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Effect of foliar spray of zinc and iron on floral characters expression and yield attributing parameters of guava cv. L-49 in vertisols of Subhumid plains of South Eastern Rajasthan

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Abstract
A field experiment was conducted at Fruit Instructional Farm of College of Horticulture and Forestry, Jhalawar during June 2019 to December 2019 to study the effect of foliar spray of zinc and iron on yield attributes of guava cv. L-49. The experiment comprising 16 different treatments of $ZnSO_4$ and $FeSO_4$ was laid out in Randomized Block Design with four replications. The results revealed that foliar application of zinc and iron under T_{15} treatment ($ZnSO_4$@ 0.60 % + $FeSO_4$@ 0.60%) resulted in outcome of maximum number of flowers per shoot (12.00), fruit set (77.88%), fruit retention (80.47%), fruit : leaf ratio (0.33), number of fruits per plant (215.00), fruit length (7.69 cm), fruit diameter (7.89 cm), fruit weight (260.60 g), fruit volume (230.25 cc), estimated yield per plant (55.91 kg), estimated yield qt./ha. (155.42 qt.) as compared with rest of the treatments.

Keywords: Guava, zinc, iron, flower, weight, yield

Introduction
Guava (*Psidium guajava* L.), synonymously known as the apple of the tropics, is one of the most popular fruits grown in tropical, sub-tropical and some parts of arid regions of India. The fruit popular among the common masses belongs to the family Myrtaceae, which has 140 genera and 3000 species widely distributed throughout the tropical and subtropical regions of the world. In India, it has been introduced in early seventeenth century and gradually became a crop of commercial significance all over the country. The three distinct flowering periods are Ambia (February-March), Mrig (June-July) and Hastha bahar (October- November) and subsequently fruiting periods for these bahar are July-August, October-December and February-April. The fruit possesses rich nutraceutical value as it imparts an excellent source of ascorbic acid (210 mg/100g) and pectin (0.60 %) but has low energy (66 cal /100g), protein content (1%) and dry matter (17%) and holds (83%) moisture content. The guava fruits are also rich in minerals like phosphorus (24-37mg/100g), calcium (14-30 mg/100g) and iron (0.6-1.4mg/100g) as well as useful vitamins like niacin, pantothenic acid, thiamine, riboflavin and Vitamin A. Apart from the fresh consumption, several delicious preserved like jam, jelly, ice cream, cheese, canned fruit and sharbat are prepared from ripe fruit of guava. Zinc is an essential micro-nutrient involved in key enzymatic reactions and act as co-factor for number of enzymes and has an important role in human health in combating various disorders. Zinc plays a pivotal role in regulating the protein and carbohydrate metabolism. Likewise zinc also increases the chlorophyll content of leaves and essential for enzyme activities like catalase, peroxidase and cytochrome chlorophyll oxidase. Zinc in consonance with Fe is important for the formation and activity of chlorophyll and in the functioning of several enzymes and for the enhancement of growth hormone auxin. Iron plays a key role in crucial metabolic processes such as chlorophyll synthesis, DNA synthesis, respiration and oxidation-reduction reaction in the plant system. The chief role of iron is involved in chlorophyll synthesis and deficiency of iron manifests itself in lower photosynthetic rates and ultimately results in low yields. The extremes of temperature (cold and hot), high soil pH, free $CaCO_3$ are the main pre-disposing factors for Fe deficiency within the fruit plants.

Material and Methods

A field experiment was conducted at Fruit Instructional Farm of College of Horticulture and Forestry, Jhalawar during June, 2018 to December, 2018. Nine years old plants of guava cv. L- 49 planted at spacing of 6 X 6 meter under square system of planting. The total number of plants included in the experiment was 64. All the guava plants were selected on the basis of morphometric uniformity in growth and vigour. All the treatments were applied in two sprays, first spray 25th June and second spray 25th July, 2019. The prime objective included studies on the foliar spray of zinc and iron on yield attributes of guava cv. L-49 during Mrig bahar season. The experiment consisted of 16 different treatment combinations of $ZnSO_4$ and $FeSO_4$ and experiment was laid out in Randomized Block Design with four replications. The details of treatments are To (Control), T_1 ($ZnSO_4$ 0.20 %), T_2 ($ZnSO_4$ 0.40%), T_3 ($ZnSO_4$ 0.60%), T_4 ($FeSO_4$ 0.20%), T_5 ($FeSO_4$ (0.40%), T_6 ($FeSO_4$ 0.60%), T_7 ($ZnSO_4$ 0.20 % + $FeSO_4$ 0.20%), T_8 ($ZnSO_4$ 0.20 % + $FeSO_4$ 0.40%), T_9 ($ZnSO_4$ 0.20 % + $FeSO_4$ 0.60%), T_{10} ($ZnSO_4$ 0.40% + $FeSO_4$ 0.20%), T_{11} ($ZnSO_4$ 0.40% + $FeSO_4$ 0.20%), T_{12} ($ZnSO_4$ 0.40% + $FeSO_4$ 0.60%), T_{13} ($ZnSO_4$ 0.60% + $FeSO_4$ 0.20%), T_{14} ($ZnSO_4$ 0.60% + $FeSO_4$ 0.40%), T_{15} ($ZnSO_4$ 0.60% + $FeSO_4$ 0.60%). Fruit were harvested at horticulture maturity stage. The data on number of fruits per tree was recorded by counting visually the number of fruits per tree under different treatment combinations during anthesis duration. The data on fruit size was recorded in terms of length and diameter with the help of Vernier callipers and average size was expressed in cm. The data on fruit weight was measured with the help of single pan balance and average weight expressed in gram. The data on fruit volume were recorded with the help of water dispersal method. The yield (kg plant^{-1}) was calculated by number of fruits on the multiplying the average fruit weight. Calculation of yield quintal per hectare was done by multiplying the yield per plant with 278. The statistical analysis of data was carried out as per method suggested by Panse and Sukhatme (1985) [10].

Results and Discussion

The data pertaining to investigated floral characters and yield parameters of guava cv.L-49 plant manifested as number of flowers per shoot, fruit set percentage, fruit retention percentage, fruit: leaf ratio, number of fruits per shoot, fruit length, fruit diameter, fruit weight and fruit volume, estimated yield per plant and estimated yield quintal per hectare are given in (Table 1 and 2). The results obtained under present investigations are presented and discussed under in suitable sub headings.

1. Number of flowers per shoot: The result obtained with response to the effect of foliar spray of zinc and iron on number of flowers per shoot of guava cv. L-49 is presented in table 1. The maximum numbers of flowers per shoot (12.00) were measured under T_{15} treatment. However, minimum number of flowers per shoot (7.25) was estimated under control. The involvement of zinc and iron treatment could be attributed to fostered auxin synthesis thus providing stimuli for floral bud primordia development and perhaps this might led to increase in blossom expression with lesser number of days required to complete the flowering process. The present findings are in consonance to those as reported by Singh and Maurya (2004) [14] and Ram and Bose (2000) [11] in mandarin.

2. Fruit set percentage: The results pertaining to the effect of foliar spray of zinc and iron on fruit set percentage of guava cv. L-49 fruit are exhibited in table 1. The maximum fruit set (77.88%) was recorded under T_{15} treatment. T_{15} treatment was observed statistically significant and superior over rest of the treatments. However, minimum fruit set (55.62%) was recorded under control. It could be attributed to the mutualistic effect of zinc and iron in hastening auxin synthesis and protein synthesis thereby facilitating chlorophyll synthesis. The present results are supported by the findings of Sharma *et al*. (1991) [13], Dahiya *et al*. (1993) [5] and Balakrishnan (2001) [2].

3. Fruit retention percentage: The perusal of data in table 1 indicated that highest fruit retention (80.47%) was estimated in T_{15} treatment and it was found statistically significant and superior over all other treatments. However lowest fruit retention (58.25%) was estimated under control. It might be due to favourable effect of zinc in enzyme acclimation, auxin enhancement concentration and enhanced tryptophan synthesis. The role of iron in triggering improved chlorophyll bio-synthesis is well known. The increased fruit retention due to zinc sprays might also result due to reduction in fruit drop owing to transport of increased auxin concentration to distal end of fruits. The results of present investigations are similar to those reported by Khan *et al*. (2009) [9].

4. Fruit: leaf ratio: The perusal of data in table 1 indicated that maximum fruit to leaf ratio (0.33) was measured in T_{15} treatment and it was found statistically significant and superior over all other treatments. However, lowest fruit: leaf ratio (0.12) was estimated under control. The attribute fruit: leaf ratio signifies the assimilation potential of leaves surrounding the fruiting terminals and maintenance of proper source sink ratio during development of fruitlets and ontogeny processes in the life cycle of fruit development.

5. Number of fruits per plant: The result on effect of foliar spray of zinc and iron on number of fruits per plant on guava cv. L-49 are exhibited in table 2. The results revealed that maximum number of fruits per plant (215.00) was estimated in T_{15} treatment. However, minimum number of fruits (189.75) was found under control. The foliar feeding of zinc and iron when sprayed in combination showed quicker response in accelerating various physiological process and enzymatic activities. It seems to have helped directly or indirectly the number of fruits per shoot either by improving pollen germination or by helping the growth of pollen tubes and thus promoting timely fertilization before the stigma loses its receptivity or the style becomes non-functional thus supported and reported by Ebeed *et al.* (2001) [7] in mango, Singh and Maurya (2004) [14] in mango, Chaturvedi *et al*. (2005) [4] in strawberry and Trivedi *et al.* (2012) [15] in guava.

6. Fruit length: The result pertaining to the effect of foliar spray of zinc and iron through various treatment combinations on morphometric improvement of fruit length (cm) of guava cv. L-49 is presented in table 2. The maximum fruit length (7.69 cm) of guava cv. L-49 fruits was obtained under T_{15} treatment. While minimum fruit length (6.40 cm) was obtained under control. The higher fruit length in this treatment could be attributed to combined application of zinc and iron which might have positive effect on increase in auxin concentration. The increase in fruit length might also be due to more accumulation of photosynthates through better

source-sink ratio through which more carbohydrates might get synthesized in the leaf and got translocated towards the fruit at different ontogeny stages of fruit development. The results are in conformity with the findings reported by Das *et al.* (2001) [6].

7. Fruit diameter: The morphometric trait fruit diameter (cm) of guava cv. L-49 fruits under the effect of foliar application of different treatment combinations of zinc and iron are presented in table 2. The maximum fruit diameter (7.80cm) was estimated under T_{15} treatment whereas; the minimum fruit diameter (6.47cm) was recorded under control. The maximum fruit diameter measured under T_{15} treatment might be done to synergistic action of foliar spray of zinc and iron on enhancement of fruit size and perhaps might be due to accelerated enzyme acclimation under this treatment. The results of present studies are in conformity with the observations recorded by Das *et al.* (2001) [6], Rawat *et al.* (2010) [12] and Kailash *et al*. (2017) [8] in guava cv. L-49 under vertisols of Jhalawar district.

8. Fruit weight: The fruit weight of guava cv. L-49 in response to different treatment combination of zinc and iron through foliar application are exhibited in table 2. The revealed that maximum fruit weight (260.60 g) was observed under T_{15} treatment. While minimum fruit weight (140.02 g) was estimated under control. The better fruit weight recorded under T_{15} treatment could be attributed to strengthening of middle lamella and consequently cell wall, which later might increased the free passage of solutes to the fruits better thus expressing morphometric gain in terms of catalytic effect of foliar spray of zinc and iron for synthesis of higher edible pulp biomass of guava cv. L-49. The results under present investigations are supported by findings of Rawat *et al.* (2010) [12] in guava; Trivedi *et al.* (2012) [15] in guava, Arora and Singh (1970) [1] in guava and Waskela *et al.* (2013) [16] in guava.

9. Fruit volume: It is obvious from the data in table 2 that maximum fruit volume (230.25 cc) was estimated under T_{15} treatment. However, minimum fruit volume (80.50 cc) was estimated under T_0 treatment (control). The increase in fruit size could be attributed to the increase in volume of guava fruit. It may be explained in light of the fact that higher concentrations of zinc and iron appears to have indirect controlling influence in hastening the process of cell division and cell elongation on fruit biomass enhancement due to which volume of guava fruits might have improved.

10. Estimated yield per plant: The result on effect of foliar spray of zinc and iron on estimated yield per plant (kg) of guava cv. L-49 are presented in table 2. The maximum estimated yield/plant (55.91 kg) of guava cv.L-49 trees was measured under T_{15} treatment. However, estimated yield/plant (26.55kg) in guava cv. L-49 plants was recorded under control. The maximum yield in the T_{15} treatment could be attributed to the more production of female flowers consequently resulting in improved fruit set which finally resulted in outcome exhibited as maximum number of fruits in this treatment thereby contributing to more yields. The results revealed that the combination of zinc and iron produced an additive effect on the yield outcome of guava cv. L-49. The outcome of present findings are in consonance with those reported by Baranwal *et al*. (2017) [3], Singh *et al.* (2004) [14] and Trivedi *et al.* (2012) [15].

11. Estimated yield quintal per hectare: The result on effect of foliar spray of zinc and iron on estimated yield/plant (qt/ha) of guava cv. L-49 are presented in table 2. The maximum estimated yield/plant (155.42 qt/ha) under T_{15} treatment. However lowest estimated yield/plant (73.79 qt/ha) was recorded under control. The increased fruit yield obtained under T_{15} treatment could be due to combined application of higher concentration of both Zn and Fe which might have increased auxin production and thus led to higher yield. The results of present investigations are in conformity with the findings of Baranwal *et al*. (2017) [3], Singh *et al.* (2004) [14] and Trivedi *et al.* (2012) [15].

Table 1: Effect of zinc and iron on floral characters of guava cv. L-49

Treatments	Number of flowers per shoot	Fruit set (%)	Fruit retention (%)	Fruit : leaf ratio
T_0	7.25	55.62	58.25	0.12
T_1	8.00	60.49	62.70	0.15
T_2	8.25	66.62	66.60	0.19
T_3	9.00	68.84	67.93	0.22
T_4	7.75	65.41	60.75	0.17
T_5	8.75	64.07	64.28	0.19
T_6	9.00	69.00	66.18	0.21
T_7	8.25	64.58	63.50	0.17
T_8	8.75	65.62	64.91	0.18
T_9	9.75	69.16	68.84	0.24
T_{10}	9.25	66.45	70.63	0.20
T_{11}	10.25	70.52	73.68	0.26
T_{12}	10.50	71.18	74.76	0.29
T_{13}	11.00	74.70	76.85	0.30
T_{14}	11.25	73.11	78.71	0.30
T_{15}	12.00	77.88	80.47	0.33
S.Em±	0.44	1.94	0.51	0.00
CD at 5%	1.23	5.53	1.45	0.02

Table 2: Effect of foliar application of zinc and iron on yield parameters of guava cv. L-49

Treatments	No. of fruits/plant	Fruit length (cm)	Fruit diameter (cm)	Fruit weight (g)	Fruit volume (cc)	Estimated yield/plant (kg)	Estimated yield/ha. (qt.)
T_0	189.75	6.40	6.47	140.25	80.50	26.55	73.79
T_1	194.00	6.78	6.59	157.62	118.50	30.56	84.94
T_2	196.00	6.45	6.73	176.20	123.50	34.51	95.94
T_3	204.00	6.84	6.70	169.50	117.25	34.74	96.58
T_4	194.25	6.84	6.60	177.32	126.25	34.54	96.02
T_5	195.00	6.59	7.00	177.62	123.00	34.75	96.60
T_6	200.00	6.94	6.67	175.65	117.50	35.04	97.41
T_7	197.00	6.91	6.92	193.07	140.25	37.92	105.40
T_8	201.00	7.10	7.20	208.30	175.25	42.31	117.62
T_9	205.75	7.08	7.18	220.35	179.75	45.03	125.19
T_{10}	207.00	7.18	7.40	224.22	179.50	46.40	128.98
T_{11}	208.00	7.30	7.29	224.05	176.00	46.59	129.51
T_{12}	210.00	7.42	7.51	239.12	201.50	50.25	139.70
T_{13}	212.00	7.19	7.62	245.00	190.75	51.87	144.18
T_{14}	213.00	7.21	7.71	257.30	219.00	54.86	152.57
T_{15}	215.00	7.69	7.80	260.60	230.25	55.91	155.42
S.Em±	5.63	0.15	0.13	6.17	10.42	1.96	5.44
CD at 5%	16.03	0.44	0.39	17.59	29.69	5.54	15.39

Conclusion

On the basis of experimental findings, application of T_{15} treatment ($ZnSO_4$@ 0.60 % + $FeSO_4$@ 0.60%) just before onset of anthesis during June-July was found significantly superior over rest of the treatments with respect to most of the floral characters and yield parameters. Zinc and iron foliar feeding to guava plants during onset of monsoon resulted in mutualistic interaction in supporting enhanced auxin synthesis and might contribute positively by triggering beneficial biochemical processes involving tryptophan and chlorophyll synthesis within the plant system. The overall better floral characters expressed in T_{15} treatment might be attributed to augmented carbohydrate, protein and amino-acid synthesis which promoted more flower induction resulting in enhanced fruit set and augmented yield in guava.

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