

Effect of Organic and Inorganic Nutrient Sources on Leaf Nutrient Content, its Correlation with Yield and Quality of Acid Lime cv Kagzi Lime

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Abstract A field experiment was conducted during the year 2016-17 to study the influence of inorganic nutrients (NPK), organic manures (FYM and Vermicompost) and Biofertilizer (VAM and Azotobactor) on leaf nutrient status of ten-year-old acid lime cv Kagzi lime plant. The experiment was laid out in randomized block design (RBD) with three replications. There were fourteen treatments comprised of graded levels of recommended dose of fertilizers (RDF), Vermicompost, FYM, VAM and Azotobactor. The result showed that highest concentration of major nutrients (NPK) in leaves with T₁₁ (75% RDF + 3 kg Vermicompost + 10 kg FYM + 150 g VAM + 25 g Azotobactor). Whereas, application of 50% RDF + 7 kg Vermicompost + 15 kg FYM + 150 g VAM + 25 g Azotobactor (T₁₂) expressed highest micro nutrients (Zn, B, Fe, Cu and Mn) contents, yield and juice (%). There was significant positive correlation was found between leaf nutrient content with yield and quality of fruit.

Keywords Acid lime, Leaf nutrient content, Inorganic, Organic, Yield.

Introduction

Acid lime (*Citrus aurantifolia* Swingle) is known as Kagzi lime or Neebu belongs to the family Rutaceae. The word Kagzi being derived from the word Kagaj meaning paper, as the rind of the fruit is very thin. It is a profusely branched thorny shrubs or small tree. It is found in most parts of the tropics. In India, It is cultivated in Andhra Pradesh, Telangana, Gujarat, Karnataka, Odisha, Madhya Pradesh, Maharashtra, Assam and Bihar. The total area, production and productivity of acid lime in India are about 269 (000'ha), 3020 (000' MT) and 11.2 MT/hectares, respectively. The total area and production of acid lime in Madhya Pradesh are 11.12 (000'ha) and 245 (000' MT), respectively [1]. It is unfortunate that this major crop has not been seriously attended by researchers for boosting up its production through judicious application of manures and fertilizers. As such there is no standard practice followed by growers. Thus, a more precise method than generalizing on rates is needed as a guide for nutrient application practice.

Nutrient responsive nature of citrus is well proven since the commercial cultivation of citrus come into being. These are numerous literature emanated in India about the wide range of nutrient deficiencies in citrus orchards and balanced nutrition program is mandatory to maintain a sustained productive life of orchard in addition to quality production. Use of organic manures along with fertilizers or inclusion of biofertilizer is a proven technology to build up fertility status of soil. However, it always, dose not give true picture of nutrient status of plants. In fruit crop

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Table 1. Initial status of mechanical and chemical composition of experimental soil.

Particulars	Content
A. Mechanical analysis	
Sand (%)	45
Silt (%)	37
Clay (%)	18
B. Chemical analysis	
pH	7.38
Electrical conductivity (dS m ⁻¹)	0.48
Organic carbon (%)	0.94
Available nitrogen (kg ha ⁻¹)	485.26
Available phosphorus (kg ha ⁻¹)	14.7
Available potassium (kg ha ⁻¹)	521

like citrus, leaves have been found to be practically sensitive and convenient index of the nutrient status of the plant and leaf nutrient composition is considered to be a basic tool for the investigation of soil fertility problems. Since the leaf is the major tissue in plant functions and a sensitive indicator of nutrient status. Lot of research is being done on use of integrated supply of nutrients based on soil fertility status but information on leaf nutrient uptake and its correlation with quality and yield is lacking [2]. Keeping this fact into consideration, present study was conducted.

Materials and Methods

The experiment was conducted during 2016-17 at Department of Fruit Science, College of Horticulture Mandsaur (MP) on ten-year-old acid lime tree cv Kagzi lime. The experiment was laid out in randomized block design (RBD) with three replications. The experiment comprised of 14 treatments combinations, viz., T₀=Control, T₁=RDF (Recommended dose of fertilizers-900:400:400 N:P:K g/plant), T₂=75% RDF + 3 kg Vermicompost + 10 kg FYM, T₃=50%RDF + 7 kg Vermicompost + 15 kg FYM, T₄=25% RDF + 10 kg Vermicompost + 20 kg FYM, T₅=75% RDF + 3 kg Vermicompost + 10 kg FYM + 150 g VAM, T₆=50% RDF + 7kg Vermicompost + 15 kg FYM + 150 g VAM, T₇=25% RDF + 10 kg Vermicompost + 20 kg FYM + 150 g VAM, T₈=75% RDF + 3 kg Vermicompost + 10 kg FYM + 25 g Azotobactor, T₉=50% RDF + 7 kg

Vermicompost + 15 kg FYM + 25 g Azotobactor, T₁₀=25% RDF + 10 kg Vermicompost + 20 kg FYM + 25 g Azotobactor, T₁₁=75%RDF + 3 kg Vermicompost + 10 kg FYM + 150 g VAM + 25g Azotobactor, T₁₂=50% RDF + 7 kg Vermicompost + 15 kg FYM + 150 g VAM + 25 g Azotobactor, T₁₃=25% RDF + 10 kg Vermicompost + 20 kg FYM + 150 g VAM + 25 g Azotobactor. The whole of the organic manure was applied as a basal dose on the onset of monsoon. Then required doses of fertilizers were applied in two split doses in the month of July and August and then bio-fertilizers were applied one week after each application of inorganic fertilizers. Some important characteristics of the soil were as follows (Table 1).

Leaf samples were collected after six month from each treatment all around the trees. Collected leaves were thoroughly washed and ground to have homogeneous sample. Nitrogen was estimated through micro- Kjeldhal method and results were expressed in per cent nitrogen on the basis of dry weight in leaves. The samples were digested in tri-acid mixture and analyzed for phosphorus determined by vanadomolybdo phosphoric yellow color method. Potassium content was estimated by flame photometer and results were expressed in per cent. The estimation of micro-nutrient (Zn, B, Fe, Cu and Mn) was done through atomic absorption spectrophotometer. Average yield per plant and juice was calculated by the following formulas :

Yield/plant (kg) = no. of fruit/plant × fruit weight

$$\text{Juice \%} = \frac{\text{Total weight of juice (g)} - \text{beaker weight (g)}}{\text{Total weight of fruit (g)}} \times 100$$

For correlation studies with fruit yield and juice different sets of leaf nutrients were considered as independent variables. The correlation studies also revealed the strength of interrelationship between the casual variables. But only correlation coefficient values (*r* values) of resultant variables was presented.

Results and Discussion

Leaf nitrogen content

The highest leaf nitrogen content (2.18%) was recorded in T₁₁ (75% RDF + 3 kg Vermicompost + 10 kg

Table 2. Leaf nutrient status as affect by different organic and inorganic treatments.

Treatments	Nitrogen (%)	Phosphorus (%)	Potassium (%)	Zn (mg/kg)	B (mg/kg)	Fe (mg/kg)	Cu (mg/kg)	Mn (mg/kg)
T ₀ Control	1.63	0.09	1.28	21.39	20.54	108.87	12.37	20.54
T ₁ RDF (Recommended dose of fertilizers- 900:400:400 N:P:K g/plant)	2.08	0.24	1.63	24.70	22.39	114.67	13.68	22.35
T ₂ 75% RDF + 3 kg VC + 10 kg FYM	2.11	0.25	1.65	31.46	32.58	127.47	16.32	28.35
T ₃ 50% RDF + 7 kg VC + 15 kg FYM	1.87	0.16	1.51	35.43	37.92	136.59	17.57	36.41
T ₄ 25% RDF + 10 kg VC + 20 kg FYM	1.74	0.09	1.37	26.44	25.58	117.10	14.21	22.65
T ₅ 75% RDF + 3 kg VC + 10 kg FYM + 150 g VAM	2.12	0.27	1.68	32.55	33.48	129.35	16.66	30.29
T ₆ 50% RDF + 7 kg VC + 15 kg FYM + 150 g VAM	1.89	0.18	1.53	36.42	38.37	140.58	17.85	38.37
T ₇ 25% RDF + 10 kg VC + 20 kg FYM + 150 g VAM	1.78	0.10	1.41	27.78	27.71	120.63	14.87	23.42
T ₈ 75% + RDF + 3 kg VC + 10 kg FYM 25 g Azotobacter	2.14	0.29	1.71	33.47	34.35	131.24	16.90	32.66
T ₉ 50% RDF + 7 kg VC + 15 kg FYM + 25 g Azotobacter	1.94	0.20	1.56	37.56	40.43	142.13	18.07	41.28
T ₁₀ 25% RDF + 10 kg VC + 20 kg FYM + 25 g Azotobacter	1.81	0.11	1.44	29.54	29.79	123.58	15.28	25.48
T ₁₁ 75% RDF + 3 kg VC + 10 kg FYM + 150 g VAM + 25 g Azotobacter	2.18	0.32	1.74	34.63	36.64	133.95	17.31	34.63
T ₁₂ 50% RDF + 7 kg VC + 15 kg FYM 150 g VAM + 25 g Azotobacter	1.97	0.21	1.58	38.39	41.39	145.70	18.50	43.59
T ₁₃ 25% RDF + 10 kg VC + 20 kg FYM + 150 g VAM + 25 g Azotobacter	1.84	0.14	1.48	30.11	31.63	125.84	15.60	27.55
SEm ±	0.0135	0.005	0.017	0.161	0.29	1.11	0.08	0.61
CD at 5%	0.0394	0.017	0.051	0.46	0.84	3.23	0.25	01.79

FYM + 150 g VAM + 25 g Azotobacter) (Table 2). This might be due to the fact that application of synthetic fertilizers, FYM along with biofertilizers must have enhanced mineralization of organic nitrogen thus, making more nitrogen available to the plant. These results are in conformity with earlier findings [3] in Khasi mandarin. Significant higher content of major nutrients in the sweet orange leaves under the combined application of organic manures and inorganic fertilizers than those at the same level with inorganic fertilizer was reported earlier [4].

Leaf phosphorus content

Leaf P content was affected significantly by different treatments. Maximum leaf P content (0.32%) was recorded with T₁₁ (75% RDF + 3 kg Vermicompost + 10 kg FYM + 150 g VAM + 25g Azotobacter) (Table 2). This may be attributed to the fact that Azotobacter and VAM is a rich source of soil micro-organism which must have helped in the solubilization of fixed P to

soluble form thus, making it easily available to the plant. The significant role of bio-fertilizers in enhancing the nutrient supply and uptake by fruit crops was also reported earlier [5].

Leaf potassium content

Effect of different treatments of organic manures and inorganic fertilizers on leaf K content of acid lime was found statistically significant as compared to control. The maximum leaf K content (1.73%) was noted in T₁₁ (75% RDF + (75% RDF + 3 kg Vermicompost + 10 kg FYM + 150 g VAM + 25 g Azotobacter) closely followed by T₈ (75% RDF + 3 kg VC + 10 kg FYM + 25 g Azotobacter) (Table 2). This increase in leaf potassium of acid lime may be due to combined use of organic and inorganic sources of fertilizers on potassium content and uptake by the fruits that may be ascribed to its role in improving soil physical properties, in turn there is better root resulting more uptake of potassium from native sources. Similar results were

Table 3. Correlation of leaf nutrients content with yield and juice of acid lime. ** and *Correlation are significant at the 0.01 and 0.05 levels.

Leaf nutrient	Coefficient of correlation (<i>r</i>) values	
	Yield	Juice (%)
N	0.668**	0.647*
P	0.688**	0.706**
K	0.738**	0.722**
Zn	0.923**	0.936**
B	0.902**	0.928**
Fe	0.904**	0.928**
Cu	0.926**	0.938**
Mn	0.876**	0.925**

reported earlier [6] in walnut and [7] in bael.

Leaf micro-nutrient content

The micro-nutrients, viz., Zn, B, Fe, Cu and Mn content in the leaves (Table 2) showed significant variation due to different treatments (Table 3). The highest content of micro-nutrient was recorded with the combined application of 50% RDF + 7 kg Vermicompost + 15 kg FYM + 150 g VAM + 25 g Azotobacter (T_{12}) followed by 50% RDF + 7 kg VC + 15 kg FYM + 25 g Azotobacter (T_9). This is as per expectation as these treatments comprised higher quantity of organic manure which contains higher concentration of micro-nutrients. Malewar and Patil [8] reported improved

Zn uptake by sweet orange with the application of 10 to 15 g organic manures per kg of soil. Substantial increase in Mn and Fe content was recorded with the sole application of FYM or in combination with bio-fertilizers Azotobacter and PSB. Finding on similar line were also reported earlier [9]. The uptake of various nutrients (NPK, Ca, Mg, Fe, Cu, Mn and Zn) was significantly higher in pomegranate upon dual inoculation with AM fungi and Azotobacter [10]. Organic manures are known to naturally provide micronutrient as they store them in both stable and usable forms [11].

The direct application of major nutrients through fertilizers leading to immediate availability could be accounted for higher nutrient contents in this treatment.

The yield and juice (%) (Table 4) were significantly influenced by the organic and inorganic nutrients. The maximum yield per plant (52.35 kg) and juice (51.82%) were recorded under T_{12} (50% RDF + 7 kg Vermicompost + 15 kg FYM + 150 g VAM + 25 g Azotobacter).

The higher uptake of nutrients with recommended dose of NPK might have occurred due to stimulation of the rates of various physiological and metabolic processes resulting in better size, weight and fruit yield of Nagpur mandarin. These results are

Table 4. Effect of organic and inorganic nutrient sources on yield and quality of acid lime.

Treatments		Yield per plant (kg)	Juice (%)
T_0	Control	22.20	36.07
T_1	RDF (Recommended dose of fertilizers- 900:400:400 N:P:K g/plant)	34.78	39.46
T_2	75% RDF + 3 kg VC + 10 kg FYM	38.77	43.78
T_3	50% RDF + 7 kg VC + 15 kg FYM	40.69	45.10
T_4	25% RDF + 10 kg VC + 20 kg FYM	33.24	37.12
T_5	75% RDF + 3 kg VC + 10 kg FYM + 150 g VAM	43.42	46.62
T_6	50% RDF + 7 kg VC + 15 kg FYM + 150 g VAM	45.31	47.48
T_7	25% RDF + 10 kg VC + 20 kg FYM + 150 g VAM	35.23	38.70
T_8	75% RDF + 3 kg VC + 10 kg FYM + 25 g Azotobacter	46.23	48.12
T_9	50% RDF + 7 kg VC + 15 kg FYM + 25 g Azotobacter	48.92	49.21
T_{10}	25% RDF + 10 kg VC + 20 kg FYM + 25 g Azotobacter	36.73	41.48
T_{11}	75% RDF + 3 kg VC + 10 kg FYM + 150 g VAM + 25 g Azotobacter	50.48	49.86
T_{12}	50% RDF + 7 kg VC + 15 kg FYM + 150 g VAM + 25 g Azotobacter	52.35	51.82
T_{13}	25% RDF + 10 kg VC + 20 kg FYM + 150 g VAM + 26 g Azotobacter	37.97	42.49
SEm $\pm$		0.43	0.28
CD at 5%		1.24	0.80

in accordance with earlier findings [12]. The ample increase in the juice content in case of combination of organic and inorganic sources of nitrogen appears to be due to the added benefits of organic matter which improves the soil structure, penetration, retention of moisture and root proliferation by biofertilizer. Since water is the chief constituent of fruit juice, its increased availability within certain limits was apt to affect the juice percentage favorably. There is enough evidence in literature to support these findings. Seshadri and Madhavi [9] also elaborated similar results in sweet orange.

The correlation coefficient value (Table 3) indicated that fruit yield was significantly correlated with all leaf nutrients. Highest significant positive correlation was observed with Cu ($r=0.926$), Zn ($r=0.923$), Fe ($r=0.904$), B ($r=0.902$) Mn ($r=0.876$), K ($r=0.738$), P ($r=0.688$) and N ($r=0.668$) contents in the decreasing order. The highest degree of correlation was observed in case of juice per cent with Cu ($r=0.938$), Zn ($r=0.936$), Fe ($r=0.928$), B ($r=0.928$) Mn ($r=0.925$), K ($r=0.722$), P ($r=0.706$) and N ($r=0.647$) content in the leaves [13].

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