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Study of Various Rootstocks and Scion on Leaf Nutrient Status in Mango (*Mangifera Indica L.*)

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Authors' contributions

This work was carried out in collaboration among all authors. Authors MdR and RPS conceptualized the study. Authors MdR, PK and KB designed the study. Authors MdR, PK, RPS and MdZQ did the experimental contributions. Authors MdR, PK, RPS and MdZQ collected the data. Authors MdR, TF, RPS, MP did formal analysis. Authors MDR, RPS, PK, MdZQ and MP prepared the original draft. All authors read and approved the final manuscript.

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ABSTRACT

The current experiment, entitled “Study of various rootstocks and scions on leaf nutrient status in mango (*Mangifera indica L.*)” The experiment was framed in RBD (Randomized Block Design) with three replications studied for leaf nutrient analysis. The combination of five rootstocks and three scions, was carried out in the Department of Horticulture (Fruit and Fruit Technology), Bihar Agricultural University, Sabour, Bhagalpur, Bihar, during 2020–21 to evaluate the best combination regarding leaf nutrient content. The appropriate rootstock allows sufficient intake of nutrients and movement while additionally allowing for lesser fertilizer treatment rates, decreasing the possibility of leaching nutrients and toxicity while preserving fruit quality and yield. The analysis of the experiment macronutrient data related to N: P: K content in the leaf of the scion with the influence of different rootstocks has been presented in Table 1. The highest percentage of nitrogen, phosphorus and potassium were observed respectively treatments *i.e.* $T_{7:}$ Zardalu grafted on Olour (1.62%); T_9: Bombay Green grafted on Olour (0.19 %); and T_{15}: Bombay Green grafted on Mahmood Bahar (0.76%), whoever the investigation of micronutrients (Cu, Fe, Mn, and Mg) in leaves of different treatments of rootstocks has been presented in Table 2. The maximum value of copper, iron, manganese and magnesium content of leaf was observed respectively in the treatments *i.e.* (T_{13}) Zardalu when grafted on Mahmood Bahar (38.33 ppm), (T_8) Zardalu grafted on Mylepalium (109.00 ppm), (T_4) Zardalu grafted on Mylipalium (0.24 ppm) and (T_4) Zardalu grafted on Mylepalium (0.24ppm).

Keywords: Leaf nutrient; macro nutrient; micro nutrient; quality and rootstocks.

1. INTRODUCTION

Mango (*Mangifera indica L.*) is an extremely major fruit crop in tropical and subtropical conditions, with India accounting for a large portion of the acreage and output [1]. Mango belongs to the Anacardiaceae family and the Sapindales order, which has 73 genera and over 830 species. It is thought to have originated in the northern conditions of the Indo-Burma region [2]. It is one of the most traded tropical fruits in the world market due to its easy availability for a longer period.

Mango can be grown from sea level to 1400 m over mean sea level (MSL), with good growing locations that receive 25-250 mm of rain each year and high humidity. In the world, there are more than 94 countries growing mangoes, but India is the major producer of mangoes with an annual production of 22.35 million tons (NHB, 2018-19). Mangoes thrive in tropical and subtropical climates throughout India. Mango-producing states include Uttar Pradesh, Bihar, Maharashtra, Gujarat, Madhya Pradesh, Haryana, Andhra Pradesh, West Bengal, and Karnataka. Generally, commercial propagation of mangoes through vegetative means, since trees developed from seeds take longer to grow a plant, grow taller and larger, and are more difficult to handle. Furthermore, trees grown from seeds exhibit variance in fruit quality. Commercial mango varieties are grafted onto rootstock, which significantly affects their performance.

Rootstock has a significant impact on the management of orchards by influencing numerous horticultural practices. Appropriate rootstock is essential for absorption of nutrients and translocation. It has a significant impact on longevity, height, appearance, yield, and size, as well as precocity, fruit maturity, root shape and depth, disease resistance, and tolerance to unfavourable climatic conditions [3]. Typically, unknown mango grafts are used as rootstock.

The proper rootstock provides optimal absorption of nutrients and translocation while likewise allowing for reduced application of fertilizer rates, reducing the risk of leaching of nutrient and related toxicity while maintaining quality of fruit and productivity [4].

Seasonal changes in leaf concentrations of nutrients have to be understand, as well as how to analyse evaluations of leaf, orchard nutrient state, and the amount of soil nutrient loss in connection to the tree's physiological health [5]. It has been clearly shown in recent years that superior rootstocks combined with precise nutrition applications can have a considerable impact on fruit quality and output [6]. Furthermore, rootstocks may affect the scion's minerals level of nutrients [7].

Rootstocks have been shown in numerous research to have an impact on fruit quality and scion leaf mineral content.

2. MATERIALS AND METHODS

The current experiment was conducted to evaluate the greatest famous mango types at Bihar Agricultural University, Sabour, Bhagalpur, Bihar. The university is located between 25^0 15' 40^0 North longitude and 45.72 meters above mean sea level. Sabour's climate is semi-arid and subtropical, with hot, desiccating summers and chilly, frost-free winters. The experiment was carried out at Sultan Bagh Fruit Garden in Sabour, Bhagalpur, Bihar, before the mango flowering season began in July 2020-21, using 5 rootstocks and 3 scions.

This study was initiated on six years old mango trees comprising varieties viz., Mahmood Bahar, Prabha Shankar, Olour, Zardalu, Bombay Green, Langra, Kurrukan and Mylipalium. The trees were spaced at 5m X 5m with RBD design. The entire varietal collection block was under same horticultural practices. The mean difference was examined using the 'F' test at the 5% level of significance (LOS). The ANOVA table demonstrates significant diversity across all kinds. The treatments were evaluated using a critical difference (CD) at the 5% level of significance.

2.1 Status of Nutrient in Leaf

The leaf contains various macronutrients (N, P, and K) and micronutrients (Cu, Fe, Mn, and Mg). were analyzed during the month of May-June before the application of fertilizers and manures. The detailed procedures for estimating each nutrient are as follows-

2.2 Collection of Leaf Samples

Collection of the leaf samples for the elemental analysis, among the different factors affecting leaf mineral composition as reviewed by [8] were considered. Collection of leaf samples during the third week of May 2021 from the replicated and selected trees of each varietal block. The procedure given by [9] was followed in collecting the leaf samples (*i.e.* about 4-5 months old, normal and healthy eighth leaf in a whorl from non-fruiting terminal).

2.3 Preparation of Leaf Samples for Analysis

Leaf samples are collected from the orchard were immediately brought to the laboratory and used as subjected for various operations as given below.

2.4 Washing

Samples of leaf were first washed with tap or running water till 15 minutes, then by using 0.3% teepol solution for removing any unwanted material. Then after the samples were rinsed in 0.2 N HCl, with single distilled water and then finally with double distilled water.

2.5 Drying, Grinding and storage

Leaf samples of oven dried were first of all powdered with hand into small pieces for easy grinding and then fed to stainless steel leaf grinder. The finely powder of the samples was then thoroughly mixed and stored in butter paper bags for further analysis.

2.6 Estimation of Macro Nutrients(N,P,K)

2.6.1 Nitrogen (%)

The total nitrogen was determined using the Kel Plus digestion and distillation machine. The plant samples were digested using concentrated H_2SO_4 and a digestion accelerator mixture (K_2SO_4:$CuSO_4$::10:1) as suggested by [10], and the product of digestion was steam distilled with concentrated 40% NaOH. The amount of NH_3 released was absorbed in 4% boric acid and then titrated with standard H_2SO_4.

2.6.2 Total phosphorus (%)

The total phosphorus was analyzed by adding the requisite volume of filtrate to the Vanadomolybdate solution, a yellow colour developed and the result was taken by the spectrophotometer at 760 nm. [11].

2.6.3 Total potassium (%)

Total potassium in plant samples went through digestion (as with total phosphorus) and evaluated using the flame photometric method [10].

2.7 Estimation of Total Micro Nutrients (Cu, Fe, Mn and Mg)

Total micro nutrients from the sample of plant were digested (prepared in total phosphorus) and analyzed by the help of Atomic Absorption Spectrophotometer (AAS). The content of micronutrients in the extract was measured using an atomic absorption spectrophotometer (AAS).

In AAS, the analyte was added to a solution that was heated. The burner flame employed was air-acetylene. Samples are transformed into excitable free ground state atoms by the flame. The atomic forms of Fe, Mn, Cu, and Mg were exposed to a flame using Hollow Cathode Lamps (HCLs) light emitting sources at a wavelength unique to the micronutrients. As the light energy was absorbed, the atoms' electrons were activated [12]. After getting the AAS reading then multiply it with dilution factor.

3. RESULTS

3.1 Nitrogen (%)

Data related to nitrogen content in leaf of scion under the influence of different rootstock has been shown in Table 1. The table clearly shows that nitrogen content varied under the influence of rootstock. Zardalu grafted on Olour (T_7) registered maximum content of nitrogen (1.62%) followed by Bombay Green grafted on Prabha Shankar (1.39%). However, no significant differences were observed when Zardalu was grafted on Mylepalium (1.40%), Bmbay Green on Mylepalium (1.41%) and Langra on Kurrukan (1.44%). Data further indicate that the minimum nitrogen uptake was recorded in the treatment (T_1) when Zardalu was grafted on Kurrukan (1.28%).

3.2 Phosphorus (%)

The estimated data of phosphorus content in the leaf of scion under the influence of different rootstocks has been shown in Table 1. Bombay Green grafted on Olour (T_9) was responsible for the maximum uptake of phosphorus (0.19%) followed by Bombay Green grafted on Mylepalium (0.16%). In contrast, the treatment (T_{12}) Langra grafted on Mylepalium had the lowest leaf phosphorus content (0.05%).

3.3 Potassium (%)

The estimated data of potassium content in leaf of scion under the influence of different rootstock has been mentioned in Table 1. The highest level of potassium uptake was registered in treatment (T_{15}) Bombay Green grafted on Mahmood Bahar (0.76%), however, no significant difference with respect to estimation of potassium in different treatments was observed. The minimum value of potassium uptake was observed in treatment (T_{10}) Zardalu grafted on Prabha Shankar (0.22%).

Table 1. Estimation of macro nutrients (Nitrogen, Phosphorus and Potash) status in leaves of mango

Sl. No.	Treatments	N (%)	P (%)	K (%)
1	T_1 (Kurukkan + Zardalu)	1.28	0.09	0.33
2	T_2 (Kurukkan + Langra)	1.44	0.08	0.41
3.	T_3 (Kurukkan + Bombay Green)	1.49	0.11	0.46
4.	T_4 (Mylipaliam + Zardalu)	1.40	0.06	0.33
5.	T_5 (Mylipaliam + Langra)	1.35	0.05	0.45
6.	T_6 (Mylipaliam + Bombay Green)	1.41	0.16	0.35
7.	T_7 (Olour + Zardalu)	1.62	0.05	0.43
8.	T_8 (Olour + Langra)	1.38	0.09	0.44
9.	T_9 (Olour + Bombay Green)	1.43	0.19	0.55
10.	T_{10} (Prabha Shankar + Zardalu)	1.55	0.11	0.22
11.	T_{11} (Prabha Shankar + Langra)	1.45	0.11	0.50
12.	T_{12} (Prabha Shankar + Bombay Green)	1.39	0.05	0.51
13.	T_{13} (Mahmood Bahar + Zardalu)	1.60	0.12	0.38
14.	T_{14} (Mahmood Bahar + Langra)	1.61	0.09	0.44
15.	T_{15} (Mahmood Bahar + Bombay Green)	1.51	0.09	0.76
16.	**Sem (±)**	0.08	0.008	0.01
17.	**CD (P=0.05)**	0.24	0.02	0.04
18.	**CV**	10.06	16.09	5.73

Table 2. Estimation of micro nutrients (Cu, Fe, Mn and Mg) status in leaves of mango

Sl. No.	Treatments	Cu (ppm)	Fe (ppm)	Mn (ppm)	Mg (ppm)
1.	T_1 (Kurukkan + Zardalu)	29.33	82.00	0.20	0.19
2.	T_2 (Kurukkan + Langra)	27.00	87.33	0.22	0.22
3.	T_3 (Kurukkan + Bombay Green)	33.67	92.67	0.23	0.23
4.	T_4 (Mylipaliam + Zardalu)	33.00	103.33	0.24	0.24
5.	T_5 (Mylipaliam + Langra)	31.33	96.67	0.20	0.20
6.	T_6 (Mylipaliam + Bombay Green)	33.33	95.00	0.23	0.23
7.	T_7 (Olour + Zardalu)	32.67	99.33	0.22	0.22
8.	T_8 (Olour + Langra)	30.00	109.0	0.20	0.20
9.	T_9 (Olour + Bombay Green)	31.33	95.00	0.22	0.22
10.	T_{10} (Prabha Shankar + Zardalu)	28.33	94.33	0.23	0.23
11.	T_{11} (Prabha Shankar + Langra)	36.00	92.66	0.23	0.23
12.	T_{12} (Prabha Shankar + Bombay Green)	30.33	98.67	0.20	0.20
13.	T_{13} (Mahmood Bahar + Zardalu)	38.33	95.33	0.23	0.23
14.	T_{14} (Mahmood Bahar + Langra)	31.00	89.33	0.23	0.23
15	T_{15} (Mahmood Bahar + Bombay Green)	32.33	89.33	0.23	0.23
16.	Sem (±)	2.04	5.94	0.00	0.00
17	CD (P=0.05)	5.94	17.30	0.02	0.02
18.	CV	11.09	10.87	7.08	7.30

3.4 Copper (ppm)

The related data of copper in leaves of different treatments of rootstocks has been mentioned in Table 2. The maximum value of copper content of leaf was observed in the treatment (T_{13}) Zardalu when grafted on Mahmood Bahar (38.33 ppm), followed by Bombay Green grafted on Kurrukan, (33.67 ppm) Zardalu was grafted on Mylepalium (33.0 ppm), Bombay Green grafted on Mylepalium. Whereas on the other hand, the minimum value of copper content of leaf was observed in the treatment (T_2) Langra grafted on Kurrukan (27.00 ppm).

3.5 Iron (ppm)

The analyzed data of iron content in the leaf of scion under the influence of different rootstock was mentioned in Table 2. In the iron estimation the highest value of iron was observed in the treatment (T_8) Zardalu grafted on Mylepalium (109.00 ppm), followed by Mylipalium grafted on Zardalu (103.33 ppm), the data were at par. The minimum value of iron was found in treatment (T_1) Zardalu grafted on Kurrukan (82.00 ppm).

3.6 Manganese (ppm)

The analyzed data of manganese content in the leaves of scion under the influence of multiple treatments of rootstocks and their values are presented in Table 2. In the analysis of Manganese, the highest value was observed in treatment (T_4). Zardalu grafted on Mylipalium (0.24 ppm), and the lowest value was foundd in treatment (T_1) Zardalu grafted on Kurukkan (0.20 ppm).

3.7 Magnesium (ppm)

The experimental data of Mg content in the leaves of scion under the influence of multiple treatments of rootstocks and their values are given in Table 2. The highest value of Magnesium uptake was observed in the treatment (T_4) Zardalu grafted on Mylepalium (0.24ppm), however it was found at par with Bombay Green grafted on Kurrukan (0.23ppm), Bombay Green grafted on Mylepalium (0.23ppm) and Zardalu grafted on Prabha Shankar (0.23ppm). On the other hand, the lowest value was analyzed in the treatment (T_1) Zardalu grafted on Kurrukan (0.19 ppm).

4. DISCUSSION

The present investigation entitled “Study of various rootstocks and scion on leaf nutrient status in mango (*Mangifera indica L.*)” was undertaken to study the performance of four commercial cultivars of mango grafted on mono-embryonic rootstocks like Mahmood Bahar, Prabha Shankar, and poly-embryonic rootstock like Kurukkan, Olour and Mylipalium. The salient features of this study are discussed. The study revealed that the nitrogen content of leaf differed significantly. Nitrogen content of leaf ranged from 1.28% to 1.61%. These results are consistent with the findings of [10] who observed that

nitrogen content of leaf ranged from 1.40 to 1.64 %. The study exposed that the phosphorous content of leaf differed significantly. The higher leaf phosphorous content was recorded in cultivar Bombay Green grafted on Olour which was at par was Bombay Green grafted on Mylepalium, whereas the lowest phosphorus content was recorded in Langra grafted on Mylepalium. The phosphorous content of leaf ranged from 0.05% to 0.19%, which was slightly lower than the observation of [13] who observed that phosphorous content varied from 0.74 to 0.10. The potassium content of the treatments differed significantly. The content of leaf potassium was studied in Bombay Green grafted on Mahmood Bahar 0.22 to 0.55 (%) which was slightly higher than the observation by [13], who recorded the potassium content 0.78 to 0.98. which is given in Table 1. The phosphorous content of leaf ranged from 0.14% to 0.21%, which was slightly lower than the observation of [13], who observed that phosphorous content varied from 0.74 to 0.10. In the analysis of micronutrient, copper content varied from 27 to 38 (ppm). The copper content of leaf was higher than reported by [14] who observed that copper content varies from 11 to 17 ppm. Similarly, the range of iron content in leaf varied from 82-109 ppm, however [14] observed higher iron content in the leaves which were reported as 139 to 248 ppm. The Manganese content of leaf varied from 0.20-0.24 ppm which was lower than that reported by [14] who reported a range of 1.10 to 5.6 ppm manganese. In case of magnesium content of leaf was observed in the ranges from 0.19 to 0.24 ppm which was similar to the observation of [14] who reported that magnesium content of leaf ranged from 0.14 to 0.28 [15].

5. CONCLUSION

From the present investigation on nutrient status of leaf, it can be inferred that the rootstock had profound effect on nutrient status of the leaves of mango. The information generated from this study will be useful for researchers and people associated with plant nurseries who normally face dilemma in choosing the right rootstock. The information pertaining to nutrient status of leaf in terms of macro and micro nutrients have significant implication on successful mango cultivation and for good quality fruit production.

DECLARATION

The contributors state that they do not have any conflicts of interest.

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DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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