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An investigation on nutrient accumulation in leaves during fruit development stages of mango (*Mangifera indica* L.)

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Abstract
Field experiment was conducted during the year 2016-17 at Regional Horticultural Research Station, Navsari Agricultural University, Navsari. Assessing the annual concentration of nutrient that tree needs to absorb in order to successfully complete a vegetative and reproductive growth is a fundamental step for developing rational fertilization in orchards. For conducting this experiment leaves of variety Kesar, Alphonso, Sonpari and Totapuri were collected at different stages like Marble, Egg and Harvest for estimation of macronutrients (N, P, K, Ca, Mg and S) and micronutrients (Zn, Fe, Mn and Cu). The result of leaf nutrients analysis displayed maximum K (1.62%), Ca (1.69%), Mg (0.70%), S (0.50%), Zn (36.39 ppm), Fe (184.00 ppm), Mn (69.18 ppm) and Cu (20.14 ppm) contents in Totapuri at harvest stage, whereas P (0.38%) was recorded higher at egg stage in the same variety and N (1.54%) was observed maximum in Kesar variety at harvest stage.

Keywords: Mango, varieties, stages, nutrients, accumulation and leaves

Introduction
Mango (*Mangifera indica* L.) belongs to the family Anacardiaceae, originating in South East Asia. Mango is one of the major fruits of Asia and has developed its own importance all over the world. Mango having good nutritional value as every 100 g of mango fruit contains 81.7 g water, 16 g carbohydrate, 0.7 g protein, 0.4 g fat and 0.1 g fibers. It is rich in calcium, phosphorus, iron, magnesium, and also full of anti-oxidants. A single fruit can provide up to 40% daily dietary fiber needs (Chandra and Chandra, 1997) [5]. India is the major producer in the world with an area of 6.490 lakh hectares with annual production of 92.846 lakh tons and productivity of 14.33 tons per hectare (Annon., 2017) [2]. The area under fruit in the state during 2017 was 0.39 lakh hectares with a total annual production of 8.48 lakh tonnes. Mango is the major fruit crop in Gujarat contributing maximum area of 0.153 lakh hectares, 1.241 lakh tonnes production with productivity of 8.11tonnes (Annon., 2017) [2].

The mineral content of plant parts, in particular leaves is used to identify nutrient deficiencies, excesses or imbalances within a crop. Leaf analysis is widely accepted as a powerful tool to monitor nutritional status of fruit plants. Since mineral composition of leaves undergoes seasonal changes as a result of growth and development, therefore, knowledge of seasonal changes of nutrients is necessary to develop criteria for describing the optimum nutrient status for both yield and quality of fruits. Comparison of the results of leaf analysis and standard of leaf nutrient accumulation, the level of sufficiency or deficiency of plant nutrient status can be estimated and as a result the optimum fertilization rate may be recommended. However, leaf analysis depends on sampling technique, including canopy height, leaf age and time of sampling. (Sun, 2015) [19].

The interpretation of leaf analysis must consider many factors that may influence foliar nutrient levels, seasonal differences related to rainfall, fruit load, pruning, variety, root stock, nutritional interaction and nutrient removal information. Which is a basic pre-requisite for its adequate nutrition and crucial to achieve high yield and productivity. The information is available on variation in nutrient content among different variety of mango during various growth stages is very meager. In order to avoid misleading soil fertility program, reference value used for interpreting the results of plant analysis should reliably reflect differences in nutrient content among very closely related plants. This is especially important for establishing and maintaining a proper fertilization in the orchards (Basar, 2006) [3].

Hence the present study was therefore proposed to establish proper nutrient management for mango in respect of nutrient accumulation in leaves of mango cultivars.

Materials and Methods

About the Location

This investigation was carried out at Regional Horticultural Research Station, Navsari Agricultural University, Navsari which is situated on the coast of Arabian sea at 20^0-57'N latitude and 72^0-54'E longitude at an altitude of about 10 meters above the mean sea level. The campus is about 12 km away from Dandi, a historical place near the Arabian seashore. The experiment was carried out at Regional Horticultural Research Station, ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari, Gujarat during 2016-17.

Treatment details

The experiment was laid out in Completely Randomized Design (with factorial concept) with 12 treatment combinations and 3 repetitions. The treatments comprised of four varieties (V_1: Kesar, V_2: Alphonso, V_3: Sonpari and V_4: Totapuri) and three fruit stages (S_1: Marble, S_2: Egg and S_3: Harvest) with the objectives of find out nutrient accumulation at different stages in various varieties namely Kesar, Aphonso, Sonpari and Totapuri with respect to following observation.

A) Primary, Secondary and Micronutrient in leaves at marble, egg and harvest stage

Methodology of nutrient analysis

The numbers of leaves were collected at marble, egg and harvest stage was 20-25 in each variety for nutrient estimation. N, P and K analysed by Jackson (1967) [10], Ca, Mg by Cheng and Bray (1951) [6] and Zn, Fe, Mn and Cu by Elwell and Gridley (1967) [8] method. The data on various parameters namely primary nutrients (%), Secondary (%) and Micronutrients (ppm) were recorded as per the standard procedures and the mean values were subjected to statistical analysis as per procedure laid down by Panse and Sukhatme (1985).

Result and Discussion

Primary nutrients (N, P and K)

Amongst different varieties significantly maximum leaf nitrogen (1.40%), leaf phosphorus (0.24%) and leaf potassium (1.29%) were found in Totapuri (Table 1). The nutrient content in the same variety of mango fruit might be due to the inherent capacity of a variety for absorbing various nutrients from the soil. This study was conformity of Albregts *et al*. (1980) [1] who observed that leaves accumulated maximum N, P, K and Mg. This study was also linear with findings of Clark and smith (1992) [7] observed all nutrient content increase in whole wine of kiwifruit.

In the present investigation, it was observed that all the nutrient varied at different stages in varieties and the pattern of content also varies with the stages. The leaf nitrogen content in mango was reported maximum at harvest stage (1.48%) in Totapuri variety (Table 1). This may be due to the role of nitrogen as an essential constituent of cell and its effect on cell division and cell elongation leading to growth and development of large leaf area, High level of nitrogen during harvest stage could be also attributed to storing of nutrient by the new leaves and stem during the off year and mobilize it during subsequent on year to support new growth. Also due to expansion and dry matter content of leaves.

This finding was in conformity with the result of Fernandez *et al*. (2004) [9] who also studied nitrogen dynamics in the olive bearing shoots. Similarly, reported slightly higher nitrogen concentration fig leaf. While as the phosphorous content in mango was maximum (0.23%) at egg stage. The leaf potassium content recorded to be highest at the harvest stage (1.46%) (Table 1). It could be attributed to slow mobility of this element in soil. This finding is in line with the results of Poovarodom (2001) [18] who also observed lower concentration of phosphorus as leaves mature in durian. Similarly, Nooruldin *et al*. (2015) [16] also found the phosphorus content decrease significantly with maturity in mulberry leaves.

The findings due to combined effect revealed that significantly higher leaf nitrogen (1.54%) in Kesar and leaf potassium (1.62%) in Totapuri at harvest stage, while leaf phosphorus content was noted maximum (0.38%) at egg stage in Totapuri (Table 2).

Secondary nutrients (Ca, Mg and S)

Amongst varieties all secondary nutrients was noticed to be higher in Totapuri variety *i.e*. leaf calcium (1.57%), leaf magnesium (0.54%) and leaf sulphur (0.44%) (Table 1). It might be due to inherent capacity of a particular variety (Basar, 2006) [3]. The present finding is in close conformity of Koo and Young (1977) [11] xwho also recorded nutrient composition of avocado leaves. also found Ca and Mg showing increasing trend during season in apple. Similarly, Menzel *et al*. (2015) [14] also recorded higher manganese in leaves of litchi.

The calcium, magnesium and sulphur content in mango leaves at different stages of growth significantly maximum at harvest stage. Leaf calcium content in mango fruit exhibiting higher content (1.58%) at harvest stage (Table 1). The increase in calcium from marble to harvest stage may be attributed to continuous absorption of calcium and primarily to increasing fruit massand also due to Ca immobility in plant tissue and no redistribution to other plant organs. This finding is in close confirmity with the results Chadha *et al*. (1980) [4] who also evaluated standardization of leaf sampling technique for mineral composition of mango cultivar 'Chausa'. Similarly, Nachtigall and Dechen (2006) [15] also study seasonality of nutrients in apple leaves.

In contrary of calcium, the maximum content of magnesium (0.62%) and sulphur (0.42%) was recorded at harvest stage (Table1). This result is also confirmed with the finding of who studied seasonal changes of leaf nutrient in kiwifruit. Similarly, present study was also line with results of Koo and Young (1977) [11] with respect to Ca, Mg and micronutrient content in avocado leaves. Nooruldin *et al*. (2015) [16] also found the calcium and magnesium content increase significantly with maturity in mulberry leaves. However, Mattos *et al*. (2003) [13] also observed that leaves accumulated significantly higher secondary nutrients in sweet orange tree.

The results due to interaction effect showed that leaf calcium, magnesium and sulphur content was significantly maximum in Totapuri variety at harvest stage with the tune of 1.69% Ca, 0.70% Mg and 0.50% S (Table 2).

Micronutrients (Zn, Fe, Mn and Cu)

In different varieties leaf zinc, iron, manganese and copper content was higher in Totapuri *viz*., 31.90 ppm zinc, 174.67 ppm iron, 66.48 ppm manganese and 13.98 ppm copper

(Table 1). This finding is in close linear with results of Koo and Young (1977) [11] who recorded higher level of all micronutrient content in avocado leaves. Similarly, result was also confirmed with the findings of Poovaradom *et al.* (2001) [18] who study the seasonal variation in nutrient concentration of durian leaves.

With regard to the micronutrient content in mango leaves at different stage maximum content of leaf zinc (32.04 ppm) was reported at harvest stage (Table 1). The increased Zn level at later stage was probably due to its role for water uptake and water relations to the system. Iron (170.50 ppm) and manganese (53.77 ppm) content was also recorded highest at harvest stage. Similarly, leaf copper content also observed to be maximum (16.01 ppm) at harvest stage (Table 1). This may be due to its high rate of uptake from soil. The present study is in conformation with the result of who recorded copper, iron, manganese declined first and increased during the rest of season. Similarly, Chadha *et al*. (1980) [4] who also evaluated standardization of leaf sampling technique for mineral composition of mango cultivar 'Chausa'.

The results due to interaction effect of varieties and stages revealed maximum leaf zinc (36.39 ppm), Iron (184.00 ppm), manganese (69.18 ppm) and copper (20.14 ppm) in Totapuri variety at harvest stage (Table 2).

Table 1: Main effect of different varieties and stages on accumulation of primary, secondary and micronutrients

Treatments	Primary nutrients (%)			Secondary nutrients (%)			Micronutrients (ppm)			
Varieties (V)	**N**	**P**	**K**	**Ca**	**Mg**	**S**	**Zn**	**Fe**	**Mn**	**Cu**
Kesar (V_1)	1.21	0.14	1.21	1.35	0.34	0.27	22.50	146.33	33.38	8.96
Alphonso (V_2)	1.28	0.15	1.03	1.44	0.42	0.30	25.83	157.33	45.16	10.53
Sonpari (V_3)	1.36	0.20	1.18	1.53	0.49	0.34	29.74	163.89	55.89	11.57
Totapuri(V_4)	1.40	0.24	1.29	1.57	0.54	0.44	31.90	174.67	66.48	13.98
$CD_{0.05}$	0.02	0.03	0.02	0.03	0.02	0.02	2.40	2.28	2.48	0.68
Stage (S)										
Marble (S_1)	1.23	0.15	0.85	1.34	0.26	0.25	22.44	153.75	47.01	7.25
Egg (S_2)	1.35	0.23	1.22	1.49	0.46	0.34	28.00	157.42	49.91	10.53
Harvest (S_3)	1.48	0.16	1.46	1.58	0.62	0.42	32.04	170.50	53.77	16.01
$CD_{0.05}$	0.02	0.02	0.02	0.03	0.02	0.02	2.08	1.98	2.15	0.59

Table 2: Interaction effect of different varieties and stages on accumulation of primary, secondary and micronutrients

Treatments	Primary nutrient (%)			Secondary nutrients (%)			Micronutrients (ppm)			
	N	**P**	**K**	**Ca**	**Mg**	**S**	**Zn**	**Fe**	**Mn**	**Cu**
V_1S_1	1.21	0.11	0.84	1.27	0.12	0.15	17.22	139.00	29.47	5.36
V_1S_2	1.38	0.15	1.25	1.35	0.36	0.29	23.11	143.00	33.25	9.00
V_1S_3	1.54	0.16	1.55	1.43	0.55	0.36	27.18	157.00	37.42	12.53
V_2S_1	1.16	0.12	0.71	1.33	0.20	0.20	21.00	150.00	41.25	6.10
V_2S_2	1.29	0.17	1.11	1.46	0.44	0.31	26.03	154.00	45.01	10.12
V_2S_3	1.40	0.15	1.26	1.53	0.61	0.40	30.47	168.00	49.23	15.38
V_3S_1	1.26	0.18	0.90	1.36	0.35	0.28	24.36	158.00	53.16	7.71
V_3S_2	1.35	0.22	1.22	1.57	0.50	0.32	30.75	160.67	55.27	11.00
V_3S_3	1.46	0.19	1.41	1.66	0.63	0.43	34.12	173.00	59.25	16.00
V_4S_1	1.30	0.20	0.93	1.41	0.38	0.38	27.19	168.00	64.15	9.81
V_4S_2	1.38	0.38	1.31	1.60	0.55	0.43	32.11	172.00	66.11	12.00
V_4S_3	1.52	0.15	1.62	1.69	0.70	0.50	36.39	184.00	69.18	20.14
$CD_{0.05}$	0.04	0.05	0.04	0.05	0.04	0.04	NS	NS	NS	1.19
C.V. %	1.78	15.07	1.89	1.89	5.06	6.57	9.00	1.46	5.08	6.28

Conclusion

On the basis of result obtained in the present investigation it can be concluded that leaf nutrients analysis displayed maximum K, Ca, Mg, S, Zn, Fe, Mn and Cu contents in Totapuri at harvest stage whereas P was recorded higher at egg stage in the same variety and N was observed maximum in Kesar variety at harvest stage.

References

1. Albregts EE, Howard CM. Accumulation of nutrients by strawberry plants and fruit grown in annual hill culture. Journal of the American Society for Horticultural Science. 1980; 105(3):386-388.
2. Anonymous. Indian Horticulture Data base, National Horticulture Board, Ministry of Agriculture, and Government of India, 2017.
3. Başar H. Elemental composition of various peach cultivars. Scientia Horticulturae. 2006; 107(3):259-263.
4. Chadha KL, Samra JS, Thakur RS. Standardization of leaf sampling technique for mineral composition of leaves of mango cultivar 'Chausa'. Scientia Horticulturae. 1980; 14(1):323-329.
5. Chandra A, Chandra A. Production and Postharvest Technology of Fruits, NBS pub. and Distributors, Bikaner, India, 1997.
6. Cheng XL, Bray RH. Determination of calcium and magnesium in soil and plant material. Soil Science. 1951; 72:42.
7. Clark CJ, Smith GS. Seasonal dynamics of biomass and mineral nutrient partitioning in mature kiwifruit vines. Annals of botany. 1992; 70(3):229-237.
8. Elwell WT, Gridley JAF. In: Atomic absorption spectrophotometery, Pergamon Press Ltd., London, 1967, 221.
9. Fernandez-Escobar R, Moreno R, Sanchez-Zamora MA. Nitrogen dynamics in the olive bearing shoot. Horticulture Science. 2004; 39(6):1406-1411.
10. Jackson ML. Soil chemical analysis, Asia Publishing House, Bombay, 1967.
11. Koo RCJ, Young TWJ. Effects of age, position, and fruiting status on mineral composition of 'Tonnage'

avocado leaves. American Society of Horticulture Science. 1977; 102(3):311-313.
12. Kumar P. Managing micronutrient deficiency in ornamental crops. Indian Horticulture. 2002; 46(4):30-31.
13. Mattos Jr D, Quaggio JA, Cantarella H, Alva AK. Nutrient content of biomass components of Hamlin sweet orange tree. Scientia Agricola. 2003; 60(1):155-160.
14. Menzel CL, Carseldine ML, Simpson DR. Effect of fruiting status on nutrient composition of litchi (*Litchi chinensis* Sonn.) during the flowering and fruiting season. Journal of Horticultural science. 2015; 53(3):547-556.
15. Nachtigall GR, Dechen AR. Seasonality of nutrients in leaves and fruits of apple trees. Scientia Agriculture. 2006; 63(5):493-501.
16. Nooruldin S, Afifa SK, Mir MR, Javid AW, Malik GN, Tariq AR, *et al*. Seasonal variation in macro nutrient contents of mulberry (*Morus alba*) leaves under temperate climatic conditions of Kashmir. International Journal of Agriculture Innovations and Research. 2015; 4(1):147-152.
17. Panse VG, Sukhatme PV. Statistical methods for agricultural workers, Indian Council of Agricultural Research, New Delhi, India, 1967.
18. Poovarodom S, Mairaing S, Ketsayom P, Tawinteung N, Prasittikhet J. Seasonal variations in nutrient concentrations of durian (*Durio zibethinus*.) leaves. Acta Horticulturae. 2001; 564:235-242.
19. Sun Y, Yang J, Wang H, Zu C, Tan L, Wu G. Standardization of leaf sampling technique in jackfruit nutrient status diagnosis. Agriculture Science. 2015; 6(02):232-237.