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SOME STUDIES ON THE MORPHOLOGY OF KINNOW MANDARIN AND FEUTRELL'S EARLY

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Study was carried out to explore the descriptive characteristics of two citrus cultivars viz: Kinnow mandarin and Feutell's early. Tree characteristics: tree shape, tree growth habit, leaf division, leaf apex and petiole wings were explored. As for as the fruit description is concerned, fruiting season, chemical and physical nature of the fruit was explored.Tree growth of both Kinnow Mandarin and Feutrell's Early was spreading and spheroid with simple leaf division. Leaf lamina attachment was brevipetiolate and petiole wing was absent in both cultivars. Leaf apex was acute in Kinnow Mandarin while it was obtuse in Feutell's Early. Fruits of Kinnow were spheroid in shape and that of Feutrell's Early were obloid. Maximum fruit weight (133.4 g) was observed in Feutrell's Early on 30th December and 164.3g in Kinnow Mandarin on 26th March. Fruit colour of Feutrell's Early turned to Indian orange on 3rd December and that of Kinnow became Spanish orange on 11th March. In Feutrell's Early TSS/acid ratio was highest (20.05) in mid January while in Kinnow the highest TSS/acid (25.34) was recorded on 11th March. Organolaptic values for Feutrell's Early were highest in late January and were lowest in November. Kinnow showed excellent organolaptic values during February-March and minimum in early December.
Key wards: Mandarin, lamina, obliod, organolaptic

INTRODUCTION

Frost bred Kinnow Mandarin in 1915 at riverside California by crossing King with Willow leaf mandarin. The name Kinnow was given to it after its parents; King (kin) and Willow (ow) names when released as a commercial variety in 1935 (Webber and Batchler, 1948) The climate of Pakistan proved to the be the best for the excellent production of Kinnow (Saunt, 1990). Feutrell's early is an old variety of New South Wales. Its history and origin are unknown. The fruit characteristics indicate that it may be a natural tangor and those of the tree suggest the possibility that Mediterranean or Willow leaf might have been the mandarin parent. The mature citrus tree is a living and changing entity. Under the influence of a Mediterranean type, subtropical climate citrus species become dormant in winter, but do not shed their leaves. Auxiliary buds begin to break during warm spell, but the new shoots do not actively grow until late February or March. Flowering and fruit formation occur annually in most citrus species. Leaves auxiliary buds, thorns, flowers, and fruits are produced on citrus stem. Leaves are arranged spirally around the stem, and phyllotaxy is 3/8 for different species including mandarin. Citrus leaf is unifoliately compound and pinnately reticulate in venation. Abscission zones occur between the petiole and stem. The dormant auxiliary vegetative bud begins growing as vegetative shoots. However, the vegetative apical meristem of the elongating shoots is transformed into a terminal flower bud (Randhawa and Isa, 1947). Polyembryonic seeds are derived from the ovule through a series of growth and development changes. There are several embryos covered by an inner coat that is thin, dry, tough, leathery, straw colored and slippery when wet. Morphological aspects of development and senescence of tissues described in these studies are based on plant material collected from Sargodha and Faisalabad districts, Pakistan. As for the description is concerned, various parameters have been employed for example, passport descriptors provide the basic information used for the general management of the accession. Management descriptors provide the basis for the management of accessions in the gene bank and assist with their multiplication and regeneration. Environment and site descriptors describe the environmental and site-specific parameters e.g. topography, hypsographic feature that are important when characterization and evaluation trials are held. Characterization descriptors enable an easy and quick discrimination between phenotypes, Evaluation descriptors include characters such as yield, agronomic performance, stress susceptibilities and biochemical and cytological traits. Although citrus is not a new fruit in Pakistan, but people are yet little conscious about its plant behaviour, propagation techniques, appropriate time of plantation, planting method, optimum edaphic conditions, environmental influence and proper measures to minimize the effect of the changes. Descriptive studies provide the documentation of vegetative and reproductive part of Kinnow mandarin and Feutrell's Early.

Objectives of this study were to create awareness in the farmers/ citrus growers about the basic infrastructure of citrus tree, to provide initiative for citrus groove plantation and help in establishing true to type citrus nursery plants.

MATERIALS AND METHODS

Five trees were selected form each garden (Faisalabad and Sargodha) of Feutrell's Early and Kinnow mandarin. A detailed narrative of materials and method employed are given below:

Tree description

a) Tree shape: Ellipsoid, spheroid, obloid
b) Tree growth habit: Erect, spreading, drooping
c) Leaf description:
   i. Leaf division: Simple, Bifoliate, Trifoliate, Pentafoliate
   ii. Intensity of green color: Light, Medium, Dark
   iii. Leaf Apex: Attenuate, Acuminate, Acute, Obtuse, Rounded and Emarginate
   iv. Petiole wings: Absent, Present

Fruit description

i. Fruiting season: Early, Mid, Late.
ii. Fruit shape: Spheriod, Ellipsoid, Pyriform, Obloid, Ovoide.
iii. Fruit skin color: Green, Green-yellow, Light yellow, Yellow, Dark Yellow, Light orange, orange, Red orange, Red.
iv. Fruit surface texure: Smooth, Rough, Papillate, Pitted, Bumpy, Grooved.

Samples of both varieties (F. Early and Kinnow) were collected with the following schedule. Ten samples were taken from the each Feutrell's early and Kinnow plantation repetitively. All these trees were grafted on rough lemon and were planted at Fruit experimental garden squire No. 9, University of Agriculture, Faisalabad and Chack No. 27 Bhalwal Road Sargodha.

Sampling schedules for both varieties

Feutrell's early mandarin		Kinnow mandarin	
T1	17th November , 2004	T1	6th December , 2004
T2	3rd December , 2004	T2	22nd December , 2004
T3	18th December , 2004	T3	7th January, 2005
T4	30th December , 2004	T4	23rd January , 2005
T5	14th January , 2005	T5	8th February, 2005
T6	30th January, 2005	T6	24th February, 2005
T7	15th February, 2005	T7	11th March , 2005
		T8	26th March, 2005
		T9	10th April , 2005
		T10	25th April, 2005

The fruit samples were brought to he Laboratory, and the samples were washed with distilled water and dried at room temperature. These fruits were then evaluated on the basis of fruit characteristics adopting the methods of Kumar and Chauhan (1990) on the same day of sample collection.

Physical characters of fruit

Size of the fruit: polar and equatorial ends were measured with vernier caliper and data was expressed in centimeters. Analytical balance was used to weight the fruit and the; data was expressed in gms. Thickness of the fruit peel was measured by vernier caliper. Juice was extracted with extracting machine then it was weighed.

For organolaptic quality of the fruits securing technique against an arbitrary scale ranging from 0-10 was followed (Krum, 1955). A panel of three judges was selected to calculate the average values. They ate the fruits and checked the taste and flavor and then marked all the fruits individually.

Chemical characters of fruits

Total soluble solids (TSS %) of the juice was estimated with the help of Abb's stage refractometer (Model RL 1372). Total titratable acidity (TA) was determined by the methods used by Hortwitz (1960). 10 ml of juice from each sample was taken in the conical flask, diluted a little bit with distilled water and titrated against 0.1 N NaOH (Sodium hydro-oxide) using 2-3 drops of phenolphthalein as indicator. The results were expressed in percentage by following formula:

$$0.1\frac{\text{N NaOH} \times 0.0064}{\text{ml of Juice taken for titration}} \times 100$$

The ratio between Total soluble solids to acid ratio (TSS/T A) was calculated simply by dividing the total soluble solids (in percentage) of the fruit by its acidity percentage (Hortwitz, 1960).

Complete Randomized Design (CRD) was laid out to conduct the experiment. Data were analyzed on computer using MSTATC software programmed by Michigan State University, Michigan, USA. Applying Duncan's new Multiple Range test at 5 percent level and treatment means were compared according to Steel and Tories (1980).

RESULTS AND DISCISSION

Non variable descriptors of Kinnow mandarin and Feutrell's Ealry

Commercial citrus species especially mandarin trees have a single trunk. The main branches usually diverge from the trunk at a height of 60 to 1200 cm above the ground. The trunk is cylindrical, except in older trees where ridges may form on the trunk above large roots and below large branches. Such ridges are more often found in the Kinnow Mandarin than in any other citrus species. The general branching system of cultivated Feutrell's Early and Kinnow Mandarin gives the top or crown of the tree a more of less spherical shape to

leaves in Feutrell's Early and Kinnow mandarin were found unifoliately compound and pinnately reticulate in venation. Abscission zones occur between the leaflet and the petiole and between the petiole and stem. Leaves are arranged spirraly around the stem and after the stem is spiraled three times the eight leaf is directly above the leaf in other words the phyllotaxy is 3/8.

Under the influence of a subtropical climate e.g. Sargodha and Faisalabad, Pakistan citrus species especially mandarin *(Citrus reticulata)* become inactive in winter, but do not shed their leaves. Axillary buds begin to break during warm spells in January and February, but the new shoots do not actively grow until late February or March. A large proportion of the axillary buds grow, particularly those at the extremities of shoots. The resulting spring-cycle shoots are predominantly flower bearing and vary in composition. The fruit of citrus is a type of berry which is called as hesperidium. It arises through growth and development of the ovary, and consists of approximately ten united carpels clustered around and joined to the floral axis. Phylogenetically, carpels are sonsidered to be modified leaves oriented vertically, with their margins curved adaxially to join the axis and thus form locules into which seeds and juice sacs grow. Some specific non variable descriptors of Kinnow Mandarin and Feutrell's Early shown below.

Variable characters of Feutrell's Early and Kinnow madanrin

Fruit weight

Fruit weight of Feutrell's Early increased up till 30th of December and fruits harvested later showed reduction in their weight (Table 3). Fruit harvested from first week of December to 30th December were similar in weight statistically, while fruits harvested fifteen days before and after this duration were low in weight but similar to each other. It is a matter of common observation that fruit weight increases when it approaches to maturity so the increase in fruit weight up to 30th of December was according to the same principle. The respective decrease in fruit weight after 30th of December might be due to the fact that the fruit passes through the prime stages of life, the cell formation ceases and process of breakdown is commenced. Rapid respiration after complete ripening may result in diminished fruit weight. Results are correlated with the finding of Gioffre (1979).

Fruit of kinnow mandarin gained their weight constantly and was maximum (164.30 g) on 26th March (Table 7) and then tended to decrease afterwards. The results are inline with the findings of Chandra *et al.*(1980) who reported that kinnow fruit weight increased up till maturity to the maximum, it remained stable for some time and then decreased.

Fruit diameter

With the increase in weight its diameter and length changed positively in both F. Early and as well as in Kinnow (Table 3 & 7).

Fruit length

The changes in fruit size were in accordance with the fruit diameter and length. Fruit size increased with the increase in fruit length and gained maximum size on 1st December and then tended to decline later, the results are correlated with the findings of Cheema (1966) who reported increase in fruit size up till November only and found similar weight up till end of December. But during these studies it was found that fruits taken after December were smaller in size. Fruits marketed on 15th of February were with minimum size. Same trend was also found in kinnow (Table 7).

In Faisalabad, under ground water is mostly unfit for irrigation, and orchards are based on canal water. Decrease in size later in the season might be due to the fact that irrigation stress at any stage after fruit set reduced the size and appeared to be the most important controllable factor to determine the fruit size as reported by Koo and Reese (1977). Sites *et at.* (1951) carried on studies in Florida and concluded that a moisture stress of any duration after the fruit was set reduced the size of the fruit and that the reduction was never entirely regained by any means.

Peel thickness

Peel thickness decreased up to maturity and increased again after ripening. Our findings on peel thickness were very harassing. The peel thickness of fruits harvested on 30th of January was with maximum peel and it has excelled all other treatment. Minimum peel thickness was on 14th of January. Kinnow mandarin maximum peel thickness was measured in fruits that harvested on 25th April and the minimum value was noted in those which were harvested on 7th January. Peel thickness decreased with the maturity. Metha and Bajaj (1984) and Lodhi, 1987 concluded that peel thickness was related with temperature fluctuations. The changes in peel thickness as found during these studies could not be explained simply neither on the basis of time factor nor on temperature fluctuations. So, difference in peel thickness might be due to difference in soil conditions or irrigation (Cruse *et. al.* 1982), nutrition (Koo and Reese, 1977) and root-stock (Wutscher, 1977).

Table 1. Vegetative non variable descriptors of Feutrell's Early mandarin

Tree growth Habit	Erect	Spreadine*	Drooping
Tree shape	Ellaipsoid	Spheriod	Obloid
Leaf Division	Simple*	Bifoliate	Trifoliated
Vegetative Life Cycle of Leaf	Evergreen*	Decidious	Semipersistent
Leaf colour varigation	Present	Absent*	
Leaf laminia attachment	Drddilr	Brevipetiolate*	Longpetiolate
Petiole wing	Present	Absent*	
Leaf apex	Acute	Obtuse*	Rounded

Table 2. Reproductive non variable descriptors of Feutrell's Early mandarin

Flowering Type	**Hermaphrodite***	**Male**	**Female**
Colour of open flower	Light yellow	Yellow	White*
Colour of Anther	White	Pale yellow	Yellow*
Fruiting season	Early	Mid*	Late
Flowering month	Jan.- Feb.	Feb.- March*	March-April
Fruit shape	Spheriod*	Ellipsoid	Obloid
Fruit surface texture	Smooth	Rough	Bumpy
Fruit Skin	Yellow	Pink	Oranee

Note. *Indicates the correct answer.

Table 3. Physical characteristic of Feutrell's Early mandarin

Date when data was collected (2004-2005)	Fruit wt. (g)	Fruit Diameter (cm)	Fruit length (cm)	Peel thickness (mm)	Juice (%)	Organolaptic (values)	Fruit colour
17th November	97.50bc	6.01b	5.04ab	3.37b	49.80ab	3.73d	Burnt orange
3rd December	107.80ab	6.30ab	5.187ab	3.24b	52.50a	4.97c	Indian orange
18th December	113.40ab	6.25ab	5.45a	3.55ab	49.60ab	5.63bc	Same
30th December	120.00a	6.61a	5.39a	3.57ab	46.30b	6.30ab	Same
14th January	97.50bc	6.60a	5.38ab	3.07b	49.80ab	6.90a	Same
30th January	86.00cd	6.59a	5.37a	4.07a	46.40b	5.37c	Same
15th February	69.70d	6.59a	5.37a	3.12b	49.30ab	5.63bc	Same

Table 4. Chemical characteristics of Feutrell's Early mandarin

Date when data was collected (2004-2005)	Acidity of the Fruit (%)	Total Soluble Solids (%)	TSS/TA
17th November	97.50bc	6.01b	5.04ab
3rd December	107.80ab	6.30ab	5.187ab
18th December	113.40ab	6.25ab	5.45a
30th December	120.00a	6.61a	5.39a
14th January	97.50bc	6.60a	5.38ab
30th January	86.00cd	6.59a	5.37a

Table 5. Vegetative non variable descriptors of Feutrell's Early mandarin

Tree growth habit	Erect	Spreading:*	Drooping
Tree shape	Ellaipsoid	Spheriod*	Obloid
Leaves habit	Simple	Bifoliate	Trifoliated
Leaf division	Evergreen*	Decidious	Semipersistent
Varigation	-	Brevipetiolate*	Longipetiolate
Petiole wing	Present	Absent*	Rounded
Leaf apex	Acute*	Obtuse	-

Table 6. Reproductive non variable descriptors of Feutrell's Early mandarin

Flowering Type	Hermaphrodite*	Male	Female
Colour of open flower	Light yellow	Yellow	White*
Colour of Anther	White	Pale yellow	Yellow*
Fruiting season	Early	Mid*	Late
Flowering month	Jan.- Feb.	Feb.- March*	March-April
Fruit shape	Spheriod*	Ellipsoid	Obloid
Fruit surface Texture	Smooth	Rough	Bumpy
Fruit Skin	Yellow	Pink	Oranee

Table 7. Physical characteristics of Kinnow mandarin

Date when data was collected	Fruit wt. (g)	Fruit Diameter (cm)	Fruit length (cm)	Peel thickness (mm)	Juice (%)	Organolaptic (values)	Fruit Colour
6th November	125.50c	6.53d	5.34b	3.66ab	51.80a	2.53e	Majol-ica Yellow
22nd December	128.30c	6.43d	5.30b	3.32bc	51.70ab	4.67d	Indian orange
7th January	124.70c	6.46d	5.36b	3.05c	52.80ab	5.00cd	Same
23rd January	137.60bc	6.85cd	5.32b	3.20bc	52.80ab	5.60c	Same
8th February	126.90c	6.76cd	5.74ab	3.35abc	55.50a	7.00b	Same
24th February	154.40ab	6.76cd	5.67ab	3.47abc	55.00a	7.50ab	Same
11th March	140.50bc	7.11bc	5.37b	3.37abc	52.50ab	7.50ab	Same
26th March	164.30a	7.33ab	5.93a	3.28bc	49.70b	7.83a	Same
10th April	152.20ab	7.76a	6.01a	3.59abc	52.90ab	7.67ab	Same
25th April	129.10d	7.75a	6.00a	3.91a	52.20ab	7.17ab	Nastutium Orange

Table 8. Chemical characteristics of Kinnow mandarin

Date when data was collected	Total titratable acidity (%) (TA)	Total soluble solids	TSS/TA
6th November	1.36a	11.110c	8.38e
22nd December	1.14b	11.05c	10.48e
7th January	1.01b	11.40bc	11.95a
23rd January	0.76c	11.75bc	15.98d
8th February	0.71cd	12.05abc	17.48cd
24th February	0.62cde	12.75a	21.16b
11th March	0.51de	12.50ab	25.34a
26th March	0.5/8de	12.55ab	22.52ab
10th April	0.54de	12.45ab	23.60ab
25th April	0.58de	11.70abc	20.16bc

Fruit colour

Harvesting of fruits started with burnt orange color on 17th of November which became deeper and deeper and become Indian orange in first week of December. The disappearance of chlorophyll exposes the carotene and xanthophylls pigments previously mashed by it in the rind tissue. B citraurin, one of the main sources of red color in mandarin fruits, increased with cool temperature (Stewart and Wheaton, 1971). Feutrell's early being an early variety finished before onset on high temperature that is why it was marketed with Indian orange color for whole the time after December. In case of Kinnow mandarins intensity of colour increased continuously and turned Spanish orange on 11th March. It also indicates that management practices have little effect on fruit colour. Cheema (1966) also held the same view.

Organolaptic values

Taste and flavour as felt by the panel (of three judges) was subjected to statistical analysis and means are presented in Table 3 & 7. Organolaptic values increased form 17th November up till mid January and

a decrease was observed again in late January and mid of February in Feutrell's early. Fruits harvested during mid January were superior and have excelled all other harvesting dates except 30th of December. Fruits harvested from December to mid February were with reasonable quality. Cheema (1966) and Ukalkar and Shanker (1979) suggested the month of December for it's harvesting due to its high organolaptic characteristics.

In Kinnow mandarins observations showed that fruits harvested on 7th and 23rd January were marginally acceptable, while early harvested were inferior. Results were in accordance with Kumar and Chauhan (1990) who suggested 3rd week of December for its harvesting on the basis of colour and flavour. Although taste and flavour tests can help to determine the maturity and quality to great extent but use of these tests as a sale criterion cannot be recommended. Error of judges may arise simply due to the fact that a higher or lower sugar contents may frequently be confused with decrease or increase in acid contents. The fallacy of tests can further be attributed to individual liking and disliking. It is therefore, suggested that taste and flavor should not be used as an index of quality. Jawanda (1964) and Cheema (1966) concluded the same findings.

Juice contents

Juice contents are dependent upon number of factors generally increased towards maturity and then decreased when once the maturity was over. Juice contents remained variable for the whole period; Feutrell's early having maximum juice contents 52.50% on 3rd of December and minimum on 30th of December. Statistically fruits marketed on 18th of December and 30th of January were with less juice contents while rest of the treatments showed similar results. In Kinnow mandarin according to the ranked order maximum juice contents was observed in fruit which were harvested on 23rd April (55.50) with the minimum value was remained on 7th January (49.70). In early season fruits contain less juice, but with the fruit development juice contents increased towards ripening. This was again followed by decrease in juice percentage when harvesting was delayed. Decrease in juice percentage reflects quality deterioration (Gill *et al.,* 1986). According to our findings juice percentage almost remained similar with slight fluctions, which indicates that fruit harvesting started with maximum juice contents and finished before quality deterioration. These findings are correlated with; Cheema (1966) who reported 51% juice from end of November uptill end of December in the same cultivar. Slight difference in the juice contents during these studies might be due to difference in cultural practices (Cruse *et al.,* 1982). Juice contents may also increase with irrigation as reported by (Gilfillan *et al.,* 1971). Juice contents also depend upon number other factors as reported by Gill et al. (1986).

Chemical characters of Feutell's Early and Kinnow mandarin

Acidity

Acidity decreased with ripening and increased again when harvesting was delayed. The acidity inclined to decrease up till end of December, increased acidity at the end of January and mid February was observed. Minimum values of acidity were observed from mid December to mid January. The highest values of acidity were observed on 17th of November, while the other treatment showed the same effect. Acidity of the fruits decreased as fruit approached towards maturity. So decrease in acidity up till end of December was in according with the findings of Sinha et al., (1930), Azim and Butt (1964) and Cheema (1966) who reported decreased acidity in different citrus cultivars up till maturity. In our findings acidity increased later in the season from 30th of January to 15th of February in accordance with Tucker and Reuther (1971), Gilfillan et at. (1971), Yamda and Nishiura (1977), who reported increased acidity when harvesting was delayed.

In Kinnow mandarin, observations presented in (Table 8) showed that acidity tended to decrease throughout the study period starting from December till end of April with unique rise and fall in later part. However, maximum acidity was recorded in early harvesting (1.36) and minimum value was observed in last harvesting (0.51). (Cheema, 1966; Yamada and Nishiura 1977). In these findings the acid contents of 0.70 percent coincided with reasonably good quality.

Total soluble solids

Total soluble solids were 8.66 percent on 17th of November and increased with the passage of time and gained maximum values at the end of December, in F. early and thereafter it started decreasing slowly. Fruits harvested on 17th November were with minimum TSS when compared with rest of the treatments. Maximum values for TSS were observed from mid December up till mid February. Total soluble solids are supposed to keep on increasing for a very long period until complete ripening. The TSS percentage started to increase from low values during mid November till end of December. Increase was however not even, quick increase was observed in November which slowed down in December. Our results closely resemble to the findings of Ukalkar and Shanker (1979) who reported maximum values of TSS up till 3rd week of December only. The results compiled by Bakhshi *et al.* (1968),

Joolka and Awasthi (1980) and Chandra and Yamdagmi (1983), showed an increase in TSS until ripening and slow decrease followed that period, are in close conformity with our findings.

The observations pertaining to total soluble solids (TSS) of Kinnow mandarin indicated consistent rise till last week of February and then tended to decrease up till end April. During these investigations TSS above 10 percent was coincided the findings of Wutscher and Shull, (1978) who reported 10% TSS as acceptable maturity index in certain mandarin hybrids.

TSS to acid ratio

The maximum values (20.05%) on mid January and the minimum (10.95%) on 17th of November were found. The other treatment means bore intermediate values. The results indicate a rise in the ratio starting from November, the first sampling till fifth sampling, there after it started decreasing to end of January and again an upsurge was observed fifteen days later. The results are in accordance with Ahmad and Khan (1964), Singh and Dhaliwal (1980) and Jookka and Awasthi (1980) who observed increased ratio up till maturity and followed by a decrease in the same sequence. But clearly contradicted with Bakhshi et al., (1968) and lodhi (1987), who were of the view that ratio increased even after ripening. TSS to acid ratio is also referred as legal maturity. According to Chandler and Nicol (1981). This ratio is best measure of quality and can be used to identify the date on which a crop should be harvested to give fruits of specific quality. In these findings TSS to acid ratio of 16.69 coincided with good quality but Cheema (1966) suggested TSS to acid ratio of 30.21: 1 for acceptable maturity for the same cultivars. The difference was due to difference in acid contents, he claimed 0.43 percent in Feutrell's Early.

As TSS to acid ratio is mainly governed by the acidity, so a slight increase or decrease in acidity is accompanied by a much bigger change in magnitude of the ratio. In Kinnow mandarin maximum values were calculated in March and the minimum on 6th of December, amounting to be 25.34 and 8.38 percent in the same sequence. Acidity depends upon a number of factors (Gill *et al.,* 1986) and it may vary from year to year in the same cultivars as reported by Kihara and Nishiura (1982).

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