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Effect of Soil and Foliar Applications of Micronutrients on Flowering and Yield of Mango

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ABSTRACT

The experiment was carried out during the spring and summer seasons of the year 2017-18 and 2018-19 at the Horticultural Research Farm, AAU, Anand to study the Effect of soil and foliar applications of micronutrients on flowering and yield of mango variety. The experiment comprised of 13 treatments of different micronutrients application *viz.* $FeSO_4$ 100 g, $ZnSO_4$ 100 g, Borax 100 g and multi micronutrients grade-V 400 g as a soil application; $FeSO_4$ 0.5 %, $ZnSO_4$ 0.5 %, borax 0.2 % and multi micronutrients grade-IV 1.0 % as a foliar application and its combinations and control (water spray). Soil application was done at second fortnight of September and foliar sprays of treatments were done at flower bud initiation, full bloom stage and pea stage initiationon 18 years old mango tree cv. Mallika. Experiment was laid out in a Completely Randomized Design (CRD) with three repetitions. Numbers of staminate, hermaphrodite and total number of flowers per panicle were found significant with respect to various micronutrients treatments during both the years of experiment. Maximum staminate flowers per panicle, hermaphrodite flowers per panicle and total number of flowers per panicle was found with soil application of multi micronutrients grade-V 400 g followed by foliar application of multi micronutrients grade-IV 1.0 % during both the years of study. The significantly higher number of fruits, average fruit weight and fruit yield per tree were recorded with soil application of multi micronutrients grade-V 400 g followed by foliar application of multi micronutrients grade-IV 1.0 % during the years 2017-18 and 2018-19.

KEYWORDS

Mango, micronutrients, flowering and yield, cv. Mallika

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INTRODUCTION

Mango (*Mangiferaindica* L.) is a premier fruit crop of India considering its area, production, popularity among the people and designated as the 'National Fruit of India'. Mango, the King of fruits, is grown in India for over 4000 years. The mango is a fleshy stone fruits belonging to the genus *Mangifera*, consisting of numerous tropical fruiting trees that are cultivated mostly for edible fruits belonging to family Anarcardiacae. It is originated in South East Asia. Mango is one of the major fruits of Asia and has developed its own importance all over the world. India share about 56 per cent of total mango production in the World. In India, it is cultivated on an area of 2.26 million hectares with annual production of 21.82 million tonnes having productivity of 9.65 MT per hectare (Anonymous, 2018). Mango is almost grown in all states of India. In Gujarat, it is cultivated on an area of 0.16 million hectares with production of 1.21 million tonnes with productivity of 7.56 MT per hectare (Anonymous, 2018).

In mango, many problems are associated with fruit set, yield and quality due to imbalance supply of nutrients and it results in poor health of plants, fruit quality, increase in fruit drop and moreover the unhealthy plants are also more prone to attack of insect-pest and diseases. Among the different constrains, a high fruit drop is a major problem of mango cultivation in India. The reason for low productivity, fruit drops and undersized fruit may be due to genetically, environmental and cultural practices including application of chemical fertilizers. Micronutrients play a vital role in various enzymatic activities and synthesis of assimilates and hormones. These micronutrients also help in the uptake of major nutrients and play an active role in the plant metabolism process starting from cell wall development to respiration, photosynthesis, chlorophyll formation, enzymatic activity, hormone synthesis, nitrogen fixation and reduction (Das, 2003).

Zinc element is important for the formation and activity of chlorophyll and in the functioning of several enzymes. It is an important constituent of Triptophane, a precursor of growth hormone (auxin). It is also essential for the transformation of carbohydrates and regulates consumption of sugars. Kumar and Chakrabati (1992) noted that the higher sugar content and lower acidity percentage of fruits by the spray of $ZnSO_4$ 1 % in 30-year-old mango orchard. Iron is necessary for many enzymatic functions and as a catalyst for the synthesis of chlorophyll, protein and regulates the respiration. It is essential for the development of young growing parts of the plant. It is very important constituent of ferredoxin. Iron deficiency is expressed as yellow leaves due to low levels of chlorophyll (chlorosis), which first appears on the younger upper leaves in interveinal tissues. Severe iron deficiencies may cause leaves to

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turn completely yellow or almost white and then brown and at last leaves will die (Pandey and Sinha, 2006). Boron element is much required for cell division and development in the growth regions of the plant near the tips of shoots and roots. It aids production of sugar and carbohydrates. It also affects sugar transport and appears to be associated with some of the functions of calcium. Boron affects pollination and the development of viable seeds which in turn affect the normal development of fruit (Zia *et al*., 2006). It also acts as enhancing the pollen germination, pollen tube growth, sugar synthesis and accumulation (Shaban, 2010). Boron deficiency also causes fruit cracking and distorted growth in plants.

MATERIALS AND METHODS

An experiment was conducted at Horticultural Research Farm, B. A. College of Agriculture, Anand Agricultural University, Anand during *Rabi* – Summerseason of the years 2017-18 and 2018-19. The soil of the experimental site was loamy sand. The soil is alluvial by their nature of origin, very deep, well drained and fairly moisture retentive. Soils respond well to manures and irrigations. The climate of Anand region is semi-arid and sub-tropical type. Winter is mild cool and dry, while summer is hot and dry and average annual rainfall is 830 mm. The experiment comprised of 13 treatments (Table 1) of different micronutrients application *viz.* ferrous sulphate 100 g, zinc sulphate 100 g, borax 100 g and multimicronutrients grade-V 400 g as a soil application; ferrous sulphate 0.5 %, zinc sulphate 0.5 %, borax 0.2 % and multimicronutrients grade-IV 1.0 % as a foliar application; soil application of ferrous sulphate 100 g followed by foliar application of ferrous sulphate 0.5 %, soil application of zinc sulphate 100 g followed by foliar application of zinc sulphate 0.5 %, soil application of borax 100 g followed by foliar application of borax 0.2 % and soil application of multimicronutrients grade-V 400 g followed by foliar application of multimicronutrients grade-IV 1.0 % and control (water spray). Soil application was done at second fortnight of September and foliar sprays of treatments were done at flower bud initiation, full bloom stage and pea stage initiation on 18 years old mango cv. Mallika. Experiment was laid out in a Completely Randomized Design (CRD) with three repetitions. Recommended dose of farm yard manure (100 kg/tree) and NPK fertilizers (750:160:750 g NPK/tree) were given as common dose in all the treatments and it's applied with band placement method. All other cultural operations including weeding and plant protection measures were carried as per the package of practices of mango.

Table 1: Treatments details

Treat. No.	Treatments details
T_1	Soil application of $FeSO_4$ 100 g
T_2	Soil application of $ZnSO_4$ 100 g
T_3	Soil application borax 100 g
T_4	Soil application of multimicronutrients grade-V 400 g
T_5	Foliar application of $FeSO_4$ 0.5 %
T_6	Foliar application of $ZnSO_4$ 0.5 %
T_7	Foliar application of borax 0.2 %
T_8	Foliar application of multimicronutrients grade-IV 1.0 %
T_9	Soil application of $FeSO_4$ 100 g followed by foliar application of $FeSO_4$ 0.5 %
T_{10}	Soil application of $ZnSO_4$ 100 g followed by foliar application of $ZnSO_4$ 0.5 %
T_{11}	Soil application of borax 100 g followed by foliar application of of borax 0.2 %
T_{12}	Soil application of multimicronutrients grade -V 400 g followed by foliar application of multimicronutrients grade -IV 1.0 %
T_{13}	Control

Staminate and hermaphrodite flowers were counted visually with the help of magnifying lens on tagged panicles and average number of staminate and hermaphrodite as well as total number of flowers per panicle calculated. The number of fruits per tree was counted treatment wise at each picking and the results were summed up and expressed as number of fruits per tree. In case of average fruit weight in gram (g) were calculated from each of the treatments five marketable fruits were harvested randomly from each experimental tree and their weight was recorded separately. Whereas, fruit yield were recorded with fruit harvested from each tree were weighted in gram during all the harvesting and then summed up and expressed as yield (kg/tree).

Statistical analysis of experimental data

The experimental data collected relating to different parameters were statistically analyzed as described by Gomez and Gomez (1976). Treatment means of all characters for individual were compared by means of critical differences at 5 % level of significance after employing 'F' test.

RESULTS AND DISCUSSION

The results obtained from the research experiment on effect of soil and foliar applications of micronutrients on flowering and yield of mango (*Mangiferaindica* L.) cv. Mallika are presented in Table 2 and 3.

Number of staminate, hermaphrodite and total number of flowers per panicle:

Number of staminate, hermaphrodite and total number of flowers per panicle as affected by soil and foliar application of micronutrientstreatments in mango cv. Mallika during both the years of study and pooled analysis are presented in Table 2.

Staminate flowers per panicle

In first year of experiment, there was no significant difference found in respect of number of staminate flowers per panicle. Whereas in second year, significantly maximum number of staminate flowers per panicle was found in treatment T_{12} *i.e.* soil application of multimicronutrients grade-V 400 g followed by foliar application of multimicronutrients grade-IV 1.0 % (563) which was statistically at par with treatments T_8 (537), T_{11} (523), T_7 (499), T_{10} (489) and T_9 (471) during second year. While lowest number of staminate flowers per panicle was recorded in control treatment. The results are in accordance with Kundu and Mitra (1999) where they have

Table 2: Effect of soil and foliar applications of micronutrients on staminate, hermaphrodite and total number of flowers per panicle

Treatments details	Number of staminate flowers per panicle		Number of hermaphrodite flowers per panicle		Number of flowers per panicle	
	2017-18	2018-19	2017-18	2018-19	2017-18	2018-19
Soil application of $FeSO_4$ 100 g	494	393	179	168	677	561
Soil application of $ZnSO_4$ 100 g	498	404	192	175	690	579
Soil application borax 100 g	514	424	198	184	712	608
Soil application of multimicronutrients grade-V 400 g	517	444	203	188	721	632
Foliar application of $FeSO_4$ 0.5 %	513	447	199	175	713	622
Foliar application of $ZnSO_4$ 0.5 %	515	424	200	182	715	605
Foliar application of borax 0.2 %	548	499	208	193	755	692
Foliar application of multimicronut rients grade-IV 1.0 %	578	537	221	205	795	742
Soil application of $FeSO_4$ 100 g followed by foliar application of $FeSO_4$ 0.5 %	520	471	205	185	725	656
Soil application of $ZnSO_4$ 100 g followed by foliar application of $ZnSO_4$ 0.5 %	536	489	206	191	742	680
Soil application of borax 100 g followed by foliar application of borax 0.2 %	556	523	213	199	768	722
Soil application of multimicronutrients grade -V 400 g followed by foliar application of multimicronutrients grade-IV 1.0 %	604	563	236	216	831	779
Control	434	391	167	160	605	551
S.Em ±	29.42	32.73	11.63	9.89	30.06	37.99
C. D. (P =0.05)	NS	95.17	33.80	28.74	87.42	110.47
C.V. %	9.70	12.26	9.96	9.20	7.16	10.15

Table 3: Effect of soil and foliar applications of micronutrients on number of fruits per tree and average fruit weight

Treatments details	**Number of fruits per panicle**		**Average fruits weight (g)**	
	2017-18	**2018-19**	**2017-18**	**2018-19**
Soil application of $FeSO_4$ 100 g	183	167	378	335
Soil application of $ZnSO_4$ 100 g	189	173	374	330
Soil application borax 100 g	193	183	380	340
Soil application of multimicronutrients grade-V 400 g	203	184	383	341
Foliar application of $FeSO_4$ 0.5 %	199	186	354	316
Foliar application of $ZnSO_4$ 0.5 %	203	190	375	318
Foliar application of borax 0.2 %	218	197	385	347
Foliar application of multimicronutrients grade-IV 1.0 %	228	199	389	351
Soil application of $FeSO_4$ 100 g followed by foliar application of $FeSO_4$ 0.5 %	206	193	382	348
Soil application of $ZnSO_4$ 100 g followed by foliar application of $ZnSO_4$ 0.5 %	214	195	379	347
Soil ap plication of borax 100 g followed by foliar application of borax 0.2 %	221	198	387	349
Soil application of multimicronutrients grade -V 400 g followed by foliar application of multimicronutrients grade-IV 1.0 %	232	207	398	353
Control	177	156	370	322
S. Em ±	**10.50**	**8.61**	**9.37**	**8.17**
C. D. (P =0.05)	**30.44**	**24.93**	**23.06**	**19.57**
C.V. %	**9.72**	**8.91**	**6.11**	**5.50**

found that spraying with Cu + B + Zn, Cu + B, Cu + Zn and Cu alone were recorded maximum number of male flowers per panicle of guava tree.

Hermaphrodite flowers per panicle

Among the different micronutrients treatments, T_{12} *i.e.* soil application of multimicronutrients grade-V 400 g followed by foliar application ofmultimicronutrients grade-IV 1.0 % recorded significantly maximum number of hermaphrodite flowers per panicle (236 and 216) and which was found at par with treatments T_8 , T_{11}, T_7, T_{10}, T_9 and T_4. Whereas, significantly minimum number of hermaphrodite flowers per panicle was recorded in control during both the years of study. These findings are agreement by Haggag *et al.* (1995); Dutta (2004), Singh and Maurya (2004) in mango and Kundu and Mitra (1999) in guava. They observed that the combined effect of different micronutrients might have played a vital role in increase of physiological activities leading to increase hermaphrodite flowers per panicle in mango. Foliar spray of micronutrients zinc sulphate 0.4 %, ferrous sulphate 0.4 %, manganese sulphate 0.2 % and boric acid 0.2 % was found responsive for increasing number of hermaphrodite flowers per panicle of mango cv. Mallika.

Number of flowers per panicle

From Table 2, it can be seen that significantly maximum number of flowers per panicle (831 and 779) was registered with soil application of multimicronutrients grade-V 400 g followed by foliar application of multimicronutrients grade-IV 1.0 % as compared to control. However, treatment T_{12} was at par with treatments T_8, T_{11}, T_7, T_{10} and T_9 during both individual years. These findings are also supported by Ghanta and Mitra (1993), Banik and Sen (1997) and Singh and Maurya (2004) in mango. They noticed that increase in the number of flowers per panicle might be due to zinc enhanced the synthesis of auxin in the plants.

Table 4: Effect of soil and foliar applications of micronutrients on mango yield (kg per tree)

Treatments details	Yield (kg/tree)	
	2017-18	2018-19
Soil application of $FeSO_4$ 100 g	69.0	56.1
Soil application of $ZnSO_4$ 100 g	70.8	57.2
Soil application borax 100 g	75.3	62.2
Soil application of multimicronutrients grade-V 400 g	77.8	62.7
Foliar application of $FeSO_4$ 0.5 %	70.5	58.8
Foliar application of $ZnSO_4$ 0.5 %	75.9	60.3
Foliar application of borax 0.2 %	85.9	68.4
Foliar application of multimicronutrients grade-IV 1.0 %	90.7	70.0
Soil application of $FeSO_4$ 100 g followed by foliar application of $FeSO_4$ 0.5 %	80.9	67.1
Soil application of $ZnSO_4$ 100 g followed by foliar application of $ZnSO_4$ 0.5 %	83.2	67.7
Soil application of borax 100 g followed by foliar application of borax 0.2 %	87.5	69.2
Soil application of multimicronutrients grade-V 400 g followed by foliar application of multimicronutrients grade-IV 1.0 %	98.1	73.8
Control	63.4	50.3
S.Em ±	**4.78**	**4.02**
C. D. (P =0.05)	**13.90**	**11.69**
C.V. %	**10.62**	**11.00**

Yield and Yield Attributing Parameters

Data pertaining to the yield and yield attributing parameters indicated that there was significant effect of different treatments of micronutrients during the both individual years as well as their pooled value (Table 4).

Number of fruits per tree:

Data on number of fruits per tree accounted significantly maximum number of fruits per plant (232 and 207) with treatment soil application of multimicronutrients grade-V 400 g followed by foliar application ofmultimicronutrients grade-IV 1.0 % (T_{12}) during both individual years. The next effective treatments T_8, T_{11}, T_7, T_{10}, T_9 and T_6 during the year 2017-18 and all the treatments except T_1, T_2 and T_{13} during second year of study. Similar results finding by Trivedi *et al.* (2012), Rajkumar *et al.* (2014) in guava. They have found that application of micronutrient treatments to increased fruit set, fruit retention and reduced fruit drop as a result of boron, iron, magnesium, manganese, zinc and copper spray could give higher number of fruits and consequently the yield.

Average fruit weight (g):

Significantly maximum average fruit weight (398 and 353 g) was observed with soil application of multimicronutrients grade-V 400 g followed by foliar application ofmultimicronutrients grade-IV 1.0 % (T_{12}) which was at par with all the treatments except treatments T_5, T_6 and T_2 during both the experimental years. The minimum fruit weight was obtained in control (T_{13}). It might be due to the zinc which plays a vital role to promote starch formation, iron required to suitable cell enlargement and cell division and boron actively involved in transportation of carbohydrates in plants. Thus, the cumulative effect of combined treatment of micronutrients (Fe + Zn + B) might have resulted higher fruit weight. These results are in conformity with the earlier report by Dutta (2004), Nehete *et al.* (2011) and Bhatt *et al.* (2012) in mango.

Fruit yield per tree (kg):

From Table 4, it can be seen significantly maximum fruit yield (98.1 and 73.8 kg/tree) was recorded with treatment T_{12} *i.e.* soil application of multimicronutrients grade-V 400 g followed by foliar application ofmultimicronutrients grade-IV 1.0 % during both individual years. However, it was at par with treatments T_8 (90.7 kg/tree), T_{11} (87.5 kg/tree) and T_7 (85.9

kg/tree) during the year 2017-18 and treatments T_8 (70.0 kg/tree), T_{11} (69.2 kg/tree), T_7 (68.4 kg/tree), T_{10} (67.7 kg/tree), T_9 (67.1 kg/tree) and T_4 (62.7 kg/tree) during the year 2018-19. These might be due to fact that micronutrients play a pivotal role in vegetative growth, flowering, development of plant and are also directly involved in the process of photosynthesis, this means that a possibility of increasing dry matter percentage as well as yield. This observation is in agreement with findings of Singh *et al*. (2003), Saran and Kumar (2011), Nehete *et al.* (2011), Singh and Varma (2011), Bhatt *et al*. (2012) and Bhowmick *et al*. (2012) in mango and Jat and Kacha (2014) in guava.

CONCLUSION

From the two years of field study, it can be concluded that soil application of multimicronutrients grade-V 100 g followed by foliar applications of multimicronutrients grade-IV 1.0 % or alone foliar applications of multimicronutrients grade-IV 1.0 % at flower bud initiation, full bloom stage and pea stage initiationeffectively found to increase flowering and higher fruit yield of mango cv. Mallika.

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