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EFFECT OF FOLIAR SPRAY OF MICRONUTRIENTS ON FLOWERING AND FRUITING OF ALPHONSO MANGO (*MANGIFERA INDICA* L.)

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ABSTRACT

Alphonso has most of the quality merits but it has some serious inherited physiological disorders such as, alternate bearing habit and excessive/heavy fruit drop that occurs at different stages of fruit growth till harvest is considered as one of the long standing unresolved problems, directly and substantially contributing to its poor yield along with other problems. To overcome this problem the experiment was planned witheleven treatments involving two levels of micronutrients ($ZnSO_4$ 1% and 2%; $FeSO_4$ 1% and 2% and Borax 0.5% and 1%), their combinations and a control. Results revealed that foliar application of 1% $ZnSO_4$, 1% $FeSO_4$ and0.5% borax in combination had influenced flowering in terms of minimum days(19.67) taken to 50% flowering and increased length of panicle(40.33 cm) compared to other treatments and control. The treatment $ZnSO_4$ 1% + $FeSO_4$ 1% + borax 0.5% significantly increased the fruit set at pea stage (14.00) and marble stage (7.50), number of fruits per tree (1.73), average fruit weight (314.69 g) and yield per tree (185.09 kg) and decreased the fruit drop (87.66 %).

INTRODUCTION

Mango (*Mangifera indica* L.) belongs to the family Anacardiaceae originated in Indo-Burma region. The fruit has been in cultivation in Indian sub-continental for well over 4000 years and has been the favourite of the kings and commoners. Alphonso is one of the most popular varieties of India. The fruits are very attractive, large in size having a prominent ventral shoulder and attractive pinkish flush toward the basal end.The taste is superb with an excellent sugar: acid blend and captivating flavour besides being a Table cultivar, much in demand it is a favoured fruits of the processing industry because it remains its characteristics flavour even during processing. But Alphonso has a problem of alternate bearing which is considered as one of the long standing unresolved problems, directly and substantially contributing to poor production. In order to improve the yield of the crop several micronutrients studied were conducted.

The food supplements, multivitamins and mineral supplements are necessary for the healthy crops. According to horticulturists, only application of primary nutrients could not prove successful to produce high quality fruit in mango trees, the application of micronutrients is compulsory as well. Major elements/ macronutrients are quickly taken up and utilized by the tissues of the plants by the catalyzing effect of micronutrients (Phillips, 2004). Micronutrients play a vital role in various enzymatic activities and synthesis of assimilates and hormones. Their acute deficiencies some time poses the problem of incurable nature (Kumar, 2002). These micronutrients also 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 *etc.*, (Das, 2003).Various experiments have been conducted earlier on foliar spray of micro-nutrients in different fruit crops (*e.g.* in mango, Nehete *et al.*, 2011)and vegetables (*e.g.* in okra, Dalal and Nandkar, 2010)and shown significant response to improve yield of fruits.

Thus keeping above facts inview the present investigation was undertaken with objectives susch as to see the influences of micronutrients on flowering and fruiting on Alphonso mango.

MATERIALS AND METHODS

The experiment was conducted at Regional Horticultural Research Station, Navsari Agricultural University, Navsari 396 450, Gujarat, during the year 2012-13. The investigation was conducted on 30 years old mango trees planted at 10 × 10 m apart under square system of planting. In order to assess the effects of various treatments, all the trees were managed with uniform cultural practices as per the standard recommendations with respect to manures and fertilizers, irrigation, plant protection measures *etc*.

The experiment was laid out in Randomized Block Design with eleven treatments combinations*viz.*, T_1: $ZnSO_4$ 1%,T_2: $ZnSO_4$ 2%, T_3 : $FeSO_4$ 1%, T_4 : $FeSO_4$ 2%, T_5: Borax0.5%, T_6: Borax1%, T_7: $ZnSO_4$1% + $FeSO_4$1%, T_8: $ZnSO_4$ 2% + $FeSO_4$ 2%, T_9: $ZnSO_4$ 1% + $FeSO_4$ 1% + Borax 0.5%, T_{10}: $ZnSO_4$

2% + $FeSO_4$ 2% + Borax 1% and T_{11}: Control. The treatments were replicated thrice.

Spray was carried out twice before initiation of flowering during 2nd fort night of October and November. Length of the panicle (cm) was measured with the help of meter scale at full bloom stage. It was measured from the point of emergence to the apex of panicle. The number of fruit retention was worked out from the number of fruits retained per panicle. The number of fruit drop was recorded at harvesting stage. The per cent fruit drop was worked out from the following formula.

$$\text{Fruit drop \%} = \frac{\text{Fruit set - Fruit retention}}{\text{Fruit set}} \times 100$$

Statistical analysis

The data collected were analyzed statistically as per the procedure (Panse and Sukhatme, 1967) appropriate for Randomized Block Design and the treatment means were compared by means of critical differences at 5 per cent level of probability.

RESULTS AND DISCUSSION

Days taken to 50% flowering (from initiation of flowering)

The plants treated with $ZnSO_4$ 1% + $FeSO_4$ 1% + Borax 0.5% (T_9) before initiation of flowering, took significantly minimum days (19.67) to 50% flowering (Table 1) over control. However, all the treatments of micronutrients were at par with treatment T_9. Zinc enhanced the synthesis of auxin in the plants. Iron is credited with a definite role in the synthesis of chlorophyll molecules. Similarly, boron regulates metabolism and translocation of carbohydrates, cell wall development and RNA synthesis (Ram and Bose, 2000). The combined effect of different micronutrients might have played a vital role in increase of physiological activities leading to early initiation of flowering in mango cv. Alphonso. The similar results werein mango (Ghanta and Mitra, 1993; Banik and Sen, 1997 and Singh and Maurya, 2004) and Sarolia *et al.* (2007) in guava supported the present investigation.

Length of panicle (cm)

The data of Table 1 indicated that foliar application of $ZnSO_4$ 1% + $FeSO_4$ 1% + Borax 0.5% before initiation of flowering significantly recorded the maximum length of panicle (40.33 cm). However, the treatments T_5, T_6 and T_7 stood at par with T_9 treatment. The minimum length of panicle was recorded in control (24 cm). This might be due to combine effect of micronutrients involved in activation of enzymes, protein synthesis and photoassimilats as well as translocation for efficient cellular activity. Auxins activated by zinc might have increased the length of panicle through cell division and cell elongation in the shoot apex. Thus, greater supply of photo assimilates *vis-à-vis* auxins in the terminal portion might have increased the length of panicle. Similar results observed by Dutta (2004) and Singh and Maurya (2004) in mango and Sarolia *et al.* (2007) in guava which are in accordance with the results of the present experiment.

Fruit retention and fruit drop

The maximum fruit set per panicle at pea stage, marble stage and fruit retention at the time of harvest were recorded with foliar application of $ZnSO_4$ 1% + $FeSO_4$ 1% + Borax 0.5%. Fruit drop was also found to be significant. Foliar spray of $ZnSO_4$ 1% + $FeSO_4$ 1% + Borax 0.5% twice before initiation of flowering during 2nd fort night of October and November decreased the fruit drop in cv. Alphonso. The beneficial effect on increasing fruit set, fruit retention and decreasing fruit drop may be due to the improving effect of such treatments on nutritional status of the trees specially boron and Zn, which reflected on increasing fruit set and fruit retention. Boron plays important role in pollen germination and pollen tube growth which is associate with better pollination, fertilization and fruit setting (Thompson and Batjer, 1950). Application of zinc could be promoted the auxin synthesis in the plant system which might delayed the formation of abscission layer during early stages of fruit development (Nason and McElroy, 1963). The increase in the fruit retention by application of micronutrient has also been reported in fruits like Guava (Gaur *et al.*, 2014) and peach (Yadav *et al.*, 2013).

Average fruit weight (g)

Micronutrient spray of $ZnSO_4$ 1% + $FeSO_4$ 1% + Borax 0.5% applied to Alphonso mango trees before initiation of flowering, significantly increased the average fruit weight recording 314.69 kg compared to control (182.72 kg). Zn plays a vital role to promote starch formation and B actively involved in transportation of carbohydrates in plants. Thus, the cumulative effect of combined treatment of Zn + Fe + B might have resulted into higher fruit weight. Similarly, Borax at 0.5% (T_5) and 1.0% (T_6) as well as $ZnSO_4$ 1% + $FeSO_4$ 1% produced the profound effect and increased the fruit weight. The possible reason for increase in fruit weight by the micronutrients might be due to faster loading and mobilization of photo assimilates to fruits and involvement in cell division and cell expansion which ultimately reflected into more weight of fruit in treated pants. Similar results were also found by Banik and Sen (1997), Dutta and Dhua (2002), Dutta (2004) in mango and Ghanta and Mitra (1993) in banana which are in agreement with the present findings.

Number of fruits per tree

Foliar application of $ZnSO_4$ 1% + $FeSO_4$ 1% + Borax 0.5% (T_9) twice before initiation of flowering, significantly gave the maximum 745 fruits per tree. However, the treatments T_5, T_6 and T_7 remained at par with T_9 treatment. All the micronutrients when sprayed alone or in combination involved directly in various physiological processes and enzymatic activity. This might have resulted into better photosynthesis, greater accumulation of starch in fruits. The involvement of Zn in auxin synthesis and B in translocation of starch to fruits. The balance of auxin in plant regulates the fruit drop or retention in plants, which altered the control of fruit drop and increased the total number of fruits per tree. Similar results were observed by Singh *et al.* (2003) and Dutta (2004) in mango and Jeyabaskaran and Pandey (2008) in banana, Kavitha *et al.* (2000) in papaya and Sarolia *et al.* (2007) in guava supported the present findings.

Yield (kg/tree)

Significantly the maximum yield (185.09 kg/ha) was obtained from the trees treated with combination of $ZnSO_4$ 1% + $FeSO_4$

Table 1: Effect of micronutrients spray on flowering of Alphonso mango.

Treatments	Days taken to 50% flowering (from initiation of flowering)	Days taken to full bloom (from initiation of flowering)	Length of panicle (cm)
T_1 $ZnSO_4$ 1%	23.67	42.33	31.51
T_2 $ZnSO_4$ 2%	24.33	45.00	28.98
T_3 $FeSO_4$ 1%	23.00	40.00	31.33
T_4 $FeSO_4$ 2%	24.00	42.67	26.62
T_5 Borax 0.5%	21.33	35.67	36.48
T_6 Borax 1%	20.67	33.67	37.33
T_7 $ZnSO_4$ 1% + $FeSO_4$ 1%	22.33	36.00	38.67
T_8 $ZnSO_4$ 2% + $FeSO_4$ 2%	24.67	46.33	32.17
T_9 $ZnSO_4$ 1% + $FeSO_4$ 1% + Borax 0.5%	19.67	31.67	40.33
T_{10} $ZnSO_4$ 2% + $FeSO_4$ 2% + Borax 1%	22.67	39.33	29.67
T_{11} Control	33.00	56.00	24.00
S.Em.±	1.74	2.25	1.40
C.D. at 5 %	5.12	6.63	4.14
C.V. %	12.76	9.55	7.49

Table 2: Effect of micronutrients spray on fruit set and fruit drop of Alphonso mango.

Treatments	No. of fruit set at pea stage	No. of fruit set at marble size	No. of fruit retention	Fruit drop (%)
T_1 $ZnSO_4$ 1%	12.25	5.83	1.07	91.24
T_2 $ZnSO_4$ 2%	12.35	6.13	0.97	92.19
T_3 $FeSO_4$ 1%	12.25	5.92	0.73	94.01
T_4 $FeSO_4$ 2%	12.19	6.00	0.80	93.15
T_5 Borax 0.5%	13.54	6.83	1.50	89.13
T_6 Borax 1%	13.29	6.50	1.23	90.71
T_7 $ZnSO_4$ 1% + $FeSO_4$ 1%	13.92	7.33	1.32	90.59
T_8 $ZnSO_4$ 2% + $FeSO_4$ 2%	13.10	5.98	0.93	92.87
T_9 $ZnSO_4$ 1% + $FeSO_4$ 1% + Borax 0.5%	14.00	7.50	1.73	87.66
T_{10} $ZnSO_4$ 2% + $FeSO_4$ 2% + Borax 1%	11.50	6.25	0.85	92.56
T_{11} Control	10.11	5.17	0.57	94.19
S.Em.±	0.56	0.41	0.08	1.32
C.D. at 5 %	1.65	1.20	0.25	3.89
C.V. %	7.68	11.13	13.73	2.49

Table 3: Effect of micronutrients spray on yield of Alphonso mango.

Treatments	Average fruit weight (g)	Total number of fruits/tree	Yield (kg/tree)
T_1 $ZnSO_4$ 1%	266.72	541.67	107.53
T_2 $ZnSO_4$ 2%	236.70	508.33	90.63
T_3 $FeSO_4$ 1%	252.83	375.33	69.34
T_4 $FeSO_4$ 2%	245.34	421.67	78.87
T_5 Borax 0.5%	289.27	729.33	162.73
T_6 Borax 1%	274.81	694.67	149.98
T_7 $ZnSO_4$ 1% + $FeSO_4$ 1%	283.42	635.00	139.22
T_8 $ZnSO_4$ 2% + $FeSO_4$ 2%	215.50	513.67	82.97
T_9 $ZnSO_4$ 1% + $FeSO_4$ 1% + Borax 0.5%	314.69	745.33	185.09
T_{10} $ZnSO_4$ 2% + $FeSO_4$ 2% + Borax 1%	198.03	366.67	55.23
T_{11} Control	182.72	298.33	49.23
S.Em.±	0.02	41.45	10.83
C.D. at 5 %	0.05	122.27	31.94
C.V. %	11.17	13.54	17.62

1% + Borax 0.5% before initiation of flowering compared to other treatments. The significant increase in fruit yield (kg/tree) is a cumulative effect of increase in number of fruits because of reduction in fruit drop *vis-a-vis* higher fruit weight by the direct and indirect effect of foliar spray of micronutrients in mango cv. Alphonso. Promotion of starch formation followed by rapid transportation of carbohydrates in plants activated by micronutrients like Zn and B are well established. In the present experiment, foliar spray of micronutrient might have affected the physiological processes resulting into higher production of mango cv. Alphonso. The minimum fruit yield was observed in control (T_{11}) (49.23 kg) which was followed by T_5 and remained at par. This indicated that single chemical or combination of low dose of chemical nutrient did not influence on fruit yield. The results are in conformity with those of Banik and Sen (1997), Dutta and Dhua (2002) and

Singh *et al.* (2003) in mango, Ghanta and Mitra (1993) in banana, Sarolia *et al.* (2007) and Gaur *et al.* (2014) in guava and Kavitha *et al.* (2000) in papaya.

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