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Variability Studies of strains of kagzi lime(*Citrus aurantifolia* Swingle) in Latur district of Maharashtra, India

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ABSTRACT

The survey work was under taken to study the variability in kagzi lime of Latur district during 2010-2011. The strain LTR_5 recorded the maximum height of plant (4.22 m), which was on par with LTR_8 (4.20 m) and LTR_{13} (4.18 m). There was a significant variation in tree volume ranged from 8.87 m^3 to 57.82 $m.^3$ The strain LTR_{19} was recorded the maximum tree volume (57.82 m^3). Maximum number of fruits per tree (2390.00) was recorded in strain LTR_5. Maximum fruit weight was recorded in LTR_{11} (65.33 g), which was on par with strain LTR_2 (64.00 g).The fruit volume was recorded maximum in LTR_{11} (65.00 ml), which was on par with strain LTR_2 (64.00 ml). The length of fruit was maximum in LTR_{11} (4.95 cm), which was on par with LTR_8 (4.92 cm), whereas, the maximum breadth of fruit was recorded in strain LTR_8 (4.70cm). The highest shape index of fruit was recorded in LTR_{11} (1.09), which was at par with LTR_3 (1.07). Many strains were yellow in colour, oval shaped and smooth in texture.

Key words: Fruit characters, Growth, Kagzi lime.

INTRODUCTION

Kagzi lime (*Citrus aurantifolia* Swingle) belongs to family *Rutaceae,* originated in India and it is the third most important citrus speciese, after Mandarin and Sweet orange. Maharashtra is leading state in acid lime cultivation grown commercially in Vidarbha and Marathwada region. The fruits are extensively used for preparation of squashes, pickles, syrups and cordials, citric acid and for table purpose in daily life of Indians (Cheema *et al*. 1954). The fruits are valued not only for its nutritional qualities but also for medicinal purposes.

Under south and central Indian conditions, normally kagzi lime produces three distinct bahar (crop) viz., Mrig, Haste and Ambe bahar. The varieties like Kagzi limbu, Pat limbu and Godhadi limbu were cultivated in the Maharashtra State (Cheema, *et al*. 1954). However, there are some types which produce fruit almost throught the year (Baramsi) and are highly value for summer crop. The citrus industry of Marathwada region have heavy demand for supply of improved kagzi lime seedlings to cultivators. It also indicated great scope for improvement in yield and fruit quality by clone's selection from the innumerable seedlings already available under cultivation (Jature and Chakrawar, 1981).Considering the importance of kagzi lime a survey was undertaken to study growth and yield attributes of various local genotypes.

MATERIALS AND METHODS

The survey was undertaken in the Latur district of Maharashtra during *mrig bahar* 2010-11. Different locations visited from which, LTR_1, LTR_2, LTR_3, LTR_4, LTR_5, LTR_6, LTR_7, LTR_8, LTR_9, LTR_{10}, LTR_{11}, LTR_{12}, LTR_{13}, LTR_{14}, LTR_{15}, LTR_{16}, LTR_{17}, LTR_{18}, LTR_{19}, LTR_{20}, LTR_{21}, LTR_{22}, LTR_{23}, LTR_{24}, LTR_{25}, LTR_{26}, LTR_{27} and LTR_{28} strains were selected for analysis. Observations were recorded for height of tree (m), Tree volume (m^3), number of fruits per tree, weight of fruit(g), volume of fruit (ml), yield (kg/tree), colour of fruit, shape of fruit, texture of fruit, length of fruit (cm), breadth of fruit (cm) and shape index of fruit (L/B).The experiment was laid out in randomized block design (RBD) with three replications as per the procedure outlined by Panse and Sukhatme (1967).

RESULTS AND DISCUSSION

The data pertaining to Height of tree (m), Tree volume (m^3), number of fruits per tree ,weight of fruit, volume of fruit (ml), yield (kg/tree), presented in Table1 were significant among the strains.

Height of tree (m): The maximum height of the tree (4.22 m) was recorded in strain LTR_5, which was on par with strains LTR_8, (4.20 m) and LTR_{13} (4.18 m). While, strain LTR_{16} was recorded the lowest height of tree (2.36 m). The maximum height of tree might be due to the more vigorous growth. Madhavi and Babu (2003) observed similar variation in

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height of tree among the seven varieties of sweet orange found the maximum height of tree (4.28 m) in Jaffa and minimum (2.41 m) in Blood Red Malta. Shinde *et al.* (2004) also reported similar variation in the height. The results of the present study are in conformity with the reports of the above research works.

Tree volume (m^3): The highest tree volume (57.82 m^3) was observed in strain LTR_{19}, which was on par with strain LTR_8 (55.22 m^3). The strain LTR_{12} was recorded the lowest tree volume (8.87 m^3). The results on tree volume revealed a wide range from 8.87 to 57.8 $m.^3$Singh *et al.* (1998) studied fruit growth and development in kinnow mandarin and found that maximum tree volume(70.0 m^3) was recorded in Troyer and minimum (40.7 m^3) in Kharna Khatta. The results found above scientists are in contradiction with present investigation.

Number of fruits per tree: The highest number of fruits per tree was recorded in strain LTR_5 (2390.00), followed by LTR_8 (2350.00), while, lowest (704.00) was recorded in LTR_{16}. The number of fruits per tree revealed a wide range form 704.00 to 2390.00. The higher number of fruits per tree obtained may be due to more vegetative growth which resulted to high rate of photosynthesis. Swammy *et al*. (1972) found the significant variation for number of fruits per tree , kagzi lime tree bear fruits from 3000 to 5000 fruits annually, Jature and Chakrawar (1981) found significant variation ranged from 600 to 2100. The results obtained in the present investigation are inconformity with the above workers.

Weight of fruit (g): The strain LTR_{11} was recorded the highest weight of fruit (65.33 g), followed by strain LTR_2 (64.00 g) and LTR_5 (60.00 g). The lowest weight of fruit (31.01 g)was observed in strain LTR_{16}-.This might be due to maximum leaf area and tree volume. These result are in conformity with the findings of Jature and Chakrawar (1981). Badiyala *et al.* (1992) and Athani *et al.* (2009).

Volume of fruit (ml): Volume of fruit varied significantly among the strains of kagzi lime. The strain LTR_{11} was recorded the highest volume of fruit (65.00 ml), followed by strain LTR_2 (64.00 ml). The lowest volume of fruit was observed in strain LTR_{16} (31.00 ml). Trithakar (2004) found the volume of fruit ranged from 33.79 cc to 48.6 cc. Athani *et al.* (2009) studied kagzi lime strains and found the volume

Table 1: Growth and yield characters of Kagzi lime(*Citrus aurantifolia* Swingle) strains

Strains	Height of tree(m)	Tree volume(m^3)	Number of fruits per tree	Weight of fruit (g)	Volume of fruit (ml)	Yield(kg/tree)
LTR_1	3.99	53.45	2012.00	53.20	52.74	107.03
LTR_2	4.08	50.95	1778.00	64.00	64.00	113.70
LTR_3	3.95	50.69	2005.00	52.85	52.27	105.96
LTR_4	3.58	36.43	2018.00	47.02	46.68	94.88
LTR_5	4.22	53.52	2390.00	60.00	60.70	144.59
LTR_6	3.29	26.22	1975.00	42.94	43.54	84.80
LTR_7	3.45	29.88	2110.00	41.58	41.11	87.73
LTR_8	4.20	55.22	2350.00	56.50	56.70	132.71
LTR_9	3.78	41.32	2000.00	53.00	52.50	106.00
LTR_{10}	2.80	17.79	1001.00	40.60	40.05	40.64
LTR_{11}	3.82	52.45	1600.00	65.33	65.00	104.52
LTR_{12}	3.01	8.87	1557.00	44.28	45.68	68.94
LTR_{13}	4.18	49.34	2120.00	52.60	52.90	111.50
LTR_{14}	2.88	23.73	945.00	52.00	51.70	49.14
LTR_{15}	3.24	20.78	1500.00	51.13	50.90	76.54
LTR_{16}	2.36	13.19	704.00	31.01	31.00	21.83
LTR_{17}	3.18	19.94	1405.00	43.00	43.02	60.41
LTR_{18}	3.28	30.99	1540.00	49.01	49.00	75.47
LTR_{19}	3.98	57.82	1910.00	56.70	56.05	108.20
LTR_{20}	3.97	51.92	2030.00	52.30	52.63	106.16
LTR_{21}	3.28	28.14	1798.00	46.01	46.02	82.72
LTR_{22}	3.84	47.86	2100.00	50.43	50.36	105.90
LTR_{23}	3.29	33.48	1527.00	55.00	54.90	83.98
LTR_{24}	3.54	34.01	1700.00	54.80	54.60	93.16
LTR_{25}	3.20	27.93	1705.00	40.65	40.32	69.30
LTR_{26}	3.92	39.07	2050.00	50.60	50.53	103.73
LTR_{27}	3.14	24.57	993.00	50.16	50.28	49.80
LTR_{28}	3.93	47.44	2040.00	51.90	51.10	105.87
S.E. ±	0.130	4.83	80.72	2.87	2.58	5.24
C.D. at 5%	0.361	13.36	223.2	7.95	7.14	14.51
C.V. (%)	9.36	12.73	10.12	10.98	9.90	10.19

of fruit ranged from (20.3 to 65.3 ml). The results obtained in the present investigation are inconformity with above findings.

Yield (kg/tree): The highest fruit yield (144.59 kg/tree)was observed in strain LTR_5, followed by strain LTR_8 (132.71 kg/tree) and strain LTR_2 (113.70 kg/tree) respectively, while the lowest fruit yield was found in strain LTR_{16} (21.83 kg/tree). The higher yield was due to more number of fruits. Jature and Chakrawar (1981) studied 89 kagzi lime strains and found the ND 1, ABD 3, PBN 8 and PBN 12 were highly productive range of variation 136 to 175 kg per plant. Badiyala *et al.* (1992) studied kagzi lime strains and found a range of variation in (30.00 kg to 195.00 kg per tree). Ranpise *et al.* (1995) evaluation acid lime clones in two year and revealed that the yield varied from (0.40 to 4.40 kg/tree).

Fruit characters: The observations pertaining to fruit characters vize,Colour of fruit ,Shape of fruit, Texture of fruit, Length of fruit (cm), Breadth of fruit (cm) and Shape index of fruit (L/B) presented in Table 2 were significant.

Colour of fruit: The results revealed variation in colour of fruit. The fruit of stain LTR_1, LTR_4, LTR_5, LTR_7, LTR_8, LTR_{12}, LTR_{13}, LTR_{16}, LTR_{19}, LTR_{22}, LTR_{23}, LTR_{26} and LTR_{27} were yellow in colour, whereas, strain LTR_2, and LTR_{11}, showed dark yellow coloured fruits. Strains LTR_3, LTR_9, LTR_{10}, LTR_{15}, LTR_{17}, LTR_{20}, LTR_{21}, LTR_{25} and LTR_{28} showed greenish coloured fruits. Strains LTR_6, LTR_{14}, LTR_{18} and LTR_{24} showed light yellow coloured fruits. This might be caused due to the genetical difference among the strains of kagzi lime and similar study was conducted by Badiyala *et al.* (1992) observed yellow coloured fruits in strain Primrose 601/1.

Shape of fruit: Oval shape was observed in fruits of strains LTR_1, LTR_2, LTR_3, LTR_4, LTR_5, LTR_8, LTR_9, LTR_{11}, LTR_{14}, LTR_{15}, LTR_{18}, LTR_{19}, LTR_{20}, LTR_{21}, LTR_{23}, LTR_{24}, LTR_{27}, and LTR_{28}, . Round shaped fruits were found in strains LTR_6, LTR_7, LTR_{10}, LTR_{12}, LTR_{16}, LTR_{17}, LTR_{22}, LTR_{25} and LTR_{26}. Spherical shape fruits were found in strain LTR_{13}. It might be due to genetical difference of the kagzi lime strains. Many research workers, Aulakh *et al.* (1992) found round shape of fruit in Dhaulakuan-18, Jature and Chakrawar (1981) found most of the strains were oval (47.19 %) and round (24.71 %) in shape. Bagde and Patil (1989) reported round shape of fruits in Chakradhar lime.

Table 2: Physical characters of fruits of Kagzi lime(*Citrus aurantifolia* Swingle) strains

Strains	Fruit					
	Colour	Shape	Texture	Length (cm)	Breadth (cm)	Shape index (L/B)
LTR_1	Yellow	Oval	Smooth	4.56	4.56	1.06
LTR_2	Dark yellow	Oval	Smooth	4.50	4.26	1.05
LTR_3	Greenish	Oval	Rough	4.46	4.15	1.07
LTR_4	Yellow	Oval	Rough	4.44	4.25	1.04
LTR_5	Yellow	Oval	Smooth	4.85	4.50	0.07
LTR_6	Light yellow	Round	Smooth	4.56	3.99	1.10
LTR_7	Yellow	Round	Smooth	4.04	3.98	1.00
LTR_8	Yellow	Oval	Smooth	4.92	4.70	1.04
LTR_9	Greenish	Oval	Rough	4.50	4.20	1.07
LTR_{10}	Greenish	Round	Rough	4.00	3.89	1.02
LTR_{11}	Dark yellow	Oval	Very smooth	4.95	4.54	1.09
LTR_{12}	Yellow	Round	Smooth	4.02	3.99	1.00
LTR_{13}	Yellow	Spherical	Smooth	4.36	4.56	0.90
LTR_{14}	Light yellow	Oval	Rough	4.41	4.19	1.05
LTR_{15}	Greenish	Oval	Very smooth	4.53	4.31	1.05
LTR_{16}	Yellow	Round	Smooth	3.75	3.70	1.01
LTR_{17}	Greenish	Round	Rough	4.07	4.05	1.00
LTR_{18}	Light yellow	Oval	Smooth	4.56	4.33	1.05
LTR_{19}	Yellow	Oval	Smooth	4.85	4.60	1.05
LTR_{20}	Greenish	Oval	Rough	4.35	4.17	1.04
LTR_{21}	Greenish	Oval	Rough	4.37	4.20	1.04
LTR_{22}	Yellow	Round	Very smooth	4.53	4.04	1.01
LTR_{23}	Yellow	Oval	Smooth	4.85	4.65	1.04
LTR_{24}	Light yellow	Oval	Smooth	4.75	4.55	1.04
LTR_{25}	Greenish	Round	Rough	3.90	3.86	1.01
LTR_{26}	Yellow	Round	Smooth	4.53	4.07	1.01
LTR_{27}	Yellow	Oval	Smooth	4.60	4.30	1.06
LTR_{28}	Greenish	Oval	Rough	4.58	4.44	1.03
S.E. ±	-	-	-	0.193	0.194	0.071
C.D. at 5%	-	-	-	0.536	0.537	0.196
C.V. (%)	-	-	-	9.53	9.90	12.30

Texture of fruit: The result revealed that , variation in texture of fruits. The fruit of stains LTR_1, LTR_2, LTR_5, LTR_6, LTR_7, LTR_8, LTR_{12}, LTR_{13}, LTR_{16}, LTR_{18}, LTR_{19}, LTR_{23}, LTR_{24}, LTR_{26} and LTR_{27} were smooth in texture, whereas, strains LTR_3, LTR_4, LTR_9, LTR_{10}, LTR_{14}, LTR_{17}, LTR_{20}, LTR_{21}, LTR_{25} and LTR_{28} showed rough texture of fruits. Strains LTR_{11}, LTR_{15} and LTR_{22} showed very smooth texture of fruits. Badiyala *et al.* (1992) studied sixty seven kagzi lime strains and found the fruits of Primose 601/1 had smooth and rough rind appeal. Singh *et al.* (2009) observed smooth, rough, semi smooth and very smooth texture fruits.

Length of fruit (cm): Length of fruit varied significantly among the strains of kagzi lime. The results on length of fruit revealed a wide ranged from 3.75 cm to 4.95 cm. The strain LTR_{11} was recorded the maximum length of fruit (4.95 cm), which was on par with LTR_8 (4.92 cm). The minimum length of fruit was observed in strain LTR_{16} (3.75 cm). Tirthakar *et al.* (2004) studied forty-eight acid lime cultivars and found the maximum length of fruit (5.20 cm) in Dongargaon which was on par with Kanheri (5.12 cm), while minimum in Maispur (3.52 cm).

Breadth of fruit (cm): Breadth of fruit was varied significantly among the kagzi lime strains. Breadth of fruit revealed a wide ranged from 3.70 to 4.70 cm. In this respect strain LTR_8 had highest breadth of fruit (4.70 cm) followed by strain LTR_{23} (4.65 cm) and lowest breadth of fruit (3.70 cm) in strain LTR_{16}. Arora and Daulta (1981) found the maximum breadth of fruit (5.84 cm) in seedless kagzi lime followed by baramsi (5.59 cm). Tirthakar *et al.* (2004) found the maximum breadth of fruit (5.10 cm) in Dongargaon followed by Kanheri (4.75 cm), while minimum in Maispur (4.13 cm).

Shape index of fruit (L/B): Shape index of fruit varied significantly among the strains of kagzi lime. The strain LTR_{11} was recorded the highest shape index of fruit (1.09) which was on par with strains LTR_3 and LTR_9 (1.07) and lowest shape index of fruit was observed in strain LTR_5 (0.07). Similar study was conducted by Jature and Charawar (1981) found a range of variation for shape index of fruit ranged from 0.83 to 2.00. Prasad (1989) reported that fruit shape index was maximum (1.03) in clone No.5 and minimum(0.81) in clone No.29. The results obtained in the present investigation are inconformity with the above findings.

CONCLUSION

It can be summarized that, out of 28 strains of kagazi lime studied, the strain LTR_5 was found most suitable for cultivation in Latur District of Maharashtra as it has performed well with higher yield (144.6 kg/tree), more number of fruits (2390/tree) and fruit weight (60.00g/fruit).

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