Environment and Ecology 39 (4) : 1008—1016, October—December 2021
ISSN 0970-0420

Effect of Foliar Application of Micronutrients on Fruit Growth, Yield and Quality of Mango (*Mangifera indica* L.) cv Dashehari

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Received 22 June 2021, Accepted 7 September 2021, Published on 8 October 2021

ABSTRACT

The present study was aimed to determine the effect of foliar application of micronutrients on fruit growth, yield and quality of mango fruits (*Mangifera indica* L.) cv Dashehari. For this purpose, 24 healthy, full bearing and mature (15–20 years old) trees were subjected to foliar application of different combination of Ca $(NO_3)_2$, H_3BO_3 and $ZnSO_4$ before flowering stage. The experiment was conducted in Randomized Block Design with eight treatments and three replications. Our pre-treatment soil analysis showed sandy loam soil class and adequate in organic matter. Results revealed that the application of all the micronutrients significantly increased the quality of fruit than the control. Whereas, trees sprayed with 0.6% Ca $(NO_3)_2$ + 0.2% H_3BO_3 + 0.8% $ZnSO_4$ (T_7) showed the maximum fruit volume, pulp weight, total soluble solids, pulp percentage and less stone weight and peel weight along with low acidity in comparison to rest of treatments and control.

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Keywords *Mangifera indica* L., Foliar spray, Ca, B, Zn.

INTRODUCTION

Mango (*Mangifera indica* L.) is native to the Indian subcontinent, belonging to family Anacardiaceae, is the most cultivated and favorite fruit of the tropics (Purseglove 1972). It is rightly titled as "King of fruits" due to its wide adaptability, high nutritive value, richness in variety, delicious taste, excellent flavor, attractive appearance and popularity among the masses. It is one of the choicest and most ancient fruit known to mankind. Its cultivation in the Indian sub-continent started well over 4000 years (De Candolle 1904). In Ain-I-Akbari, Abul-Fazl has mentioned in detail the cultivars, cultivation and quality of mangoes (Bose *et al.* 2001). Ahmad and Rashid (2003) were mentioned that unbalanced fertilization, micronutrients deficiencies, poor tree management and inadequate cultural practices are mainly responsible for orchard related quality issues. These problems appear mainly due to enigmatic blooming and vegetative growth behavior (Chacko 1991). Horticulturists mentioned that 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 micro-nutrients/minor elements (Phillips

2004). Foliar spray of micronutrients is the common practice to overcome the micronutrients deficiencies in order to improve the fruit quality. Nutrients are generally quickly available to the plants by the foliar application than the soil application (Bahadur *et al.* 1998). Application of micro-nutrients through foliage can be from 10 to 20 times as efficient as soil application (Zaman and Schumann 2006).

Micro-nutrients such as boron, zinc and iron are essential for different biological functions that might be attributed to yield and fruit quality (Shoeib and El-Sayed 2003). It also increased resistance to disease and insect pests and improved drought tolerance (Tariq *et al.* 2007). Application of zinc or boron each at the rate of 0.2–0.8% on 13 years old mango cv Langra trees at full bloom stage and found the tremendous enhancement in total sugars, TSS and ascorbic acid of fruit at higher rates of boron or zinc (Rath *et al.* 1980). Boron increases the germination of pollen grains and elongation of pollen tube, fruit setting and yield in orchards (El-Sheikh *et al.* 2007). Zinc plays an important role in photosynthesis and related enzymes resulting in increasing sugar and decreasing acidity (Abedy 2001). Fe fertilization increases fruit quality and yield in many crops (Alvarez-Fernandez *et al.* 2006, Bakshi *et al.* 2013a). Foliar application of boric acid on the Langra cultivar improved flushes, inflorescence, fruit setting percentage and biochemical characteristics (Rajput *et al.* 1977). The highest $ZnSO_4$ application rate increased fruit yield, fruit sugars and ascorbic acid (Singh and Rajput 1977). Singh *et al.* (1987) found significant strengthening in total soluble solids and total sugars of mango fruit due to application of different concentrations of boric acid to mango trees. Syamal and Mishra (1989) observed that the ascorbic acid increased by the increasing concentration of NPK alone or in combination with micronutrients as a foliar spray on seventeen years old Langara trees. Kumar and Chakraborty (1992) found the higher sugar content and lower acidity of fruits by the spray of 1% $ZnSO_4$ to 30 years old Dashehari trees. Keeping in view of the present study was assessing the impact of foliar application of Ca, B and Zn for improving the fruit quality of Mango (*Mangifera indica* L.) cv Dashehari.

MATERIALS AND METHODS

This experiment was conducted during 2016 and 2017 at Advanced Center for Horticulture Research, Udheywalla, Sher-e-Kashmir University of Agriculture Sciences and Technology, Jammu (J & K) on mango cultivar Dashehari. 24 healthy, full bearing and mature (15–20 years old) trees were selected nearly similar vigor and size. The NPK were supplied to the trees as per recommendation given by Tiwari *et al.* (2004). The micronutrients were calcium nitrate as $Ca(NO_3)_2$, boric acid as H_3BO_3 and zinc sulfate as $ZnSO_4$. Eight foliar treatments were replicated thrice in a Randomized Block Design (RBD), each replicate consisted of three trees (i.e., 3×8= 24 trees).

The details of the treatment composition were as

T_1= 0.6% $Ca(NO_3)_2$
T_2= 0.2% H_3BO_3
T_3= 0.8% $ZnSO_4$
T_4= 0.6% $Ca(NO_3)_2$ + 0.2% H_3BO_3
T_5= 0.6% $Ca(NO_3)_2$ + 0.8% $ZnSO_4$
T_6= 0.2% H_3BO_3 + 0.8% $ZnSO_4$
T_7= 0.6% $Ca(NO_3)_2$ + 0.2% H_3BO_3 + 0.8% $ZnSO_4$
T_8= Water spray (Control).

The foliar spray of all these treatments was carried out just before flowering and second at full bloom stage. At maturity (after the sign of 'tapka'), when the shoulders of the fruit were swelled out, harvesting was done, leaving 6 cm stalk intact with the fruit to avoid the exudation of cell sap. During harvest, five disease and insect-free, fruits were taken, wrapped in paper and stored at room temperature in a basket up to ripening. Then the peel, pulp and stone of these fruits were separated and were weighed.

Initial soil status

The soil analysis of the experiment plot containing mango trees was determined before treatment application (February 2016, 2017). For this composite, soil samples were collected from the several points between the rows of the experimental trees. Three soil samples, of 100g each were drawn from the soil

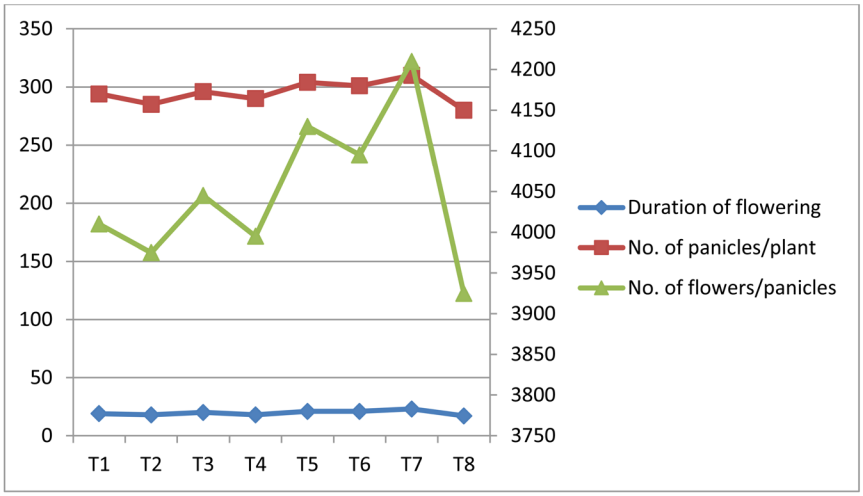

Fig. 1. Effect of foliar application of micronutrients on flowering characters of mango (*Mangifera indica* L.) cv Dashehari (2016).

collected and pooled from the three different depths viz.,0–20 cm, 20–40 cm and 40–60 cm. The collected samples were dried in shade, gently powdered with a wooden mortar and sieved through 2 mm sieve and the samples were analyzed for physico-chemical properties of the soil.

The data on fruit growth (cm) was recorded at weekly intervals starting from 1st-week of March and 1st-week of June during both years. A 5 fruit sample from each replicate was taken to determine fruit weight (g), length (mm), diameter (mm), fruit volume (ml) and pulp : Stone ratio. The fruit were harvested at the first week of June in both years and average yield in kilograms ; numbers of fruits as well as fruit retention per tree were recorded. For biochemical analysis, fruits were peeled and flesh was homogenized in a blender. Biochemical analysis of the fresh fruit juice was carried out. At ago hand refracto meter was used to determine the total soluble solids percentage. Total acidity (%) was determined by the method given by Hortwitz (1960). The statistical analyses of pooled data of both the years were carried out as per the method prescribed by Panse and Sukhatme (1985).

RESULTS AND DISCUSSION

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads :

Physico-chemical characteristics of experimental soil

The physico-chemical characteristics of soil are presented in Table 1. The soil was clay loam, pH ranged from 7.2 – 8.4, which was low in the surface and increased linearly with depth. The differences might be due to leaching of bases from the surface and its accumulation in subsurface. The pH of the soil is generally alkaline (Rashid *et al.* 2008). The EC of the suspension varied from 0.17 – 0.21 dS m^{-1}. The results showed that the soil organic matter ranged 1.31% – 1.87 %. The available N ranged from 151.6 to 235.2 kg ha^{-1} and the available P ranged

Table 1. Physico-chemical properties of soil samples obtained from the experimental plot.

Soil parameters	Soil depth (cm) 0-20	20-40	40-60
pH (1:2.5)	7.2	7.7	8.4
EC (dSm^{-1})	0.21	0.19	0.17
OM (%)	1.87	1.56	1.31
Available N (kg ha^{-1})	235.2	165.5	151.6
Available P (kg ha^{-1})	16.2	14.5	12.8
Available K (kg ha^{-1})	175.2	155.1	138.3

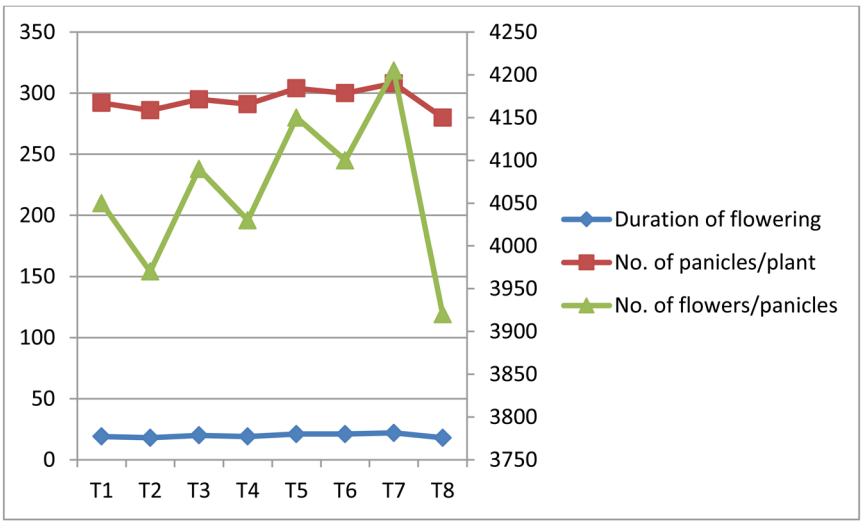

Fig. 2. Effect of foliar application of micronutrients on flowering characters of Mango (*Mangifera indica* L.) cv Dashehari (2017).

12.8 – 16.2 kg ha^{-1}. The available K concentration ranged from 138.3 to 175.2 kg ha^{-1}.

Flowering characters

Date of flowering : The date of full bloom was obtained in 2nd week of February to 4th week of February in both the years. Simao *et al.* (1996) observed that similar trend of flower initiation in mango. Date of flowering in T_7 (0.6% $Ca(NO_3)^2$ + 0.2% H_3BO_3 + 0.8% $ZnSO_4$) was found in 2nd week of February.

Date of full bloom : The date of flower initiation was obtained in 4th week of February to week 2nd of March in both the years. In general, treatment which showed early flowering also showed early full bloom and fruit set but they did not necessarily ripen in the same. Hoda *et al.* (2003) also reported observation in

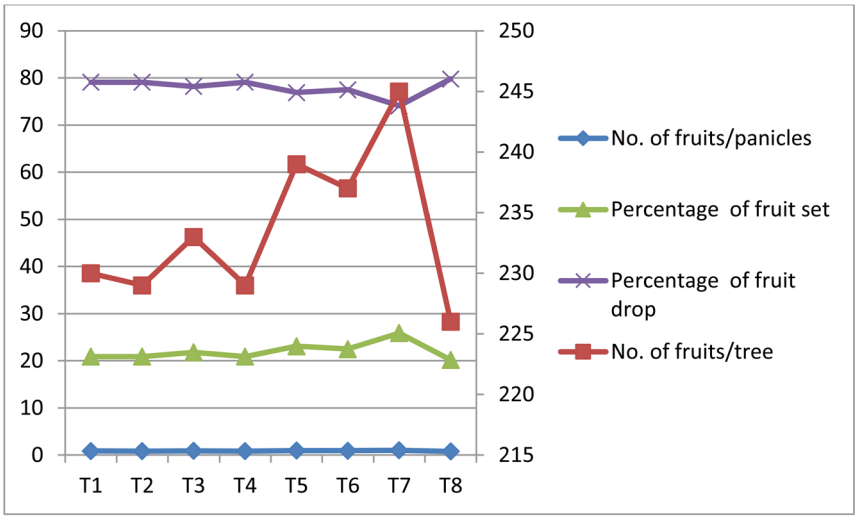

Fig. 3. Effect of foliar application of micronutrients on fruit characters of Mango (*Mangifera indica* L.) cv Dashehari (2016).

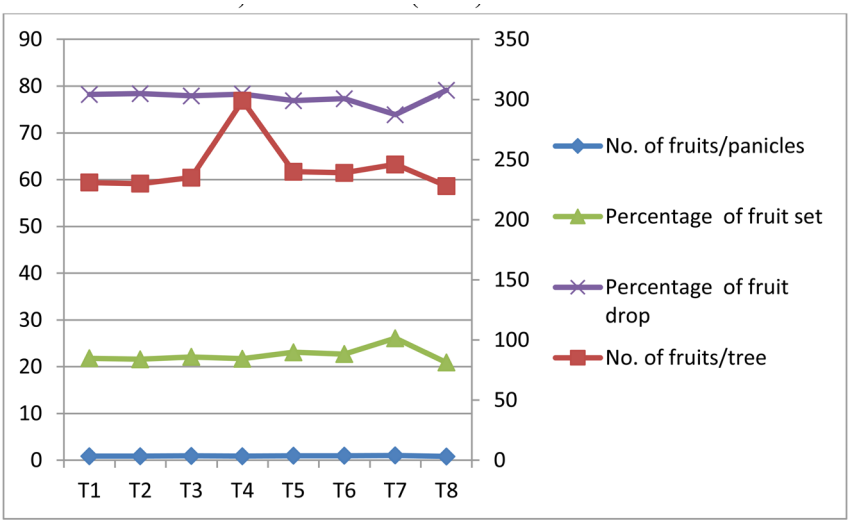

Fig. 4. Effect of foliar application of micronutrients on fruit characters of Mango (*Mangifera indica* L.) cv Dashehari (2017).

mango. Date of full bloom in T_7 (0.6%) Ca $(NO_3)_2$ + 0.2% H_3BO_3 + 0.8% $ZnSO_4$) was found in 4th week of February in both years which was earlier than other treatments.

Duration of flowering : Duration of flowering in both the years was found longest (22 days) in T_7 (0.6% Ca $(NO_3)_2$ + 0.2% H_3BO_3 + 0.8% $ZnSO_4$) and shortest (18 days) in T_8 (Control). A significant variation was recorded among the treatments with respect to the duration of flowering (Figs.1–5). Bose *et al.* (2001) who stated that the duration of flowering in mango was usually 2-3 weeks.

Number of panicle per plant : The maximum number of panicle per plant (308) in T_7 (0.6% Ca $(NO_3)_2$ + 0.2

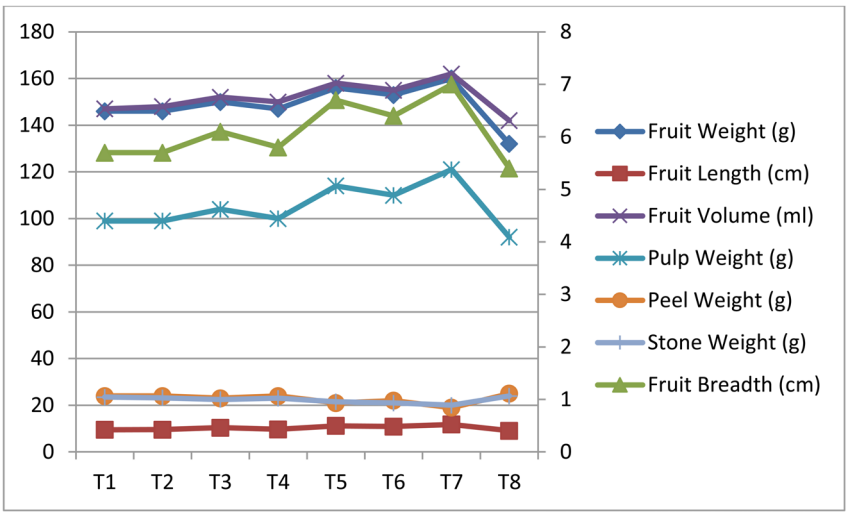

Fig. 5. Effect of foliar application of micronutrients on physical characters of mango (*Mangifera indica* L.) cv Dashehari (2016).

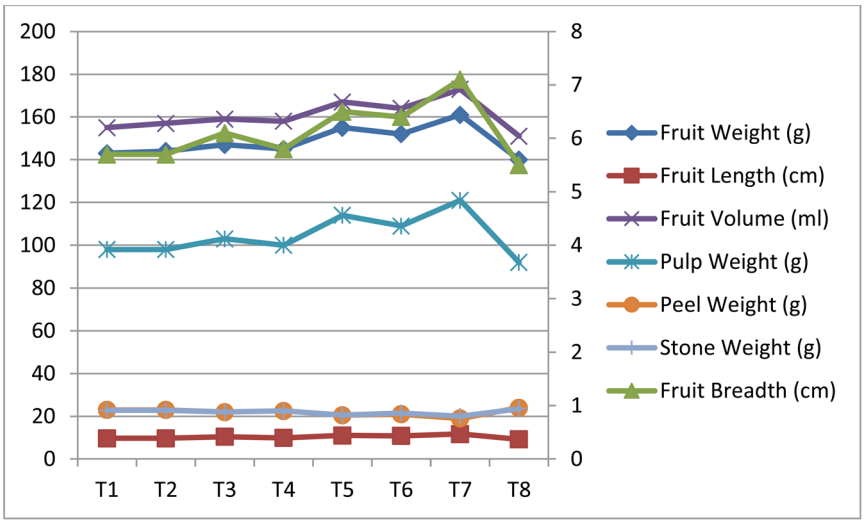

Fig. 6. Effect of foliar application of micronutrients on physical characters of mango (*Mangifera indica* L.) cv Dashehari (2017).

% H_3BO_3 + 0.8 % $ZnSO_4$) and minimum (280) in T_8 (Control) and it was found in both the years shown in Figs. 4, 5.

Number of flower per panicle : The maximum number of flower per panicle (4205) in T_7 (0.6% Ca $(NO_3)_2$ + 0.2 % H_3BO_3 + 0.8% $ZnSO_4$) and minimum (3920) in T_8 (Control) and it was found in both the years shown in Figs. 4, 5.

Fruit characters

Fruiting characters data in Fig. 3 (year 2016) and 4 (year 2017) like number of fruits per panicles,

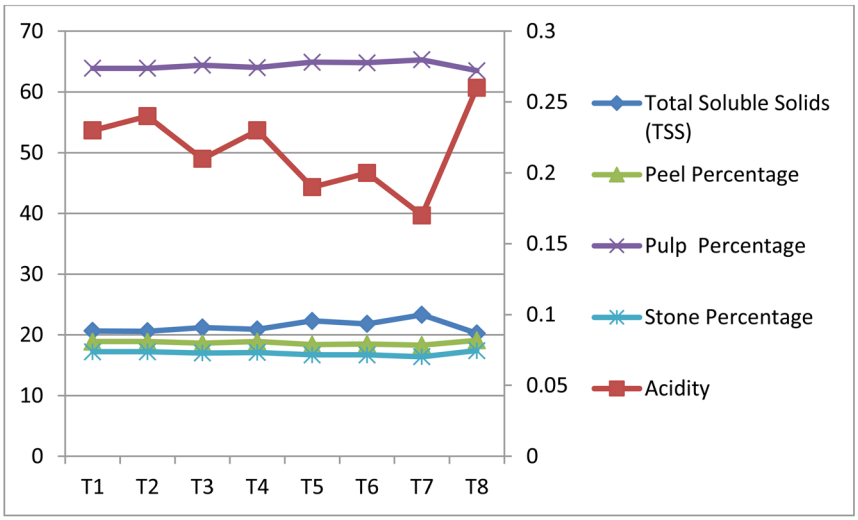

Fig. 7. Effect of foliar application of micronutrients on chemical characters of mango (*Mangifera indica* L.) cv Dashehari (2016).

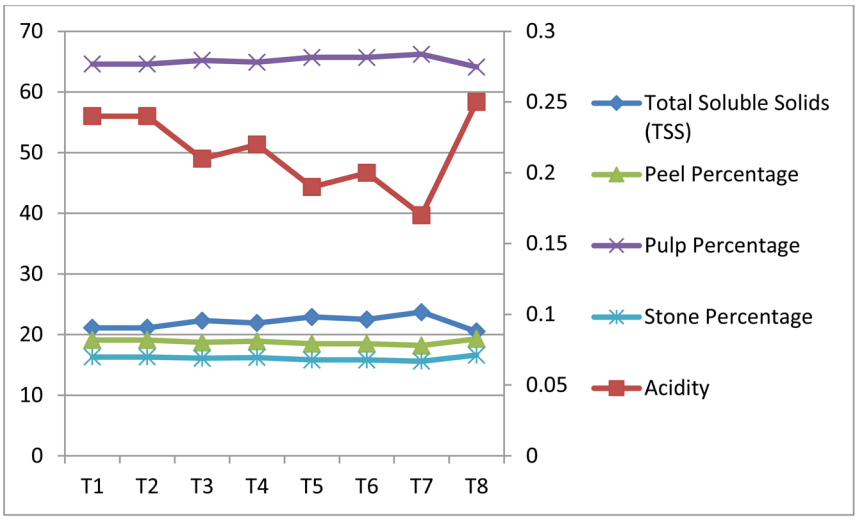

Fig. 8. Effect of foliar application of micronutrients on chemical characters of mango (*Mangifera indica* L.) cv Dashehari (2017).

number of fruits per tree, percentage of fruit set and percentage of fruit drop was found significantly variation in T_7 (0.6% Ca $(NO_3)_2$ + 0.2% H_3BO_3 + 0.8 % $ZnSO_4$) among the other treatments. The results were found in T_7 treatment that is number of fruits per panicles (1.02), number of fruits per tree (246), percentage of fruit set (26.1) and percentage of fruit drop (74.1) and T_7 treatment was superior to the other treatments Figs. 4-6.

Physical characters

The data of physical characters like fruit weight, fruit length, fruit breadth, fruit volume, pulp weight, peel weight and stone weight are presented in Figs. 5,6. The highest fruit weight, fruit length, fruit breadth, fruit volume and pulp weight were registered in treatment T_7 (0.6% Ca $(NO_3)_2$ + 0.2% H_3BO_3 + 0.8% $ZnSO_4$) among the other treatments. The increase in fruit weight with the application of boron, zinc and iron might be due to its role in cell division, cell elongation, sugar metabolism and accumulation of carbohydrates and other photosynthesis (Crane and Brown 1950). This type of result was also reported in orange (Sourour 2000) and straw berry (Chaturvedi *et al.* 2005). The lowest peel weight and stone weight were observed in treatment T_7 (0.6% Ca $(NO_3)_2$ + 0.2% H_3BO_3 + 0.8% $ZnSO_4$), which showed in significant variation among the treatments. These results were found in harmony with the work of Bakshi *et al.* (2013b) in green chilly.

Chemical characters

The data of parameters like total soluble solids, acidity, peel percentage pulp percentage and stone percentage were presented in Figs. 7 and 8. The results showed that foliar application of micronutrients significantly increased the total soluble solids. It was noted that the higher total soluble solids (23.30 and 23.70%) were reported in T_7 (0.6% Ca $(NO_3)_2$ + 0.2 % H_3BO_3 + 0.8% $ZnSO_4$). The TSS content was increases in the fruits as ripening advances. Total soluble solids content was significantly different among the treatments. The increased TSS content due to fact that boron is known to increase transportation of sugar and forms complexes with sugar. This confirms with the findings of Khanduja *et al.* (1976), Chharia (1977) in grapes, Sarkar *et al.* (1984), Jain *et al.* (1985) in litchi, Banik *et al.* (1997), Meena *et al.* (2006), Nehete *et al.* (2011) in mango. The results showed that foliar spray significantly low acidity over the other treatments.

During ripening there was a fall in acidity. The maximum acidity (0.23 and 0.24%) was noted in

control. Peel percentage and stone percentage was observed lowest and pulp percentage was highest in T_7 (0.6% Ca $(NO_3)_2$ + 0.2% H_3BO_3 + 0.8% $ZnSO_4$). This might be due to their utilization in respiration and rapid metabolic transformation of organic acids into sugars. This observation is in corroboration with the finding of Mishra and Khan (1981) in litchi. The lowest acidity by boron might be due to the role of boron in conversion of acid into sugar and their derivatives by the reaction involving reversal of glycolytic pathway. Similar findings were reported by Sarkar *et al.* (1984) in litchi, Hoggag *et al.* (1995), Banik *et al.* (1997) in mango and Meena *et al.* (2005) in grapes. Transformation of organic acids to sugars is one of the reasons for decrease in acidity during fruit maturity and ripening (Badhe *et al.* 2007). Fruit quality is mainly judged by the balance between total sugar and acidity present in the fruit.

CONCLUSION

The results obtained in the present research proved that foliar application of micronutrients (calcium nitrate, boric acid and zinc sulfate) alone and in combination were the most effective treatments for increasing all the characters like flower, fruit, physical and chemical parameters of mango fruit. To increase duration of flowering, number of panicles per plants, number of flowers per panicles, number of fruits per panicles, number of fruits per tree, percentage of fruit set, fruit weight (g), fruit length (cm), fruit breadth (cm), fruit volume (ml), pulp weight (g), TSS (%), pulp (%) and decrease date of flowering, date of full bloom, percentage of fruit drop, peel weight (g), stone weight (g), acidity (%), peel (%), stone (%) under clay loam and alkaline condition of udheywalla, Jammu, it is recommended to apply foliar spray twice a year to the orchards in order to enhance the efficiency of micronutrients and avoid losses by leaching and interaction among the nutrients.

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