Effect of soil and foliar application of macro and micronutrients on flowering, fruit set and yield of mango cv. Dashehari

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Received: 15-11-2018
Accepted: 01-04-2019
DOI: 10.18805/ag.D-4845

ABSTRACT
The experiment was carried out at Horticulture Research Centre, Pattharchatta, G. B. Pant University of Agriculture and Technology, Pantnagar, district- Udham Singh Nagar, Uttarakhand during the year 2015-16. The experiment was laid out in RBD (Randomized Block Design) with 10 treatments and 3 replications. The earlier (February 10 - February 19) panicle emergence, maximum duration of flowering (27.66 days), number of fruit set per panicle at marble stage was found significantly higher (3.69), higher yield plant⁻¹ (228.24 kg) and maximum shelf life (12.33 days) were found with the application of T₁₀: RDF + NPK: 20:20:20 @ 1% (2 Spray: first-15 days and second- 45 days after fruit set) + foliar spray of ZnSO₄ @ 0.4% + Boric acid @ 0.2% + CuSO₄ @ 0.2% (2 Spray at just before flowering and marble stage). The maximum flowering intensity percentage was found maximum (48.48 %) in T₇: [RDF + ZnSO₄ @ 100 g + CuSO₄ @ 50 g + Boric acid @ 50 g (soil application) + Foliar spray of ZnSO₄ @ 0.2 % + CuSO₄ @ 0.1 % + Boric acid @ 0.1 % (2 sprays at just before flowering and marble stage], the minimum flowering intensity (32.66%) percentage was obtained in T₁: [Control (RDF)].

Key words: Dashehari, Flowering intensity, Fruit set, Mango, Yield.

INTRODUCTION
Mango is the national fruit of India and it has developed its own importance all over the world. Being a useful and delicious fruit, it is a part of culture and religion since long time. Mango can be grown under both tropical and sub-tropical climate. It is originated from Indo-Burma (Myanmar) region (Vavilov, 1926; Popenoe, 1920). It occupies prime place in fruit crops and has largest area under fruit cultivation in India. Mango belongs to the genus Mangifera of the family Anacardiaceae. The genus Mangifera consists of 69 species and classified into two subgenus i.e. Mangifera and Limus and 11 uncertain position species (Kosterman and Bumpard, 1993). The effects of mineral nutrients including macro and micronutrients on flowering, fruit set, yield and quality can be greatly enhanced by studying their effects on other phenological events that contribute to productivity and fruit quality. An adequate supply of nutrients including both macro and micronutrients is critical to nutrient management and its sustainability.

MATERIALS AND METHODS
The experiment was conducted to study the efficacy of soil and foliar application of macro and micronutrients
on yield and quality of mango (*Mangifera indica* L.) cv. Dashehari at Horticulture Research Centre, Patharchatta, Govind Ballabh Pant University of Agriculture and Technology, Pantnagar, U.S. Nagar (Uttarakhand) during the years 2015-2016. The experiment was laid out in RBD (Randomized Block Design) with 10 treatments and 3 replications. The 10 treatments consisted of recommended dose of fertilizer, macro (primary nutrients), micronutrient and their combinations were selected to see the effect on flowering, fruit set and quality of mango cv. Dashehari. The treatments consists $T_1$: Control (RDF), $T_2$: RDF + ZnSO$_4$ @ 200 g + Boric acid @ 100 g (soil application) in basin after harvest, $T_3$: RDF + ZnSO$_4$ @ 200 g + CuSO$_4$ @ 100 g + Boric acid @ 100 g (soil application) in basin after harvest, $T_4$: RDF + Foliar spray of ZnSO$_4$ @ 0.4 % + Boric acid @ 0.2 % (2 sprays at just before flowering and marble stage), $T_5$: RDF + Foliar spray of ZnSO$_4$ @ 0.4 % + CuSO$_4$ @ 0.2 % + Boric acid @ 0.2 % (2 sprays at just before flowering and marble stage), $T_6$: RDF + ZnSO$_4$ @ 100 g + CuSO$_4$ @ 50 g + Boric acid @ 50 g (soil application) + Foliar spray of ZnSO$_4$ @ 0.2 % + Boric acid @ 0.1 % (2 sprays at just before flowering and marble stage), $T_7$: RDF + ZnSO$_4$ @ 100 g + CuSO$_4$ @ 50 g + Boric acid @ 50 g (soil application) + Foliar spray of ZnSO$_4$ @ 0.1 % + CuSO$_4$ @ 0.4 % + Boric acid @ 0.2 % (2 sprays at two months before flowering and marble stage), $T_8$: RDF + NPK: 20:20:20 @ 1 % (2 spray: first- 15 days and Second - 45 days after fruit set) + ZnSO$_4$ @ 200 g + Borax @ 100 g + CuSO$_4$ @ 100 g (Soil application) in basin after harvest, $T_9$: RDF + NPK: 20:20:20 @ 1 % (2 Spray: first-15 days and Second- 45 days after fruit set) + foliar spray of ZnSO$_4$ @ 0.4 % + Boric acid @ 0.2% + CuSO$_4$ @ 0.2% (2 Spray at just before flowering and marble stage). Date of first panicle initiation was noted by regular visit at alternate days during the month of February, Date of start of flowering was noted earlier (February, 27 – March, 3) in $T_1$, and late emergence found in $T_9$, The date of start of flowering was affected with the application of different treatments, which varied from February, 27 to March, 12 during the year 2016. The start of flowering was found earlier (February, 27 – March, 3) in the trees treated with $T_1$, and flowering was found late (March, 4 – March, 12) in the trees treated with $T_9$. Full bloom in different trees under different treatments varied from March, 19 - April, 3. The blooms were found earlier (March, 19 - March, 25) in $T_1$, and late blooms (March, 27 -April, 3) were found in $T_9$.

### Table 1: Effect of soil and foliar application of nutrients on panicle emergence, start of flowering, full bloom, flowering intensity and fruit set in mango cv. Dashehari.

| Treatments # | Date of panicle emergence | Date of start of flowering | Date of full bloom | Flowering intensity (%) | Number of fruit set per panicle (at marble stage) |
|--------------|---------------------------|---------------------------|-------------------|-------------------------|-----------------------------------------------|
| $T_1$        | Feb. 14 –Feb. 22          | Mar. 4 – Mar. 12          | Mar. 25 – Apr. 1  | 32.66                   | 0.95                                          |
| $T_2$        | Feb. 19 – Feb. 27         | Mar. 2 – Mar. 8           | Mar. 27 – Apr. 3  | 38.23                   | 1.14                                          |
| $T_3$        | Feb. 14 – Feb. 27         | Mar. 3 – Mar. 11          | Mar. 20 – Mar. 27 | 39.66                   | 1.33                                          |
| $T_4$        | Feb. 15 – Feb. 26         | Feb. 27 – Mar. 8          | Mar. 20 – Mar. 29 | 38.00                   | 1.58                                          |
| $T_5$        | Feb. 20 – Feb. 28         | Mar. 2 – Mar. 9           | Mar. 19 – Mar. 28 | 45.35                   | 2.36                                          |
| $T_6$        | Feb. 14 – Feb. 22         | Mar. 4 – Mar. 10          | Mar. 20 – Mar. 26 | 47.93                   | 2.49                                          |
| $T_7$        | Feb. 19 – Feb. 28         | Feb. 27 – Mar. 4          | Mar. 25 – Apr. 2  | 48.58                   | 2.64                                          |
| $T_8$        | Feb. 14 – Feb. 18         | Feb. 27 – Mar. 5          | Mar. 25 – Mar. 28 | 34.71                   | 1.65                                          |
| $T_9$        | Feb. 10 – Feb. 19         | Feb. 27 – Mar. 3          | Mar. 19 – Mar. 25 | 44.16                   | 3.69                                          |
| SEm*         |                           |                           |                   | 1.57                    | 0.015                                         |
| CD (5%)      |                           |                           |                   | 4.66                    | 0.046                                         |

RESULTS AND DISCUSSION

The data presented in Table 1 on date of panicle emergence, start of flowering, date of full bloom, flowering intensity and fruit set. The emergence of panicle was found earlier (February, 10 - February, 19) in $T_1$, and late emergence found in $T_9$. The date of start of flowering was affected with the application of different treatments, which varied from February, 27 to March, 12 during the year 2016. The start of flowering was found earlier (February, 27 – March, 3) in the trees treated with $T_1$, and flowering was found late (March, 4 – March, 12) in the trees treated with $T_9$. Full bloom in different trees under different treatments varied from March, 19 - April, 3. The blooms were found earlier (March, 19 - March, 25) in $T_1$, and late blooms (March, 27 -April, 3) were found in $T_9$. [RDF + ZnSO$_4$ @ 200 g + Boric acid @...
100 g (soil application) in basin after harvest]. This might be due to stimulation effect of zinc sulphate, boric acid and copper sulphate along with the foliar application of primary macronutrients (NPK) that causes the physiological and

table 2: effect of soil and foliar application of nutrients on yield, yield efficiency, fruit weight and shelf life in mango cv. dashehari.

| treatments | yield (kg) | yield efficiency (kg m$^{-2}$) | fruit weight (g) | shelf life (days) |
|------------|-----------|--------------------------------|-----------------|------------------|
| T$_{1}$    | 76.66     | 0.16                          | 105.00          | 9.00             |
| T$_{2}$    | 91.66     | 0.16                          | 125.20          | 9.33             |
| T$_{3}$    | 101.66    | 0.18                          | 136.10          | 9.33             |
| T$_{4}$    | 112.30    | 0.21                          | 178.94          | 10.67            |
| T$_{5}$    | 146.66    | 0.26                          | 198.26          | 11.33            |
| T$_{6}$    | 155.00    | 0.34                          | 195.30          | 11.00            |
| T$_{7}$    | 165.92    | 0.36                          | 212.00          | 12.00            |
| T$_{8}$    | 115.00    | 0.28                          | 191.58          | 12.00            |
| T$_{9}$    | 187.25    | 0.46                          | 216.41          | 11.00            |
| T$_{10}$   | 228.24    | 0.5 3                         | 254.60          | 12.33            |
| SEm±(5%)   | 13.00     | 0.02                          | 18.24           | 0.56             |
| CD(5%)     | 38.64     | 0.08                          | 54.20           | 1.67             |

harmonal changes in the tissues which ultimately influences the flowering characteristics.

Similar findings were also reported by Haldankar et al. (2012) in Kokum and Chaudhary et al. (2016) in kinnow mandarin, Yadav et al. (2014) in ber, and Gurjar and Rana (2014) in kinnow. The data related to the flowering intensity percentage and number of fruit set per panicle at marble stage are presented in Table 1 and Fig. 1. The data related to flowering intensity and fruit set showed significant difference under different treatments, which varied from 32.66 to 48.48 %. The maximum Flowering intensity percentage (48.48 %) was found in T$_{7}$, which was found statistically at par with T$_{5}$, T$_{6}$, T$_{9}$ and T$_{10}$ whereas, the minimum flowering intensity (32.66%) percentage was obtained in T$_{1}$, which was found statistically at par with T$_{2}$.

The higher fruit set at marble stage (3.69) was obtained with T$_{9}$ followed by T$_{8}$ (2.92), T$_{7}$ (2.64) and T$_{4}$ (2.49), whereas, lower fruit set (0.95) was found with T$_{1}$ followed by T$_{5}$ (1.14), T$_{3}$ (1.33) and T$_{4}$ (1.58). Increase in fruit set might be due to promoting effect of boron on cell division and multiplication as well as cell elongation of the plant and retention of fruit more on the trees treated with foliar application of both macro

fig 1: effect of soil and foliar application of nutrients on flowering intensity and fruit set at marble stage in mango cv. dashehari.

fig 2: effect of soil and foliar application of nutrients on yield per plant, yield efficiency and fruit weight in mango cv. dashehari.
and micronutrients because efficiency of primary nutrient increases due to catalysing effect of micronutrients. This study on fruit set was also in conformity with the observations made by Phillips (2004), Jayaprahasam et al. (2010) in mango and Singh et al. (2013) in mango. The data pertaining to yield per plant, yield efficiency and fruit weight are presented in Table 1 and Fig. 2 show significant influence of different treatments under study. The higher yield (228.44 kg plant⁻¹) was obtained with the application of T₃ which showed significantly higher yield as compared to the other treatments. The lower yield per tree (76.66 kg plant⁻¹) was recorded in T₄, which was found statistically at par with T₂ (91.66 kg plant⁻¹), T₅ (101.67 kg plant⁻¹) and T₆ (112.30 kg plant⁻¹). The maximum yield efficiency (0.53 kg m⁻³) was found in T₂, whereas minimum yield efficiency was found in T₃. The wide range of fruit weight from 105.00 to 254.60 g was obtained with different treatments under study. The maximum (254.60 g) fruit weight was obtained in T₄, which was found statistically at par with T₅ and T₆ which was found statistically at par with T₇. The maximum duration of shelf life (12.33) in T₄ whereas, the lower duration of shelf life (9.00 days) was recorded with T₁ which was found statistically at par with T₂, T₃ and T₄. It was suggested that the application of zinc promotes the auxin synthesis in the plant which might delayed the formation of abscission layer during the early stages of fruit development and also the foliar application of potassium at time of fruit set was also one of the reason of improvement of shelf life. The results of shelf life are in agreement with findings of Bhatt et al. (2012) in mango and Tamboli et al. (2015) in Fig 2.

CONCLUSION

On the basis of above observations it may be inferred that the application of RDF + NPK : 20:20:20 @ 1 % (2 spray : first-15 days and second 45 days after fruit set) + foliar spray of ZnSO₄ @ 0.4 % + Boric acid @ 0.2 % + CuSO₄ @ 0.2 % (2 spray at just before flowering and marble stage) was also found to be most effective for increasing the number of fruit set at marble stage (3.69), yield plant⁻¹ (228.24 kg), fruit weight (254.60 g) and maximum shelf life (12.33 days) but in case panicle initiation and earlier start of flowering and full blooms there was no significant effect was found under different treatments. Thus, finally it may be concluded that the micronutrients must also be supplied with application of NPK to the plants to have better flowering intensity, fruit set, yield and ultimately increase in productivity of mango. To standardize the optimum doses and time of foliar application of macro and micronutrients, the long term study is suggested to arrive at valid recommendation.

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