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Effect of foliar application of micro nutrients on yield and Physical quality of Mango (*Mangifera indica* L.) cv. Amrapali

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Abstract
The present investigation "Effect of foliar application of micro nutrients on yield and Physical quality of Mango (*Mangifera indica* L.) cv. Amrapali" was conducted at Main Experiment Station, Department of Horticulture, Narendra Deva University of Agriculture & Technology, Narendra Nagar (Kumarganj), Faizabad (U.P.) during the year 2017-2018. The experiment was conducted in Randomized Block Design with eight treatments *i.e.* Control (water spray), $ZnSO_4$ 1%, $FeSO_4$ 1%, Borax 0.5%, $ZnSO_4$ 1% + $FeSO_4$ 1%, $ZnSO_4$ 1% +Borax 0.5%, $FeSO_4$ 1% + Borax 0.5% and $FeSO_4$ 1% +$ZnSO_4$ 1% + Borax 0.5% in three replications and considering one plants as a unit. The results were recorded for yield and Physical attributes.

Keywords: foliar, micro nutrients, physical quality, mango, *Mangifera indica*

Introduction
The mango (*Mangifera indica* L.) is a considered to be the king of fruit. It is, undoubtedly, one of the choicest and most ancient fruits known to mankind. In India, it has always been a prized and favourite fruit throughout the recorded history of the country. The fruit not only finds a prominent mention in the old Sanskrit literature but almost all the foreigners, right from the Chinese pilgrims who travelled here in Seventh Century A.D. down to the modern writers, have spoken in glowing terms about this fruit. During the Mughal rule, mango was honoured with a real patronage. The well known Lakh Bagh, known to be stocked with 1,00,000 mango tree, was planted near Darbhanga in Bihar state by Akbar. Some mango orchards planted during that period notable the Shalimar Garden of Lahore and Mughal Gardens at Pinjore near Chandigarh are still preserved and bear testimony to the high esteem this fruit enjoyed in the past. The mango occupies the same position in the tropical and sub-tropical regions, which in enjoyed by the apple in temperate region.

The main mango growing States in India are Uttar Pradesh, Andhra Pradesh, Bihar, West Bengal, Kerala, Karnataka, Maharashtra, Orissa, Tamil Nadu, Punjab, Haryana, Himachal Pradesh and Jammu Kashmir.

India is the largest mango producing country, accounting for 44 per cent of world production. There are bright prospects of building up a flourishing trade for the export of this fruit to other countries as well as of its products like canned mango slices and bottled mango juice. Already mangoes are exported to nearly 20 countries, where as its products are sent to over 40 countries. However, the present turn out is too meager. Mango can thus earn for India a handsome foreign exchange, through the export of fresh mangoes and mango products. There are vast stretches of areas where the cultivation of this choice fruit could be developed and expanded usefully and profitably.

Mango possess unique nutritional and medicinal qualities apart from being a rich sources of carbohydrate as well as vitamins A and C. Mango fruit contains 73.0-86.7 per cent moisture, 11.6-24.3 per cent carbohydrate, 0.3-1.0 per cent protein, 0.1-0.8 per cent fat, 0.3-0.7 per cent mineral, 650-25900 µg vitamin 'A' and 3-83 mg vitamin 'C' per 100 g fruit. Besides its attractive form and appearance, delicious taste and appetizing flavor, the ripe mango fruit, according to nutritional experts, is also highly invigorating, fattening, laxative and diuretic. Seed kernels contain 9.5 per cent protein, 8-12 per cent fat, 79.2 per cent starch,

2 per cent mineral matter and 2 per cent fibers. The stones, besides their use for propagation, can serve as a good stock feed for cattle.

The tree is medium in size, ranging from 8-10 meters in height. The tree top is oval or doe shaped. The trunk of the tree is mostly straight, cylindrical, 75-100 cm in diameter. Mango is a evergreen tree bearing numerous branches. The leaves are dark shinning, green from above and yellow green from below. Inflorescence of mango is large panicles which grows terminally. Sometimes inflorescence is axillary also. These panicles may be 6- 30 cm long and 3-25 cm in diameter. Flowers are small in the inflorescence and both side of male and female flowers are borne in the same flower i.e. hermaphrodite. Mango fruit is drupe and mesocarp is the edible portion.

The fruit in raw stage is used for extraction of tannin and other astringent products as well as for the preparation of delightful chutneys, curries and pickles. Ripe fruits are a delicacy for the table, while the unmarketable and inferior ones can be converted into delicious squashes, juices, nectars, syrups, jams and jellies. Canned mango slices and pulp are indeed very popular.

The micro nutrients plays as important role in improving the fruit set growth and development, control of fruit drops, fruit maturation and fruit quality and over coming of physiological and nutritional disorders have been well established in number of tropical, sub-tropical and temperate fruit crops.

Boron plays an important role for proper development of ovule, pollen tube growth and increases well number of fruit set. It helps in the uptake of calcium and encourages efficient utilization of calcium in plants. It also helps in protein synthesis.

Zinc plays an important role in growth and development of fruits. It is one of the essential elements for the formation of chlorophyll and hence useful towards photosynthetic activity. Zinc is a cofactor of over 300 enzymes and proteins and has an early and specific effect on cell division, nucleic acid metabolism, and protein synthesis. It is an essential trace element for plants, being involved in many enzymatic reactions and is necessary for their good growth and development. Zinc is also involved in regulating the protein and carbohydrate metabolism. Moreover, zinc uptake rate was faster in mango trees when zinc sulphate was foliar applied as compared with its soil application. The positive effect of foliar application of zinc in increasing the productivity of mango was cited by and improving the fruit quality in terms of TSS and total sugars.

Iron plays an important role associated with the development flavoprotein. The improved Fe poly flavonoid activity enhances the biosynthesis of pigments like xanthophylls and carotenoids. Iron has involved in the transfer of electrons (redox reactions), such as cytochromes. In this role, it is reversibly oxidized from Fe^{2+} to Fe^{3+} during electron transfer. Iron acts as a catalyst in formation of chlorophyll and in several enzymes. It is a key element in various reactions of respiration, photosynthesis and reduction of nitrates and sulphates.

In mango, fruit drop is serious problem and it is very high especially in the northern plains of Uttar Pradesh. Heavy fruit drops reduces the production of crop greatly. The intensity of fruit drop can be minimized and growth and development of fruit can be enhanced by foliar feeding of micro nutrients.

Materials & Methods

The present investigation "Effect of foliar application of micro nutrients on yield and Physical quality of Mango (*Mangifera indica* L.) cv. Amrapali" was carried out at Main Experiment Station Horticulture, Narendra Deva University of Agriculture and Technology, Narendra Nagar (Kumarganj), Faizabad (U.P.) during the year 2017. 25 years old Uniform mango plants, planted at a distance of 2.5x 2.5 meters were used as experimental material in the present investigation. All the schedule based cultural practices were followed as per recommendations. The experiment was laid out in Randomized Block Design (R.B.D.) with 3 replications in the month of January, 2017. Two plants were taken as unit per treatment.

Results & Discussion

1. Number of fruits per shoot

Observations gathered with respect to number of fruits per shoot at pea stage have been referred in Table1, which reveals that number of fruits per shoot was found to be maximum with the application of $FeSO_4$ 1%+ $ZnSO_4$ 1%+ Borax 0.5% and value obtained (2.6) followed by $ZnSO_4$ 1%+ Borax 0.5% The minimum (1.09) number of fruits per shoot was recorded in T_1 (Control).

Table 1: Effect of foliar spray of nutrients on number of fruits per shoot.

Treatments	No. of fruit per shoot
T_1 : Control (Water spray)	1.09
T_2 : $ZnSO_4$ 1%	2.42
T_3 :$FeSO_4$ 1%	1.69
T_4 : Borax 0.5%	2.34
T_5 : $ZnSO_4$ 1% + $FeSO_4$ 1%	1.94
T_6 : $ZnSO_4$ 1% + Borax 0.5%	2.55
T_7 : $FeSO_4$ 1% + Borax 0.5%	2.49
T_8 : $FeSO_4$ 1% + $ZnSO_4$ 1% + Borax 0.5%	2.60
S. Em ±	0.16
CD at 5%	0.48

2. Fruit drop (%)

Data pertaining to per cent fruit drop have been presented in Table2. The minimum (91.00%) fruit drop was recorded with the use of $FeSO_4$ 1%+ $ZnSO_4$ 1%+ Borax 0.5% followed byT_6 (92.98%) with the foliar application of $ZnSO_4$ 1%+ Borax 0.5% while, maximum fruit drop (96.02%) was recorded under (control) treatment.

Table 2: Effect of foliar spray of nutrients on fruit drop.

Treatments	Fruit drop (%)
T_1 : Control (Water spray)	96.02
T_2: $ZnSO_4$ 1%	93.78
T_3 : $FeSO_4$ 1%	96.86
T_4 : Borax 0.5%	94.23
T_5 : $ZnSO_4$ 1% + $FeSO_4$ 1%	95.43
T_6: $ZnSO_4$ 1% + Borax 0.5%	92.98
T_7: $FeSO_4$ 1% + Borax 0.5%	93.32
T_8 : $FeSO_4$ 1% + $ZnSO_4$ 1%+ Borax 0.5%	91.00
S. Em ±	0.42
CD at 5%	1.29

3. Fruit retention (%)

Data pertaining to per cent fruit retention presented in Table-3 indicated that foliar application of various micro-nutrients significantly influences the percentage of fruit retention over control. The maximum (8.49%) fruit retention was obtained with the foliar application of $FeSO_4$ 1%+ $ZnSO_4$ 1%+ Borax 0.5% followed by (8.21%) which use of $ZnSO_4$ 1%+ Borax

0.5% while, the minimum (3.5%) fruit retention was obtained in control.

Table 3: Effect of foliar spray of nutrients on fruit retention.

Treatments	Fruit retention (%)
T_1 : Control (Water spray)	3.50
T_2 : $ZnSO_4$ 1%	7.35
T_3: $FeSO_4$ 1%	4.41
T_4 : Borax 0.5%	6.78
T_5 : $ZnSO_4$ 1% + $FeSO_4$ 1%	5.32
T_6: $ZnSO_4$ 1%+ Borax 0.5%	8.21
T_7 : $FeSO_4$ 1%+ Borax 0.5%	7.89
T_8 : $FeSO_4$ 1% +$ZnSO_4$ 1%+ Borax 0.5%	8.49
S. Em ±	0.29
CD at 5%	0.88

4. Fruit yield (kg/tree)

It is obvious from data presented in Table-4that all treatments were found effective in improving fruit yield (kg/tree) over control. The highest fruit yield (24.5 kg/tree) was obtained treatment T_8 with the application of $FeSO_4$ 1% +$ZnSO_4$ 1%+ Borax 0.5% followed by T_{6-} (23.83 kg/tree) in with spray of $ZnSO_4$ 1% + Borax 0.5% and T_{7-} $FeSO_4$ 1%+ Borax 0.5% which were found significantly at par. However, the lowest fruit yield (16.89 kg/tree) was recorded in control.

Table 4: Effect of foliar spray of nutrients on fruit yield.

Treatments	Fruit yield(kg/tree)
T_1 : Control (Water spray)	16.89
T_2 : $ZnSO_4$ 1%	22.65
T_3 : $FeSO_4$ 1%	18.05
T_4 : Borax 0.5%	21.23
T_5 : $ZnSO_4$ 1%+ $FeSO_4$ 1%	20.57
T_6: $ZnSO_4$ 1%+ Borax 0.5%	23.83
T_7: $FeSO_4$ 1%+Borax 0.5%	23.09
T_8 : $FeSO_4$ 1% +$ZnSO_4$ 1%+ Borax 0.5%	24.50
S. Em ±	0.51
CD at 5%	1.54

Physical characters of fruit

Size of fruit (cm)

1.1 Fruit length (cm)

The data regarding fruit size with respect to their length were noted for the different treatments are given in Table-1.1. The maximum fruit length (10.9 cm) was recorded in T_8 with the spray of $FeSO_4$ 1%+ $ZnSO_4$ 1%+ Borax 0.5% followed by T_6 ($ZnSO_4$ 1%+ Borax 0.5%) which were found significantly at par. The minimum fruit length (8.55 cm) was noted in control.

Table 1.1: Effect of foliar spray of nutrients on fruit length.

Treatments	Fruit length(cm)
T_1 : Control (Water spray)	8.55
T_2 : $ZnSO_4$ 1%	9.56
T_3 : $FeSO_4$ 1%	8.78
T_4 : Borax 0.5%	9.43
T_5 : $ZnSO_4$ 1%+ $FeSO_4$ 1%	8.96
T_6: $ZnSO_4$ 1% + Borax 0.5%	10.72
T_7 : $FeSO_4$ 1%+ Borax 0.5%	10.03
T_8 : $FeSO_4$ 1%+ $ZnSO_4$ 1%+ Borax 0.5%	10.90
S. Em ±	0.08
CD at 5%	0.24

1.2 Fruit width (cm)

The data presented in Table1.2 that all the treatments were increased the fruit width significantly over control. The maximum fruit width (6.53 cm) was recorded in $T_8$with foliar application of $FeSO_4$ 1%+ $ZnSO_4$ 1%+ Borax 0.5% which was markedly better than other treatments except T_6 with application of $ZnSO_4$ 1%+ Borax 0.5% which was found at par. The minimum fruit width (5.50 cm) was obtained under control (T_1).

Table 1.2: Effect of foliar spray of nutrients on fruit width.

Treatments	Fruit width (cm)
T_1 : Control (Water spray)	5.50
T_2 : $ZnSO_4$ 1%	5.93
T_3 : $FeSO_4$ 1%	5.65
T_4 : Borax 0.5%	5.89
T_5 : $ZnSO_4$ 1% +$FeSO_4$ 1%	5.83
T_6: $ZnSO_4$ 1% + Borax 0.5%	6.26
T_7 : $FeSO_4$ 1% +Borax 0.5%	6.10
T_8 : $FeSO_4$ 1% + $ZnSO_4$ 1% + Borax 0.5%	6.53
S. Em ±	0.11
CD at 5%	0.34

1.3 Fruit weight (g)

It is evident from data presented in Table 1.3 revealed that foliar application of all micro-nutrients significantly increased the weight of fruits in compression to control. Significant variations were obtained in fruit weight, which varies from 140.5 to 198.67 g. The maximum (198.67 g) fruit weight was recorded with application of $FeSO_4$ 1%+ $ZnSO_4$ 1%+ Borax 0.5% which was found significantly higher over other treatments except T_6 $ZnSO_4$ 1%+ Borax 0.5% which showed at par effect while, the minimum fruit weight (140.50 g) was noted in control (T_1).

Table 1.3: Effect of foliar spray of nutrients on fruit weight.

Treatments	Fruit weight (g)
T_1 : Control (Water spray)	140.50
T_2 : $ZnSO_4$ 1%	163.22
T_3 : $FeSO_4$ 1%	153.24
T_4 : Borax 0.5%	161.54
T_5 : $ZnSO_4$ 1% + $FeSO_4$ 1%	156.37
T_6: $ZnSO_4$ 1% + Borax 0.5%	187.23
T_7 : $FeSO_4$ 1% + Borax 0.5%	171.93
T_8 : $FeSO_4$ 1% + $ZnSO_4$ 1% + Borax 0.5%	198.67
S. Em ±	4.73
CD at 5%	14.34

1.4 Volume of fruit (cm^3)

Data pertaining to volume of fruit have been presented in Table 1.4 that the volume of fruit was increased with the foliar application of nutrients. The maximum fruit volume (160.54 cm^3) was recorded in T_8 $FeSO_4$ 1% + $ZnSO_4$ 1% + Borax 0.5% followed by T_6 ($ZnSO_4$ 1% + Borax 0.5%). However, the minimum value obtained volume of fruit (126.24 cm^3) was recorded in control (T_1).

Table 4.8: Effect of foliar spray of nutrients on volume of fruit.

Treatments	Volume of fruit (cm^3)
T_1 : Control (Water spray)	126.24
T_2 : $ZnSO_4$ 1%	145.98
T_3 : $FeSO_4$ 1%	132.54
T_4 : Borax 0.5%	140.07
T_5 : $ZnSO_4$ 1% + $FeSO_4$ 1%	136.86
T_6: $ZnSO_4$ 1% + Borax 0.5%	156.28
T_7 : $FeSO_4$ 1% +Borax 0.5%	151.63
T_8 : $FeSO_4$ 1% + $ZnSO_4$ 1% + Borax 0.5%	160.54
S. Em ±	0.14
CD at 5%	0.43

1.5 Pulp weight (g)

It is evident from the data presented in Table 1.5 clearly showed that pulp weight was significantly affected by different treatments. The maximum pulp weight (130.62 g) was recorded with the foliar feeding of $FeSO_4$ 1% + $ZnSO_4$ 1% + Borax 0.5% followed by (123.65g) in T_6 with application of $ZnSO_4$ 1% + Borax 0.5%. The minimum pulp weight (90.00 g) was recorded with the spray of water (control).

Table 1.5: Effect of foliar spray of nutrients on pulp weight.

Treatments	Pulp weight (g)
T_1 : Control (Water spray)	90.00
T_2 : $ZnSO_4$ 1%	109.61
T_3 : $FeSO_4$ 1%	95.32
T_4 : Borax 0.5%	101.47
T_5 : $ZnSO_4$ 1% +$FeSO_4$ 1%	98.73
T_6: $ZnSO_4$ 1% +Borax 0.5%	123.65
T_7: $FeSO_4$ 1% +Borax 0.5%	115.84
T_8 : $FeSO_4$ 1% +$ZnSO_4$ 1% + Borax 0.5%	130.62
S. Em ±	0.16
CD at 5%	0.48

1.6 Stone weight of fruit

The data on the effect of foliar application of nutrients on stone weight of fruit are presented Table1.6 clearly showed significant difference among treatments. The maximum stone weight (29.54g) was recorded with T_8 ($FeSO_4$ 1% + $ZnSO_4$ 1% + Borax 0.5%) followed by T_6 ($ZnSO_4$ 1%+ Borax 0.5%) while, minimum value (24.95g) stone weight was recorded under control (T_1).

Table 1.6: Effect of foliar spray of nutrients on stone weight.

Treatments	Stone weight (g)
T_1 : Control (Water spray)	24.95
T_2 : $ZnSO_4$ 1%	26.68
T_3 : $FeSO_4$ 1%	25.72
T_4 : Borax 0.5%	26.11
T_5 : $ZnSO_4$ 1% +$FeSO_4$ 1%	25.70
T_6: $ZnSO_4$ 1% + Borax 0.5%	29.12
T_7 : $FeSO_4$ 1% +Borax 0.5%	28.65
T_8 : $FeSO_4$ 1% + $ZnSO_4$ 1%+ Borax 0.5%	29.54
S. Em ±	0.81
CD at 5%	2.46

1.7 Pulp: stone ratio

The data presented in Table-1.7 that there were significant variation in pulp: stone ratio in the values obtained under different treatments. The maximum pulp: stone ratio (4.42) was noted under with the spray of $FeSO_4$ 1%+ $ZnSO_4$ 1% + Borax 0.5% (T_8) followed by T_6 with $ZnSO_4$ 1%+ Borax 0.5%. The minimum pulp: stone ratio (3.61) was recorded under control.

Table 1.7: Effect of foliar spray of nutrients on pulp: stone ratio

Treatments	Pulp: stone ratio
T_1 : Control (Water spray)	3.61
T_2 : $ZnSO_4$ 1%	4.11
T_3 : $FeSO_4$ 1%	3.70
T_4 : Borax 0.5%	3.89
T_5 : $ZnSO_4$ 1% + $FeSO_4$ 1%	3.83
T_6: $ZnSO_4$ 1% + Borax 0.5%	4.25
T_7 : $FeSO_4$ 1% + Borax 0.5%	4.04
T_8 : $FeSO_4$ 1% + $ZnSO_4$ 1% + Borax 0.5%	4.42
S. Em ±	0.12
CD at 5%	0.36

A. Yield attributes

A perusal of data recorded on number of fruits per shoot, fruit drop per cent, fruit retention per cent and fruit yield (kg/tree) have been presented in (Table-4.1, Fig. 4.1), (Table 4.2, Fig-4.2), (Table-4.3, Fig-4.3) and in Table-4.4, fig. 4.4 respectively, clearly indicated that maximum number of fruits per shoot, fruit retention, fruit yield (kg/tree) and minimum fruit drop per cent were recorded with the spray of T_8 $FeSO_4$ 1%+ $ZnSO_4$ 1%+ Borax 0.5% followed with the spray of T_6 $ZnSO_4$ 1% + Borax 0.5%. However, the maximum fruit drop, minimum number of fruits per shoot and fruit retention per cent noted water control (water spray). The increase in fruit retention might be due to increase the endogenous level of auxin and other metabolites. The role of zinc is known to be essential for the biosynthesis of auxin (IAA) as it is an activator of the enzyme typtophane synthetase. Increased fruit retention under sprays is suggestive of interference that the treatments have in one way of other influenced the auxin balance to prevent fruit drop.

These results are in close conformity with the finding in which maximum number of fruits per shoot, fruit retention and reduced fruit drop were also noted Malik *et al.*, (1990) in kinnow mandarin with the foliar spray of $ZnSO_4$. Ruby and Brahmachari (2001) reported that the fruit drop was significantly minimum with application of 1% zinc sulphate in litchi, Kumar *et al.* (2008) reported, foliar application of urea 2% in combination with $ZnSO_4$ 0.5% or Borax 0.5% were the most effective treatments in improving the flowering and fruiting characters as number of perfect flowers and fruit retention in mango cv. Amrapali. Khan *et al.* (2009) reported that with foliar spray of 0.5% $ZnSO_4$+ 0.1% thiourea followed by 0.25% Borax+0.1% thiourea on aonla fruits and Vashistha *et al.* (2010) also obtained maximum number of fruits/shoots and fruit retention with foliar application of urea @ 1%+ZnSO4 @ 0.4%+Borax @ 0.4% whereas, minimum number of fruits and retention was recorded with water spray (control) in mango fruit (*Mangifera indica* L.) cv. Amrapali.

Data recorded on fruit yield (kg/ tree) showed that application of T_8 $FeSO_4$ 1%+ $ZnSO_4$ 1%+ Borax 0.5% followed with the spray of T_6 $ZnSO_4$ 1% + Borax 0.5% was found to be best to increase fruit yield. Where a minimum fruit yield/ tree was observed in control. The increased fruit yield due to foliar feeding of nutrients, might be attributed to more uptake of nutrients because efficient absorption and consequently more luxuriant vegetative growth at the initial stage, which later on resultant more metabolites for developing fruits. The importance of these nutrients in improving the physiological activities, which improve width of fruit, length of fruit and weight of fruit, ultimately increasing the yield. The present finding is also in conformity with observations recorded by Singh (2002) [16] noted Zinc spray either singly or in combination with other nutrients resulted in significant increase in yield of aonla cv. NA-10 as compared to control, Bhowmick *et al.* (2012) noted maximum fruit yield per tree (36.00 kg) with the foliar application of Borax @ 0.5% in mango cv. Amrapali.

B. Physical characters of fruit

The results clearly indicated that the fruit size was markedly improved by all the treatments over control (Table-4.5, fig-4.5 and Table 4.6, fig. 4.6, respectively) indicated significant increase in fruit size. The maximum fruit length and fruit breadth were recorded with the spray of (T_8) $FeSO_4$ 1%+ $ZnSO_4$ 1%+ Borax 0.5%. The minimum fruit length and fruit breadth were recorded with control treatment. The reasons for

increase fruit size due to spraying of nutrients might be attributed to efficient absorption and accumulation of metabolites in initial stage of developing fruit. Spraying of $ZnSO_4$, which provide zinc to the plant, might have regulated the cell-wall permeability, thereby allowing more mobilization of water in fruit attributing to larger fruit size. These results are in close conformity with the findings of various workers in guava (Pal *et al.* (2008) [10] and Singh *et al.* (2011) also obtained maximum fruit length and breadth with the foliar application of Zn (0.5%) + B (0.2%) + Mn (1%) + Ca (0.6%) twice (August and October) and organic mulching (10 cm thick of dry leaves) in mango cv. Himsagar.

Increased in weight and volume of fruits also improved appreciably in all the treatments over control (Table 4.7, fig. 4.7 and Table 4.8, fig. 4.8). However, maximum impact was observed with the spray of T_8 $FeSO_4$ 1%+ $ZnSO_4$ 1%+ Borax 0.5%. The zinc application might be due to rapid cell division and higher pulp content. The increase in fruit weight by zinc spray may be due to the accumulation of more food material in fruit trees. The spray of $ZnSO_4$ has been also proved efficacious to improve the fruit weight and volume significantly in litchi Kumar *et al.* (2004) reported significantly increment in fruit weight with foliar spray of Zn (0.5%, 1.0%), B (0.4%, 0.6%), Cu (0.5%, 1.0%) and NAA (15mg 1-1) and Goswami *et al*. (2012) observed maximum fruit volume in guava (*Psidium guajava* L.) cv. Sardar with the foliar application of $ZnSO_4$ @ 0.4%.Almost similar pattern was also noted with respect to increase in volume of fruit by foliar application of$ZnSO_4$ @ 0.4%.

Observations recorded on stone weight, pulp weight, and pulp: stone ratio shown in (Table 4.9, fig. 4.9, Table 4.10, fig. 4.10, and Table 4.11, fig. 4.11) clearly indicated that application of T_8 ($FeSO_4$ 1%+ $ZnSO_4$ 1%+ Borax 0.5%) was found to be significant and increased of all these parameters in mango fruit. The minimum pulp weight was observed in control treatment. Increase in pulp weight may be due to more absorption of water, nutrients and increase the volume of inter-cellular spaces in the pulp. Such type results are in conformity to those reported by Vejendla *et al.* (2008) noted higher pulp (71.90%) in mango cv. Amrapali with spraying of $ZnSO_4$ @ 0.75% and also Moazzam *et al.* (2011) [7] noted maximum pulp weight and less stone weight in comparison to control with foliar application of 0.4% $FeSO_4$ +0.8% H_3BO_3 +0.8% $ZnSO_4$.

Summary & Conclusion

1. All the nutrients increased number of fruits per shoot in mango over control. The maximum number of fruits per shoot was obtained with the use of T_8 ($FeSO_4$ 1% + $ZnSO_4$ 1%+ Borax 0.5%) followed by T_6 -$ZnSO_4$ 1%+ Borax 0.5% in mango fruit.
2. The minimum fruit drop was obtained with the use of T_8 -$FeSO_4$ 1%+ $ZnSO_4$ 1%+ Borax 0.5% followed by T_6 -$ZnSO_4$ 1%+ Borax 0.5% in mango fruit.
3. The maximum fruit retention was recorded with the spray of T_8 -$FeSO_4$ 1%+ $ZnSO_4$ 1%+ Borax 0.5% followed by T_6 -$ZnSO_4$ 1%+ Borax 0.5% in mango fruit.
4. The higher fruit yield per tree was recorded with the spray of T_8 -$FeSO_4$ 1%+ $ZnSO_4$ 1%+ Borax 0.5% followed by T_6 -$ZnSO_4$ 1%+ Borax 0.5% in mango fruit.
5. The maximum fruit length and fruit width were observed with the foliar application of T_8 -$FeSO_4$ 1%+ $ZnSO_4$ 1%+ Borax 0.5% followed by T_6 -$ZnSO_4$ 1%+ Borax 0.5% in mango fruit.
6. The maximum fruit weight and volume were recorded with the use of T_8 -$FeSO_4$ 1%+ $ZnSO_4$ 1%+ Borax 0.5% followed by T_6 -$ZnSO_4$ 1%+ Borax 0.5% in mango fruit.
7. The highest stone weight and pulp weight were obtained with the foliar application of T_8 -$FeSO_4$ 1%+ $ZnSO_4$ 1%+ Borax 0.5% followed by T_6 -$ZnSO_4$ 1%+ Borax 0.5%.
8. The highest pulp: stone ratio were obtained with the foliar application of T_8 -$FeSO_4$ 1%+ $ZnSO_4$ 1%+ Borax 0.5% followed by T_6 -$ZnSO_4$ 1%+ Borax 0.5% in mango fruit.

Based on the present investigation it can be concluded that foliar application of $FeSO_4$ 1%+ $ZnSO_4$ 1%+ Borax 0.5% from the overall experimental finding was proved to be mass effective to decrease fruit drops, increase fruit retention, fruit yield (kg/tree), physico-chemical attributes of fruit viz. fruit length, fruit width, fruit volume, fruit weight, pulp weight, stone weight, pulp: stone ratio, Therefore, foliar application of $FeSO_4$ 1%+ $ZnSO_4$ 1%+ Borax 0.5% at panicle initiation and at pea stage can be recommended to mango growers of eastern Uttar Pradesh for higher fruit yield and better quality traits.

References

1. Anonymus. NHB Database Indian Horticulture Data base, National Horticulture Board, Gurgaon, Haryana, 2015.
2. Bakshi P, Jasrotia A, Wali VK, Sharma A, Bakshi M. Influence of pre-harvest application of calcium and micro-nutrients on growth, yield, quality and shelf-life of strawberry cv. Chandler. Indian Journal of Agricultural Sciences. 2013; 83(8): 831-835.
3. Balakrishnan K. Foliar spray of iron, zinc, boron and magnesium on vegetative growth and quality of guava. Annals of Plant Physiology. 2000; 14:151-153.
4. Bhatt R, Mishra NK, Mishra DS, Singh CP. Foliar application of potassium, calcium, zinc and boron enhanced yield, quality and shelf life of mango. Horticulture Flora Research Spectrum. 2012; 1(4):300-305.
5. Meena VS, Yadav PK, Meena PM. Yields attributes of ber (*Zizyphus mauritiana* Lamk.) *cv*. Gola as influenced by foliar application of ferrous sulphate and borax. Agricultural Science Digest. 2008; 28(3):219-221.
6. Mishra Deepa S, Singh AK, Lal RL. Effect of micronutrient sprays on fruit yield and quality during storage in *ber* cv. Umran under ambient conditions. Indian Journal of Horticulture. 2008; 65(4):399-404.
7. Moazzam A, Tahir FM, Shahzad J, Mahmood N. Effect of foliar application of micronutrients on the quality of mango (*Mangifera indica* L.) cv. Dashehari fruit. Mycopath. 2011; 9(1):25-28.
8. Negi SS, Singh AK, Singh CP. Effect of foliar application of nutrients on fruit-set, yield and quality of mango cv. Dashehari. Haryana Journal of Horticultural Sciences. 2009; 38(1-2):20-22.
9. Nehete DS, Padhiar BV, Shah NI, Bhalerao PP, Kolambe BN, Bhalerao RR. Influence of micro-nutrient spray on flowering, yield, quality and nutrient content in leaf of mango cv. Kesar. Asian Journal of Horticulture. 2011; 6(1):63-67.
10. Pal A, Pathak RK, Pal K, Singh T. Effect of foliar application of nutrients on yield and quality of guava fruits (*Psidium guajava* L.) cv. Sardar guava. Progressive Horticulture. 2008; 3(1):89-90.

11. Patel AR, Saravaiya SN, Patel AN, Desai KD, Patel NM, Patel JB. Effect of micro-nutrients on yield and fruit quality of banana (*Musa paradisica* L.) cv. BASRAI under pair row planting method. Asian Journal of Horticulture. 2010; 5(1):245-248.
12. Pathak RA, Singh AK, Yadav AL. Studies on foliar feeding of micro-nutrients in guava *cv.* Sardar. National seminar on production and post-harvest technology of guava, C.S.A.U.A. &T. Kanpur, 2002, 7.
13. Sarolia D, Mukharjee S. Growth, yield and quality of ber (*Zizyphus mauritiana* Lamk.) *cv*. Umran as influenced by nitrogen, phosphorous and zinc application in Semi-Arid condition of Rajasthan In: National Seminar on Commercialization of Horticulture in Non-traditional Areas, Organized by Central Institute for Arid Horticulture Bikaner (Rajasthan) from. 2005; 5-6:91.
14. Sharma P, Singh AK, Sharma RM. Effect of plant bio-regulators (PBRs) and Micro nutrients on fruit set and quality of litchi cv. Dehradun. Indian Journal of Horticulture. 2005; 62(1):24-26.
15. Shekhar C, Yadav AL, Singh HK, Singh MK. Influence of micronutrients on plant growth, yield and quality of papaya fruit (*Carica papaya* L.) cv. Washington. Asian Journal of Horticulture. 2010; 5(2):326-329.
16. Singh DM. Studies on foliar feedings of nutrient on yield and quality of aonla fruit (*Emblica officinalis* Gaetn.) M.Sc. (Ag) Horticulture, Thesis submitted to N.D.U.A. &.T. Faizabad, 2002.
17. Singh NTD, Prasad VB, Collis JP. Effect of foliar application of zinc and boron on yield and fruit quality of guava (*Psidium guajava* L.). Horticulture Flora Research Spectrum. 2012; 1(3):281-283.
18. Singh Rathore R, Chandra A. Effect of application of nitrogen in combination with zinc sulphate on nutrient content, quality and yield of ber (*Zizyphus mauritiana* Lamk.) *cv*. Gola. National Seminar on Commercialization of Horticulture in Non-traditional Areas. Organized by Central Institute for Arid Horticulture, Bikaner (Rajasthan) from. 2005; 5-6:149.