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Effect of polyembryonic rootstocks on leaf mineral composition of five cultivars under Inceptisol

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ABSTRACT

The leaf macro- and micro-nutrient concentrations of five mango scion cultivars grown on three polyembryonic rootstock genotypes were studied during 2012-13 and 2013-14. Among the cultivars, Pusa Arunima appeared be the good accumulator for most of the nutrient elements except leaf N. Though, Amrapali seems to be the good accumulator of N and Mg but poorest accumulator of P, K, and Zn. Whereas, Mallika was good accumulator of N and Mg but poorest accumulator of Mn, Zn and Cu. Among rootstocks, Kurakkan was found potential for higher accumulation of leaf N, Ca, Mg and Zn concentrations in scion cultivars. Among different rootstock-scion combinations, leaf nitrogen (1.25%) and K (0.54%) in Pusa Arunima was observed higher on K-5 rootstock, while higher leaf N in Amrapali (1.36%) and Mallika (1.37%) were estimated on Kurakkan rootstock but Pusa Surya tree on Olour had higher leaf N (1.26%). In most of the cultivars, leaf K was higher on K-5 rootstock. Besides, higher leaf Ca in Pusa Arunima, Mallika and Dushehari were observed on K-5 rootstock, while in Amrapali and Pusa Surya, trees on Kurakkan had higher leaf Ca concentration. Similarly, leaf Mg concentration was also found higher on K-5 rootstock in Pusa Arunima, Amrapali, Mallika and Dushehari. The Pusa Arunima and Pusa Surya on Kurakkan proved its ability for leaf Fe and Mn concentrations, whereas, K-5 rootstock found superior over other rootstocks for the highest accumulations of Fe and Mn in Dushehari and Mallika. Both Kurakkan and Olour were equally effective for higher accumulation of Zn in Amrapali. Based on present study, it can also be inferred that metabolism of Kurakkan and/ or K-5 is better adapted for N, K, Ca, Mn, Fe and Zn accumulation for most of the mango cultivars tested.

Key words: Cultivar, leaf mineral composition, mango, polyembryonic rootstock.

INTRODUCTION

Mango (*Mangifera indica* L.) is one the most delicious and ancient fruit of India, which is widely grown mainly in tropical and subtropical regions of the world. Mangoes are also good source of vitamins A and C, carotenoids, phenolic compounds, and other dietary bioactive compounds. The mango fruit is rich in antioxidants and can reduced risk of cardiac disease, anti-cancer, and anti-viral activities. It is majorly grown in more than 90 countries, whereas in India, it is grown in about 2.51 m ha area with a productivity of 7.3 MT/ ha along with production of 18.43 MT (Anon, 2). In the present times, the productivity of mango in India and several other mango growing countries is very low. There are many factors responsible for low yield of which the use of seedling type non-descript rootstock might be considered as most important one. Hence, it is necessary to find out the different rootstock characteristics for enhancing mango fruit production. Selection of rootstocks with high nutrient uptake efficiency, well adapted to the soil and climatic conditions, will not only reduce production costs but also contribute to the sustainability and competitiveness of the Indian mango production.

Very few rootstocks studies have been reported and information is scanty on the long-range effect of rootstocks on mango yield, though some researchers studied the effect of rootstock in mango (Duran-Zauzo *et al*., 4). The studies on effect of the rootstock on nutrient composition of scion cultivar are meagre in mango adapted to tropical and subtropical conditions, though; studies in many tropical parts of the world have demonstrated the strong influence of mango polyembryonic rootstocks on the fruit yield, growth and mineral nutrition of the cultivar. This study, therefore aims to compare the influence of three polyembryonic rootstocks on accumulation of macro and micro nutrients that are important for growth, yield and quality of mango.

MATERIALS AND METHODS

The experimental materials utilized for the present investigation consists of five mango cultivars (Pusa Arunima, Pusa Surya, Amrapali, Mallika and Dushehari) and three polyembryonic rootstocks (K-5, Kurakkan and Olour). Experiments were conducted on seven-year-old grafted plant spaced at 4 m x 4 m

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apart during 2011-15. Before starts of experiment, the available N in the soil was determined by using alkaline $KMnO_4$ method (Subbiah and Asija, 12), P by Olsen's method (Olsen *et al.*, 10), K by ammonium acetate method (Hanway and Heidal, 6). However, soil available Ca, Mg, Fe, Cu, Zn and Mn were determined according to Hanway and Heidal (6) using atomic absorption spectrophotometery. For leaf tissue nutrient analysis, 10 four-month-old mature leaves were collected from the each replication and from all directions on the tree for determination of leaf nutrient contents during October in each year. These leaves were washed in series of tap water, 0.2% Teepol™ solution, 0.1N HCl and double-distilled water. The cleaned and decontaminated leaf samples were dried in a hot air oven at temperature of 70°C. Then, the dried sample was grinded with the help of a Willey mill and the ground material was passed through 1 mm mesh sieve. Leaf samples were digested in wet diacid by using nitric acid (HNO_3) and perchloric acid ($HClO_4$) in the ratio of 9:4 for the estimation of mineral nutrients such as potassium, calcium, magnesium, iron, copper, zinc and manganese (Jackson, 8). Nitrogen in plant leaves was determined using Digestion Block method (Bremner *et al.*, 3) and concentration on N in leaf samples was determined by using formula N (%) = [(T-B) × N × 1.4] /S, while P in plant leaves was determined by vandomolybdo phosphoric yellow colour method (Jackson, 8). The experiment was conducted in a factorial randomized block design (FRBD) with five replications. Data were analysed using the SAS package to calculate F values followed by Tukey's honest significance test. P values ≤ 0.05 were considered as significant.

RESULTS AND DISCUSSION

On the bases of two years mean data leaf N concentration was higher in Dushehari without differing significantly with rest of the cultivars except Pusa Arunima (Table 1). Higher, leaf P and K concentrations were observed in Pusa Arunima, while they were lower in Amrapali than other cultivars (Table 1). Pusa Arunima had the highest leaf Ca concentration, while almost similar concentration of leaf Mg was observed in all cultivars except Dushehari (Table 2). Among the rootstocks, trees on Kurakkan had the highest leaf N, Ca and Mg concentrations, while trees on K-5 proved superior for leaf P and K concentrations (Table 1). Interaction between rootstock and cultivar also revealed significant differences for leaf N, P and K concentrations in Pusa Arunima, Mallika and Dushehari (Table 2). Among the rootstocks, K-5 and Kurakkan had significantly higher leaf N concentration in Pusa Arunima. However, in Mallika and Dushehari trees on Kurakkan accumulated higher N in leaf

Table 1. Mean effect of cultivar and rootstock on leaf N, P and K concentrations in mango grafted on different rootstocks.

Rootstock/ cultivar	N (%)	P (%)	K (%)	Ca (%)	Mg (%)
Cultivar					
Pusa Arunima	1.19^{b}	0.17^{a}	0.48^{a}	1.41^{a}	0.19^{a}
Pusa Surya	1.21^{ba}	0.15^{bac}	0.47^{bc}	1.21^{d}	0.19^{ba}
Amrapali	1.23^{ba}	0.13^{c}	0.43^{c}	1.36^{b}	0.19^{ba}
Mallika	1.23^{ba}	0.15^{bc}	0.46^{b}	1.33^{c}	0.19^{ba}
Dushehari	1.25^{a}	0.16^{ba}	0.44^{c}	1.32^{c}	0.18^{b}
Rootstock					
K-5	1.20^{b}	0.17^{a}	0.49^{a}	1.37^{b}	0.19^{b}
Kurakkan	1.30^{a}	0.15^{b}	0.42^{c}	1.39^{a}	0.20^{a}
Olour	1.18^{b}	0.13^{c}	0.45^{b}	1.22^{c}	0.18^{c}
LSD (p ≤ 0.05)					
Cultivar	0.05	0.02	0.01	0.02	0.01
Rootstock	0.04	0.01	0.02	0.02	0.01

Table 2. Leaf N, P and K concentrations of mango cultivars grafted on different rootstocks.

Rootstock/ cultivar	N (%)	P (%)	K (%)	Ca (%)	Mg (%)
Pusa Arunima					
K-5	1.25^{dc}	0.22^{a}	0.54^{a}	1.51^{ba}	0.18^{bdc}
Kurakkan	1.23^{edc}	0.15^{b}	0.48^{bcd}	1.56^{a}	0.21^{ba}
Olour	1.10^{e}	0.13^{b}	0.41^{e}	1.15^{ed}	0.19^{bdc}
Pusa Surya					
K-5	1.19^{edc}	0.16^{b}	0.52^{ba}	1.05^{f}	0.19^{bdc}
Kurakkan	1.18^{edc}	0.15^{b}	0.43^{ed}	1.45^{b}	0.19^{bdc}
Olour	1.26^{bc}	0.13^{b}	0.46^{ecd}	1.11^{ef}	0.18^{dc}
Amrapali					
K-5	1.15^{edc}	0.15^{b}	0.49^{bc}	1.29^{c}	0.17^{d}
Kurakkan	1.27^{bac}	0.13^{b}	0.45^{ecd}	1.47^{b}	0.22^{a}
Olour	1.27^{bac}	0.12^{b}	0.35^{f}	1.32^{c}	0.17^{dc}
Mallika					
K-5	1.16^{edc}	0.17^{b}	0.49^{bc}	1.48^{b}	0.20^{bac}
Kurakkan	1.40^{ba}	0.14^{b}	0.45^{ecd}	1.31^{c}	0.21^{ba}
Olour	1.11^{ed}	0.12^{b}	0.43^{ed}	1.21^{d}	0.16^{d}
Dushehari					
K-5	1.22^{edc}	0.16^{b}	0.41^{e}	1.50^{ba}	0.18^{bdc}
Kurakkan	1.41^{a}	0.16^{b}	0.45^{ecd}	1.18^{ed}	0.19^{bdc}
Olour	1.14^{edc}	0.14^{b}	0.45^{ecd}	1.29^{c}	0.19^{bdc}
LSD (p ≤ 0.05)	0.15	0.06	0.05	0.07	0.03

tissues. Moreover, except Pusa Arunima, leaf P concentration was not affected by rootstock in rest of the cultivars. K-5 rootstock proved superior in terms of leaf P concentration for Pusa Arunima, However, rootstock influenced leaf K concentration in all cultivars except Dushehari. Among the rootstocks it is evident that K-5 had significantly higher leaf K content as compared to rest of the rootstocks irrespective of the cultivars. However, for Amrapali and Mallika, Kurakkan was also as good as K-5. Differences in K accumulation in leaf tissues of scion cultivars may be due to variation in absorption capacity of rootstock or differences in the uptake of K ion into xylem and its translocation from root to shoot. Moreover, for leaf Ca, both Kurakkan and K-5 rootstocks proved efficient with higher accumulation of Ca in Pusa Arunima and Pusa Surya, however Amrapali was on either Kurakkan or Olour. These results are in agreement to earlier findings in mango (Duran Zuazo *et al*., 5); Mexican lime (Khankahdani *et al*., 9). In present investigation, rootstock had significant effect on leaf nutrient concentrations in some cultivars, while it did not affect significantly in others. Differences in nutrient accumulation in scion cultivars as result of rootstock-scion combination may be due to various reasons such as structure of root system, variations in root CEC, and characteristics of root exudates and phenotype of the scion cultivars. It is clear from the present results that except Pusa Arunima, higher leaf N was observed in vigorous or medium vigorous rootstocks, while reverse trend was noticed for leaf K concentration and higher K concentration was noticed in rootstock imparting dwarfing in scion cultivars. As a result of low yield in these cultivars on K-5 rootstock had thus lower demand for K, higher leaf K concentration might be the possible reason in such rootstock-scion combinations. In contrast, Abdalla *et al.* (1) reported low leaf K concentration in dwarfing rootstock of apple. Rootstock and variety could influence leaf nutrient composition of mango even when grown under similar agro-climatic and soil conditions.

The differences in leaf micronutrients concentrations were observed due to cultivars and rootstocks tested in the present study (Fig. 1). From micronutrients analysis, it is clear that Pusa Arunima and Pusa Surya had higher leaf Fe, concentrations than rest of the cultivars. Pusa Arunima seems to be good Cu and Zn accumulators, however, highest leaf Cu concentration was observed in Pusa Surya. Among rootstock genotypes, K-5 proved to be potential for enhancing Fe and Mn concentrations in leaf tissues of scion cultivars, while Kurakkan was promising for higher accumulation of Zn. Kurakkan as well as Olour proved better rootstocks for leaf Cu concentration. Rootstock influenced leaf micronutrient concentrations in all mango cultivars (Fig. 1). Pusa Arunima and Pusa Surya on Kurakkan proved superior for leaf Fe and Mn levels, however, trees on K-5 also accumulated higher Fe than trees on Olour. For Dushehari, K-5 rootstock was found superior over others for highest accumulations of Fe and Mn. This rootstock promoted leaf Mn concentrations in Mallika also. Rootstocks K-5 and Kurakkan were found equally good for Amrapali with regard to leaf Mn concentration. Leaf Zn concentrations were not much affected significantly in Pusa Surya and Mallika but significantly highest level was observed in Pusa Arunima and Dushehari on Kurakkan rootstock. Both Kurakkan and Olour were equally effective for higher accumulation of Zn in Amrapali. Furthermore, leaf Cu concentration in Pusa Arunima was noticed highest on Kurakkan, while for Pusa Surya both Olour and K-5 rootstock proved to be a good Cu accumulator. Amrapali leaf had the highest Cu on Olour rootstock as compared to rest of the rootstocks taken into study. Our findings are in agreement to those of Khankahdani *et al*. (9) in citrus for all micronutrients and Reddy and Kurian (11) in mango for Fe. Based on the results, it can be argued that metabolism of Kurakkan was better adapted for Fe and Zn for most of the mango cultivars studied. However, K-5 rootstock genotype performed better to support Mn uptake for most of the cultivars except Pusa Surya, where Kurakkan seemed to be better. In Mallika, the levels of Fe, Zn and Cu were higher on rootstock that promotes vigorous growth, however, a reverse relation was observed in case of Pusa Arunima, where all micronutrients were higher either on dwarf or semi-dwarf rootstocks. Our findings conformed to the findings of Ikinci *et al.* (7) for most of the cultivars except Pusa Arunima.

Based on present study, it could be inferred that metabolism of Kurakkan and/ or K-5 were better for N, K, Ca, Mn, Fe and Zn accumulation for most of the mango cultivars studied. Furthermore, vigorous rootstock was more effective for Fe and Mn absorption in Pusa Surya.

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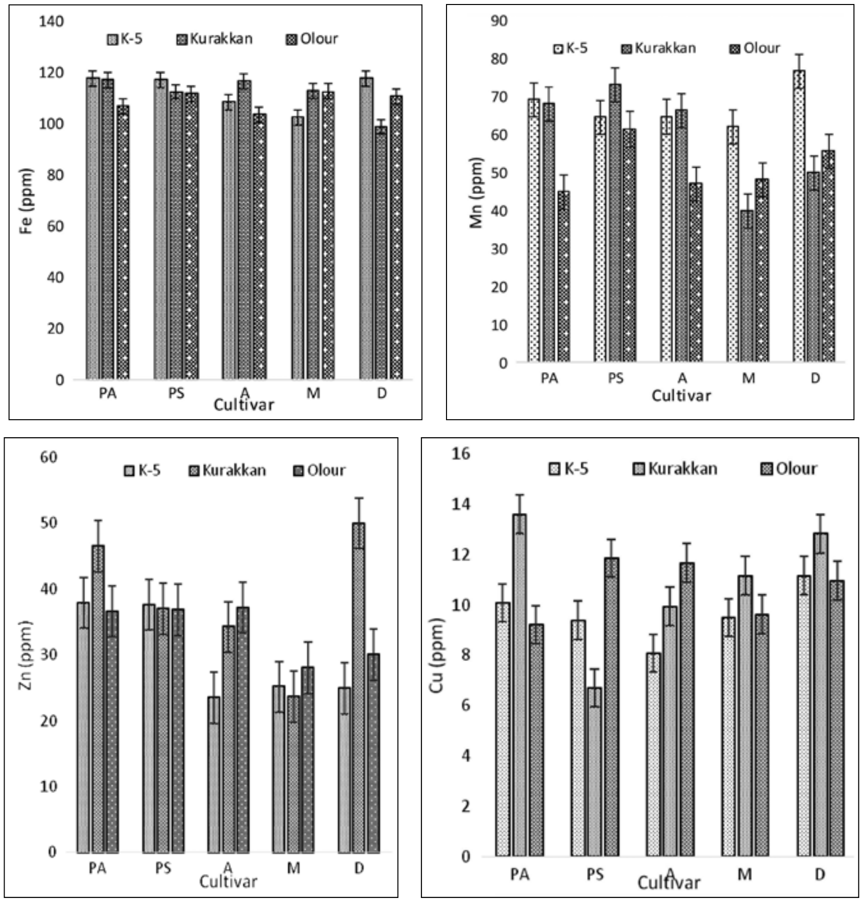

Fig. 1. Effect of rootstocks on leaf Fe (A), Mn (B), Zn (C) and Cu (D) of different mango cultivars. Vertical bar represent mean of five replicates ± SE m. The LSD (P ≤ 0.05) for Fe; 5.18, Mn; 6.43, Zn; 3.88, Cu; 2.64. PA, Pusa Arunima; PS, Pusa Surya; A, Amrapali; M, Mallika, and D; Dushehari

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