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Leaf nutrient concentration at different growth stages and yield of Alphonso mango as influenced by foliar application of nutrients

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Abstract
The field experiment was carried out to evaluate "Effect of foliar application of nutrients on leaf nutrient concentration at different growth stages and yield of Alphonso mango" at Mango Orchard of Department of Horticulture, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Dist. Ratnagiri (M.S.) during 2016-17. There were seven treatments with three replications in randomized block design comprised of foliar application of urea, potassium nitrate and Amrashakti each at 1 per cent and 3 per cent level. The soil application of recommended dose of nitrogen, phosphorus and potassium (1.5:0.5:1.0 kg ha^{-1}) was undertaken initially to each experimental tree. The results of the experiment indicated that the foliar application of nutrients increases the leaf nutrient concentration at different growth stages and yield of the crop. The treatment comprising foliar spray of 3 per cent Amrashakti multinutrient solution showed its superiority in respect of leaf nutrient concentration *viz*. total phosphorus and sulphur content and micronutrients content *viz*. Total zinc, copper, boron and molybdenum as well as in improving yield of Alphonso mango as compared to all other treatments.

Keywords: Foliar spray, Alphonso mango, yield, nutrient content

1. Introduction
Mango (*Mangifera indica* L.) popularly known as 'King of fruits' and 'Nectar of God' belongs to the family Anacardaceae. Being most palatable and rich in sugars, organic acids and minerals, it captures great demand in all walks of life (Azhar *et al*., 2007) [18]. India is bestowed with mango germplasm, thus able to produce more than 1000 varieties in the country. However, only a few *viz*., Alphonso, Banganpally, Chausa, Dashehri, Langra, Totapuri and Kesar are commercially cultivated in the mango growing regions of India (Yadav, 1997) [21]. The overall mango production in the world is 43.00 million tons with a productivity of 7.51 tons ha^{-1} covering an area of 4.95 million ha. India is the biggest producer of mango with a share of about 41 per cent of the world's production where it is cultivated in an area of 2.20 million ha with the production of 18.64 million tons approximately and a productivity of 8.4 tons ha^{-1}. Uttar Pradesh, Karnataka, Andhra Pradesh, Bihar, Gujarat, Tamil Nadu and Maharashtra are the major mango producing states in India. Maharashtra state produces 0.51 million tons of mango from an area of 0.16 million ha with a productivity of 2.86 tons ha^{-1} (Anonymous, 2017) [17].

Mango trees largely suffer due to the deficiency of macro and micronutrients. These nutrients if supplied in the right amounts and at the right time, are sure to boost up the economic yield of the tree. Nitrogen is one of the most important nutrient responsible for the growth and has a relevant role in the production and quality of the fruits (Albuquerque *et al*., 1999) [16]. Phosphorus is also required for the synthesis of ATP and the cellular molecules which are engaged in respiration process to support plant life. Potassium also increases the ability of the plant to withstand drought, cold, salinity and attack of diseases and pests (Samra and Arora, 1997) [20]. Calcium, magnesium and sulphur play an important role in the assimilation of nitrogen and transport of carbohydrates and amino acids and also maintain pulp consistency (Silva, 1997) [13].

Besides major nutrients, application of micronutrients is also gaining importance in nutrient management system. The significant role of micronutrients during flowering, fruiting, fruit development and quality is proven. The characteristics like fruit size, colour, shape, taste, shelf life, processing ease, etc. essentially depend on supply of micronutrients (Ganeshmurthy *et al*., 2013) [19]. Boron, copper, zinc and iron have been proved beneficial in improving the fruit

Growth, weight, volume, firmness, yield and overall quality including total soluble solids, total sugars and ascorbic acid content (Nehete *et al*., 2011) [7]. Copper has a role in chlorophyll formation and is a part of enzymes like cytochrome oxidase. It also has a role in lignin formation, protein and carbohydrate metabolism and is possibly required for symbiotic N fixation, as a part of plastocyanin, which forms a link in the electron transport chain involved in photosynthesis (Anonymous, 2014) [1]. Boron is found to be associated with the reproductive phase in plants as its deficiency leads to sterility and malformation of reproductive organs. It exhibits pronounced effect on yield and yield attributing characters. It also helps in the uptake of calcium and enhances other nutrient use efficiency through blanced nutrient ratio (Anonymous, 2014) [1]. Molybdenum is present in the chloroplasts of leaves and is involved in several enzyme systems like nitrate reductase and nitrogenase which plays an active role in nitrogen fixation by *Rhizobium, Azatobacter* and some algae and actinomycetes. It is also involved in the absorption and translocation of iron in plants (Anonymous, 2014) [1]. Therefore, the present investigation was undertaken to study the effect of foliar application of nutrients on yield and leaf nutrient concentration of Alphonso mango in lateritic soils of Konkan region.

Material and Methods

The experiment was conducted at Mango orchard of Department of Horticulture, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Dist. Ratnagiri which is situated in the tropical region on 17º 45' N latitude and 73º11' E longitude. The town is located at altitude of 800 ft (240m) and 8 km from Arabian sea having hot and humid climate with well-expressed three seasons *viz*. Summer (March to May), Rainy (June to October) and Winter (November to February). The region receives very high rainfall (above 3000 mm, annually).The present experiment was laid out in Randomized Block Design with seven treatments which were replicated thrice. The treatment comprised of T_1– Control, T_2- Urea @ 1 per cent, T_3- Potassium nitrate @ 1 per cent, T_4- Amrashakti @ 1 per cent, T_5- Urea @ 3 per cent, T_6- Potassium nitrate @ 3 per cent, T_7-Amrashakti @ 3 per cent. Urea, single super phosphate and muriate of potash were applied @ of 3 kg urea, 3 kg SSP and 1 kg MOP at fertilizer ring periphery to all experimental trees, respectively. The foliar spray of urea, potassium nitrate and amrashakti were applied as per treatment details. Full grown fruits (85% maturity) were harvested by mango picker (Nutan Zela) developed by Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli. Number of harvested fruits trees^{-1} was counted and their total weight in kilograms (kg) per tree was recorded and calculated on the basis of yieldha^{-1}. Leaf samples of three to four months old and situated at fourth and fifth position from terminal bud were collected by following standard procedures (Tandon, 1993) [14]. The fresh collected leaf samples were first washed with tap water and then rinsed with 0.1 N HCl solution followed by double distilled water then air dried and stored in the labelled brown paper bag. These samples were adequately dried in oven at a temperature of 60 ± 5^{O} C and ground in Willey type Grinding Machine to pass through a 60 mesh stainless steel sieve and kept in polythene bags for further analysis by using following methods:

Total nitrogen was estimated by micro-kjeldahl method, total phosphorous by vanado-molybdate yellow colour method and total potassium by flame photometry method (Tandon, 1993) [14]. Total Sulphur was determined by Turbidimetric method (Chesnin and Yien, 1951) [2]. The Calcium and Magnesium were determined titrimetrically by using known quantity of di-acid extract by using Versenate method given by Chopra and Kanwar (1978) [3]. Micronutrients i.e. Cu, Zn, Fe and Mn in the digested sample were estimated by using atomic absorption spectrophotometer (Mclaren and Crawford, 1950). Total B was determined by hot water method given by Berger and Truog (1939) and Mo contents in the digested samples were determined by Thiocyanate method outlined by Purvis and Peterson (1956). The experimental data have been subjected to appropriate method of statistical analysis as described by Panse and Sukhatme (1967) [8].

Results and Discussion

Nutrient concentration in mango leaves

Primary nutrients

Nitrogen content

The data pertaining to the total nitrogen content in mango leaf at different stages as influenced by foliar application of nutrients are presented in Table 1. It was observed from the data that the total nitrogen content in mango leaf at initial stage was non-significant. The treatment T_5 receiving foliar application of 3 per cent urea recorded highest nitrogen content i.e. 1.37, 1.34 and 1.24 per cent nitrogen at pre-flowering, flowering and at harvest stage, respectively. The treatment T_5 (1.24%) showed its superiority in maximum nitrogen content as compared to other treatments but it was at par with T_6 (1.19%), T_2 (1.17%) and T_3 (1.11%) treatments at harvest stage. The increased content of nitrogen in leaves at pre-flowering stage may be due to the application of nitrogenous fertilizers by spraying on leaves. It may also be due to absorption of the nitrogen from soil due to its requirement for vegetative and floral growth by tree and its highly mobile nature in leaves. The depletion in the nutrient contents of mango leaves might be due to translocation of the nutrients for cell division, leaf and stem growth, carbohydrate production and fruit quality which make it a prominent nutrient during the physiological processes of plants as well as developing fruits where the nutrient is required for fruit development in large quantities. These results are in agreement with the results reported by Thakare (2016) and Patil (2018) [9].

Table 1: Effect of foliar application of nutrients on total nitrogen, phosphorus, potassium Contentin leaves of Alphonso mango at different growth stages

Tr. No.	Treatment	N content (%)				P content (%)				K content (%)			
		Initial Stage	Pre-flowering Stage	Flowering Stage	At harvest	Initial Stage	Pre-flowering Stage	Flowering Stage	At Harvest	Initial Stage	Pre-flowering Stage	Flowering Stage	At Harvest
T_1	Control	0.90	0.92	0.88	0.81	0.02	0.08	0.07	0.04	0.43	0.51	0.48	0.42
T_2	Urea 1%	0.84	1.28	1.22	1.17	0.02	0.11	0.09	0.07	0.43	0.63	0.51	0.46
T_3	Potassium nitrate 1%	1.04	1.25	1.19	1.11	0.04	0.12	0.11	0.08	0.40	0.81	0.65	0.57
T_4	Amrashakti 1%	0.84	1.09	1.06	0.98	0.04	0.16	0.14	0.12	0.39	0.72	0.56	0.49
T_5	Urea 3%	0.91	1.37	1.34	1.24	0.05	0.13	0.13	0.09	0.44	0.69	0.53	0.47

T_6	Potassium nitrate 3%	0.97	1.33	1.27	1.19	0.03	0.14	0.12	0.10	0.40	0.83	0.69	0.65
T_7	Amrashakti 3%	0.86	1.17	1.12	1.03	0.04	0.18	0.15	0.12	0.41	0.79	0.60	0.53
	Mean	0.91	1.20	1.16	1.08	0.03	0.13	0.11	0.09	0.41	0.71	0.57	0.51
	S.E.±	0.200	0.064	0.062	0.057	0.006	0.004	0.003	0.006	0.009	0.012	0.024	0.011
	C.D. (P=0.05)	NS	0.196	0.191	0.176	0.020	0.013	0.011	0.018	0.027	0.036	0.073	0.034

Phosphorus content

The phosphorus content in mango leaves as influenced by foliar application of nutrients are presented in Table 1. At initial stage, the treatment T_5 consisting foliar spray of 3 per cent urea recorded significantly maximum phosphorus content (0.05%). However, treatment T_7 comprising foliar spray of 3 per cent Amrashakti showed maximum phosphorus content and at pre-flowering (0.18%), flowering (0.15%) and harvest stage (0.12%), respectively. The total phosphorus content in mango leaves increased after fertilizer application and foliar spray up to pre-flowering stage and steadily decreased with advancement of growth period from flowering stage to harvest stage. The depletion in the nutrient contents of mango leaves might be due to translocation of the nutrients for cell division, cell enlargement, and various plant metabolisms, stimulating flowering and improving fruit quality make it primordial for the reproductive parts of the plants. Similar range of total phosphorus content in leaves at flowering and at harvest stage from Konkan region was observed by More (2013) [6].

Potassium content

The data pertaining to the total potassium content in mango leaf at different stages as influenced by foliar application of nutrients are presented in Table 1. The treatment T_5 receiving foliar application of 3 per cent urea recorded maximum potassium content at initial stage. The treatment T_6 receiving foliar application of 3 per cent potassium nitrate recorded significantly maximum potassium content as compared to other treatments but it was at par with treatment T_3 at pre-flowering and flowering stage. While at harvest stage, treatment T_6 was significantly superior over rest of the treatments. The increased content of potassium in leaves at pre-flowering stage may be due to the application of potassic fertilizers by spraying on leaves. It may also be due to absorption of the potassium from soil due to its requirement for vegetative and reproductive growth by tree. It was also observed that the total potassium content in mango leaves increased after fertilizer application and foliar spray up to pre-flowering stage and steadily decreased with advancement of growth period from flowering stage to harvest stage. The depletion in the nutrient contents of mango leaves might be due to absorption of potassium from soil and further translocation to leaf and developing fruits during flowering and fruiting for photosynthesis, transfer of starch in to sugar which improve fruit weight, size and quality, it act as accelerator for various enzymes which make it prominent nutrient during the physiological processes of plant. The above results are in conformity with those reported by Dabke *et al*. (2013) [4] who reported that the 1 per cent KNO_3 foliar spray recorded maximum potassium content up to before flowering stage and then decreased at post-harvest stage.

Secondary nutrients

Sulphur content

Effect of foliar application of nutrients on sulphur content in mango leaves at different growth stages of crop are presented in table 2. The higher concentration of sulphur content in mango leaves was exhibited by the treatment T_7 comprising foliar application of 3 per cent Amrashakti and was significantly superior over rest of the treatments but at par with treatment T_4 receiving foliar application of 1 per cent Amrashakti at pre-flowering and flowering stage. It was also observed that the sulphur content in mango leaves increased after fertilizer application and foliar spray up to pre-flowering stage and steadily decreased with advancement of growth period from flowering stage to harvest stage. The decrease in the nutrient content might be due to absorption and translocation of sulphur to leaf and developing fruits during flowering and fruiting for metabolism of carbohydrates, formation of cell walls and impart flavour to mango fruit. Similar range of total sulphur content in mango leaves was recorded by Thakre (2016) [15].

Table 2: Effect of foliar application of nutrients on total sulphur, calcium and magnesium content in leaves of Alphonso mango at different growth stages

Tr. No.	Treatment	S content (%)				Ca content (%)				Mg content (%)			
		Initial Stage	Pre-flowering Stage	Flowering Stage	At Harvest	Initial Stage	Pre-flowering Stage	Flowering Stage	At harvest	Initial Stage	Pre-flowering Stage	Flowering Stage	At harvest
T_1	Control	0.42	0.45	0.40	0.37	1.09	1.11	1.08	1.01	0.75	0.79	0.76	0.69
T_2	Urea 1%	0.39	0.51	0.46	0.44	1.11	1.14	1.07	0.99	0.76	0.80	0.76	0.70
T_3	Potassium nitrate 1%	0.39	0.49	0.42	0.40	1.09	1.15	1.10	1.03	0.79	0.83	0.78	0.73
T_4	Amrashakti 1%	0.40	0.58	0.52	0.46	1.10	1.16	1.11	1.06	0.76	0.79	0.74	0.70
T_5	Urea 3%	0.41	0.54	0.47	0.43	1.08	1.13	1.05	1.02	0.75	0.79	0.75	0.67
T_6	Potassium nitrate 3%	0.41	0.52	0.43	0.41	1.12	1.19	1.14	1.06	0.76	0.80	0.75	0.69
T_7	Amrashakti 3%	0.41	0.61	0.53	0.49	1.09	1.15	1.07	1.00	0.75	0.80	0.76	0.71
	Mean	0.40	0.53	0.46	0.42	1.10	1.15	1.09	1.02	0.76	0.80	0.76	0.70
	S.E.±	0.003	0.018	0.006	0.005	0.022	0.028	0.035	0.035	0.021	0.022	0.024	0.023
	C.D. (P=0.05)	0.009	0.056	0.019	0.016	NS	NS	NS	NS	NS	NS	NS	NS

Calcium content

The data regarding calcium content in mango leaves at different growth stages of crop are presented in Table 2. The calcium content of mango leaves ranged from 1.08 to 1.12 per cent, 1.11 to 1.19 per cent, 1.05 to 1.14 per cent and 0.99 to 1.06 per cent with a mean value 1.10 per cent, 1.15 per cent, 1.09 per cent and 1.02 per cent at initial, pre-flowering, flowering and at harvest stage, respectively. It was observed from the data that the calcium content in mango leaves showed non-significant effect of different treatments at all growth stages of mango. At pre-flowering stage increase in calcium content due to fertilizer application and absorption from soil to leaf and steadily decreased from flowering to harvest stage due to translocation to leaf and developing fruit.

The above results are in conformity with those reported by Puranik (2015) [11] and Patil (2018) [9] at different growth stages of mango.

Magnesium content

From the data presented in Table 2 it was revealed that themagnesium content of mango leaves ranged from 0.75 to 0.79 per cent, 0.79 to 0.83 per cent, 0.74 to 0.78 per cent and 0.67 to 0.73 per cent with a mean value of 0.76 per cent, 0.80 per cent, 0.76 per cent and 0.70 per cent at initial, pre-flowering, flowering and at harvest stage, respectively. At initial, pre-flowering, flowering and harvest stage, it did not observed any significant effect. The total magnesium content at all growth stages i.e. initial, pre-flowering, and flowering and at harvest stage was 'high' on the basis of nutrient norms given by Raghupathi and Bhargava (1999) [12]. The similar decreasing trend of total magnesium from initial stage up to post harvest was also observed by Puranik (2015) [11].

Micronutrients

Iron content

The data pertaining to the total iron content in mango leaves at different stages as influenced by foliar application of nutrients are presented in Table 3. At initial stage maximum iron content 98.46 µg g^{-1} was recorded with treatment T_2 consisting foliar application of 1 per cent urea. The treatment T_6 receiving 3 per cent foliar application of potassium nitrate recorded significantly higher iron content i.e. 133.72 µg g^{-1}, 131.94 µg g^{-1} and 97.95 µg g^{-1} at pre-flowering, flowering and at harvest stage, respectively over rest of the treatments at different growth stages. The increased content of iron in leaves at pre-flowering stage may be due to the absorption of the iron from soil to leaf due to its requirement for chlorophyll formation, protein synthesis, photosynthesis and reduction of nitrates and sulphates. It was also observed that the total iron content in mango leaves increased after fertilizer application up to pre-flowering stage and steadily decreased with advancement of growth period from flowering stage to harvest stage. The depletion of total iron content in leaves of mango due to the absorption from leaves to fruit for the development of fruit and colour. The above results are inconformity with results reported by Joshi (2015) [5].

Table 3: Effect of foliar application of nutrients on total iron and manganese content in leaves of Alphonso mangoat different growth stages

Tr. No.	Treatment	Fe content(µg g^{-1})				Mncontent (µg g^{-1})				Zn content (µg g^{-1})			
		Initial Stage	Pre-flowering Stage	Flowering Stage	At harvest	Initial Stage	Pre-flowering Stage	Flowering Stage	At Harvest	Initial Stage	Pre-flowering Stage	Flowering Stage	At Harvest
T_1	Control	89.13	108.70	104.63	87.58	123.26	126.26	120.31	114.25	35.75	36.60	34.08	30.35
T_2	Urea 1%	98.46	117.57	115.07	92.64	118.3	130.23	126.18	121.15	33.12	38.14	35.41	31.54
T_3	Potassium nitrate 1%	80.55	123.91	121.02	89.47	113.70	142.96	134.52	131.18	35.37	38.70	35.23	31.19
T_4	Amrashakti 1%	94.93	130.28	127.29	91.59	113.47	145.79	139.89	136.75	32.83	48.95	44.63	38.62
T_5	Urea 3%	96.71	130.49	127.63	94.10	126.99	133.80	124.57	117.37	36.00	38.84	34.96	31.41
T_6	Potassium nitrate 3%	97.09	133.72	131.92	97.95	122.91	152.65	146.22	141.42	34.44	37.88	35.16	32.10
T_7	Amrashakti 3%	81.44	128.97	125.66	90.56	120.81	138.83	133.08	129.43	33.75	49.52	45.48	41.80
	Mean	91.19	124.81	121.89	91.98	119.92	138.65	132.11	127.36	34.47	41.29	37.85	33.86
	S.E.±	1.595	0.788	0.963	0.780	2.647	2.222	2.609	1.956	0.998	0.867	0.705	0.611
	C.D. (P=0.05)	4.915	2.427	2.967	2.404	8.157	6.845	8.038	6.026	3.076	2.672	2.171	1.882

Manganese content

The effect of application of nutrients on manganese content in mango leaves at different growth stages of mango are presented in Table 3. At initial stage, treatment T_5 comprising foliar application of 3 per cent urea recorded maximum manganese content but it was at par with T_1, T_6 and T_7 treatments. However, treatment T_6 i.e. foliar application of 3 per cent potassium nitrate recorded significantly maximum manganese content 152.65 µg g^{-1}, 146.22 µg g^{-1} and 141.42 µg g^{-1} at pre-flowering, flowering and at harvest stage, respectively. The increase in manganese content of mango leaf at pre-flowering stage may be due to absorption from soil to leaf for various physiological processes while steadily decrease in manganese content from flowering stage to harvest stage may be due to the fact that the manganese might have taken part in chlorophyll formation and protein synthesis. Also it might be due to absorption by leaf and fruit for the growth and development of mango. As per the nutrient norms suggested by Raghupahti and Bhargava (1999), all the samples showed in 'optimum' status for total manganese content in mango leaves.

Zinc content

The data pertaining to the total zinc content in mango leaves at different stages as influenced by foliar application of nutrients are presented in Table 3. At initial stage treatment T_5 receiving foliar application of 3 per cent urea recorded maximum zinc content in mango leaves but it was at par with T_1, T_3, T_6, T_7 and T_2 treatments. While, at pre-flowering, flowering stage treatment T_7consisting 3 per cent Amrashakti multinutrient solution recorded significantly maximum zinc content that was at par with T_4 treatment and at harvest stage treatment T_7 was significantly superior over rest of the treatments.As zinc is less mobile as compared to phosphoruswithin the plant and therefore a large accumulation of zinc takes place in leaves, nodes and internodes. Application of P fertilizer in small doses results in higher concentration of zinc in the roots accompanied by large reduction in zinc concentration in the plant tops thus decrease in zinc concentration in plants may arise from the dilution effect resulting from marked increase in plant growth and fruit development. These results are in agreement with More (2013) [6] and Patil (2018) [9].

Copper content

From the data presented in Table 4 it was revealed from the data that the magnesium content of mango leaves was significantly affected due to application of manures, fertilizers and foliar spray**.** The treatment T_7 receiving foliar application of 3 per cent Amrashakti recorded significantly maximum copper content i.e. 27.53 µg g^{-1}, 35.85 µg g^{-1} and 27.80 µg g^{-1} at pre-flowering, flowering and at harvest stage, respectively. The treatment T_7 recorded significantly maximum copper content but it was at par with T_6 and T_4 treatment at flowering stage and it was superior over rest of the treatment at pre-flowering and harvest stage. It was observed that the total copper content in mango leaves increased after fertilizer application and foliar spray up to pre-flowering stage and

steadily decreased with advancement of growth period from flowering stage to harvest stage. The depletion in the nutrient contents of mango leaves might be due to translocation of the nutrients leaf and fruit for chlorophyll formation, photosynthesis, reproduction and formation of fruit colour and flavour by enzyme activation. Similarly, results are in agreement with More (2013) [6] and Patil (2018) [9].

Table 4: Effect of foliar application of nutrients on total boron and molybdenum content in leaves of Alphonso mangoat different growth stages

Tr. No	Treatment	Cu content (µg g^{-1})				B content(µg g^{-1})				Mo content(µg g^{-1})			
		Initial Stage	Pre-flowering Stage	Flowering Stage	At Harvest	Initial Stage	Pre-flowering Stage	Flowering Stage	At harvest	Initial Stage	Pre-flowering Stage	Flowering Stage	At Harvest
T_1	Control	27.05	28.91	24.63	21.09	45.97	50.91	44.08	42.10	0.052	0.048	0.043	0.033
T_2	Urea 1%	27.53	30.72	28.32	24.07	42.86	59.26	55.18	49.57	0.047	0.051	0.048	0.037
T_3	Potassium nitrate 1%	26.19	31.69	30.63	24.96	41.15	54.67	50.02	41.12	0.049	0.058	0.050	0.045
T_4	Amrashakti 1%	25.98	33.96	31.22	26.09	48.57	89.60	83.67	60.32	0.046	0.077	0.070	0.058
T_5	Urea 3%	24.22	31.73	30.03	25.11	59.90	75.15	66.34	48.78	0.059	0.077	0.069	0.053
T_6	Potassium nitrate 3%	25.14	32.71	31.31	25.60	61.42	70.54	63.05	53.30	0.060	0.074	0.065	0.047
T_7	Amrashakti 3%	26.54	35.85	32.77	27.80	56.56	93.93	86.01	57.69	0.053	0.092	0.083	0.065
	Mean	26.09	32.15	29.84	24.96	50.92	70.58	64.05	50.41	0.052	0.068	0.061	0.048
	S.E.±	0.474	0.410	0.563	0.425	6.949	6.958	6.864	6.870	0.009	0.008	0.008	0.006
	C.D. (P=0.05)	1.461	1.263	1.735	1.310	NS	21.441	21.150	NS	NS	0.025	0.025	0.020

Boron content

The data regarding boron content in mango leaves at different growth stages as influenced by application of manures, fertilizers and foliar spray with different treatments are presented in Table 4. Boron content in mango leaves showed non-significant effect at initial and harvest stage while, at pre-flowering and flowering stage it was significantly affected with different treatments. However, at pre-flowering and flowering stage the treatment T_7 receiving foliar spray of 3 per cent Amrashakti recorded significantly maximum boron content in mango leaves and it was at par with treatment T_4 and T_5 treatments. While, minimum boron content was recorded with treatment T_1 i.e. control treatment. The increase in boron content at pre-flowering stage in mango leaves may be due to foliar spray of nutrients and due to translocation of boron from soil to leaves through absorption by tree. While, it steadily decreased up to harvest stage which might be due to requirement of boron in larger amount by tree during reproductive stages for germination of pollen grains and elongation of tubes, seed formation, hormone movement during flowering, fruiting, fruit setting, sugar translocation and fruit quality. Joshi (2015) [5] reported the increase in boron content of mango leaves after fertilizer application up to flowering stage and gradual decrease from marble stage to after harvest stage.

Molybdenum content

The data pertaining to the molybdenum content in leaves of mango at different stages as influenced by application of manures, fertilizers and foliar spray of nutrients are presented in Table 4. At pre-flowering stage and flowering stage, treatment T_7 receiving foliar spray of 3 per cent Amrashakti recorded significantly maximum molybdenum in mango leaves and it was at par with treatment T_4, T_5 and T_6 treatments. While, at harvest stage treatment T_7 consisting foliar spray of 3 per cent Amrashakti recorded significantly maximum molybdenum content and it was at par with treatment T_3, T_4, T_5 and T_6 treatments. The minimum molybdenum content in mango leaves was recorded with treatment T_1 i.e. control treatment at all growth stages except initial stage. The application of molybdenum through foliar spray might have also increased the content of molybdenum. While, steadily decrease content was observed from flowering stage to harvest stage due to absorption of molybdenum for pollen tube formation, seed formation, activation of enzymes required for flowering, fruit development and maturity with hormonal regulation during reproductive stages. Similar findings were also reported by Joshi (2015) [5].

Yield

As far as the fruit yield of mango (Table 5) was concerned, it differed significantly between different treatments and it ranged from 2.93 to 5.39 t ha^{-1} with a mean value of 3.91 t ha^{-1}. Among the various treatments, the treatment T_7 consisting foliar spray of 3 per cent Amrashakti multi-nutrient solution produced significantly higher fruit yield (5.39 t ha^{-1}) of mango and showed its superiority over all other treatments. It was followed by treatment T_6 receiving foliar spray of 3 per cent potassium nitrate (4.59 t ha^{-1}), treatment T_4 consisting foliar spray of 1 per cent Amrashakti (4.44 t ha^{-1}) and treatment T_5 receiving foliar spray of 3 per cent urea (3.77 t ha^{-1}) showed individual effect of treatments on mango yield. The minimum yield of mango was recorded with treatment T_1 i.e. control treatment (2.93 t ha^{-1}). This indicated that the single chemical or combination of low dose of chemical nutrient did not influence the fruit yield in mango. Patil *et al.* (2010) [10] also reported the increase in the yield of mango due to increasing doses of foliar nutrient spray on Alphonso.

Table 5: Effect of foliar application of nutrients on fruit yield of mango

Tr. No.	Treatments	Yield (t ha^{-1})
T_1	Control	2.93
T_2	Urea 1%	3.10
T_3	Potassium nitrate 1%	3.13
T_4	Amrashakti 1%	4.44
T_5	Urea 3%	3.77
T_6	Potassium nitrate 3%	4.59
T_7	Amrashakti 3%	5.39
	Mean	3.91
	S.E.±	0.03
	C.D. (P=0.05)	0.10

Conclusion

On the basis of the results obtained during present investigation it could be concluded that the foliar spray of 3 per cent Amrashakti multi-nutrient solution can be used for improving leaf nutrient concentration as well as producing higher yield of Alphonso mango in lateritic soils of Konkan region.

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