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Md. Rizwanullah
Department of Horticulture (Fruit and Fruit Technology, Bihar Agricultural University, Sabour, Bhagalpur, Bihar, India

Feza Ahmad
Department of Horticulture (Fruit and Fruit Technology, Bihar Agricultural University, Sabour, Bhagalpur, Bihar, India

Samik Sengupta
Department of Horticulture (Fruit and Fruit Technology, Bihar Agricultural University, Sabour, Bhagalpur, Bihar, India

Pritam Ganguly
Department of Horticulture (Fruit and Fruit Technology, Bihar Agricultural University, Sabour, Bhagalpur, Bihar, India

Ram Preet Singh
Department of Fruit Science, College of Horticulture and Forestry, Central Agricultural University, Pasighat, Arunachal Pradesh, India

Roopendra Kumar
Department of Horticulture (Fruit and Fruit Technology, Bihar Agricultural University, Sabour, Bhagalpur, Bihar, India

Ankur Kumar Rai
Department of Horticulture (Fruit and Fruit Technology, Bihar Agricultural University, Sabour, Bhagalpur, Bihar, India

Corresponding Author:
Ram Preet Singh
Department of Fruit Science, College of Horticulture and Forestry, Central Agricultural University, Pasighat, Arunachal Pradesh, India

Effects of various rootstock and scion stock of vegetative growth of mango

Md. Rizwanullah, Feza Ahmad, Samik Sengupta, Pritam Ganguly, Ram Preet Singh, Roopendra Kumar and Ankur Kumar Rai

Abstract
The present experiment titled "Effects of various rootstocks on leaf nutrient status and vegetative growth of mango" (*Mangifera indica*) with combination of rootstock and scion" was carried out in the Department of Horticulture (Fruit and Fruit Technology) at Bihar Agricultural College, Sabour, Bhagalpur, Bihar, with five rootstocks (Mahmood Bahar, Prabha Shankar, Kurukkan, Olour and Mylepalium) and three scion (Zardalu, Bombay Green and Langra) were studied for vegetative characteristics.
The combination of rootstock and scion this experiment showing for leaf venation was $<45^0$. Leaf margin of mango was wavy of almost all grafted mango varieties. In leaf blade width, leaf length and leaf petiole length were found in the minimum range like (3-5 cm, 17-19 cm and 3-4 cm.) respectively. On the other hand the plant girth is recorded 14-26 cm and scion girth was 12-18 cm. Plant spread of minimum range (N-S and E-W) was (0.74 and 0.80) was recorded. Later on the minimum canopy volume was recorded on grafted mango cultivars was 0.96 m^3. In leaf venation the maximum grafted varieties was found $<45^0$ and the leaf margin was wavy in maximum varieties.

Keywords: Rootstock, scion, leaf venation, translocation, longevity

Introduction
Mango (*Mangifera indica* L.) is one of the main fruit crops of tropical and subtropical areas of the world in which India contributes a major share in area and production (Chadha, 1989) [1]. Mango is grown from sea level to an altitude of 1400 m above mean sea level (MSL), with well growing areas which receives an annual rain fall of 25-250 mm with high humidity. In India mangoes are growing in tropical and sub-tropical areas. The important mango growing states are Uttar Pradesh, Bihar, Maharashtra, Gujarat, Madhya Pradesh, Haryana, Andhra Pradesh, West Bengal and Karnataka.
Bihar is an important mango growing region of India producing 147.58 thousand metric tons from an area of 150.64 thousand ha (NHB, 2017). The important mango cultivars grown in Bihar are Langra, Zardalu, Gulab Khas, Himsagar and Bombay Green. The cultivar Zardalu has recently been granted GI tag which will aid in further commercialization.
Mango is commercially propagated by vegetative means, as trees grown from seeds takes longer time to bear fruits, grows taller and larger and are difficult to manage. Moreover, trees obtained from seeds shows variation in its fruit quality. The most popular method of propagation of mango is through veneer grafting (Mukherjee and Majumder, 1976) [6]. Commercial mango cultivars are grafted on rootstock, which influence their performance to a great extent. Rootstock has profound influence on orchard management by affecting many horticultural characteristics. The right rootstock is important for nutrient absorption and translocation. It plays an important role in influencing longevity, height, stature, yield and size precocity, maturity of fruits, root shape and depth and affects the disease, pest resistance and tolerance to adverse weather conditions (Singh and Singh 1976) [7]. Usually, unknown mango seedlings are used as rootstock. Due to high heterozygous nature of these seedlings, their effect on the scion varieties is varied (Chhonkar and Singh 1972) [14]. Besides due to unknown rootstock, the production may become unpredictable and poor in mango growing regions.
The right rootstock promotes adequate nutrient absorption and translocation while also allowing for lower fertilizer application rates, lowering the danger of nutrient leaching and associated toxicity without sacrificing fruit quality or output (Zhang *et al.* 2010) [8]. Leaf mineral analysis can be used to evaluate the tree's nutritional status and serve as effective fertilization guidance.

Seasonal change in leaf nutrient concentrations must be understood, as well as how to interpret leaf analyses, orchard nutritional state, and the quantity of soil nutrient loss (Nachtigall and Dechen 2006) [9] in relation to the tree's physiological status. The results are necessary for the exact application of fertilizer (Kucukyumuk *et al*. 2012) [15].
Through the absorption of water and nutrients, as well as the creation of hormones, rootstocks can have a significant impact on scion health and make it more tolerant to a variety of situations. Furthermore, rootstocks might have an impact on the scion's mineral nutrition levels (Ahmed *et al*. 2007) [2].
There were several methods for the identification and characterization of mango cultivars have been developed based on outstanding fruit morphological traits. The International Plant Genetic Resources Institute (IPGRI) OF Rome Italy, has established a list of descriptors for mango that includes the morphological traits and of plant, leaves, flowers, fruits and seeds and provides a universal format for the characterization and identification of mango genetic resources (IPGRI), 2006 [13].

Materials and Methods
The present study was undertaken to investigate the most popular mango varieties of Bihar Agricultural University, Sabour, Bhagalpur, Bihar. The university is situated between 25^0 15'40^0 North longitude and 45.72 meters above mean sea level. The climate of Sabour is semi-arid, subtropical with hot desiccating summer and cold frostless winter. The experiment was conducted before the flowering season of mango beginning from July 2020-21 at Sultan Bagh Fruit garden at Sbour, Bhagalpur, Bihar on five rootstocks and three scions.

Leaf Parameters (As per IPGRI descriptor-2006) [13]
The morphological data leaf venation, leaf margin, leaf margin was taken on the basis of descriptor of IPGRI (2006) [13]. Leaf venation and leaf margin was estimated with the help of IPGRI descriptor.

Leaf blade width (cm)
Leaf blade width was estimated by the help of measuring scale and was found in cm.

Leaf blade length (cm)
Leaf blade length was estimated by the measuring of leaves from base to tip of the leaf with the help of measuring scale. Approx 5-10 leaves were taken for estimation.

Leaf petiole length (cm)
Petiole length was measured by the help of measuring scale from the stem to the base of the leaf blade. Approx 10-15 leaves were taken for estimation.

Plant height (cm)
Plant height was measured in the plot by using the measuring tape, and the E-W and N-S Direction was also measured.

Plant girth (cm)
Plant girth was estimated in the experimental plot by using measuring tape, plant girth was measured from the ground level height approx 10-15 cm.

Scion girth (cm)
Scion girth was estimated in the plot by using measuring tape and it was measured from the grafted part approx 10 cm upper.

Canopy volume (m^3)
Canopy volume was calculated by the following formula suggested by Samaddar and Chakraborti (1988) [16]. It was expressed as m^3.

Canopy volume = $\prod r^2 h$

Where,
r= radius of crown (in E-W and N-S directions) and
h= Height of tree (m)

Results
Table-1 Estimation of leaf shape and their characters of different mango cultivars.

Leaf Blade Width (cm)
The analyzed data of plant leaf blade width of different treatments and their values has been shown in the table 4.2. The highest value of leaf blade width was recorded in treatment Zardalu grafted on Prabha Shankar (5.53 cm) and it was found at par with Zardalu grafted on Mahmood Bahar (4.03 cm), cultivar Langra grafted on Prabha Shankar (4.20 cm), on the other hand, the minimum leaf blade width was found Zardalu was grafted on Olour (3.50 cm).

Leaf Blade Length (cm)
In respect to leaf blade length significant variation was recorded. The highest value was found in the treatment Langra grafted on Kurrukan (19.07 cm). On the other hand, minimum leaf blade length was recorded in treatment Bombay Green grafted on Mylepalium (16.40 cm).

Petiole Length (cm)
The analyzed data of petiole length of different treatments and their values has been shown in table 1. The maximum value of petiole length was found in treatment Bombay Green grafted on Kurukkan (4.10 cm) and was followed by Bombay Green grafted on Mahmood Bahar (3.4 0 cm), Zardalu grafted on (3.45 cm), Langra grafted on Kurukkan (4.00 cm), Zardalu grafted on Mylepalium (4.07 cm). On the other hand, the minimum petiole length was found in Langra grafted on Prabha Shankar (3.07 cm).

Plant height
The measurement of plant height under the influence of rootstock and scion is presented in table 2. The maximum plant height was measured in Zardalu grafted on Prabha Shankar (3.13 m) which was at par with Zardalu grafted on Olour (2.56 m) Langra grafted on Mahmood Bahar (2.83 m). On the other hand, the minimum value was observed in Zardalu grafted on Kurrukan (1.53 m).

Plant Girth (cm)
The analysis of data revealed that there was significant difference with respect to plant girth. The treatment Bombay Green grafted on Mylepalium producing the highest plant girth (25.90 cm). On the other hand, Zardalu was grafted on Kurukkan (14.67 cm) produced the minimum plant girth.

Table 1: Estimation of leaf shape and their characters of different mango cultivars

Treatments	Leaf venation	Leaf margin	Leaf blade width (cm)	Leaf blade length (cm)	Leaf petiole length (cm)
T_1 (Kurukkan + Zardalu)	$<45^0$	Entire	4.81	17.61	3.45
T_2 (Kurukkan + Langra)	$<45^0$	Wavy	4.60	19.07	4.00
T_3 (Kurukkan + Bombay Green)	$45\text{-}60^0$	Wavy	4.63	17.30	4.10
T_4 (Mylepalium + Zardalu)	45^0	Entire	4.63	17.40	4.07
T_5 (Mylepalium + Langra)	45^0	Wavy	4.90	17.15	3.83
T_6 (Mylepalium + Bombay Green)	$45\text{-}60^0$	Entire	4.30	16.40	3.77
T_7 (Olour + Zardalu)	$<45^0$	Wavy	3.50	18.67	3.67
T_8 (Olour + Langra)	$<45^0$	Wavy	4.23	18.93	3.40
T_9 (Olour + Bombay Green)	$45\text{-}60^0$	Entire	3.87	18.67	3.60
T_{10} (Prabha Shankar + Zardalu)	$45\text{-}60^0$	Entire	5.53	19.07	3.67
T_{11} (Prabha Shankar + Langra)	$<45^0$	Wavy	4.20	18.00	3.07
T_{12} (Prabha Shankar + Bombay Green)	45^0	Wavy	4.50	17.77	3.40
T_{13} (Mahmood Bahar + Zardalu)	$45\text{-}60^0$	Entire	4.03	17.27	3.13
T_{14} (Mahmoood Bahar + Langra)	45^0	Wavy	4.70	19.04	3.63
T_{15} (Mahmood Bahar + Bombay Green)	$45\text{-}60^0$	Entire	3.60	17.90	3.40
Sem (±)			0.59	0.99	0.26
CD (P=0.05)			1.21	2.87	0.77
CV (%)			16.37	9.53	12.60

Scion Girth

The analysis of data revealed that significant difference was observed with respect to scion girth. The highest value was observed in treatment Zardalu grafted on Olour rootstock (18.10 cm), and it was found at par with treatment Langra grafted on Mahmood Bahar (17.77 cm), Zardalu grafted on Prabha Shankar (17.07 cm). On the other hand, Bombay Green grafted on Prabha Shankar (11.57 cm) produced the minimum plant scion girth.

Plant Spread (N-S)

The analyzed data of plant spread in N-S direction of different treatments and their values has been presented in table 2. The Maximum value was found in cultivar Bombay Green grafted on Mahmood Bahar (1.95 m) and the minimum plant spread value (0.74 m) was recorded in treatment Zardalu grafted on Kurukkan.

Plant Spread (E-W)

The data of plant spread of different treatments and their values are presented in table 2. From the table on plant spread in East-West direction it can be observed that maximum value was found in cultivar Bombay Green grafted on Mahmood Bahar (2.06 m). The data revealed that the significant variation with respect to plant spread and was found at par with Langra grafted on Mahmood Bahar (1.81 m). On the other hand, the minimum plant spread was found in the treatment Zardalu grafted on Kurukkan (0.80 m).

Canopy Volume (m^3)

In the analysis of canopy volume, significant variation was observed in terms of plant canopy volume. The highest value was observed in the treatment Bombay Green grafted on Mahmood Bahar (13.66 m^3) and it was found at par with (12.17 m^3). On the other hand minimum plant canopy volume was observed in treatment Zardalu grafted on Kurukkan (0.96 m^3).

Table 2: Estimation of Plant height, plant girth, scion girth, plant spread and canopy volume of different mango cultivars

Treatments	Plant height (m)	Plant girth (cm)	Scion girth (cm)	Plant spread N-S (m)	Plant spread E-W (m)	Canopy volume (m^3)
T_1 (Kurukkan + Zardalu)	1.53	14.6	12.6	0.74	0.80	0.96
T_2 (Kurukkan + Langra)	2.06	21.2	16.8	1.22	1.03	3.30
T_3 (Kurukkan + Bombay Green)	2.26	21.8	16.0	1.20	1.10	3.20
T_4 (Mylepalium + Zardalu)	2.30	22.2	15.1	1.34	1.32	4.26
T_5 (Mylepalium + Langra)	1.73	20.0	15.9	1.16	1.19	2.61
T_6 (Mylepalium + Bombay Green)	2.25	25.9	15.6	1.36	1.22	3.87
T_7 (Olour + Zardalu)	2.56	23.6	18.1	1.35	1.44	5.36
T_8 (Olour + Langra)	2.40	21.9	15.0	1.40	1.26	4.51
T_9 (Olour + Bombay Green)	1.93	16.7	13.0	1.27	1.32	3.40
T_{10} (Prabha Shankar + Zardalu)	3.13	25.3	17.0	1.32	1.29	5.79
T_{11} (Prabha Shankar + Langra)	3.03	22.5	16.8	1.40	1.33	6.15
T_{12} (Prabha Shankar + Bombay Green)	2.38	16.9	11.5	1.01	0.98	2.46
T_{13} (Mahmood Bahar + Zardalu)	2.95	20.7	15.0	1.48	1.49	7.20
T_{14} (Mahmoood Bahar + Langra)	2.83	23.2	17.7	1.95	1.81	12.17
T_{15} (Mahmood Bahar + Bombay Green)	2.71	23.9	16.1	1.75	2.06	13.66
Sem (±)	0.23	1.62	1.12	0.12	0.12	0.52
CD (P=0.O5)	0.66	4.73	3.26	0.36	0.36	1.51
CV (%)	16..33	16.1	12.5	16.01	16.01	17.04

Discussion

The various growth parameters were recorded (Table 1 and 2) were found to be significant. The cultivar Zardalu grafted on Kurrukan showed the least growth in respect of plant height, plant spread, canopy volume which the major factors were contributing to vigour of plant. Teaotia *et al*. (1971) [17] observed least growth of Dushehari scion when grafted on Vellaikulamban rootstock while Gowder *et al*. (1971) [18] reported maximum growth of cultivar Neelum when grafted on Bappakai rootstock.

Effect of rootstock on vegetative growth parameters regardless of the scion cultivar used. Greater plant height was observed in treatment Zardalu scions grafted on Prabha Shankar (3.13 m) while small statured plants were observed in treatment Zardalu scion grafted on poly-embryonic rootstock Kurrukan (1.53 m). This result agrees with those reported by Iyer and Subramanyam (1986) [11]. The difference in plant height may be because of higher concentration of gibberellins found in roots of vigorous rootstocks Mushtaq (2016) [5].

Conclusion

The results obtained in the present study showed the best rootstock to manage the canopy of commercial cultivar Zardalu was grafted on Kurrukan which reduced the plant height to 1.53 m, canopy volume (0.96 m^3) scion girth 14.67, plant spread to 0.74 and 0.80 in north-south and east-west direction respectively. The best rootstock to manage the canopy of commercial cultivar Langra and Mylepalium which reduced the plant height 1.73 m, canopy volume (2.61 m^3).

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