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Effect of zinc and iron on yield and quality of summer okra

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Abstract
An experiment entitled "effect of zinc and iron on yield and quality of summer okra" was carried out during summer season of the year 2020-21 at the farm of Horticulture section, College of Agriculture, Nagpur. The treatment comprised of the four zinc levels *viz.*, 0% control i.e. (water spray), 0.25% $ZnSO_4$, 0.5% $ZnSO_4$, 0.75% $ZnSO_4$ and four iron levels 0% control i.e. water spray, 0.25% $FeSO_4$, 0.5% $FeSO_4$, 0.75% $FeSO_4$. The experiment was laid out in Factorial Randomized Block Design with three replications. The result obtained the present investigation indicated that, the fruit yield parameter in terms of maximum Number of fruit plant^{-1} 0.5% $ZnSO_4$ (51.47) as well as 0.5% $FeSO_4$ (43.88), fruit yield plant^{-1}, fruit yield plot^{-1} (kg) and fruit yield hectare^{-1} (T) were recorded in 0.5% ZnSO4 as well as 0.5% FeSO4. The quality parameters like weight of fruit (g), Vitamin C content of fruit (mg/100 g) was recorded maximum in 0.5% ZnSO4 as well as 0.5% $FeSO_4$.

Keywords: Zinc, iron, fruit yield, quality and summer okra

Introduction
Okra [*Abelmoschus esculentus* (L.) Moench] commonly known as lady's finger or that, belongs to the family Malvaceae. It is widely adopted and popular vegetable in Indian kitchens and can be grown in summer and rainy seasons throughout India. It is widely adopted and popular vegetable in Indian kitchens and can be grown in summer and rainy seasons throughout India. India is the highest producer in the world and exported there by helping in earning foreign exchange. Okra is an important vegetable grown for its tender fruits which are used as a vegetable in various ways. Matured fruits and stem containing crude fibers are used in the paper industry, roots and stems are used for clarification of sugar cane juice in preparation of jaggery.

Now-a-days, micronutrients especially zinc and iron are gradually gaining momentum among the flower growers because of their beneficial nutritional support and to ensure better harvest and returns. These micronutrients generally activate several enzymes and envolve themselves in chlorophyll synthesis and various physiological activities by which plant growth and development are encouraged. Hence, considering the above facts, the present investigation was undertaken to study the yield and quality of. summer okra as influenced by zinc and iron.

Material and Methods
An experiment entitled yield and quality of summer okra as influenced by zinc and iron" was laid out at the field of Horticulture Section, College of Agriculture, Nagpur during 2020-2021. The treatment comprised of the four zinc levels *viz.*, 0% control i.e. (water spray), 0.25% $ZnSO_4$, 0.5% $ZnSO_4$, 0.75% $ZnSO_4$ and four iron levels 0% control i.e. water spray, 0.25% $FeSO_4$, 0.5% $FeSO_4$, 0.75% $FeSO_4$. The experiment was laid out in Factorial Randomized Block Design (FRBD) with sixteen treatment combinations and three replications. The seed were sowing in field on 10th jan 2021 at 45 cm × 60 cm spacing. A standard dose of NPK at the rate of 150 Kg N, 100 Kg P and 100 Kg K hectare^{-1} was applied through urea, single super phosphate and murriate of potash. The basal dose of 50 Kg N and full dose of P and K was applied at the time of sowing. The foliar application was done by solution of zinc and iron each of 0.25%, 0.5% and 0.75% were prepared on molecular weight basis by dissolving respective amount of zinc sulphate and ferrous sulphate respectively in distilled water. Then the prepared solution was spread at 45 and 60 days after planting individually and in combinations as per the treatment. Five uniform plants were selected randomly from each plot for recording f yield parameters *viz.*, number of fruit plant^{-1}, fruit yield plant^{-1} fruit yield plot^{-1}, fruit yield hectare^{-1} and quality parameters *viz.*, weight of fruit, Data were statistically analyzed

in FRBD.

Result and Discussion

The data presented in table revealed that, different levels of zinc and different levels iron had significant effect on all fruit yield and quality parameters of summer okra.

Fruit yield parameters

a) Effect of zinc

Significantly, maximum number of fruit plant^{-1} (28.56) was recorded in Z_2 (0.50% $ZnSO_4$) which was followed by Z_3 - 0.75% $ZnSO_4$ (23.02). However, significantly minimum number of fruit plant^{-1} (19.03) was recorded in control (water spray). It was observed that, number of fruit plant^{-1} in summer okra increased with the increase in zinc level up to 0.50%, but further augmenting of zinc depressed the number. Significantly, maximum fruit yield plant^{-1} (0.223 kg) was recorded in Z_2 (0.50% $ZnSO_4$) which was followed by Z_3 - 0.75% $ZnSO_4$ (0.188 kg). However, significantly minimum fruit yield plant^{-1} (0.170 kg) was recorded in control (water spray). In foliar application of zinc might be due to more zinc received by plant produced larger canopy associated with leaf area, resulting in accumulation of higher amount of photosynthate which showed the positive effect on fruit yield plant^{-1}. Significantly, maximum fruit yield plot^{-1} (6.70 kg) was recorded in Z_2 (0.50% $ZnSO_4$) which was followed by Z_3 - 0.75% $ZnSO_4$ (5.60 kg). However, significantly minimum fruit yield plot^{-1} (5.12 kg) was recorded in control (water spray). From the above result, the foliar spray of 0.50% $ZnSO_4$ recorded maximum fruit yield plot^{-1}, this might have been be due to maximum fruit yield plant^{-1} with foliar application of 0.50% $ZnSO_4$. Significantly, maximum fruit yield hectare^{-1} (248.10 q) was recorded in Z_2 (0.5% $ZnSO_4$) which was followed by Z_3 - 0.75% $ZnSO_4$ (207.25 q) and Z_1 - 0.25% $ZnSO_4$ (205.52 q). However, significantly minimum fruit yield hectare^{-1} (189.79 q) was recorded in control (water spray). The maximum fruit yield hectare^{-1} recorded at 0.50% $ZnSO_4$ might be attributed to increased growth parameters *viz.*, plant height, branches plant^{-1} and leaf area of summer okra and various yield contributing characters *viz.*, fruit plant^{-1}, fruit yield plant^{-1} and fruit yield plot^{-1} at 0.50% $ZnSO_4$. From the above findings, it was shown that, maximum fruit yield was recorded in the treatment combination Z_2F_2 - 0.50% $ZnSO_4$ and 0.50% $FeSO_4$. It might be due to the fact that, zinc activates several enzymes *viz*., catalyase, tryptophan, synthate etc. and envolve itself in chlorophyll synthesis and various physiological activities by which plant growth and development are encouraged, due to which the fruit yield might have been increased. The findings are in close confirmity with Patil (2001) [5] in okra, Raj *et al*. (2001) [6] in brinjal, Basavarajeshwari *et al*. (2006) [2] in tomato and Kumar *et al*. (2019) [7] in okra.

The data presented in Table revealed that, vitamin C content of fruit was significantly influenced by different levels of zinc. Significantly, maximum vitamin C content of fruit (17.77 mg) was recorded in Z_2 (0.50% $ZnSO_4$) which was followed by Z_3 - 0.75% 68 $ZnSO_3$ (15.81 mg). Zo, Z_1 and Z_3 were at par with each other. Whereas, significantly minimum vitamin C content of fruit (15.49 mg) was recorded in control (water spray). Similar results were reported by Dubalgunde *et al*. (2015) [4] in okra. Significantly, maximum weight of fruit (13.20 g) was recorded in Z2 (0.50% ZnSO4) which was followed by Z3 - 0.75% ZnSO4 (11.33 g) and Z2 - 0.25% ZnSO4 (10.58 g). However, significantly minimum weight of fruits (9.44 g) was recorded in control (water spray). From the above findings, it is indicated that, maximum, weight of fruit was recorded with foliar application of 0.50% $ZnSO_4$. These findings were in close conformity with the findings of Chingakham *et al*. (2013) [3] in chilli and Ali *et al*. (2015) [1] in tomato.

b) Effect of iron

Significantly, maximum number of fruit plant^{-1} (26.95) was recorded in F_2 (0.50% $FeSO_4$) which was followed by F_3 - 0.75% $FeSO_4$ (24.03). However, significantly minimum number of fruit plant^{-1} (20.94) was noticed in control (water spray). It was clear from the data that, 0.50% $FeSO_4$ produced maximum number of fruit plant^{-1} in summer okra and it was slightly decreased with further increase in level of iron. Iron would have helped in biosynthesis of photo assimilates; thereby enhanced vegetative growth of plant which in turn might have improved the quality of flower by increasing number of fruit plant^{-1}. Significantly, maximum fruit yield plant^{-1} (0.223 g) was recorded in F_2 (0.5% $FeSO_4$) which was found at par with F_3 - 0.75% $FeSO_4$ (0.196 g). However, significantly minimum fruit yield plant^{-1} (0.160 g) was recorded in control (water spray). The increase in fruit yield plant^{-1} with foliar application of 0.50% $FeSO_4$ might be due to accumulation of higher amount of photosynthate which showed the positive effect on fruit yield plant^{-1} and also higher in number of fruit plant^{-1} which ultimately favoured photosynthesis and translocation of assimilates into flower organ. Significantly, maximum fruit yield plot^{-1} (6.65 kg) was recorded in F_2 (0.50% $FeSO_4$) which was found at par with F_3 - 0.75% $FeSO_4$ (5.90 kg). However, significantly minimum fruit yield plot^{-1} (4.80 kg) was recorded in control. From the above findings, it is indicated that, maximum fruit yield plot^{-1} was recorded with foliar application of 0.50% $FeSO_4$. This might have been due to increased fruit yield plant^{-1}. Significantly maximum fruit yield hectare^{-1} (246.25 q) was recorded in F_2 (0.5% $FeSO_4$) which was followed by F_3 - 0.75% $FeSO_4$ (218.50 q). However, significantly minimum fruit yield hectare^{-1} (177.74 q) was recorded in control (water spray). Per hectare fruit yield of summer okra increased with increase in the concentration of iron and the maximum fruit yield hectare^{-1} was recorded at 0.50% $FeSO_4$. This might be due to fact that, all the growth and yield parameters significantly increased by application of iron as iron plays an important role in chlorophyll synthesis, photosynthesis and respiration. Similar results were also reported by Singh *et al*. (2009) [10] in faba bean, Chingakham *et al*. (2013) [3] in chilli and Satpute *et al*. (2015) [8] in okra.

Significantly, maximum weight of fruit (12.63 g) was recorded in F_2 (0.50% FeSO4) which was followed by F_3 - 0.75% $FeSO_4$ (11.41 g). However, significantly minimum weight of fruit (9.75 g) was recorded in control. From the above findings, it is indicated that, maximum, weight of fruit was recorded with foliar application of 0.50% $FeSO_4$. Similar observations were recorded by Surendra *et al*. (2006) [9] in, Ghritlahare *et al*. (2015) [11] in okra. Significantly maximum vitamin C content of fruit (17.24 mg) was found in F_2 (0.50% iron) which was at par with F_3 - 0.75% $FeSO_4$ (16.96 mg) and F_1 - 0.25% $FeSO_4$ (16.07 mg). However, significantly minimum vitamin C content of fruit (14.52 mg) was noticed in control (water spray). Similar results were reported by Dubalgunde *et al*. (2015) [4] in okra.

Table 1: Effect of zinc and iron on yield and quality parameters of summer okra

Treatments	Number Of fruit plant^{-1}	Fruit yield plant^{-1} (g)	Fruit yield plot^{-1} (kg)	Fruit yield per hectare (t)	Weight of fruit (g)	Vitamin C content of fruit (mg/100 g)
Z_0 - 0% (Control)	19.03	0.170	5.12	189.79	9.44	15.49
Z_1 - 0.25% $ZnSO_4$	22.89	0.185	5.55	205.52	10.58	15.73
Z_2 - 0.50% $ZnSO_4$	28.56	0.223	6.70	488.10	13.20	17.17
Z_3 - 0.75% $ZnSO_4$	23.02	1.188	5.60	207.25	11.33	15.81
SE (m)+	0.36	0.004	0.12	4.53	0.14	0.66
C.D. at 5%	1.06	0.01	0.36	13.09	0.41	1.35
F_0 - 0% (Control)	20.94	0.160	4.80	177.74	9.75	14.42
F_1 - 0.25% $FeSO_4$	21.57	0.189	5.67	208.18	10.76	16.07
F_2 - 0.50% $FeSO_4$	26.95	0.223	6.65	246.25	13.63	17.24
F_3 - 0.75% $FeSO_4$	24.03	0.196	5.90	218.50	11.41	16.96
SE (m)+	0.36	0.01	0.12	4.53	0.14	0.66
C.D. at 5%	0.96	0.03	0.36	13.09	0.41	1.33
Interaction effect A x B						
SE (m)+	0.90	0.01	0.30	11.10	0.35	1.14
C.D. at 5%	2.61	0.03	0.88	32.09	1.02	-

c) Interaction effect

The interaction effect of zinc and iron on number of fruits plant^{-1} was found significant. The treatment combination Z_2F_2 0.50% $ZnSO_4$ and 0.50% $FeSO_4$ had recorded significantly maximum number of fruits plant^{-1} (32.20) which was followed by treatment combination Z_2F_3 - 0.50% $ZnSO_4$ and 0.75 $FeSO_4$ (29.16) and Z_1F_2 - 0.25% $ZnSO_4$ and 0.50 $FeSO_4$ (28.17). However, minimum number of fruits plant^{-1} (18.15) was recorded in control treatment. The treatment combination Z_2F_2 - 0.50% $ZnSO_4$ and 0.50% $FeSO_4$ had recorded significantly maximum fruit yield plant^{-1} (0.293 kg) which was followed by treatment combination Z_2F_3 - 0.50% $ZnSO_4$ and 0.75% $FeSO_4$ (0.220 kg). However, minimum fruit yield plant^{-1} (0.113 kg) was recorded in control treatment. The treatment combination Z_2F_3 - 0.50% $ZnSO_4$ and 0.50% $FeSO_4$ had recorded significantly maximum yield plot^{-1} (8.80 kg) which was followed by treatment combination Z_2F_3 - 0.50% $ZnSO_4$ and 0.75% $FeSO_4$ (6.60 kg). However, minimum fruit yield plot^{-1} (3.40 kg) was recorded in control treatment. The treatment combination Z_2F_2 - 0.50% $ZnSO_4$ and 0.50% $FeSO_4$ had recorded significantly maximum yield hectare^{-1} (325.8 q) which was followed by treatment combination Z_2F_3 - 0.50% $ZnSO_4$ and 0.75% $FeSO_4$ (244.4 q). However, minimum yield hectare^{-1} (125.9 q) was recorded in control treatment. The data from revealed that, the interaction effect of zinc and iron on the weight of fruit was found significant. The treatment combination Z_2F_3 - 0.50% $ZnSO_4$ and 0.50% $FeSO_4$ had recorded significantly maximum weight of fruits (16.31 g) which was followed by treatment combination Z_2F_3 - 0.50% $ZnSO_4$ and 0.75% $FeSO_4$ (12.73 g) and Z_1F_1 – 0.25% $ZnSO_4$ and 0.50% $FeSO_4$ (12.41 g). However, minimum weight of fruit (7.25 g) was recorded in control treatment Z_0F_0. showed that the interaction effect of zinc and iron on vitamin C content of fruit of summer okra was found non significan. The findings are in close confirmity with Patil (2001) [5] in okra, Raj *et al*. (2001) [6] in brinjal, Basavarajeshwari *et al*. (2006) [2] in tomato and Kumar *et al*. (2019) [7] in okra.

Conclusion

The yield parameters in respect of number of flowers plant^{-1}, number of fruits plant^{-1}, weight of fruit, yield plant^{-1}, yield plot^{-1} and yield hectare^{-1} were found significantly maximum with individual application of Z_2 - 0.50% $ZnSO_4$ and F_2 - 0.50% $FeSO_4$. The interaction effect of zinc and iron for yield parameters were found significant. Significantly maximum number of flowers plant^{-1}, number of fruits plant^{-1}, weight of fruit, yield plant^{-1}, yield plot^{-1} and yield hectare^{-1} were recorded with treatment combination Z_2 F_2 - 0.50% $ZnSO_4$ and 0.50% $FeSO_4$ Significantly maximum number of fruits plant^{-1}, weight of fruit, yield plant^{-1}, yield plot^{-1} and yield hectare^{-1} were recorded with treatment combination Z_2 F_2 - 0.50% $ZnSO_4$ and 0.50% $FeSO_4$. Vitamin C content of fruit were recorded significantly maximum with individual application of Z_2 - 0.50% $ZnSO_4$ and F_2 - 0.50% $FeSO_4$. The interaction effect of zinc and iron for the quality parameters of summer okra were found non significant.

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