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SHORT COMMUNICATION

Performance of Kinnow mandarin as influenced by longevity of rootstocks

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Rootstocks are known to have a influence on bearing behaviour, tree vigour, yield, fruit quality and tolerance to adverse conditions (Castle and Krezdorn, 1977; Syvertsen, 1981; Castle et al., 1988 and Wutscher, 1989). The problem of replanting old citrus soils with young trees may be solved to some degree by the use of proper rootstocks. Furthermore, the performance/adaptability of fruit trees varied greatly with the type of rootstock and agro-climatic conditions of the area. A tree may render unproductive after certain years of production on a given site. Therefore, economic longevity of a commercial orchard significantly depends upon selecting promising rootstocks.

Kinnow is considered as highly productive and remunerative crop in Punjab. It has assumed special economic importance and export demand due to its high juice content, special flavour and as a rich source of vitamin C. According to Punjab horticulture department, the total area under Kinnow was 47101 hectares and the total production was 1017725 metric tonnes during 2013-14. South-Western regions of Punjab are very conducive for the production of excellent quality Kinnow.

Establishing orchards is a long term investment. Therefore, an economic longevity is one of the important considerations to defer cyclic initial unproductiveness of trees. However, these studies have not yet been carried out in Kinnow mandarin especially in Punjab. Therefore, the effect of rootstock longevity on growth, yield and quality of Kinnow was evaluated.

Field trials were executed at the experimental farm of Punjab Agricultural University (PAU) Regional Research Station Abohar, Punjab, India in the year 1988, The study area is located at an altitude of 180 m above mean sea level and lies between 30.14^{o} N latitude and 74.20^{o} E longitude. Climate of area is considered as desert type and has been classified as BWh by Köppen-Geiger system of classification. The experimental soil was sandy loam type. The soil had average pH of 7.85, EC 0.22 dS/m and organic carbon 0.37%. The soil was low in available N, medium in P and high in K content.

Kinnow mandarin was budded on seven rootstocks *viz.* Jatti khatti (*Citrus jambhiri* Lush), Karun Jambhir (*Citrus aurantium*), Shekwasha (*Citrus depressa*), Jambhiri (*Citrus jambhiri* Lush), Pectinifera (*Citrus depressa*), Estes Rough Lemon (*Citrus jambhiri*) and Cleopatra (*Citrus reshni).* Field plantation of these rootstocks was done at a standard spacing of 22x22 ft. Two trees in each combination were replicated thrice in a Randomized Block Design. All other cultural practices were followed as per standard package and practices, PAU, Ludhiana. Leaf samples were collected in the year 2015 during mid July –mid august and analysed for nutrient content (Jackson, 2005). The data was recorded on trunk girth, tree height and spread during February. Healthy plants were distinguished visually. Randomly selected 20 fruits in each combination were analysed for physico-chemical characteristics following standard procedures (AOAC, 1980).

The data on growth parameters of Kinnow as influenced by rootstocks is presented in Table 1. Maximum tree height was noted in Karun Jambhir (5.15 m) which was statistically at par with all other trees except raised on Shekwasha. Tree spread was significantly higher in Jatti Khatti (6.54 m) which was statistically comparable with Shekwasha (6.45 m). Trees on Jatti khatti rootstock registered significantly higher canopy volume (78.95 m^3), followed by Cleopatra (69.99 m^3). Minimum canopy volume was noticed in Pectinifera (59.55 m^3). The data also revealed maximum average fruit weight in Jatti Khatti (171.2 g) which , however, was statistically at par with Karun Jambhir (168 g), Shekwasha (162.4 g) and Jambhiri (160 g). Fruit number was significantly higher in trees budded on Jatti Khatti and Cleopatra. On the other hand, trees on Shekwasha, and Estes Rough Lemon registered minimum fruit number. The superiority of Jatti Khatti and Cleopatra in terms of tree vigour, fruit weight and number of fruits over other rootstocks may be attributed to better

absorption of nutrients from the soil as reflected by significantly higher leaf N, P and K content (Figure 1). This may have resulted in higher tree growth in terms of canopy volume. Canopy volume is a measure of source size which directly contributes in the synthesis of photosynthates, consequently in higher growth, more number of fruits and heavier fruits. The significance of canopy volume in light interception, crop growth and yield has well been reported by Duncan (1971).

Fruit yield was significantly influenced by different rootstocks (Table 2). The data revealed maximum average fruit yield (146.5 kg/tree) in trees raised on Jatti Khatti followed by Cleopatra (123.6 kg/tree). Minimum fruit yield was recorded on Estes Rough Lemon rootstock (97.4 kg/tree). These results may be attributed to higher number of fruits per plant and higher fruit weight in trees budded on Jatti Khatti. and Cleopatra rootstock. Anderson (1987), Obreza and Rouse (1993) and Syvertsen and Lloyd (1994) also positively coo-related the size of canopy with number of fruits and yields in citrus.

Among chemical quality parameters, different rootstock significantly influenced TSS and TSS/acidity ratio of the fruits (Table 3). Maximum TSS content was noted in Cleopatra
(12.5%), the value, however, was statistically at par with Karun Jambhir (11.7%), Shekwasha (11.8%), Jambhiri (11.8%) and Pectinifera (12.1%). The value of fruit quality index (TSS/acidity ratio) was maximum in Cleopatra (14.07) which was statistically as good as other rootstocks except Karun Jambhir. Almost similar trend in quality of Kinnow on different rootstocks was earlier reported by Sharma et al. (2002).

Tree growth and fruit yield of kinnow on Jatti Khatti was highest as compared to other rootstocks. However, fruit quality was excellent on Cleopatra even after 25 years of planting. Therefore, Jatti Khatti and Cleopatra are the potential rootstock in South-Western part of Punjab to attain long term productivity of Kinnow orchards.

Table 1. Effect of rootstocks on leaf nutrient content, tree growth and physical characteristics of fruits

Rootstock	Stock/scion (Ratio)	Tree spread (m)	Tree height (m)	Canopy volume (m^3)	No. of fruits/tree	Avg. fruit wt. (g)
Jatti Khatti	1.00	6.54	4.80	78.95	856	171.2
Karun Jamir	1.00	5.16	4.94	65.95	671	168
Shekwasha	1.03	6.45	4.29	62.20	594	162.4
Jambhiri	1.03	5.20	4.89	65.11	715	160
Pectinifera	1.03	4.93	4.80	59.55	765	152.6
Estes R. Lemon	1.01	5.51	4.81	66.78	651	149.4
Cleopatra	1.02	5.04	5.15	69.99	774	159.6
$CD_{0.05}$	NS	0.48	0.41	5.46	56.8	14.5

Table 2.Effect of rootstocks on fruit yield

Rootstock	Fruit yield in kg/tree after the year						Average
	2010	2011	2012	2013	2014	2015	
Jatti Khatti	165.5	124.5	130.4	127.5	162.6	168.5	146.5
Karun Jamir	94.8	127.5	118.4	130.8	107.2	98.1	112.8
Shekwasha	95.6	85.0	84.0	97.5	109.1	108.1	96.6
Jambhiri	128.3	118.5	113.0	113.0	102.0	112.0	114.5
Pectinifera	111.1	109.3	126.0	116.0	121.6	116.4	116.7
Estes R. Lemon	113.8	87.2	85.2	91.5	89.1	117.5	97.4
Cleopatra	128.6	125.6	135.2	89.3	128.9	134.0	123.6
CD 0.05	14.5	11.7	9.5	10.7	11.5	12.1	12.1

Table 3. Effect of rootstocks on chemical characteristics of fruits

Rootstock	Juice content (%)	TSS (%)	Acidity (%)	TSS/acidity	Ascorbic acid (mg/100 ml juice)
Jatti Khatti	50.78	11.3	0.841	13.45	29.67
Karun Jamir	48.43	11.7	0.898	13.03	27.34
Shekwasha	50.54	11.8	0.868	13.59	27.45

Jambhiri	48.45	11.8	0.858	13.75	26.24
Pectinifera	49.66	12.1	0.862	14.03	29.35
Estes R. Lemon	49.67	11.5	0.846	13.59	28.44
Cleopatra	48.88	12.5	0.888	14.07	28.12
$CD_{0.05}$	NS	0.81	NS	1.02	NS

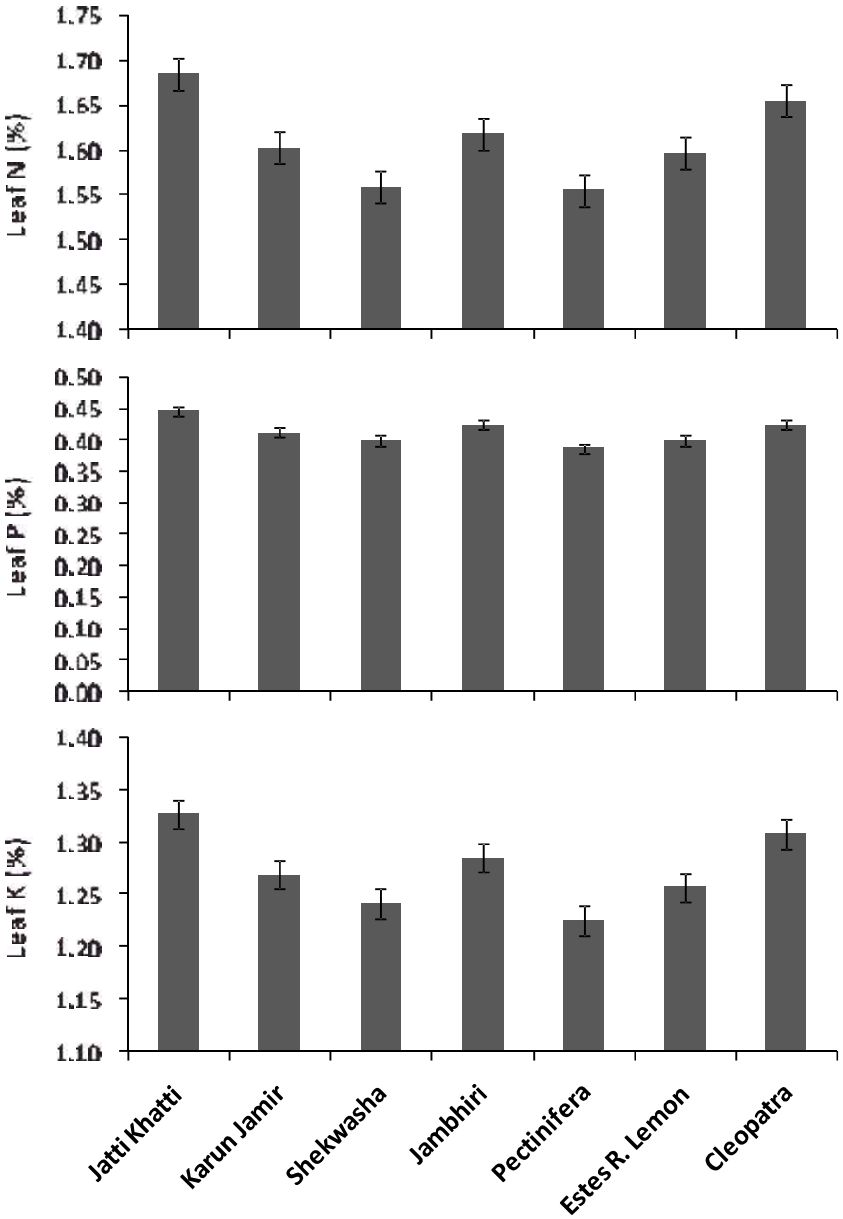

Fig. 1. Effect of rootstock on leaf nutrient content (values are square root transformations)