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Evaluation of elite mandarin (*Citrus reticulata* Blanco) genotypes for yield parameters

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Abstract

The present investigation entitled "Evaluation of elite mandarin (*Citrus reticulata* Blanco) genotypes for yield parameters" was carried out during 2021-2022 and 2022-2023 at farmer's field and Post Graduate Laboratory, Department of Horticulture, Mahatma Phule Krushi Vidyapeeth, Rahuri. The study was undertaken on 25 genotypes along with one commercial variety as check namely Nagpur mandarin. Further these genotypes were screened for yield parameters for two years. The experimental results showed that large variability was observed in mandarin genotypes for yield related traits. The maximum number of fruits per tree was recorded in RHRM-10 (406.00), whereas the maximum fruit weight was recorded in RHRM-19 (226.65 g), the maximum fruit yield was recorded in RHRM-10 (73.04 kg/tree) and the maximum fruit yield was recorded in RHRM-10 (29.21 t/ha). Form the present study we can conclude that genotype RHRM-10 found superior for overall yield parameters.

Keywords: Evaluation, mandarin, genotypes and yield parameters etc.

Introduction

Citrus is one of the most important group of fruit crops in the world. It is grown throughout the tropical and sub-tropical regions of the world where the winter temperatures are sufficiently moderate for tree survival and enough water is available for its growth (Gmitter *et al.*, 1992) [6]. However, the best fruit quality is achieved under sub-tropical conditions and the highest acreage concentrated between 40° North and South of equator due to its wide adaptability to the tropical as well as sub-tropical conditions (Patil *et al.*, 2012) [12].

It occupies third position after mango and banana in fruits production in India. Among the citrus fruits, mandarin is placed at first position with respect to area and production followed by sweet oranges and limes. In India the area under mandarin crop during 2022-23 was 4.60 lakh hectares with production of 61.78 lakh MT on (Anon., 2023) [11]. Mandarins are predominantly grown in Maharashtra, parts of Madhya Pradesh, Punjab and north-eastern regions. The role of citrus fruits in providing nutrients as well as medicinal value has been recognized since ancient times. The fruits are well known for their refreshing fragrance, thirst-quenching ability and providing adequate vitamin C. In addition to ascorbic acid, these fruits contain several phytochemicals, which play the role of nutraceuticals, such as carotenoids (lycopene and β -carotene), limonoid, flavanones (naringins and retinoid), vitamin-B complex and related nutrients (thiamine, riboflavin, nicotinic acid/niacin, pantothenic acid, pyridoxine, folic acid, biotin, choline and inositol). Flavonoids found in citrus juices, especially those from oranges and grapefruits, are effective in improving blood circulation and have anti-allergic, anticarcinogenic, and antiviral properties. (Filatova and Kolesnova, 1999) [5]. Fresh grapefruits, pummelos and oranges also provide fibre and pectin, which are known to reduce the risk of heart attacks if taken daily in the diet (Ladaniya, 2010) [10]. Environmental factors, including temperature fluctuations, drought, and soil conditions, also affect mandarin growth and fruit quality. Mandarins are particularly sensitive to cold temperatures, which can cause significant damage to the trees and fruits. Additionally, soil health and nutrient availability play crucial roles in determining the vigor and yield of mandarin orchards. Effective management practices are essential to mitigate these challenges and ensure sustainable mandarin production. Therefore, the knowledge of genetic variation and relationship among different genotypes is an important consideration for strengthening the citrus industry in India.

Materials and Methods

The present investigation entitled "Survey and surveillance of mandarin (*Citrus reticulata* Blanco) in Ahmednagar District" was carried out during 2021-23. For this study the survey work was undertaken to trap the diversity in Ahmednagar district. An extensive survey was carried out in the farmer's field in Ahmednagar district of Maharashtra, India during *Kharif* season in 2021-22 to 2022-23 to study the quantitative traits of mandarin fruits collected from twenty five different genotypes. The genotypes were characterized for their tree yield parameters. Ahmednagar situated in the rain shadow region of the western ghat, Ahmednagar has a hot semi-arid climate. The climate is hot throughout the year. It lies between 18° 20' to 19° 59' North latitude and 73° 40' to 75° 43' East longitude. The average rainfall is 578.8 mm and mean daily maximum temperature is 39 °C and mean daily minimum temperature is 11.7 °C. The detailed survey was undertaken for two years during regular fruiting of *mrig* bahar of the *kharif* season. Studies were conducted on 8-10 years old, healthy and vigorously growing trees of mandarin crop.

Results and Discussion

Yield parameters

Number of fruits/tree

The data presented in Table 1 revealed that the number of fruits per tree during year 2021-22 varied significantly from

329 to 430 with population mean 370.69. The significantly maximum number of fruits per tree was recorded in RHRM-10 (430.00) which was followed by RHRM-11 (423), RHRM-9 (416), RHRM-23 (410) and RHRM-20 (402), while the minimum number of fruits per tree was recorded in RHRM-8 (329.00), respectively. In 2022-23, the number of fruits per tree ranged from 275.00 to 382.00 with the population mean 317.42. The significantly maximum number of fruits per tree was recorded in RHRM-10 (382.00) which was followed by RHRM-11 (378), RHRM-9 (370), RHRM-20 and RHRM-24 (350), while the minimum number of fruits per tree was recorded in RHRM-8 (275.00). On the basis of pooled analysis, significantly the number of fruits per tree ranged from 302.00 to 406.00 with population mean of 344.06. The significantly maximum number of fruits per tree was recorded in RHRM-10 (406.00) which was followed by RHRM-11 (400.50), RHRM-9 (393), RHRM-20 (376) and RHRM-23 (375), while the minimum number of fruits per tree was recorded in RHRM-8 (302.00). More number of fruits per tree may be due to the more height and spread of the tree which might be due to genetical content and their interaction with environment. Similar findings were obtained by Diwan *et al.* in sweet orange (2014) ^[4], Talukder *et al.* (2015) ^[15] in mandarin, Goud *et al.* (2017) ^[7] in Nagpur Mandarin and Shirgure *et al.* (2016) ^[13] in Nagpur mandarin.

Table 1: Performance of mandarin genotypes on Fruit weight (g) and number of fruits per tree

S. N.	Genotypes	Number of fruits per tree			Fruit weight (g)		
		2021-22	2022-23	Pooled mean	2021-22	2022-23	Pooled mean
1.	RHRM-1	359.00	300.00	329.50	172.84	178.30	175.57
2.	RHRM-2	378.00	324.00	351.00	198.93*	204.12*	201.53*
3.	RHRM-3	388.00	306.00	347.00	162.94	174.31	168.63
4.	RHRM-4	372.00	318.00	345.00	165.96	163.20	164.58
5.	RHRM-5	360.00	278.00	319.00	170.15	184.67	177.41
6.	RHRM-6	349.00	297.00	323.00	145.26	162.15	153.71
7.	RHRM-7	365.00	310.00	337.50	176.23	182.76	179.50
8.	RHRM-8	329.00	275.00	302.00	190.67*	190.54	190.61*
9.	RHRM-9	416.00*	370.00*	393.00*	174.49	176.32	175.41
10.	RHRM-10	430.00**	382.00**	406.00**	182.59	176.85	179.72
11.	RHRM-11	423.00*	378.00*	400.50*	167.96	172.98	170.47
12.	RHRM-12	370.00	304.00	337.00	140.71	161.24	150.98
13.	RHRM-13	367.00	320.00	343.50	169.79	172.64	171.22
14.	RHRM-14	340.00	286.00	313.00	173.35	176.35	174.85
15.	RHRM-15	336.00	279.00	307.50	150.86	159.20	155.03
16.	RHRM-16	355.00	310.00	332.50	163.06	164.29	163.68
17.	RHRM-17	377.00	327.00	352.00	155.54	141.87	148.71
18.	RHRM-18	342.00	288.00	315.00	125.89	126.35	126.12
19.	RHRM-19	330.00	284.00	307.00	220.69**	232.61**	226.65**
20.	RHRM-20	402.00*	350.00*	376.00*	172.29	178.21	175.25
21.	RHRM-21	357.00	308.00	332.50	187.89*	190.32	189.11
22.	RHRM-22	355.00	314.00	334.50	167.87	172.58	170.23
23.	RHRM-23	410.00*	340.00	375.00*	139.78	143.20	141.49
24.	RHRM-24	388.00	350.00*	369.00	131.81	134.98	133.40
25.	RHRM-25	342.00	310.00	326.00	154.19	158.20	156.20
26.	Standard check (Nagpur Mandarin)	398.00	345.00	371.50	156.87	160.24	158.56
	Min.	329.00	275.00	302.00	125.89	126.35	126.12
	Max.	430.00	382.00	406.00	220.69	232.61	226.65
	Mean	370.69	317.42	344.06	166.10	170.71	168.41
	SD	28.92	30.49	29.15	20.89	21.72	21.03
	Mean + SD	399.61	347.91	373.21	186.99	192.43	189.43
	Mean+ (2 x SD)	428.53	378.40	402.35	207.88	214.16	210.46
	S.Em. ±	5.67	5.98	5.72	4.10	4.26	4.12
	CV (%)	7.80	9.60	8.47	12.58	12.73	12.49

Note: * Mean > Mean + SD, **: Mean > Mean + 2 SD

Fruit weight (g)

The data regarding the fruit weight of mandarin genotypes presented in Table 1. The fruits weight during year 2021-22 varied significantly from 125.89 to 220.69 g with population mean 166.10 g. The significantly maximum fruits weight was recorded in RHRM-19 (220.69 g) which was followed by RHRM-2 (198.93 g), RHRM-8 (190.67 g) and RHRM-21 (187.89 g), while the minimum fruits weight was recorded in RHRM-18 (125.89 g), respectively. In 2022-23, the fruits weight ranged from 126.35 to 232.61 g with the population mean 170.71 g. The significantly maximum fruits weight was recorded in RHRM-19 (232.61 g) which was followed by RHRM-2 (204.12 g), while the minimum fruits weight was recorded in RHRM-18 (126.35 g).

On the basis of pooled analysis, significantly the fruits weight ranged from 126.12 to 226.65 g with population mean of 168.41 g. The significantly maximum fruits weight was recorded in RHRM-19 (226.65 g) which was followed by RHRM-2 (201.53 g) and RHRM-8 (190.61 g), while the minimum fruits weight was recorded in RHRM-18 (126.12 g). The variation in the weight of fruit which might be due to genetic and environmental interaction. The present findings are in conformation with the results of Verma *et al.* (2012)^[17] in Nagpur Mandarin, Bhatnagar *et al.* (2015)^[3] in Nagpur Mandarin, Tripathi *et al.* (2016)^[16] in Coorg mandarin and Kalatippi *et al.* (2022) in Nagpur Mandarin.

Fruit yield (kg/tree): The data regarding the fruit yield of mandarin genotypes presented in Table 2. The fruit yield

during year 2021-22 varied significantly from 43.05 to 78.51 kg/tree with population mean 61.51 kg/tree. The maximum fruit yield was recorded in RHRM-10 (78.51 kg/tree) which was followed by RHRM-2 (75.20 kg/tree), RHRM-19 (72.83 kg/tree), RHRM-9 (72.59 kg/tree) and RHRM-11 (71.05 kg/tree), while the minimum fruit yield was recorded in RHRM-18 (43.05 kg/tree), respectively. In 2022-23, the fruit yield ranged from 36.39 to 67.56 kg/tree with the population mean 54.07 kg/tree. The maximum fruit yield was recorded in RHRM-10 (67.56 kg/tree) which was followed by RHRM-2 (66.13 kg/tree), RHRM-19 (66.06 kg/tree), RHRM-11 (65.39 kg/tree) and RHRM-9 (65.24 kg/tree), while the minimum fruit yield was recorded in RHRM-18 (36.39 kg/tree).

On the basis of pooled analysis, significantly the fruit yield ranged from 39.72 to 73.04 kg/tree with population mean of 57.79 kg/tree. The maximum fruit yield was recorded in RHRM-10 (73.04 kg/tree) which was followed by RHRM-2 (70.67 kg/tree), RHRM-19 (69.44 kg/tree), RHRM-9 (68.91 kg/tree) and RHRM-11 (68.22 kg/tree), while the minimum fruit yield was recorded in RHRM-18 (39.72 kg/tree). The difference observed in fruit yield per tree is due to more number of fruits and variation in the weight of fruits as well as maximum weight of fruit might be due to the genotypic content and their interaction with environment. Similar results were also recorded by Diwan *et al.* (2014)^[4] in Nagpur Mandarin, Meena *et al.* (2016)^[11] in Nagpur Mandarin, Barbora *et al.* (2019)^[2] in Khasi Mandarin and Singh *et al.* (2022)^[14] in mandarin.

Table 2: Performance of mandarin genotypes on fruit yield (kg/ tree) and fruit yield (t/ha)

S. N.	Genotypes	Fruit yield (kg/ tree)			Fruit yield (t/ha)		
		2021-22	2022-23	Pooled mean	2021-22	2022-23	Pooled mean
1.	RHRM-1	62.05	53.49	57.77	24.82	21.40	23.11
2.	RHRM-2	75.20*	66.13*	70.67*	30.08*	26.45*	28.27*
3.	RHRM-3	63.22	53.34	58.28	25.29	21.34	23.31
4.	RHRM-4	61.74	51.90	56.82	24.69	20.76	22.73
5.	RHRM-5	61.25	51.34	56.30	24.50	20.54	22.52
6.	RHRM-6	50.70	48.16	49.43	20.28	19.26	19.77
7.	RHRM-7	64.32	56.66	60.49	25.73	22.66	24.20
8.	RHRM-8	62.73	52.40	57.56	25.09	20.96	23.03
9.	RHRM-9	72.59*	65.24*	68.91*	29.04*	26.10*	27.57*
10.	RHRM-10	78.51*	67.56*	73.04*	31.41*	27.02*	29.21*
11.	RHRM-11	71.05*	65.39*	68.22*	28.42*	26.15*	27.29*
12.	RHRM-12	52.06	49.02	50.54	20.83	19.61	20.22
13.	RHRM-13	62.31	55.24	58.78	24.93	22.10	23.51
14.	RHRM-14	58.94	50.44	54.69	23.58	20.17	21.88
15.	RHRM-15	50.69	44.42	47.55	20.28	17.77	19.02
16.	RHRM-16	57.89	50.93	54.41	23.15	20.37	21.76
17.	RHRM-17	58.64	46.39	52.52	23.46	18.56	21.01
18.	RHRM-18	43.05	36.39	39.72	17.22	14.56	15.89
19.	RHRM-19	72.83*	66.06*	69.44*	29.13*	26.42*	27.78*
20.	RHRM-20	69.26	62.37*	65.82	27.70	24.95*	26.33*
21.	RHRM-21	67.08	58.62	62.85	26.83	23.45	25.14
22.	RHRM-22	59.59	54.19	56.89	23.84	21.68	22.76
23.	RHRM-23	57.31	48.69	53.00	22.92	19.48	21.20
24.	RHRM-24	51.14	47.24	49.19	20.46	18.90	19.68
25.	RHRM-25	52.73	49.04	50.89	21.09	19.62	20.35
26.	Standard check (Nagpur Mandarin)	62.43	55.28	58.86	24.97	22.11	23.54
	Min.	43.05	36.39	39.72	17.22	14.56	15.89
	Max.	78.51	67.56	73.04	31.41	27.02	29.21
	Mean	61.51	54.07	57.79	24.60	21.63	23.12
	SD	8.54	7.72	8.04	3.41	3.09	3.22
	Mean + SD	70.05	61.79	65.84	28.02	24.72	26.33
	Mean+ (2 x SD)	78.58	69.50	73.88	31.43	27.80	29.55
	S.Em. ±	1.67	1.51	1.58	0.67	0.61	0.63
	CV (%)	13.88	14.27	13.92	13.88	14.27	13.92

Note: * Mean > Mean + SD, **: Mean > Mean + 2 SD

Fruit yield (t/ha)

The data regarding the fruit yield of mandarin genotypes presented in Table 2. The fruit yield during year 2021-22 varied significantly from 17.22 to 31.41 t/ha with population mean 24.60 t/ha. The maximum fruit yield was recorded in RHRM-10 (31.41 t/ha) which was followed by RHRM-2 (30.08 t/ha), RHRM-19 (29.13 t/ha), RHRM-9 (29.04 t/ha) and RHRM-11 (28.42 t/ha), while the minimum fruit yield was recorded in RHRM-18 (17.22 t/ha), respectively. In 2022-23, the fruit yield ranged from 14.56 to 27.02 t/ha with the population mean 21.63 t/ha. The maximum fruit yield was recorded in RHRM-10 (27.02 t/ha) which was followed by RHRM-2 (26.45 t/ha), RHRM-19 (26.42 t/ha), RHRM-11 (26.15 t/ha), RHRM-9 (26.10 t/ha) and RHRM-20 (24.95 t/ha), while the minimum fruit yield was recorded in RHRM-18 (14.56 t/ha).

On the basis of pooled analysis, significantly the fruit yield ranged from 15.89 to 29.21 t/ha with population mean of 23.12 t/ha. The maximum fruit yield was recorded in RHRM-10 (29.21 t/ha) which was followed by RHRM-2 (28.27 t/ha), RHRM-19 (27.78 t/ha), RHRM-9 (27.57 t/ha), RHRM-11 (27.29 t/ha) and RHRM-20 (26.33 t/ha), while the minimum fruit yield was recorded in RHRM-18 (15.89 t/ha). The difference observed in fruit yield per hectare is due to more number of fruits per tree and variation in the weight of fruits as well as maximum weight of fruit might be due to the genotypic content and their interaction with environment. Similar results were also recorded by Shirgure *et al.* (2016)^[13] in Nagpur Mandarin, Barbora *et al.* (2019)^[2] in Khasi Mandarin, Kakoti *et al.* (2019)^[2] in Khasi Mandarin and Singh *et al.* (2022)^[14] in mandarin.

Conclusion

The performance of most of the genotypes were superior to the performance of the check (Nagpur mandarin) for most of the yield parameters which were studied. Overall RHRM-10 was found best for yield parameters highest number of fruits/tree, fruit yield (kg/tree) and fruit yield (t/ha) which were followed by the genotype RHRM- 2, RHRM- 19, RHRM- 9 and RHRM- 11.

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