

FRUIT VARIABILITY IN KINNOW MANDARIN (*CITRUS RETICULATA*)

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Abstract

Kinnow mandarin is hybrid of King and Willow leaf. The cultivar has extreme variability in all fruit characteristics which is undesirable for fresh fruit export. Twelve lots of good looking, healthy clean fresh fruits were taken from different locations. The characteristics studied were fruit and peel weight, fruit volume, diameter, height, number of segments, seed shapes, total seeds, aborted seeds, seed embryony, juice pH and juice Brix. The fruit weight ranged from 101-287 grams, volume 110-300 ml, diameter 5.2-8.5 cm, fruit height 4.2-7.0 cm, number of segments per fruit 8-12, the fruit central core solid to hollow, fruit peel weight 24-71 grams, total seeds including aborted seeds 4-37, while developed seeds per fruit 3-35, developed seeds have 2-5 different shapes. Both mono and polyembryonic seeds were present in fruits of Kinnow lots. The lowest seed number was found in marker fruits. The fruit juice pH ranged 3.5-4.4 and the fruit juice Brix ranged 8-12.5 at the end of January, indicating the differences in the physiological maturity time of different fruits. The variability in Kinnow fruit orchards can be exploited for selection of superior quality strains.

Introduction

Kinnow mandarin is the adapted dominant *Citrus* in Pakistan, because of heat tolerance capability of the cultivar which it has inherited from its parent cultivar King. The maximum temperatures exceeds above 45°C for some days in hot summer without much harm to Kinnow. The core production area lies in central Punjab. Kinnow plant has vigorous growth and heavy yield with favorable growing conditions in orchards and sufficient irrigation. It has attractive fruit color, size and good eating quality, flesh color deep yellowish orange, juicy and rich, aromatic and distinctive flavor. Kinnow fruit production is intended for fresh fruit market. Kinnow fruits show immense variation in color, size, shape, texture, easiness of peeling, adherence of peel and segments, solid or hollow central core, juice pH, color, volume, Brix, TSS, seed number per fruit, seed size and shape, and embryony status of plant. This extreme variation expresses the loss of quality and purity of the fruit cultivar because of the variation in scion bud wood. Just like mono cropping the dependence upon single cultivar is not reliable as it is vulnerable to destruction over the period of time if the clone is not properly maintained. Earlier cultivar variability has been documented by various scientists (Altaf *et al.*, 2002; Khan, 1992). The fruit quality in Owari cultivar is different in fruits having leafy and leafless inflorescence origin (Iqbal *et al.*, 2004). The solution lies in selecting desirable strains from Kinnow orchards from different agro climatic conditions of Punjab and good management practices of trees for producing good quality healthy clean fruits. Fruit quality in Kinnow mandarin is influenced by foliar application of K and N fertilizers and foliar application of Zn, Fe and Mn (Monga & Josan, 2000). Rootstocks significantly influence the leaf mineral composition and reproductive characteristics of Kinnow mandarin (Din *et al.*, 2001). *Citrus* are mainly cultivated for their fruit. The quality of the fruit is defined in simple complex and specific terms recognizing that it is eventually a matter of consumer preferences. Fruit quality is foremost an inherent scion cultivar trait (Castle, 1995). He also documented that rootstock as a fruit quality factor in *Citrus*

cannot be ignored. The objective of the study was to have an idea of the extent of variation in fruit lots which originated in different locations within same climatic conditions.

Materials and Methods

Twelve lots (L₁-L₁₂) of Kinnow fruits mentioned below were randomly collected from different locations of Punjab Province in the end of January-2008. L₁: UAF Orchard, L₂: Sargodha orchards, L₃: Bhalwal orchards, L₄: Faisalabad orchards, L₅: Nucellar Plants, L₆: Marker fruits from Okara, L₇: Marker fruits (T.T Singh), L₈: Market fruits from Faisalabad, L₉: Lahore market, L₁₀: Sahiwal orchards, L₁₁: Seedling Trees, L₁₂: Samundri market. Ten healthy good looking clean fruits were selected from each lot. Weight, volume, height, and diameter of the 10 fruits in each lot were recorded. Fruit diameter was measured at the equator of each fruit while height was measured between stem and stylar end. From these values fruit shape can be assessed. The overall characteristics of fruits were recorded. The carpel polymorphism as number of segments per fruit was also noted. The juice characteristics were recorded in end of January. The extracted juice was filtered by muslin cloth to remove the aborted seeds and few drops of the juice were put on the hand refractometer. The reading was noted and was considered as Brix. For Juice pH, the pH meter was calibrated with buffers and pH of the juice was noted. The total number of seeds including aborted and developed seeds per fruit were recorded. The developed seeds (S₁-S₁₀) per fruit were also recorded. The number of seed shapes of developed seeds in each fruit were also noted. In order to determine the embryony status, the number of cotyledons in each seed were observed after removing both the seed coats. Seeds having two cotyledons and those with more than two were noted as monoembryonic and poly embryonic respectively. The embryony status of each fruit was noted. The data was subjected to an analysis of variance followed by Duncan's Multiple Range Test (Steel & Torrie, 1980).

Results and Discussion

Lots 1-4 and 7-12 were completely polyembryonic. Lot₅ had 2 fruits with mono embryonic seeds, the developed seed number of 2 fruits were 7 and 12. In lot 6 one fruit had 16 developed seeds, which were polyembryonic; the rest of the fruits had monoembryonic seeds. Lot 6 had minimum 3seeds per fruit and lot 9 had maximum 35 seeds per fruit. Sharma & Thind (2005) observed that the seed number per fruit ranged 0-35 in Kinnow orchards in Ferozpur of Indian Punjab. The mean seed number was less than 10 in lot 6, 7 and 11(Table 1). Mean number of seeds (16.33) per fruit was noted in Kinnow in Nagpur, Maharashtra, India (Singh & Singh, 2004). In this study, higher seed number was usually polyembryonic which clearly indicated that apomictic seeds contribute to seediness character of Kinnow mandarin. The degree of Polyembryony of a *Citrus* variety is influenced by the environment, variation being observed from seed to seed, from fruit to fruit, from sector to sector in the same plant and from year to year (Filho *et al.*, 1995). The developed seeds have different seed shapes may be due to the Kinnow orchards have usually mixed *Citrus* plants. Different seed shapes may be due to different pollens around. The aborted seeds ranged from 0-9 per fruit in 12 Kinnow lots. The fruit characteristics like weight, volume, height, peel weight, number of segments, juice pH, and Brix all were variable in Kinnow lots, indicate the fruit quality variation which has negative impact on fresh fruit market. The number of segments in 12 fruit lots were 8-12. Number of Segment per fruit were 11.5 in Kinnow in India (Singh & Singh, 2004). The number of segments

represents the number of carpals within the ovary. As Kinnow is a hybrid variety, crossing parents with dissimilar fruit segment numbers produces progeny with a range of segment numbers (Tisserat *et al.*, 1990). The number of developed and undeveloped ovules also varies per segment in fruits of each lot. The juice pH in 12 lots ranged from 3.7 to 4.3 and juice Brix ranged between 8 to 11.5 in end of January which was the coldest month of the winter. This clearly indicated the variability in physiological maturity time of the Kinnow fruit. All the fruit lots have variability (Table 2). Changes of fruit quality traits in seven Clementine selections during maturation was studied in Morocco and it was found that the rate of rind color change is the only parameter that differs between most of Clementine (Chahidi *et al.*, 2008). Lot 6 and 7 have marker fruits (Fig. 1), marker is formed due to late abscission of style at the proximal end. The normal fruits have no marker as they have style abscission after petal fall. The marker fruits are characteristics of hybrid cultivars (Garcia *et al.*, 2001). The seed shapes are not uniform (Fig. 2) in any fruit lot. Both mono and polyembryonic seeds were present in lot 5 and 6 (Fig. 3). The low seeded trait (3seeds per fruit) was present in lot₆ (Fig. 4).



Fig. 1. Marker fruits.



Fig. 2. Seed shapes.



Fig. 3. Mono (left) & Poly embryony (right).

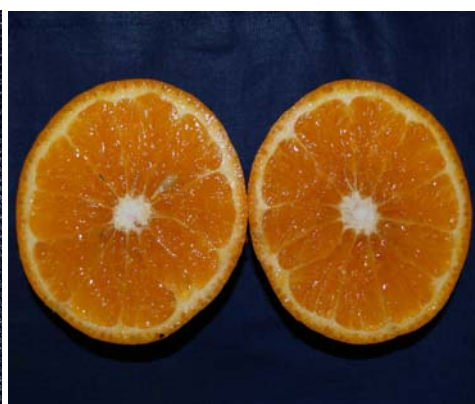


Fig. 4. Three Seeded Kinnow fruit.

Table 1. Seed: mono and poly embryony in Kinnow fruits.

Lot ▶ Number ◀	L ₁	L ₂	L ₃	L ₄	L ₅	L ₆	L ₇	L ₈	L ₉	L ₁₀	L ₁₁	L ₁₂
S ₁	27	8	23	27	7*	6*	9	22	21	20	14	22
S ₂	33	25	21	23	21	6*	8	15	28	22	6	19
S ₃	23	15	17	20	6	4*	11	18	35	25	8	20
S ₄	21	29	17	27	14	16	10	27	25	20	7	16
S ₅	24	26	29	29	20	6*	10	14	24	22	8	22
S ₆	25	27	32	22	10	5*	6	19	26	21	13	20
S ₇	21	21	21	13	12*	6*	9	12	29	27	7	17
S ₈	21	23	23	26	15	5*	10	16	32	20	7	17
S ₉	17	26	19	23	12	3*	10	13	24	23	9	19
S ₁₀	13	26	16	13	7	4*	7	21	21	27	7	16
Means	22.5	22.6	21.8	22.3	12.4	6.1	9	17.7	26.5	22.7	8.6	18.8
Seed range	13-33	8-29	16-32	13-29	7-21	3-16	6-11	12-27	21-35	20-27	6-14	16-22

* Mono embryonic seeds, L = Lot, S = Sample

L₁: U/AF Orchard, L₂: Sargodha, L₃: Bhalwal, L₄: Faisalabad, L₅: Nucellar Plants, L₆: Marker fruits from Okara, L₇: Marker fruits (T.T Singh), L₈: Market fruits from Faisalabad, L₉: Lahore, L₁₀: Sahiwal L₁₁: Seedling Trees, L₁₂: Samundri

Table 2. Kinnow fruit characteristics.

	Weight (g)	Volume (ml)	Diameter (cm)	Height (cm)	Peel wt.	Total seeds	Seed shapes	Aborted seeds	pH	Brix
Lot ₁	157.4 ^e	171.9 ^f	7.200 ^d	5.570 ^{def}	40.90 ^{defg}	26.20 ^{abc}	2.800 ^{bcd}	3.700 ^{bcd}	4.020 ^{bc}	8.800 ^f
Lot ₂	211.2 ^{bc}	218.4 ^{bc}	8.040 ^b	5.750 ^{cde}	63.10 ^{ab}	26.70 ^{abc}	3.600 ^a	4.100 ^{abc}	4.010 ^{bc}	9.300 ^{ef}
Lot ₃	200.0 ^{bcd}	214.4 ^{bcd}	7.630 ^{bcd}	5.600 ^{cdef}	54.00 ^{bc}	23.00 ^{bc}	3.300 ^{ab}	4.200 ^{abc}	4.060 ^{ab}	9.900 ^{de}
Lot ₄	196.5 ^{bcd}	213.2 ^{bcd}	7.350 ^{cd}	5.690 ^{cde}	52.20 ^c	27.40 ^{ab}	2.900 ^{bc}	5.100 ^a	4.080 ^{ab}	10.10 ^{cd}
Lot ₅	173.3 ^{de}	187.6 ^{def}	7.410 ^{cd}	5.460 ^{ef}	45.40 ^{cdef}	16.80 ^d	3.600 ^a	4.500 ^{ab}	4.090 ^{ab}	11.00 ^a
Lot ₆	180.0 ^{de}	189.5 ^{cdef}	7.580 ^{bcd}	6.030 ^{bc}	32.10 ^g	7.200 ^e	2.200 ^{de}	1.100 ^f	3.840 ^d	9.970 ^{de}
Lot ₇	217.5 ^b	217.5 ^{bcd}	7.850 ^{bc}	6.340 ^{ab}	51.90 ^{cd}	11.50 ^e	2.000 ^e	2.500 ^e	4.080 ^{ab}	9.700 ^{de}
Lot ₈	172.5 ^{de}	177.0 ^{ef}	7.350 ^{cd}	5.180 ^f	39.40 ^{fg}	21.80 ^c	2.400 ^{cde}	4.100 ^{abc}	3.910 ^{cd}	10.90 ^{ab}
Lot ₉	244.2 ^a	262.0 ^a	8.550 ^a	6.630 ^a	72.60 ^a	28.80 ^a	2.100 ^e	2.300 ^e	3.870 ^d	10.26 ^{bcd}
Lot ₁₀	195.5 ^{bcd}	203.5 ^{bcd}	7.870 ^{bc}	5.910 ^{cd}	51.20 ^{cde}	25.90 ^{abc}	2.600 ^{cde}	3.200 ^{cde}	3.690 ^e	10.19 ^{bcd}
Lot ₁₁	189.1 ^{cd}	225.0 ^d	7.670 ^{bcd}	5.840 ^{cde}	40.30 ^{efg}	10.70 ^e	2.200 ^{de}	2.100 ^{ef}	4.170 ^a	10.25 ^{bcd}
Lot ₁₂	180.5 ^{de}	207.5 ^{bcd}	7.240 ^d	5.400 ^{ef}	46.40 ^{cdef}	21.70 ^c	2.600 ^{cde}	2.900 ^{de}	4.040 ^{abc}	10.70 ^{abc}

Figures with in a column followed by different letters are significantly different by Duncan's Multiple Range Test ($p < 0.05$).

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