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Effect of Fe and Zn fertilization on fruit setting and yield attributes of mango cv. Kesar

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Abstract
An experiment was conducted to study the effect of foliar spray of iron and zinc fertilization on yield of mango cv. Kesar at Regional Horticultural Research Station, ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari (Gujarat). The foliar spray of $FeSO_4$ (0.25 and 0.50 %) and $ZnSO_4$ (0.25 and 0.50 %) alone and in combinations were done in 20 years old mango orchard at flowering, pea and egg stage of fruit. It is revealed from the results that the foliar spray of 0.25 % $FeSO_4$ and 0.50 % $ZnSO_4$ in combination showed superior performance by getting higher fruit set and retention percentage; and yield attributes over other treatments under study. The highest TSS and ascorbic acid was also noted in those fruits obtained from the trees treated with 0.25 % $FeSO_4$ and 0.50 % $ZnSO_4$.

Keywords: mango, kesar, Fe, Zn, yield, fruit set, fruit retention

Introduction
Mango (*Mangifera indica* L.) is native to the Indian subcontinent, belonging to family Anacardiaceae, is the most cultivated and preferred fruit of the tropics. Since it is perceived by the farmers as a 'hardy' crop capable of growing in varying climates and soil types at low external inputs (Water, nutrients), adequate attention has not been paid to its nutrient management.

Irregular bearing is still a major problem in India and poor nutrition is one of the reasons for this phenomenon and micronutrients especially iron and zinc deficiency. The deficiency of iron and zinc in visible and hidden form is widespread in mango and is suspected to be one of the reasons for low productivity. Micronutrients play a major role in crop production due to their essentiality in plant metabolism and adverse effects that manifest due to their deficiency. Zinc is highly immobile in soil and its deficiency is common in mango, banana, guava, litchi, apple, grape and pomegranate. Little-leaf and rosette symptoms are the most common visual indicators of Zn deficiency (Edward, 2009) [4]. Whereas, Fe is one of the most abundant elements in soil, its deficiency in plant tissues is a major challenge. The very pronounced symptoms of iron deficiency found in mango are unique and differ from typical lime induced iron deficiency symptoms found in other fruit trees. At an early stage the entire young leaf blade has a yellowish green color; later on, the new leaves cease to grow and a gradual dieback of the branches starts. Short term correction by organic manures (produced in India) is not suitable due to inadequate quality standards (C:N ratio, humification, pH, exchange capacity). Thus, soil applications are not very effective because the roots of fruit crops occupy deep soil layers and micronutrient does not easily move in the soil therefore, foliar sprays are more effective (Chandler *et al.*, 1931) [3]. Owing to role and importance of both the micronutrients, the study has been framed on effect of foliar application of iron and zinc on yield of mango cv. Kesar.

Materials and Methods
An experiment was conducted at Regional Horticultural Research Station, ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari (Gujarat) during the year 2016-2017. It is situated at 20° 57' North latitude, 72° 54' East longitude and has altitude of 10 meters above the mean sea level. The climate of this area is characterized by three well defined seasons *viz.*, monsoon, mild winter and summer. A study was carried out on 20 year old uniform mango trees of Kesar cultivar planted at 10m×5m distance. Experiment was layout

with nine treatments viz., Control (T_1), 0.25 % $FeSO_4$ (T_2), 0.50 % $FeSO_4$ (T_3), 0.25 % $ZnSO_4$ (T_4), 0.50 % $ZnSO_4$ (T_5), 0.25% $FeSO_4$ + 0.25 % $ZnSO_4$ (T_6), 0.25 % $FeSO_4$ + 0.50 % $ZnSO_4$ (T_6), 0.50% $FeSO_4$ + 0.25% $ZnSO_4$ (T_8), 0.50 % $FeSO_4$ + 0.50 % $ZnSO_4$ (T_9) and three replications. For the preparation of Zn and Fe foliar spray solution, commercial grade of $ZnSO_4.7H_2O$ and $FeSO_4.7H_2O$ fertilizers were used, respectively. The required quantity of ferrous sulphate and zinc sulphate were weighed and dissolved in water and then pH of solution was adjusted to 6.0 by using saturated $CaCO_3$ solution. The foliar spray of $FeSO_4$ and $ZnSO_4$ were done at the time of flowering (21/12/2016), pea (17/02/2017) and egg stages (20/03/2017). Five panicles in each direction were randomly tagged for counting the fruit set at marble, egg and maturity stage; and for fruit retention at harvest and computed using following formula.

$$\text{Fruit set (\%) at marble/egg/maturity stage} = \frac{\text{No. of fruits at marble/egg/maturity stage}}{\text{No. of fruits at pea stage}} \times 100$$

$$\text{Fruit retention (\%) at harvest} = \frac{\text{No. of fruits at marble stage} - \text{No. of fruits dropped at harvest}}{\text{No. of fruits at marble stage}} \times 100$$

The number of fruits was counted treatmentwise at the time of fruit harvesting. The sums of all harvested fruits were expressed as number of fruits per tree. Five fruits were arbitrarily taken for calculating the average fruit weight then it was empirically compensated to find the average fruit weight (g) corresponding to yield (kg/tree) and number of fruits and for recording yield, total produce per tree was weighted and recorded in kilogram. The statistical analysis of data were carried out as per the method prescribed by Panse and Sukhatme (1967) [8].

Results and Discussion

Fruit set and fruit retention (%)

The maximum fruit set per panicle at marble (27.20 %), egg (9.54 %), maturity stage (2.69 %) and fruit retention (2.95 %) were recorded in T_9 (0.50 % $FeSO_4$ + 0.50 % $ZnSO_4$) which was statistically at par with treatment T_5 (0.50 % $ZnSO_4$) and T_7 (0.25 % $FeSO_4$ + 0.50 % $ZnSO_4$). Application of zinc at higher level increased zinc content in leaves which ultimately encourage the endogenous production of auxin thereby reducing fruit drop and thus increasing fruit set and fruit retention. The findings are in conformity with Singh *et al.* (2015) [9] and Nehete *et al.* (2011) [7] in mango; Meena *et al.* (2014) [6] in aonla and Yadav *et al.* (2013) [12] in peach.

Yield attributes

Similarly, the highest number of fruits per tree(284.23), average fruit weight(289.77 g) and yield (82.36 kg/tree) were obtained in treatment T_9 (0.50 % $FeSO_4$ + 0.50 % $ZnSO_4$) which was statistically at par with treatment T_7 (0.25 % $FeSO_4$ + 0.50 % $ZnSO_4$) and T_5 (0.50 % $ZnSO_4$). An increase in number of fruits per tree might be due to an application of Zn, Fe. All the micronutrients when micronutrients sprayed alone or in combination involved directly in various physiological processes and enzymatic activity for higher accumulation of food materials and Zinc responsible for auxin biosynthesis. The balance of auxin in plant also regulates the fruits drop or retention in plants, which ultimately increased the total number of fruits per tree. An increased in fruit yield per tree might be due to cumulative effect of more number of fruits, reduction in fruit drop *vis-a-vis* higher average weight of fruit by direct and indirect effect of micronutrients in mango cv. Kesar (Gurjar *et al.*, 2015) [5]. Zn promotes of starch formation followed by rapid transportation of carbohydrates in plants. Increase in fruit weight might be due to the zinc plays an important role to promote starch formation while iron requires for cell enlargement and cell division. Thus, the cumulative effect of combined treatment of Zn and Fe might have resulted in higher fruit weight. The increase in fruit weight by the micronutrients might be due to faster loading and mobilization of photo assimilates to fruits which ultimately reflected into more weight of fruit in treated plants. Similar results were obtained by the findings of Nehete *et al.* (2011) [7], Bhowmick *et al.* (2012) [2], Banik and Sen (1997) [1] and Waskela *et al.* (2013) [11] in guava.

Table 1: Effect of foliar spray of Zn and Fe on per cent fruit set and fruit retention of mango cv. Kesar

Treatments	Fruit set (%)			Fruit retention (%)
	Marble Stage	Egg stage	Maturity Stage	
T_1: Control	15.73	5.86	0.94	1.22
T_2: 0.25 % $FeSO_4$	16.33	6.64	1.33	1.67
T_3: 0.50 % $FeSO_4$	20.93	7.31	1.50	1.94
T_4: 0.25 % $ZnSO_4$	17.13	7.74	1.62	2.12
T_5: 0.50 % $ZnSO_4$	24.10	9.09	2.46	2.69
T_6: 0.25 % $FeSO_4$ + 0.25 % $ZnSO_4$	18.53	7.54	1.69	2.09
T_7 : 0.25 % $FeSO_4$ + 0.50 % $ZnSO_4$	25.47	9.17	2.58	2.72
T_8: 0.50 % $FeSO_4$ + 0.25 % $ZnSO_4$	19.17	7.81	1.75	2.22
T_9 : 0.50 % $FeSO_4$ + 0.50 % $ZnSO_4$	27.20	9.54	2.69	2.95
S.Em±	1.11	0.48	0.09	0.09
C.D. at 5 %	3.31	1.41	0.27	0.27
C.V %	9.41	10.50	8.49	7.21

Table 2: Effect of foliar spray of Zn and Fe on yield and its attributes of mango cv. Kesar

Treatment	Number of fruits per tree	Average weight of fruits(g)	Yield (kg/tree)
T_1 : Control	221.93	236.97	53.57
T_2 : 0.25 % $FeSO_4$	233.10	246.87	57.60
T_3: 0.50 % $FeSO_4$	240.06	255.13	61.20
T_4: 0.25 % $ZnSO_4$	251.90	272.20	68.53
T_5: 0.50 % $ZnSO_4$	271.33	276.93	75.13
T_6: 0.25 % $FeSO_4$ + 0.25 % $ZnSO_4$	254.97	273.97	69.90
T_7: 0.25 % $FeSO_4$ + 0.50 % $ZnSO_4$	277.23	280.03	77.57
T_8: 0.50 % $FeSO_4$ + 0.25 % $ZnSO_4$	258.77	275.33	71.17
T_9: 0.50 % $FeSO_4$ + 0.50 % $ZnSO_4$	284.23	289.77	82.36
S.Em±	6.13	4.67	2.61
C.D. at 5 %	18.22	13.90	7.75
C.V %	4.17	3.03	6.59

Conclusion

It is concluded from the present study that the foliar application of 0.50 % $FeSO_4$ + 0.50 % $ZnSO_4$ can be done at flowering, pea and egg stage of fruit for getting higher fruit set, fruit retention and yield of mango cv. Kesar.

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