8.68
F_0Z_2	6.06	7.11	8.20	8.82
F_0Z_3	6.80	7.58	8.33	9.09
F_1Z_0	6.60	7.15	7.73	8.18
F_1Z_1	6.70	7.57	8.20	8.73
F_1Z_2	6.90	7.75	8.30	8.90
F_1Z_3	7.26	7.84	8.31	9.16
F_2Z_0	6.63	7.16	8.12	8.38
F_2Z_1	6.83	7.63	8.38	8.71
F_2Z_2	7.26	7.91	8.32	8.88
F_2Z_3	7.73	7.16	8.50	9.16
F_3Z_0	7.53	7.93	8.13	8.46
F_3Z_1	7.53	8.13	8.29	8.80
F_3Z_2	7.7	8.24	8.41	9.03
F_3Z_3	8.20	8.56	8.50	9.33
C.D.at 5%	N.S.	.017	.086	.006

5. Length of longest leaf of plant

The maximum length of longest leaf of plant (8.05cm) was observed under F_3Z_3 treatment. While; the minimum length of longest leaf of plant (7.31cm) was noted under F_3Z_0 treatment and control (7.30cm) after 60 days of transplanting (Table-5).

Table-5: Length of longest leaf of plant (cm)

Treatment combination	15 DAT	30 DAT	45 DAT	60 DAT
F_0Z_0	5.59	6.41	6.45	7.30
F_0Z_1	5.62	6.84	6.89	7.63
F_0Z_2	5.63	6.86	6.91	7.77
F_0Z_3	6.14	6.88	6.94	7.86
F_1Z_0	5.70	6.38	6.91	7.28
F_1Z_1	6.25	6.69	6.79	7.58
F_1Z_2	6.81	6.81	6.93	7.73
F_1Z_3	7.02	7.20	7.25	7.82
F_2Z_0	6.34	6.63	6.71	7.39
F_2Z_1	6.85	7.11	7.24	7.63
F_2Z_2	6.99	7.22	7.35	7.85
F_2Z_3	7.24	7.72	7.82	8.09
F_3Z_0	6.64	6.91	7.01	7.31
F_3Z_1	7.21	7.14	7.25	7.63
F_3Z_2	7.40	7.47	7.54	7.93
F_3Z_3	7.64	7.69	7.85	8.05
C.D.at 5%	N.S.	.013	.027	.018

The micro-nutrients were sprayed on plants at 15 and 30 days after transplanting, hence the micro-nutrients could not affect the growth characters at 15 days stage. At 45 and 60 days of growth stages, different treatments produced significant effect on different growth characters. F_3Z_3 treatment was found superior and control (F_0 Z_0) treatment was found inferior as compared to other treatments. Sharova *et al* (1977) [8] also reported the same results in gladiolus, Chen *et al* (1982) [1], Harvey *et al* (1984) [3], Skii *et al* (1977) [7], Richard *et al* (1984) [5] and Savva (1976) [6] also reported the same results.

(B) Flowering characters

1. Time Taken To 1st Flower Bud Appearance after Transplanting

The maximum time taken to 1st flower bud appearance after transplanting was (70) days under F_1Z_1, treatment. While; the minimum time taken to 1st flower bud appearance after transplanting was (67 days) under F_0Z_1 treatment (Table-6).

Table 6: Time Taken To 1st Flower Bud Appearance after Transplanting (Days)

Treatment combination	50 DAT	60 DAT	70 DAT
F_0Z_0	56.33	62.00	67.00
F_0Z_1	54.33	60.66	67.00
F_0Z_2	55.00	60.00	68.66
F_0Z_3	53.00	59.33	69.33
F_1Z_0	52.33	58.66	68.66
F_1Z_1	54.00	58.66	70.00
F_1Z_2	54.66	57.66	68.66
F_1Z_3	55.66	59.33	67.66
F_2Z_0	54.66	56.33	67.00
F_2Z_1	55.00	60.33	67.00
F_2Z_2	54.00	59.00	67.66
F_2Z_3	51.33	59.66	68.00
F_3Z_0	52.33	61.33	68.00
F_3Z_1	54.66	62.33	68.00
F_3Z_2	56.00	61.66	69.00
F_3Z_3	53.00	60.66	69.66
C.D.at 5%	N.S.	N.S.	.51

2. Number of flower per plant

The maximum number of flowers per plant (12) was obtained under F_3Z_3 treatment. While; the minimum number of flowers (8.66) was recorded under F_0Z_2 treatment (Table-7).

Table 7: Number of flower per plant

Treatment combination	50 DAT	60 DAT	70 DAT
F_0Z_0	4.00	6.66	8.33
F_0Z_1	4.00	7.33	9.00
F_0Z_2	4.60	7.63	8.66
F_0Z_3	5.30	8.33	9.00
F_1Z_0	3.30	7.66	9.00
F_1Z_1	2.00	8.00	9.00
F_1Z_2	2.60	9.00	10.3
F_1Z_3	3.30	9.33	10.0
F_2Z_0	5.00	7.66	9.33
F_2Z_1	4.00	8.00	9.33
F_2Z_2	2.30	8.00	10.0
F_2Z_3	4.00	10.0	10.0
F_3Z_0	3.00	8.00	10.0
F_3Z_1	2.60	9.66	11.3
F_3Z_2	6.00	10.0	11.0
F_3Z_3	3.00	11.3	12.0
C.D.at 5%	N.S.	.05	.107

3. Diameter of flower

The maximum diameter of flower (5.26 cm) was observed under F_3Z_3 treatment. However; the minimum diameter of flower (4.41 cm) was recorded under F_2Z_0 and control (4.35 cm) treatments (Table-8).

Table 8: Diameter of flower (cm)

Treatment combination	50 DAT	60 DAT	70 DAT
F_0Z_0	3.56	4.25	4.35
F_0Z_1	3.36	4.50	4.64
F_0Z_2	3.53	4.34	4.46
F_0Z_3	4.10	4.65	4.80
F_1Z_0	3.80	4.23	4.43
F_1Z_1	3.85	4.63	4.68
F_1Z_2	3.93	4.68	4.91
F_1Z_3	3.56	4.73	4.93
F_2Z_0	3.46	4.23	4.41
F_2Z_1	3.80	4.36	4.59
F_2Z_2	2.33	4.79	5.00
F_2Z_3	4.10	4.96	5.09
F_3Z_0	3.56	4.36	4.61
F_3Z_1	2.50	4.73	4.91
F_3Z_2	4.56	4.97	5.06
F_3Z_3	4.78	5.18	5.26
C.D.at 5%	N.S.	.003	.02

4. Time taken to full opening of flower after flower bud appearance

The maximum time taken to full opening of flower after flower bud appearance (2.66 days) was obtained under control (F_0Z_0) treatment. While; the minimum time taken to full opening of flower after flower bud appearance (2 days) was recorded under F_1Z_1 treatment (Table-9).

Table 9: Time taken to full opening of flower after flower bud appearance (Days)

Treatment combination	50 DAT	60 DAT	70 DAT
F_0Z_0	2	2	2.66
F_0Z_1	2	2	2.33
F_0Z_2	2.33	2	2.33
F_0Z_3	2	2.66	2.33
F_1Z_0	2	2.33	2.00
F_1Z_1	2	2	2.33
F_1Z_2	2	2.33	2.00
F_1Z_3	2	2.66	2.00
F_2Z_0	2	2.33	2.00
F_2Z_1	2	2	2.00
F_2Z_2	2	2	2.00
F_2Z_3	2	2	2.00
F_3Z_0	2.66	2	2.00
F_3Z_1	2	2	2.00
F_3Z_2	2.33	2	2.00
F_3Z_3	2.33	2	2.33
C.D.at 5%	N.S.	N.S.	.038

The different flowering characters like time taken to Ist flower bud appearance after transplanting, number of flowers Per plant, diameter of flower, thickness of flower stalk and time taken to full opening of flower after flower bud appearance table (7 and 8) were influenced significantly by different treatments. This is because the different treatments brought about change in the growth of the plants. Zinc plays an important role in biosynthesis of plant auxin which promotes the plant in growth. Iron helpful chlorophyll formation. The same results reported Richard *et al* (1984) [5], Savva (1976) [6], Harvey *et al* (1984) [3] and Hanger *et al* (1984) [2].

Conclusion

Based on the results obtained from the present study, it may be concluded that, better growth and flowering of Zinnia can be obtained with treatment $^{F}{}_{3}{}^{Z}{}_{3}$ (1500 ppm, Iron and 1500 ppm Zinc.).

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