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# Yield sustainability in mango (*Mangifera indica*) as influenced by different levels of foliar Zn sprays

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## ABSTRACT

Zn nutrient technology impacting mango (*Mangifera indica* L.) sustainability and nutrient components in pulp, peel and stone of fruit needs to be addressed on sandy loam soils for farmers' benefit. ICAR networking field trials on micronutrient management in horticultural crops for enhancing yield and quality were conducted at ICAR-CISH, Rehmankhera, Lucknow during 2015–18. The results showed highest sustainable yield index of 0.87 followed by 0.83 with least sustainable yield index of 0.67. The yield increment was 4.3–27.1% in different levels of Zn (0.25%, 0.50%, 0.75%, 1.0%, 1.5% and 2.0% $ZnSO_4$) as compared to control plot trees. Nutrient components suggested significant positive role of Zn application at different fruit setting to developmental stages. Maximum B, Zn, Cu, Mn and Fe was noted to be 28.1 ppm, 8 ppm, 26 ppm, 40 ppm, 119 ppm, respectively, along with P & K content of 0.123%, 2.01%, respectively, in pulp of Dashehari fruits. Similar changes in peel and stone nutrient content were also observed. Data indicated that optimum to sufficient range of micronutrients is indeed required for better yield sustainability in mango.

**Keywords**: Dashehari mango, Micronutrient management, Nutrient richness, Sustainable yield index, Yield increment

To make a sustainable system viable production capacity is needed, for which assessment of soil, weather and tree components are vital. The soil on which trees grow needs complete screening, deficiency if any and requires topmost priority to correct it, so that the system in question becomes robust and dynamic. Ganeshamurthy *et al.* (2016) reported detailed delineation and deficiencies in mango production system and also suggested remediation to make the system profitable which is otherwise sustainable. Likewise, Denis *et al.* (2017) proposed the appraisal of soil nutrient index to indicate the fertility status, a mandatory requirement for any sustainability study. Adak and Pandey (2018) evaluated the nutritional status in fruit pulp of mango germplasm to show the exactness of nutrients present and further management needed for nutrient enhancement. In sustainability study, a vast range of thematic areas are focused based on the need to identify the lacuna of lower sustainable production. Arachchi (2009) assessed the influence of deep ploughing on compactness and water status in Coconut ecosystem. The land management practices are the obvious factors sensitive to the sustainability determination factor (Thapa and Yila 2012). Interaction between soil-foliar nutrients is also a source of weighted factor for appraising the ability of the tree with regard to production capability and its contribution to overall system (Koukoulakis *et al.* 2013). In a crop like mango, the proportion of peel, pulp and stone have the potentiality to the sustainability factor and overall sustainable yield index (SYI). In this direction, El-Jendoubi *et al.* (2013) assessed the whole tree nutrition in peach to quantify and show the response factor while Shukla *et al.* (2020) assessed boron nutrition in enhancing productivity and quality of mango. The SYI factor is affected by the agroclimatic conditions along with management factors associated with three components. The role of nutrition is obviously an important aspect to look into the overall SYI in majority of fruit bearing orchards. Yadav *et al.* (2011) reported positive role in Amrapali mango. Keeping in view the lack of required information on SYI under nutritional levels, the present study was laid out to assess the SYI and nutrient richness of Mango on sandy loam soil in Lucknow.

## MATERIALS AND METHODS

Nutritional trials, with different Zn levels, were conducted on Mango cv. Dashehari planted at 10 m ×10 m spacing in a randomized block design to assess the SYI and nutrient richness in pulp, peel and stone. The soil was sandy loam soil with subtropical climate at ICAR-CISH, Rehmankhera Farm, Lucknow, Uttar Pradesh. Zn levels of 0.0 ($T_1$), 0.25 ($T_2$), 0.50 ($T_3$), 0.75 ($T_4$), 1.0 ($T_5$), 1.5 ($T_6$) and

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2.0% ($T_7$) in the form of $ZnSO_4$ were applied at flowering, fruit setting and growth stages. Fruit developmental stages were taken into consideration for enhancing the nutrient richness in pulp. Irrigation water was applied at 60% open pan evaporation basis during summer months of fruit setting to developmental periods. Tree basin management, organic manure and fertilizer application as well as insect-diseases were done as per the prescribed package of practices. Fruits were harvested randomly from the replicated trees for observation on fresh weight, dry weight, fruit weight, peel, pulp, stone weight along with their percentage in overall fruit production. Nutrient content in peel, pulp and stone was determined on fresh and dry weight basis, sustainable yield index (SYI) was estimated as per Singh *et al.* (1990) and yield increment was analyzed. All these observations were completed during 2015–18 to quantify the exactness of sustainability factors to the overall SYI. Standard procedures were adopted for determining the nutrient contents in fruits using AAS.

## RESULTS AND DISCUSSION

The weather condition during the fruit growth, maturity and harvesting periods indicated vast ranges in temperatures, relative humidity, bright sunshine hours (BSS), wind speed, rainfall and evaporation factors. It was recorded that the maximum and minimum temperatures varied from 26.3–38.5°C and 8.0–22.7°C, respectively, along with >80% relative humidity. Pan evaporation of 5.1–11.5 m with BSS of 6.7–8.0 h/day was noted. Scanty rainfall of 6 mm was observed along with low wind speed of 2.2–3.9 km/h.

Recent dataset on yield and its increment showed maximum harvesting of 46.5 kg/tree followed by 45.7 kg/tree, and least of 36.6 kg/tree. The per cent yield increment over the control potted trees was 11.3–27.1%. In some trees, the response was registered slower (4.3–16.8%). The yield increment data suggested that increment of Zn levels up to 1.0% is sufficient for growers. Maximum SYI of 0.87 followed by 0.81 was recorded with least 0.67 in control trees (Table 1). The nutrient content on fresh and dry weight basis is given in Table 2. The P (%) in pulp, peel and stone was noted as 0.1–0.123, 0.166–0.191 and 0.166–0.171 respectively, while the corresponding values of K (%) were 0.180–2.01, 2.81–3.08 and 2.16–2.42, respectively. Boron (B) content of 8.2–28.1 ppm, 21.4–34.8 ppm, 28.2–90.9 ppm was recorded in pulp, peel and stone, respectively. The estimated highest Zn, Cu, Mn and Fe in pulp was 8 ppm, 26 ppm, 40 ppm and 119 ppm, respectively; 10 ppm, 19 ppm, 57 ppm and 64 ppm, respectively, in peel; and 11 ppm, 23 ppm, 66 ppm, 261 ppm in stone, respectively. The dry weight basis nutrient content indicated improvement over the control. Fruits enriched with different Zn levels had B content of 1.83–5.66, 6.95–10.93 and 19.44–50.28 ppm in pulp, peel and stone, respectively. P and K content was 0.02–0.026%, 0.050–0.064%, 0.088–0.117% and 0.347–0.410%, 0.88–0.99%, 1.23–1.57%, respectively, in pulp, peel and stone . The highest Zn content of 1.64 ppm, 3.05 ppm and 7.58 ppm was observed. Cu content of 5.61 ppm, 6.26 ppm and 12.72 ppm, respectively, was recorded in pulp, peel and stone of Dashehari fruits. Mn content of 4.43–8.21 ppm, 15.85–17.99 ppm, 32.08–45.5 ppm; and Fe content of 22.19–25.06 ppm, 15.20–20.10 ppm and 133.17–171.68 ppm was estimated in pulp, peel and stone on dry weight basis. The values showed positive enrichment of nutrients in fruits under nutritional trial. This has actually formed the basis for improving both the yield and sustainability in mango cv. Dashehari under subtropical climatic condition.

Table 1 Sustainable yield index and yield increments in mango as influenced by different Zn levels

| Treatment | SYI | Yield (kg/tree) | SD | CV (%) | Yield increment over control (%) |
|---|---|---|---|---|---|
| $T_1$ | 0.67 | 36.6 | 2.4 | 6.47 | - |
| $T_2$ | 0.74 | 40.7 | 3.3 | 8.11 | 11.3 |
| $T_3$ | 0.83 | 43.8 | 1.6 | 3.67 | 19.6 |
| $T_4$ | 0.87 | 45.7 | 1.6 | 3.45 | 24.9 |
| $T_5$ | 0.87 | 46.5 | 2.2 | 4.74 | 27.1 |
| $T_6$ | 0.81 | 42.7 | 1.4 | 3.24 | 16.8 |
| $T_7$ | 0.69 | 38.1 | 3.2 | 8.30 | 4.30 |

Determination of sustainability factors has been adopted recently in orchard management. It helps to plan better for nutrient enrichment in fruits along with greater productivity level. The environmental conditions during the fruit productivity are very important for quantifying the impact of canopy conductance and branch removal (Molina *et al.* 2019). Roussos *et al.* (2019) evaluated the complete set of parameters for assessing the effect of orchard management in Clementine mandarin. This has emphasized the need for determining the zonation for enhancing the production levels (Xin-Zhang *et al.* 2009, Foroughifar *et al.* 2013). Soil biodiversity in terms of microbes, physical and chemical nutrients influences both soil and tree ecophysiological response (Fitter *et al.* 2005, Siczek *et al.* 2008). The nutritional status of orchard soil apart from foliar part varies and it influences the SYI and productivity, as observed by Dris and Niskanen (1998) and Behera *et al.* (2018). The proportion of different factors or biomass in different biological parts is also statistically important (Adak *et al.* 2018). Nutrient variation in present experiments is the direct response of different Zn levels and the physiological response of replicated trees across mango orchards. Higher content might be the result of spraying effect, but improvement in SYI is the outcome of the overall field trial. Kurian *et al.* (1996) recorded the quality, yield parameters in 13th year Alphonso mango tree under Bangalore condition. Similarly, Syvertsen *et al.* (1993) also recorded mineral nutrition in the salinized citrus tree. Das and Jana (2012) suggested adoption of canopy management for improving yield in Amrapali. Adak *et al.* (2019) quantified soil nutrient index in mango orchards for appraising mango orchard soil fertility ratings while Adak *et al.* (2020) evaluated SYI in guava. Thus, vast range of research literature suggests variations in productivity,

Table 2 Analysis of nutrient content in pulp, peel and stone in mango on dry weight basis under the influenced of different Zn levels. * Values in parentheses are in fresh weight basis

| Treatment | Zn (ppm) | Cu (ppm) | Mn (ppm) | Fe (ppm) | B (ppm) | K (%) | P (%) |
|---|---|---|---|---|---|---|---|
| | | | | *Pulp* | | | |
| $T_1$ | 1.61(8) | 4.43(22) | 4.43(22) | 23.18(115) | 3.74(18.6) | 0.376(1.87) | 0.022(0.111) |
| $T_2$ | 1.32(7) | 3.38(18) | 4.51(24) | 22.19(118) | 5.02(26.7) | 0.347(1.85) | 0.020(0.110) |
| $T_3$ | 1.61(8) | 4.10(20) | 5.64(28) | 23.57(117) | 5.66(28.1) | 0.362(1.80) | 0.023(0.112) |
| $T_4$ | 1.64(8) | 4.92(24) | 6.76(33) | 23.38(114) | 1.68(8.2) | 0.381(1.86) | 0.020(0.100) |
| $T_5$ | 1.41(7) | 4.81(24) | 5.82(29) | 22.69(113) | 1.86(9.3) | 0.389(1.94) | 0.020(0.107) |
| $T_6$ | 1.22(6) | 4.86(24) | 8.11(40) | 24.13(119) | 2.14(10.6) | 0.407(2.01) | 0.021(0.106) |
| $T_7$ | 1.30(6) | 5.61(26) | 8.21(38) | 25.06(116) | 1.83(8.5) | 0.410(1.90) | 0.026(0.123) |
| | | | | *Peel* | | | |
| $T_1$ | 2.51(8) | 5.65(18) | 16.02(51) | 20.10(64) | 10.93(34.8) | 0.88(2.81) | 0.057(0.182) |
| $T_2$ | 2.58(8) | 5.50(17) | 15.85(49) | 15.20(47) | 7.86(24.3) | 0.99(3.08) | 0.058(0.182) |
| $T_3$ | 3.02(9) | 5.71(17) | 17.49(52) | 17.15(51) | 8.37(24.9) | 0.96(2.88) | 0.064(0.191) |
| $T_4$ | 3.05(9) | 5.77(17) | 17.99(53) | 16.63(49) | 9.23(27.2) | 0.77(2.79) | 0.056(0.166) |
| $T_5$ | 2.63(8) | 6.26(19) | 17.48(53) | 15.83(48) | 7.05(21.4) | 0.98(2.98) | 0.058(0.178) |
| $T_6$ | 3.00(10) | 5.11(17) | 17.15(57) | 17.15(57) | 6.95(23.1) | 0.90(3.00) | 0.050(0.169) |
| $T_7$ | 2.26(7) | 4.52(14) | 17.46(54) | 18.43(57) | 7.86(24.3) | 0.93(2.89) | 0.057(0.179) |
| | | | | *Stone* | | | |
| $T_1$ | 3.31(6) | 12.72(23) | 32.08(58) | 138.85(251) | 50.28(90.9) | 1.23(2.23) | 0.093(0.169) |
| $T_2$ | 3.90(7) | 10.03(18) | 34.57(62) | 142.21(255) | 39.03(70.0) | 1.30(2.34) | 0.094(0.170) |
| $T_3$ | 4.64(9) | 11.86(23) | 34.03(66) | 127.37(247) | 25.21(48.9) | 1.16(2.26) | 0.088(0.171) |
| $T_4$ | 4.70(9) | 8.89(17) | 33.99(65) | 136.50(261) | 46.33(88.6) | 1.26(2.42) | 0.088(0.169) |
| $T_5$ | 5.24(10) | 7.34(14) | 34.07(65) | 133.17(254) | 47.02(89.7) | 1.24(2.37) | 0.088(0.168) |
| $T_6$ | 7.58(11) | 11.72(17) | 45.50(66) | 171.68(249) | 19.44(28.2) | 1.57(2.28) | 0.117(0.170) |
| $T_7$ | 2.75(5) | 11.56(21) | 35.23(64) | 133.79(243) | 21.69(39.4) | 1.18(2.16) | 0.091(0.166) |

nutrient content and sustainability based on management options.

The current study was conducted with the aim of assessing the sustainability in mango cv. Dashehari under subtropical climatic condition. A range of 0.67–0.87 SYI was recorded; yield increment of 4.3–27.1% was noted. Greater pulp, peel, stone weight on both fresh and dry weight basis was recorded. The nutrient content in these factors on dry and fresh weight basis were documented. Results indicate richness in nutrients in pulp, peel and stone as well. Growers should adopt 0.75–1.0% $ZnSO_4$ spray in mango to maximize the benefit. The role of nutritional trial towards enriching fruits along with sustainability is evidenced.

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