J. Hortic. Sci.
Vol. 18(1) : 142-149, 2023

https://doi.org/10.24154/jhs.v18i1.2157

Original Research Paper

Stionic effects on leaf mineral nutrient contents in Pummelo (*Citrus maxima* Merr.) grafted on different rootstocks

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ABSTRACT

A study was conducted to determine the mineral nutrients concentration in the index leaf of pummelo accessions. Index leaf samples from 25 pummelo accessions grafted on pummelo and 12 pummelo clones grafted on Rangpur lime rootstocks were collected for assessing leaf mineral nutrient status. The results revealed that pummelo plants grafted on pummelo, the concentration of leaf N (1.43-2.49 %), P (0.17-0.22 %), K (0.75-4.45 %), Ca (2.37-6.29 %), Mg (0.60-1.04 %), S (0.06-0.22 %), Fe (124-245.45 mg kg^{-1}), Mn (9.85-50.05 mg kg^{-1}), Zn (17-69 mg kg^{-1}) and Cu (8.8-25.15 mg kg^{-1}) showed significant variation with different accessions. Out of 25 pummelo accessions, twenty-four accessions were deficient in N and S, fourteen were deficient in K, four were deficient in Mn and five were deficient in Zn and all accessions were sufficient in P, Ca, Mg, Fe and Cu. The observed trends in the leaf nutrient concentration of pummelo accessions clearly indicated the significance of the genotypic variation when chemical analysis is used for diagnosing the leaf nutrient status of pummelo trees. Similarly, leaf N, P, K, Ca, Mn, Cu and Zn varied significantly among twelve pummelo clones grafted on Rangpur lime. Among the clones grafted on Rangpur lime, 18-3 and 18-5 found to have higher and lower leaf nutrient content in most of the mineral nutrients, respectively. The leaf nutrient content of pummelo varies among genotypes, but there is no genotype that stands out in all macro and micronutrients evaluated. The N, P, K, Ca, S, Fe, Mn and Cu leaf contents in pummelo were always higher in plants grafted on Rangpur lime. However, the foliar Mg and Zn contents were continually higher in plants grafted on 'pummelo' compared to Rangpur lime which eventually reduces leaf yellowing/chlorosis in pummelo. Pummelo rootstocks were found to respond well in terms of Mg and Zn nutrient uptake and tolerance to *Phytophthora* as compared to Rangpur lime. Therefore, it is concluded that pummelo can be an ideal rootstock for commercial pummelo cultivation.

Keywords : Accessions, grafting, leaf mineral nutrient, pummelo, Rangpur lime, rootstock

INTRODUCTION

Pummelo [*Citrus maxima* Merr., (*C. grandis* Osbeck; *C. decumana* L.)], family Rutaceae, was known in the western world mainly as the principal ancestor of the grapefruit. The areas in southern Thailand and northern Malaysia are most likely the centre of origin of pummelos (Wen *et al.*, 2010). In India, it is grown in home gardens in all states of India and maximum diversity is reported from North-East (NE) Region Bihar and Bengal (Roy *et al.*, 2014). Pummelo is now gaining popularity in India due to its high nutritional value and antioxidant property. It has played an important role as a parent of many citrus fruits, such as lemon, oranges and grapefruit (Youseif *et al.*, 2014). Pummelo fruit has several health benefits because of its super-rich Vitamin C and Vitamin B content. It also contains Vitamin A, bioflavonoids, healthy fats, protein, fiber, antioxidants and enzymes. It contains high amount of beta carotene and folic acid and is very beneficial for pregnant women.

Nutrients are required for supporting the metabolism within the tree-ecosystem and also to support quality fruit production (Thamrin *et al.*, 2014). Both maximum fruit quality and yield of pummelo will occur only in the presence of optimum nutrient balance and intensity. Maintaining orchards at optimal leaf nutrient concentrations is one of the key issues for maximizing yield. Low fruit quality and yield is often associated with poor soil fertility and poor nutrient management (Zhuang, 1995). Leaf analysis is a method of determining plant nutrient requirement based on assumption that within certain limits, there is positive relationship between nutrient availability, leaf nutrient content, yield and quality of fruits (Srivastava and Singh, 2004a; 2004b). Stebbins and Wilder (2003) reported that leaf nutrient concentrations can be used as a guide to determine nutrient status of plant that are directly linked/related to the pattern of growth and development.

Impact of stock on scion and scion on stock is known as stionic effect. Rootstock choice is one of the most important aspects in orchard management because scion cultivars respond differently to growth, fruit quality, disease resistance and nutrients accumulation when grown on diverse rootstocks. Plant nutrient concentrations in scion cultivar may differ even though they are grown in the same conditions. Rootstocks directly affect the ability of plants to uptake the water and nutrients from the soil. Similarly, different scions exhibit variable quantities of nutrients from different rootstocks. The long-term performance of stionic combinations and their significant effects on leaf nutrient levels in different fruit crops have been studied for different climatic conditions across the world (Dubey and Sharma, 2016). However, no such studies were carried out in pummelo. Hence, selection of an appropriate graft/stionic combination with better leaf nutrient absorption is very critical to produce pummelo commercially. Therefore, the main purpose of the present research was to determine the status of various macro and micronutrients in the leaf of pummelo genotypes grafted on Pummelo and Rangpur lime for choosing the right graft combination with enhanced nutrient absorption. It is also possible to reduce the application of nutrients in pummelo by employing perfect stionic combination that have high nutrient absorption capacity.

MATERIALS AND METHODS

To determine the nutrient concentration of leaf as influenced by genotypes and rootstocks, index leaf samples (4^{th} and 5^{th} leaf from tip of new shoots/flush with age of 4 to 6 months) from 25 pummelo genotypes (>15 years old) grafted on pummelo and 12 pummelo clones (4 years old) grafted on Rangpur lime rootstocks were collected in the month of June 2019 from the field gene bank maintained at ICAR-IIHR, Bengaluru, which is situated in south-east tract of Karnataka state at $12^0 58$ North latitude and $77^0 34$ East longitude and at an altitude of 900 m above mean sea level. The study area comes under semi-arid, sub-tropical climate with hot summer and cold winter with an average rainfall of 866 mm. Most of the rainfall is received from the south-west monsoon during July to August. Twenty leaf samples, five leaves from each direction of east, west, north and south were taken individually from five trees per genotypes from non bearing fruit terminals. The samples were washed first under tap water followed by 0.1 N HCl, distilled water and finally with double distilled water. The cleaned leaf samples were then dried by spreading on clean blotting papers and final drying was done in an oven at 68^{o}C (Chapman and Pratt, 1961) by separately packing in labeled paper bags. The dried leaf samples were sequentially ground by electrical grinder for further analysis.

The nitrogen (N) content in the leaf samples was analysed by Kjeldahl method (AOAC, 1970). Phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg), iron (Fe), manganese (Mn), zinc (Zn) and copper (Cu) were estimated by diacid mixture (9:4 HNO_3: $HClO_4$) as given by Jackson (1973). Phosphorus content in leaf samples was determined by vanadomolybdo phosphoric acid yellow colour method (Jackson, 1973). The intensity of yellow colour was read at 430 nm in the spectrophotometer. Potassium content was estimated using flame photometer (Jackson, 1973). Calcium and magnesium content was determined by Atomic Absorption Spectrophotometer (AAS) (Sarma *et al.,* 1987). Micronutrient content *viz.* Fe, Mn, Cu and Zn was determined using Atomic Absorption Spectrophotometer (AAS) (Sarma *et al.,* 1987). The data were statistically scrutinized using analysis of variance of SAS 9.3 statistical package.

RESULTS AND DISCUSSION

Leaf macronutrients

Index leaf samples of 23 pummelo genotypes grafted on pummelo rootstock and 12 pummelo clones grafted on Rangpur lime rootstock were analyzed for N, P, K, Ca, Mg, S, Fe, Mn, Zn and Cu contents and presented in Table 1, 2, 3 and 4 and Fig.1, 2. The data on leaf macronutrients content in pummelo grafted on pummelo and Rangpur lime is presented in Table 1 & 2 and Fig. 1. The concentration of different nutrients in leaf exhibited a wide variation among the genotypes irrespective of the rootstocks. However, the N concentration of leaves was not differed significantly among pummelo genotypes grafted on own rootstocks. Genotype 'Kunigal selection' had the highest leaf N

Table 1 : Leaf macronutrient content in pummelo grafted on pummelo

Genotype	N (%)	P (%)	K (%)	Ca (%)	Mg (%)	S (%)
Devenahalli Selection-1	1.53	0.19	0.95^{C}	4.70^{BCDEF}	0.74	0.13
Midnapur Selection 1	1.57	0.21	1.90^{BC}	4.10^{DEFG}	0.80	0.22
Midnapur Selection 1	1.64	0.21	1.30^{BC}	3.83^{EFGHI}	0.86	0.09
Tirupati-1	1.86	0.18	1.45^{BC}	4.17^{DEFG}	0.77	0.06
Hyderabad Selection	1.97	0.20	2.00^{BC}	5.51^{ABCD}	0.85	0.15
Kallar Selection	2.11	0.20	0.85^{C}	3.46^{FGHI}	0.82	0.15
Raichur Selection	1.58	0.22	1.15^{C}	3.77^{EFGHI}	0.72	0.11
Khanapur Selection	1.95	0.21	2.10^{BC}	4.11^{DEFG}	0.76	0.12
IKP-1	2.03	0.17	0.75^{C}	4.37^{CDEFG}	0.82	0.17
IKP-2	1.92	0.20	1.15^{C}	2.40^{HI}	0.60	0.07
Tirupati-2	1.43	0.19	0.90^{C}	4.26^{CDEFG}	0.81	0.11
Tirupati -2A	1.89	0.19	0.75^{C}	5.76^{ABC}	1.04	0.12
Kalenahalli-1	1.53	0.19	1.55^{BC}	3.97^{DEFG}	0.75	0.15
Devenahalli Selection-2	1.54	0.19	1.95^{BC}	5.95^{AB}	0.88	0.08
Midnapur Selection-2A	1.90	0.19	2.75^{B}	6.29^{A}	0.93	0.14
Kunigal Selection	2.59	0.20	4.45^{A}	3.94^{EFGH}	0.83	0.11
Devenahalli Selection-3	1.64	0.17	1.00^{C}	4.02^{DEFG}	0.83	0.14
Accession-18	1.54	0.20	1.75^{BC}	3.84^{EFGHI}	0.69	0.13
Accession-19	1.62	0.22	1.25^{BC}	3.41^{FGHI}	0.75	0.17
Devenahalli Selection -4	1.93	0.18	1.25^{BC}	2.37^{I}	0.71	0.12
Devenahalli Selection-5	1.61	0.18	2.25^{BC}	4.45^{BCDEFG}	0.92	0.14
Devenahalli Selection-6	1.69	0.19	1.05^{C}	3.02^{GHI}	0.70	0.14
Devenahalli Selection-7	1.79	0.20	1.10^{C}	5.27^{ABCDE}	1.01	0.12
Gollehalli	2.07	0.20	1.65^{BC}	4.01^{DEFG}	0.94	0.13
Kalenahalli-1A	1.62	0.19	0.80^{C}	2.99^{GHI}	0.73	0.15
General Mean	1.78	0.19	1.52	4.16	0.81	0.13
p-Value	0.7806	0.3407	0.0176	0.0014	0.3237	0.9886
SE(d)	0.413	0.018	0.734	0.753	0.133	0.075
LSD at 5%	NS	NS	1.5139	1.5549	NS	NS

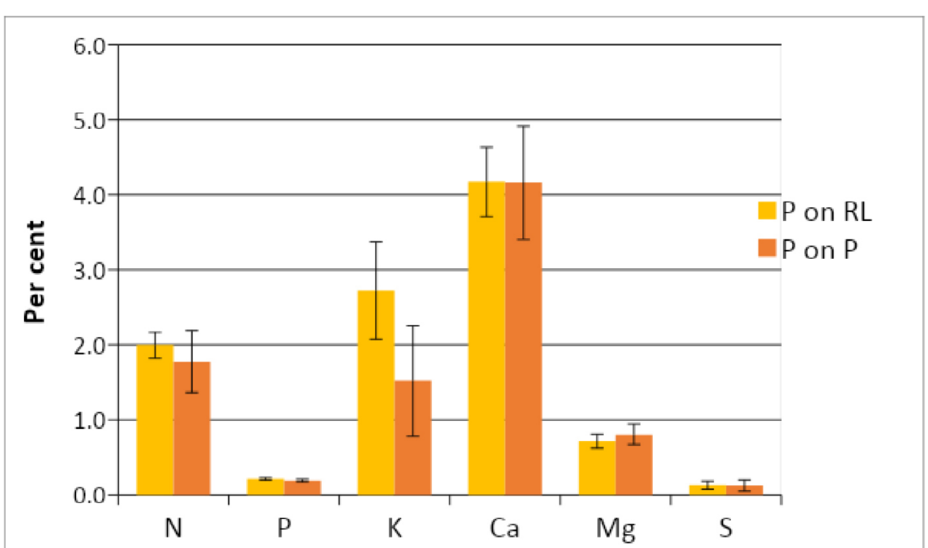

Fig. 1 : Leaf macronutrient content in pummelo grafted on pummelo (P) and Rangpur lime (RL)

Table 2 : Leaf macronutrient content in pummelo grafted on Rangpur lime

Genotype	N (%)	P (%)	K (%)	Ca (%)	Mg (%)	S (%)
Clone 19-1	1.59^{D}	0.23^{BCD}	3.30^{AB}	3.03^{EF}	0.72	0.13
Clone 18-5	1.57^{D}	0.17^{G}	2.30^{BCD}	2.72^{F}	0.67	0.13
Clone 24-4	2.39^{A}	0.18^{FG}	3.07^{ABC}	4.80^{ABC}	0.81	0.14
Clone 8-4	1.83^{CD}	0.22^{BCDE}	1.10^{D}	5.04^{A}	0.77	0.14
Clone 25-5	2.03^{BC}	0.19^{EFG}	1.73^{CD}	3.85^{CDE}	0.73	0.10
Clone 18-4	1.79^{CD}	0.24^{BC}	2.73^{ABC}	3.96^{CDE}	0.75	0.13
Clone 21-4	2.33^{AB}	0.21^{CDEF}	2.40^{ABCD}	4.95^{AB}	0.71	0.15
Clone 18-1	1.66^{D}	0.24^{B}	3.23^{AB}	4.00^{BCD}	0.67	0.12
Clone 10-5	2.25^{AB}	0.20^{DEFG}	3.17^{AB}	3.57^{DEF}	0.65	0.10
Clone 18-3	2.52^{A}	0.31^{A}	3.67^{A}	4.95^{AB}	0.69	0.20
Clone 25-2	1.73^{CD}	0.22^{BCDE}	2.53^{ABC}	4.74^{ABC}	0.75	0.13
Clone 20-4	2.28^{AB}	0.21^{BCDEF}	3.47^{AB}	4.40^{ABCD}	0.72	0.13
General Mean	2.00	0.22	2.73	4.17	0.72	0.13
p-Value	<.0001	<.0001	0.0224	0.0003	0.9196	0.9228
SE(d)	0.171	0.016	0.649	0.461	0.096	0.054
LSD at 5%	0.3542	0.0328	1.3465	0.9568	NS	NS

(2.59%) and 'Tirupati Selection' had the lowest leaf N (1.43%) when grafted with pummelo. Zhuang *et al.* (1991) reported that leaf N content ranging from 2.5 to 3.1% indicated sufficiency in Guanximiyou' pummelo leaves. The concentration of leaf N in most of the pummelo accessions was below the critical value of 2.50% except in genotype 'Kunigal Selection. Similar trend was observed in leaf N content of pummelo accessions grafted on Rangpur lime also (Table 2). The highest mean leaf N content (2.00%) was observed in the pummelo grafted on Rangpur lime rootstock compared to pummelo grafted on pummelo (1.78%). The range of N levels in leaf of pummelo accessions grafted on pummelo and Rangpur lime was compared well with the reported values of 1.7 to 2.81 per cent in citrus by Srivastava and Singh (2002; 2003; 2005; 2006; 2008).

The pummelo accessions grafted on pummelo did not influence the P concentration of leaves significantly. The values ranged from 0.17 to 0.22% with a mean value of 0.19%. The range of P levels in leaf matched well with the values 0.14-0.18 % reported by Zhuang *et al.* (1991) in pummelo and 0.09-0.17 % reported by Srivastava and Singh (2002; 2003; 2005; 2006; 2008) in citrus. The concentration of leaf P was the highest in the genotype 'Raichur selection' (0.22%) and was the least in 'Devenahalli Selection-3' (0.17%) accession. Of the 23 accessions, the values of P in the foliage were found to be sufficient in five accessions and excess in twenty accessions. According to Zhuang *et al.* (1991), leaf P content ranging from 0.14 to 0.18% indicated sufficiency, whereas, P content below 0.14% indicated P deficiency in pummelo. Similar to leaf N, the highest mean leaf P content (0.22%) was also observed in the pummelo grafted on Rangpur lime rootstock compared to pummelo grafted on pummelo (0.19%).

The leaf K concentration of pummelo accessions grafted on pummelo ranged from 0.75 to 4.45% with a mean value of 1.52%. Leaf K was significantly higher in the Kunigal Selection (4.45%) and genotypes Tirupati-2 (0.75%) recorded the lowest leaf K content. However, the concentration of leaf K was below the critical value of 1.40% in 14 pummelo accessions. The range of K levels in leaf were almost similar to that reported by Srivastava and Singh (2002; 2003; 2005; 2008) (1.02-2.59%) in citrus. According to Zhuang *et al*. (1991), the leaf K content ranging from 1.4 to 2.2% indicated sufficiency. Like leaf N and P, the highest mean leaf K content was observed in the pummelo grafted on Rangpur lime (2.73%) rootstock compared to pummelo on pummelo (1.52%). The concentration of Ca and Mg in leaf of pummelo genotypes exhibited wide variation. Highest Ca concentration of 6.29% was observed in accession 'Midnapur Selection-2A' and the lowest Ca concentration of 2.37% was in genotype 'Devenahalli Selection-4'. The Ca concentration of leaf was at par in 'Devenahalli

Selection-2, 'Tirupati-2' and 'Hyderabad Selection' genotypes. The range of Ca level in leaf (2.37-6.29%) was higher than the range reported by Zhuang *et al.* (1991) (2.0-3.8%) and Srivastava and Singh (2002; 2003; 2005; 2008) in citrus (1.80-3.28%). The concentration of leaf Ca in all the genotypes was higher than the critical level (2.0%). The concentration of Mg in leaves of pummelo genotypes varied from as low as 0.6% in genotype 'Tirupati-2' to as high as 1.04% in genotype 'A-10' which was above the critical levels (0.32%). The range of Mg level in leaf was compared well with standards of Zhuang *et al.* (1991) (0.32-0.47%) and Srivastava and Singh (2002; 2003; 2005; 2008) (0.43-0.92%). The mean leaf Ca (4.16%) and S (0.13%) in pummelo genotypes grafted on pummelo were found almost comparable with the pummelo genotypes grafted on Rangpur lime (4.17% and 0.13%). However, the pummelo genotypes grafted on pummelo had better mean leaf Mg content (0.81%) than the plants grafted on Rangpur lime (0.72%). With respect to leaf sulphur content, no significant difference was observed in different pummelo genotypes grafted on pummelo nevertheless found to be matching with leaf S content of pummelo clones grafted on Rangpur lime. The range of S levels in leaf (0.06-0.22%) was noticeably lower than those reported by Zhuang *et al.* (1991) (0.2-0.39%).

Leaf micronutrients

The data on leaf micronutrients in pummelo grafted on pummelo and Rangpur lime is presented in Table 3 & 4 and Fig. 2. Considerable differences were observed, in the micronutrient concentration of leaf in pummelo genotypes. A relatively wide range of leaf Fe was found among the pummelo genotypes. The concentration of leaf Fe was found to be statistically significant in pummelo genotypes grafted on pummelo and the genotype 'IKP-1' recorded the highest leaf Fe (245.45 mg kg^{-1}). The lowest leaf Fe content (124 mg kg^{-1}) was recorded in genotype 'Devenahalli Selection-4'. The range of Fe levels in pummelo leaf (124-245.45 mg kg^{-1}) of the present study was compared well with standards of Srivastava and Singh (2002) reported in Khasi mandarin (84.6-249.0 mg kg^{-1}). Pummelo genotypes differed significantly with respect to leaf Mn concentration. Higher concentration of leaf Mn was recorded in genotype 'Tirupati-2' (50.05 mg kg^{-1}), and 'IKP-1' (36.40 mg kg^{-1}). The range of Mn levels in leaf (9.85-50.05 ppm) was appreciably lower than those reported by Zhuang *et al.* (1991) (15-140 mg kg^{-1}).

The concentration of leaf Zn ranged from 17 to 69 mg kg^{-1} with a mean value of 33.3 mg kg^{-1}. The accession 'IKP-1' recorded the highest leaf Zn concentration of 69 mg kg^{-1} whereas; accession 'A-20' had the lowest leaf Zn concentration of 17 mg kg^{-1}. The values of Zn levels in leaf of most of accessions were relatively higher than those reported by Zhuang *et al.* (1991) (24-44 mg kg^{-1}). The concentration of Zn in the leaves were in the deficient range (<24 mg kg^{-1}) in few pummelo genotypes (A-18, Devenahalli selection-4, Devenahalli Selection-5, Devenahalli Selection-6 and Kalenahalli) grafted on pummelo. Copper concentration of the pummelo leaf ranged from 8.80 to 25.15 mg kg^{-1} with a mean of 15.36 mg kg^{-1}. Higher concentration of leaf Cu was recorded in accessions 'Gollehalli Selection, 'Devenahalli Selection-2' and 'Kalenahalli. The concentration of leaf Cu was statistically significant among the pummelo accessions. The ranges of Cu levels in leaves were much higher than the values of 8-17 mg kg^{-1} reported by Zhuang *et al.* (1991). The values of Cu in the foliage of all the accessions under study were above the critical value of 8.0 mg kg^{-1}. Pummelo genotypes grafted on Rangpur lime recorded the highest Fe, Mn, and Cu except Zn. Low leaf Zn might be one of the causes for wide spread appearance of severe yellowing/chlorosis in pummelo trees grafted on Rangpur lime. The highest leaf Zn was recorded in the pummelo accessions grafted on pummelo might be reason for reduced level of leaf yellowing/chlorosis. The Zn is required in plants for synthesis of auxins which act as plant growth promoter in various phenophases of the plant.

The data recorded on leaf macro and micronutrient status of pummelo grafted on different rootstocks revealed that the nutrient content of the leaf samples was significantly influenced by the rootstocks and scions as well. Differences in leaf nutrient content among the stionic combinations could be due to the variances among the rootstocks in the morphology, density of the roots in the soil profile, rooting pattern, root volume, and variations in nutrient absorption capacity of the roots (Zhuang *et al.*, 1991; Srivastava and Singh 2002). The rootstock having higher root volume can be more efficient in absorbing nutrients from the soil. Variation in leaf nutrient content could also be caused by scions of different genotypes, and

Table 3 : Leaf micronutrient content in pummelo grafted on pummelo

Genotype	Fe (mg kg^{-1})	Mn (mg kg^{-1})	Zn (mg kg^{-1})	Cu (mg kg^{-1})
Devenahalli Selection-1	180.45^{BC}	19.30^{GHIJ}	31.60^{FG}	13.85^{FGHI}
Midnapur Selection 1	163.60^{BCDE}	19.35^{GHIJ}	27.45^{GH}	15.70^{EF}
Midnapur Selection 1	133.05^{DE}	18.60^{GHIJ}	32.40^{F}	15.05^{EFGH}
Tirupati-1	176.05^{BCD}	21.45^{FGHI}	39.65^{D}	15.45^{EFG}
Hyderabad Selection	176.35^{BCD}	24.90^{DEF}	34.70^{EF}	11.75^{HIJ}
Kallar Selection	157.50^{BCDE}	17.45^{HIJKL}	29.95^{FG}	11.50^{IJ}
Raichur Selection	192.00^{B}	17.80^{GHIJK}	46.90^{C}	16.00^{EF}
Khanapur Selection	170.65^{BCD}	21.90^{FGHI}	33.40^{EF}	12.05^{GHIJ}
IKP-1	245.45^{A}	36.40^{C}	69.00^{A}	13.70^{FGHI}
IKP-2	186.45^{BC}	16.95^{IJKL}	27.40^{GH}	11.70^{HIJ}
Tirupati-2	195.40^{B}	50.05^{A}	47.35^{BC}	14.95^{EFGHI}
Tirupati -2A	172.70^{BCD}	44.30^{B}	42.90^{CD}	20.35^{BCD}
Kalenahalli-1	174.90^{BCD}	22.90^{EFG}	38.15^{DE}	16.90^{DEF}
Devenahalli Selection-2	182.40^{BC}	29.45^{D}	52.20^{B}	22.50^{AB}
Midnapur Selection-2A	157.60^{BCDE}	19.30^{GHIJ}	30.35^{FG}	18.25^{CDE}
Kunigal Selection	146.40^{CDE}	12.45^{LM}	26.85^{GHI}	11.90^{HIJ}
Devenahalli Selection-3	146.55^{CDE}	15.15^{JKL}	24.00^{HIJ}	8.80^{J}
Accession-18	134.95^{DE}	14.45^{JKLM}	23.50^{HIJ}	9.35^{J}
Accession-19	162.05^{BCDE}	15.75^{JKL}	24.10^{HIJ}	12.10^{GHIJ}
Devenahalli Selection -4	124.00^{E}	9.85^{M}	17.00^{K}	10.10^{J}
Devenahalli Selection-5	146.80^{CDE}	17.20^{HIJKL}	23.30^{HIJ}	21.25^{BC}
Devenahalli Selection-6	145.30^{CDE}	12.80^{KLM}	20.10^{JK}	18.00^{CDE}
Devenahalli Selection-7	181.90^{BC}	22.30^{EFGH}	33.85^{EF}	16.25^{EF}
Gollehalli	188.10^{BC}	27.25^{DE}	34.35^{EF}	25.15^{A}
Kalenahalli-1A	145.55^{CDE}	22.00^{FGHI}	22.05^{IJ}	21.50^{BC}
General Mean	167.45	21.97	33.30	15.36
p-Value	0.0080	<.0001	<.0001	<.0001
SE(d)	21.819	2.513	2.391	1.717
LSD at 5%	45.033	5.1872	4.9356	3.5442

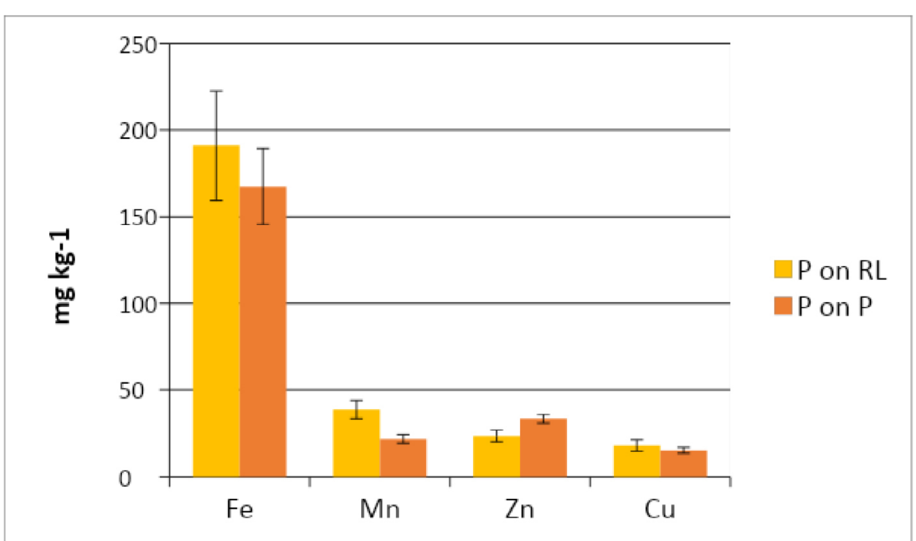

Fig. 2 : Leaf micronutrient content in pummelo grafted on pummelo (P) and Rangpur lime (RL)

Table 4 : Leaf micronutrient content in pummelo grafted on Rangpur lime

Genotype	Fe (mg kg^{-1})	Mn (mg kg^{-1})	Zn (mg kg^{-1})	Cu (mg kg^{-1})
Clone 19-1	147.20	38.37^{CDE}	21.67^{BC}	13.57^{D}
Clone 18-5	156.40	33.80^{CDEF}	15.73^{C}	14.30^{CD}
Clone 24-4	223.27	28.50^{EF}	26.60^{AB}	13.73^{D}
Clone 8-4	221.37	42.70^{BC}	26.80^{AB}	25.60^{A}
Clone 25-5	201.23	50.27^{AB}	21.27^{BC}	17.87^{BCD}
Clone 18-4	170.73	42.70^{BC}	24.03^{AB}	22.43^{AB}
Clone 21-4	175.87	27.27^{F}	23.97^{AB}	20.83^{ABC}
Clone 18-1	167.43	39.97^{BCD}	22.33^{BC}	16.03^{BCD}
Clone 10-5	188.97	54.80^{A}	21.90^{BC}	14.33^{CD}
Clone 18-3	183.73	36.00^{CDEF}	23.10^{B}	21.90^{AB}
Clone 25-2	230.97	30.50^{DEF}	25.90^{AB}	19.00^{ABCD}
Clone 20-4	223.97	37.93^{CDEF}	30.77^{A}	18.63^{BCD}
General Mean	190.93	38.57	23.67	18.19
p-Value	0.1478	0.0007	0.0396	0.0202
SE(d)	31.527	5.273	3.401	3.346
LSD at 5%	NS	10.935	7.0538	6.939

differences in the incorporation from the roots to shoots and then leaves (Srivastava and Singh 2003; 2005 and 2008).

CONCLUSION

Present investigation, clearly indicated the leaf nutrient content of pummelo varies among genotypes, but there is no genotype that stands out in all macro (N, P, K, Ca, Mg and S) and micronutrients (Fe, Mn, Zn and Cu) analyzed. However, Hyderabad Selection, Raichur Selection, IKP-1, Tirupathi-2, and Kalenahalli Selction-1 could be considered as superior pummelo accessions offering a great scope for genetic improvement programmes and maximizing productivity with less inputs. Average leaf nitrogen, potassium, iron, and manganese contents in pummelo were higher in plants grafted on Rangpur lime. Phosphorus, calcium, sulphur, and copper contents in pummelo-pummelo stionic combination were found almost comparable with the pummelo-Rangpur lime stionic combination. However, the foliar magnesium and zinc contents were found higher in pummelo - pummelo stionic combination which eventually reduces leaf yellowing/chlorosis in pummelo. Pummelo rootstocks were found to respond well in terms of P, Ca, Mg, S, Zn and Cu nutrient uptake and tolerance to Phytophthora as compared to Rangpur lime. Therefore, it can be concluded that pummelo can be an ideal rootstock for commercial pummelo cultivation with better nutrient absorption capacity, reduced chlorosis, and phytophthora incidence. Wider variations in leaf nutrients contents in pummelo accessions indicated the differential response of pummelo germplasm under similar soil-climatic conditions which emphasize due consideration while formulating leaf nutrient standards of pummelo for diagnostic and future nutrient management strategy as well.

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(Received : 25.12.2022; Revised : 03.06.2023; Accepted 05.06.2023)