International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2017; 5(2): 43-46

Received: 10-01-2017
Accepted: 11-02-2017

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# Secondary nutrient status in soil and leaf of alphonso mango orchards from Ratnagiri and Devgad in relation to yield

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**Abstract**
In order to study the secondary nutrients in soil and leaf of Alphonso mango orchards from Ratnagiri and Devgad and their relationship with yield, two orchards from Ratnagiri tahasil *viz.* Warwade-1 and Warwade-2 and two from Devgadtahasil *viz*. Padel and Rameshwar were selected. The analysis of the available soil nutrients showed to be low in Ca, Mg and low to optimum in S While, the concentration of nutrients in leaf to be optimum to high in Ca and Mg and optimum in S. The overall nutrient contents of soil and leaf were gradually decreased up to harvest at all locations with few exceptions. In case of yield, the highest yield was observed at Warwade-2 while, lowest at Rameshwar amongst all locations. The exchangeable Ca and Mg insoil while, nutrient contents in leaf viz. Ca, Mg and S, were significantly correlated with yield.

**Keywords:** Secondary nutrients, Ratnagiri, Devgad, Alphonso mango, yield

## Introduction
Mango grown in area of 4.95 million ha producing 37.12 million tons showing a productivity of 7.51 tons/ha is important fruit crop of India (Anonymous, 2014) [1]. The Konkan region is famous and well known for mango production. Particularly, the two districts of the region viz. Ratnagiri and Sindhudurg are known as 'Mango baskets'. However, the production efficiency of mango orchards can be partially attributed to variations in soil and leaf nutrients (Ray and Mukherjee, 1982) [11]. In addition to this, under nutrition and negligence of orchards due to improper management practices are thus been the important reasons affecting the yield in the region (Reddy *et al*. 2003) [12]. It has been aware that the yield of mango fruits is depending on adequate amount and balance of plant nutrients in trees (Pathak *et al.* 1978) [7]. In the Konkan region, the studies on Alphonso mango are quite limited irrespective of stages and concentrated only on physico-chemical properties and N P K. Hence, in light of the available information and sparse related research, the present investigation was undertaken.

## Material and Methods
Survey of four mango orchards comprising of Alphonso mango variety was done in present study. Two orchards from Ratnagiri tahasil especially at Warwade-1 and Warwade-2 and two from Devgadtahasil viz. Rameshwar and Padel were selected and in all, fifteen trees from each orchard were included. From each mango orchard, the surface soil samples (0-15 cm) were collected from fertilizer ring periphery of each tree while, leaf samples of three to four months old and situated at fourth and fifth position from terminal bud were collected at pre-flowering, flowering, egg stage and at harvest stage by following standard method of collection of soil and leaf samples (Tandon, 1993) [6]. The exchangeable $Ca^{++}$ and $Mg^{++}$ in soil and total Ca and Mg in leaf was determined titrimetrically as per the procedure given by Chopra and Kanwar, 1978 and available S in soil and total S in leaf turbidimetrically outlined by Chesnin and Yein, 1995 [5].

## Results and Discussion
The results obtained are presented in appropriate tables and figures and discussed under suitable headings with abbreviations as follows. The values given in the table 2, 3 and 4 is an average of 15 trees.
Abbreviations: W-1= Warwade-1; W-2; Warwade-2; R= Rameshwar; P= Padel; PF=Pre-flowering; FF= Full Flowering; E= Egg stage; AH= At Harvest

**Soil nutrients**

**Exchangeable $Ca^{++}$:** The data regarding the exchangeable calcium presented in Table 2 when studied revealed that the exchangeable $Ca^{++}$ of Warwade-1, Warwade-2 and Padel got decreased from pre-flowering stage up to at harvest. In case of Rameshwar location, no specific trend was found at pre-flowering and flowering, but at egg stage it increased and further decreased at harvest. As per the ratings given by Sankaram (1966) [13], exchangeable $Ca^{++}$ categorized under low class at all growth stages. These values were also noticed by Chavan *et al.* (1995) [3]. The reducing trend of exchangeable calcium at Warwade-1, Warwdae-2 and Padel locations might be due to no application of calcium sources in the soil from pre-flowering till harvesting of fruits and its utilization by plant while, at Rameshwar the increase in exchangeable calcium at egg stage might be due to foliar application of calcium on leaves after flowering hence it may not have been absorbed from soil.

**Exchangeable $Mg^{++}$:** The declining trend of exchangeable $Mg^{++}$was observed from pre-flowering up to harvest stage at Warwade-1 and Warwade-2.At Rameshwar, the exchangeable magnesium decreased at flowering stage and then increased at egg stage of fruit and harvest of fruits, there was decrease in the content but overall decreasing trend was observed. In case of Padel, increasing trend was observed up to egg stage and at harvesting of the fruits, the exchangeable $Mg^{++}$ was decreased (Table 2). In general, at all stages exchangeable $Mg^{++}$ categorized under low class as per the ratings given by Sankaram (1966) [13]. The values of exchangeable magnesium are in close vicinity with Suryawanshi (2010) [15]. The decreasing trend might be due to its utilization by plant and moreover no replenishment of Mg was done by application. The increase in the content up to egg stage may be due to addition of manures and which may be responsible for creating more availability of nutrient.

**Table 2:** Average soil nutrient status at different stages of Alphonso mango orchards from different locations

| Loc. | Exchangeable $Ca^{++}$ (c mol ($p^+$) $kg^{-1}$) | | | | Exchangeable $Mg^{++}$ (c mol ($p^+$) $kg^{-1}$) | | | | Available S (mg $kg^{-1}$) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PF | FF | E | AH | PF | FF | E | H | PF | FF | E | AH |
| W-1 | 8.15 | 6.51 | 6.48 | 6.31 | 4.37 | 4.09 | 3.96 | 3.64 | 52.54 | 82.59 | 72.13 | 22.95 |
| W-2 | 10.78 | 9.75 | 9.47 | 8.47 | 6.03 | 4.45 | 4.34 | 3.57 | 78.39 | 67.17 | 65.39 | 31.89 |
| R | 7.29 | 7.29 | 7.92 | 7.84 | 7.41 | 3.17 | 4.44 | 3.66 | 68.50 | 62.29 | 61.87 | 26.32 |
| P | 11.39 | 9.71 | 9.16 | 8.97 | 3.29 | 4.10 | 4.42 | 3.28 | 71.64 | 70.84 | 59.11 | 32.45 |

**Available S:** For Warwade-2, Rameshwar and Padel, available sulphur showed declining trend from pre-flowering up to at harvest. At Warwade-1, increase in the content of available S was observed at flowering stage but from flowering stage up to harvesting of the fruits declining trend was observed. The samples had low to optimum amount of available sulphur at all growth stages of mango as per the soil fertility norms given by Raghupathi and Bhargava, (1997) [9] for Alphonso mango. The above mentioned values of available sulphur in lateritic soils of Konkan are also observed by Pednekar (1998) [8]. The decreasing trend of available sulphur from pre-flowering stage up to harvesting stage might be attributed to its absorption from soil by tree for flowering and fruit development.

**Leaf nutrients**

**Total Ca:** Data on overall mean (Table 4.6) for total calcium of Warwade-1, Rameshwar and Padel location showed increasing trend from pre-flowering up to egg stage but at harvest stage, it was decreased. At Warwade-2 increasing trend was observed from pre-flowering stage up to at harvest. In general, total calcium found to have optimum at all growth stages of mango as per the norms given by Raghupathi and Bhargava (1999) [10]. Similar values of total calcium were denoted by Sukthumrong *et al.* (2000) [14] at pre-flowering stage and Chadha *et al.* (1980) [2] at flowering stage. The mango orchards showed increasing trend due to foliar application of calcium on leaves and decreased at harvest due to translocation of Ca into fruit.

**Total Mg:** The total magnesium content from leaf of Warwade-1 and Warwade-2 showed declining trend from pre-flowering up to harvest stage while, at Rameshwar and Padel the total magnesium content decreased from pre-flowering to flowering stage and then again increased at egg stage of fruit. At harvest of fruits, there was decrease in the content of total magnesium. As per the ratings given by Raghupathi and Bhargava (1999) [10], the total magnesium was optimum to excess. The similar decrease in total magnesium content of mango leaf from pre-flowering stage to harvest was also observed by Chadha *et al.* (1980) [2]. The similar values and oscillation of total magnesium among developmental stages (pre-flowering stage up to at harvest) was observed by Medeiros *et al.* (2004) [6]. The decrease or increase in magnesium content of leaf composition might be a result of translocation of it for flowering and fruit development.

**Table 3:** Average leaf nutrient contents at different stages of Alphonso mango orchards from different locations

| Loc. | Total Ca (%) | | | | Total Mg (%) | | | | Total S (%) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PF | FF | E | AH | PF | FF | E | H | PF | FF | E | AH |
| W-1 | 1.37 | 1.43 | 1.53 | 1.22 | 1.62 | 0.94 | 0.75 | 0.74 | 0.52 | 0.61 | 0.66 | 0.65 |
| W-2 | 1.66 | 1.87 | 1.91 | 2.04 | 1.47 | 0.83 | 0.53 | 0.47 | 0.65 | 0.72 | 0.75 | 0.71 |
| R | 1.87 | 1.76 | 2.02 | 1.89 | 0.94 | 0.67 | 0.72 | 0.39 | 0.43 | 0.49 | 0.67 | 0.55 |
| P | 1.55 | 1.55 | 1.82 | 1.49 | 1.41 | 0.70 | 0.71 | 0.52 | 0.43 | 0.57 | 0.70 | 0.47 |

**Total S:** An increasing trend was seen for the total sulphur up to egg stage, and it was decreased at harvest at all locations. As per the nutrient norms given by Raghupathi and Bhargava (1999) [10], the available sulphur found to have high category at all growth stages of mango. The similar values of total sulphur were also reported by Medeiros *et al.* (2004) [6]. The increase in sulphur content up to egg stage due to foliar application of sulphur prior to flowering and egg stage and found to have decreased at harvest of the fruits due to absorption by fruit for its growth and development.

**Table 4:** Yield of mango orchard of different locations

| Contents | Locations | | | |
|---|---|---|---|---|
| | Warwade-1 | Warwade-2 | Rameshwar | Padel |
| Average Yield(kg tree$^{-1}$) | 49.73 | 155.20 | 25.82 | 57.60 |

As seen from Table 4 the average yield of Warwade-1, Warwade-2, Rameshwar and Padel locations were 49.73, 155.20, 25.82 and 57.60 kg tree$^{-1}$. The average yield of Warwade-2 location was higher, while the average yield of Rameshwar was low amongst all locations.

**Correlation:** In the present investigation, among the selected four mango orchards, Warwade-1 and Warwade-2 are in close vicinity in Ratnagiri tahasil while, Rameshwar and Padel are in close vicinity in Devgadtahasil. So for correlation purpose, correlation of nutrients were found out within Ratnagiri (including both Warwade-1 and Warwade-2) and Devgadtahasil (including both Rameshwar and Padel). The data showed that the available nutrient content in the soil and total nutrients in the leaf of Alphonso mango orchards were found to be positively and negatively correlated, which suggested the existence of dynamic equilibrium between them.

**Table 5:** Correlation between available soil nutrients and yield of mango orchard of different locations at different growth stages

| Parameters | W-1 & W-2 (Ratnagiri tahasil) | | | | R & P (Devgadtahasil) | | | |
|---|---|---|---|---|---|---|---|---|
| | PF | FF | E | AH | PF | FF | E | H |
| Ca | 0.33 | 0.63* | 0.11 | 0.21 | 0.65* | 0.31 | -0.05 | 0.43* |
| Mg | 0.34 | 0.06 | -0.24 | -0.20 | -0.71 | 0.24 | -0.04 | -0.10 |
| S | 0.46* | -0.24 | 0.10 | 0.13 | 0.06 | 0.40* | -0.25 | 0.23 |

**Correlation between available soil nutrients and yield of mango orchards:** A perusal of the data presented in Table 5 revealed that available sulphur exhibited positive and significant correlation with yield at pre-flowering stage and exchangeable calcium at flowering stage at Warwade-1 and Warwade-2 (Ratnagiri) locations. Whereas positive and significant relationship was found between yield and exchangeable calcium at pre-flowering and harvest stage and available sulphur at flowering stage at Rameshwar and Padel (Devgad) locations. The positive and significant correlation indicates available soil nutrients (Caand S) proved beneficial in increasing fruit yield.

**Table 6:** Correlation between leaf nutrients and yield of mango orchard of different locations at different growth stages

| Parameters | W-1 & W-2 (Ratnagiri tahasil) | | | | R & P (Devgadtahasil) | | | |
|---|---|---|---|---|---|---|---|---|
| | PF | FF | E | AH | PF | FF | E | H |
| Ca | 0.24 | 0.55* | 0.40* | 0.48* | -0.24 | 0.55* | -0.26 | -0.37 |
| Mg | 0.03 | 0.55* | -0.42 | -0.11 | 0.25 | 0.55* | -0.09 | 0.24 |
| S | 0.58* | 0.21 | 0.27 | 0.20 | -0.003 | 0.21 | 0.24 | -0.46 |

**Correlation between available leaf nutrients and yield of mango orchards:** The data presented in Table 6 when studied revealed that total calcium exhibited positive and significant correlation with yield at flowering stage, egg stage and at harvest of the fruits; total magnesium at flowering stage and total sulphur at pre-flowering stage at Warwade-1 and Warwade-2 (Ratnagiri) locations. Whereas positive and significant relationship was found between yield and calcium and magnesium at flowering stage; at Rameshwar and Padel (Devgad) locations. The total Ca, Mg and S contents in the leaves proved that they were beneficial in increasing the yield of mango.

## Conclusion

The study revealed that there is positive significant correlation between available nutrients in soil and corresponding nutrient in plant which indicates that soil application of nutrients is beneficial. The location wise yield levels showed that the mango yield is dependent on fertilizer management of the orchard.

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