

EVALUATION OF KINNOW MANDARIN AS INFLUENCED BY PRE-HARVEST MANAGEMENT PRACTICES

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ABSTRACT

A study was conducted at Post Harvest Research Centre, Ayub Agricultural Research Institute, Faisalabad, Pakistan during the year 2009. The objective was to evaluate the effect of pre-harvest orchard management practices like nutrient application, pruning, spraying and number of irrigations on Kinnow fruit quality and yield. For this purpose, various lots of good looking, healthy, clean and fresh fruits were taken from major citrus growing area in Sargodha district i.e. Sillanwali, Sargodha and Bhalwal tehsils. The farmers were selected for this survey according to their orchard holdings upto 4.05 hectares. The results indicated that fruit diameter, fruit weight and peel thickness ranged from 64.33 to 71.58mm, 112.82 to 170.80g and 3.31 to 4.58mm, respectively in three tehsils of Sargodha district. The other physicochemical quality parameters like TSS, acidity and pH obtained from three tehsils of Sargodha district ranged from 10.57 to 12.66 °Brix, 1.01 to 1.21 percent and 3.85 to 4.30, respectively. These parameters showed that Kinnow from Sillanwali and Sargodha tehsils was superior to that of Bhalwal owing to better pre-harvest management practices of their orchards. Improved fertilization (organic and inorganic), irrigation and pruning are main pre-harvest management practices that need special attention of the farmers to improve quality of Kinnow mandarin. In a nutshell, pre-harvest management of orchards is directly linked with quality and yield of Kinnow fruit.

KEYWORDS: Kinnow mandarin; performance; chemico-physical properties; Sargodha; Pakistan.

INTRODUCTION

Citrus occupies a prominent position in fruit industry of the world including Pakistan. The area under citrus in Pakistan during 2008 was 199.5 thousand hectares with total production of 2458.5 thousand tons. Punjab province

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contributed 95 percent to total citrus production while export was 3, 00,000 metric tons during the crop year 2010-11 (9). There are many factors which adversely affect the quality of citrus fruit like pH and EC of soil; the adequate pH of soil for citrus cultivation is 5.5 to 6.0 (10). The major problems faced by the citrus growers are observed mainly during harvesting, post harvest handling and marketing, which are responsible for a large yield gap (14).

Kinnow mandarin (easy peel citrus) has assumed special economic importance and export demand is being acknowledged for its high juice content, special flavour, delicious taste and as a rich source of vitamin-C. In per capita terms, annual availability of citrus is nearly 12.5 kg, of which share of Kinnow is about 8 kg. A consumption of 8 kg per capita implies the availability of 1206 mg of vitamin-C, 1520 mg of calcium, 684 mg of phosphorous and nearly 16 mg of iron per head during the citrus production season (22). The citrus fruits are nutritionally important, as nearly all of its species are rich in vitamin-C, minerals, phytochemicals and dietary fibre (4). Additional benefits of citrus fruits include protection against infections, diseases and cancer insurgence. The citrus fruits are mainly processed for pure orange juice that does not contain fibre. It is exceptionally nutritious as 12 oz (354.84 mL) of orange juice contains approximately 110 percent of recommended dietary allowance (RDA) of vitamin-C. Additionally, it also provides vitamin A, B₁, B₆, calcium, folic acid, iron, magnesium and potassium. An average orange fruit yields 60 calories. Besides these functional ingredients, oranges are also rich in beta-carotene and bioflavonoid and these all components are essential elements in healthy diet (19).

The average yield of Kinnow in Pakistan is far less than other citrus producing countries of the world like USA and Australia. The main reasons for low productivity are excessive winter leaf drop, poor fruit set and fruit drop at different stages of fruit development. Proper fertilization is an essential feature for enhancing the productivity of citrus fruits (6). In this regard scientists reported that combined application of NPK before initiation of new growth increased the yield by 28.5 percent but fruit acidity was also increased (23). The application of foliar fertilizer at three different stages (pre-flowering stage, physiological fruit drop stage and fruitlet development stage) had positive effects. Application of NPK with different combinations before time of flowering improved fruit quality and size (26). The application of macro-nutrients particularly nitrogen, phosphorus and potassium plays important role in yield, as well as fruit quality (16, 20, 21, 30), The soluble solid contents of fruits of sprayed trees were increased by 1.5-1.9 percent with better

colour and flavour. The juice of Kinnow mandarin is found to be very refreshing, delicious and soothing (1).

Similarly, effect of micronutrients on fruit quality has been highlighted by other researchers (24). The use of growth regulators has become an important component of agro-technical procedures for most of the cultivated plants especially fruit plants (25). The auxins and gibberellins are used to control fruit drop in citrus and improve fruit quality (3), however, in Pakistan these practices are very limited. The quality of citrus/Kinnow mandarin primarily depends upon the pre-harvest management practices being followed in orchards.

In view of foregoing facts a study was initiated to compare the quality of fruit from different orchards following various pre-harvest management practices in district Sargodha. These findings would show that how pre-harvest management practices affect the quality of Kinnow mandarin under agro-environmental conditions of Punjab province, Pakistan.

MATERIALS AND METHODS

Collection of samples

Kinnow mandarin samples were collected from three citrus growing areas of district Sargodha i.e. Sillanwali, Sargodha and Bhalwal tehsils. The farmers selected for this study owned upto 4.05 hectares of citrus orchards. Fresh samples of fruit were brought to the Post Harvest Physiology Laboratory, Ayub Agricultural Research Institute, Faisalabad, Pakistan, for physicochemical analysis. In every tehsil five lots (L₁-L₅) were selected randomly for survey and in each lot, ten orchards were further selected making a total number of 50 Kinnow mandarin samples with healthy, good-looking and free from decay rotting. The randomly selected ten farmers for each lot were given a detailed questionnaire which was filled by the technical member of survey team, to record all pre-harvest management practices performed throughout the year. This survey was completed in three phases in the month of January and February, 2009.

Physicochemical analyses of fruit samples

All collected samples of Kinnow mandarin were subjected to measure fruit weight, fruit diameter and peel thickness. Physicochemical characteristics like

total soluble solids (TSS), pH and acidity were also measured to assess the fruit quality. Detail is given below:

Fruit diameter (mm): The diameter of ten randomly selected fruits from each lot was measured at equator of each fruit with the help of vernier caliper and average fruit diameter was calculated.

Fruit weight (g): Average weight of randomly selected ten fruits from each lot was measured with weighing balance (Sartorius, Japan) and then their average weight was calculated in grams.

Peel thickness (mm): The peel thickness of randomly selected ten fruits was measured by vernier caliper from three different points and then average values were calculated.

Total soluble solids ($^{\circ}$ Brix): Total soluble solids (TSS) of juice were estimated according to official methods of analysis, following method No. 983.17 in which 1-2 drops of juice were placed on clean prism of Refractometer (Atago 3T, Japan) and results were expressed as $^{\circ}$ Brix (7).

pH: The pH of each sample was determined with digital pH meter (HANA 8520, Japan). Sufficient quantity (50mL) of Kinnow juice was taken in 100mL beaker and pH meter was used to record pH according to the method explained in official methods of analysis (8).

Acidity of juice (%): Acidity was measured by using AOAC method No. 942.15 (7). Acidity of juice was determined by taking 10mL of juice from each sample and diluted with distilled water in a 100mL beaker then 2-3 drops of phenolphthalein as an indicator were added and samples were titrated against 0.1N NaOH upto the light pink colour end point (14). The results were expressed as percent citric acid.

$$\text{Acidity (\%)} = \frac{0.1N \text{ NaOH used} \times 0.0064}{\text{Volume or weight of sample used}} \times 100$$

RESULTS AND DISCUSSION

To acquire optimum quality of fruit fertilization (organic and inorganic) farmyard manure is mixed with phosphorus and potash and applied in the month of December. Generally nitrogen is splitted into three doses and applied during February - March, May - June and August- September as per

departmental recommendations. The differences observed in results relating to fruit quality parameters were solely due to the incorrect pre-harvest management practices being followed in three tehsils of district Sargodha. The physicochemical analysis of data from overall district Sargodha showed that all fruit quality parameters are similar to those obtained by other scientists (5, 15).

Physicochemical analysis

Fruit diameter (mm): Fruit diameter is of commercial importance for citrus fruit marketing and trade. The results (Fig. 1) showed major differences among fruit diameter of different growing regions. It ranged from 65.90 to 71.58mm in Sillanwali, 67.70-70.96mm in Sargodha and 64.33 to 69.71mm in Bhalwal. The awareness level of farmers about cultural practices was higher in Sillanwali and Sargodha as compared to Bhalwal. The results also showed that fertilizer application at proper time influenced the yield and fruit diameter thus improving the quality of produce.

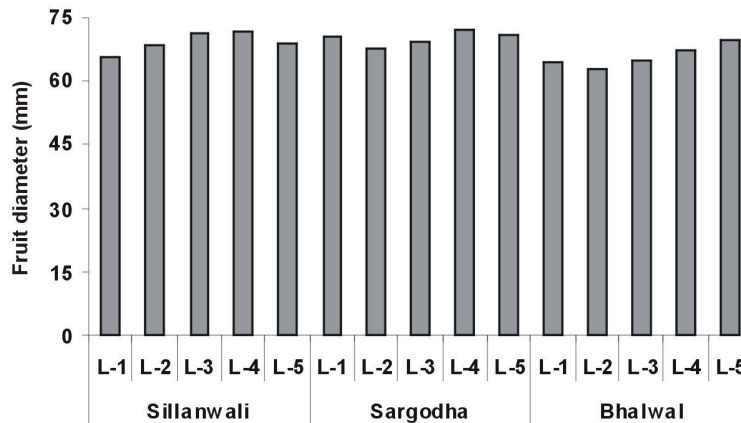


Fig. 1. Fruit diameter (mm) of Kinnow mandarin in orchards of three citrus growing areas.

Fruit weight (g): Fruit weight also differed significantly in various orchards of three major citrus growing areas. Maximum fruit weight (170.80g) was noted in lot (L-4) of Sillanwali (Fig.2), whereas minimum fruit weight (112.82g) was found in the fruit produced at Bhalwal. The fruit weight of Kinnow belonging to Sargodha remained stable and was in close proximity with that of Sillanwali. Proper and appropriate number of pruning can be helpful to supply the sufficient nutrients to the plant which results in better fruit quality. The abiotic factors; less irrigation water and environmental drought conditions

results in decline of Kinnow mandarin in Pakistan and are adversely affecting its quality (2).

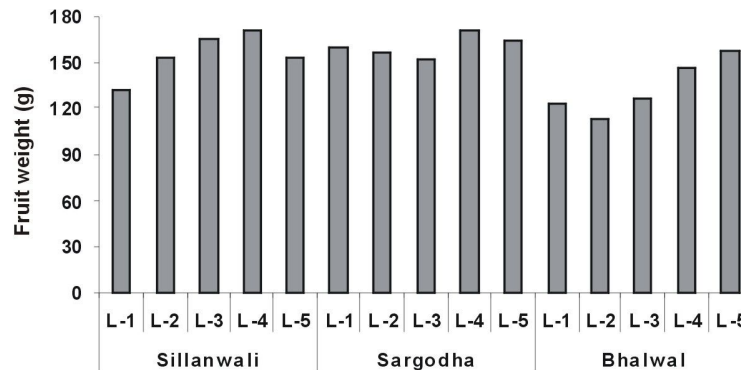


Fig. 2. Fruit weight (g) of Kinnow madarin in orchards of three citrus growing areas.

Similarly researchers (27) suggested that timely application of fertilizer particularly in the month of January including farmyard manure, urea, single super phosphate (SSP) and sulphate of potash should be used according to departmental recommendations which greatly affect the number of fruits, fruit size, juice contents, fruit weight and total soluble solids.

Peel thickness (mm): Significant variation of peel thickness was also observed among fruits of three tehsils. Peel thickness of five lots of fruits ranged from 3.33 to 3.77 mm in Sillanwali, 3.31 to 3.88 mm in fruits of Sargodha and 3.58 to 4.58 mm in fruits of Bhalwal (Fig.3). It was further

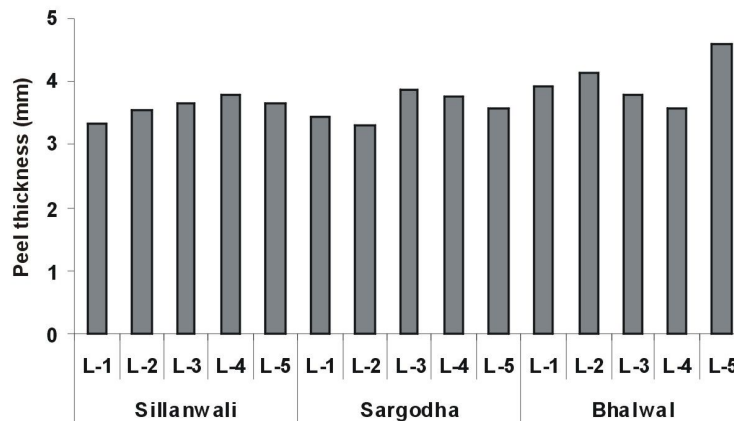


Fig. 3. Peel thickness (mm) of Kinnow fruit in orchards of three citrus growing areas.

observed that peel thickness of one orchard (L-5) from Bhalwal was exceptionally higher (4.58mm) while rest of values were comparable with other citrus growing areas. This parameter may be affected by management practices like nutrient application at proper time and pruning. It has earlier been reported (28) that peel percentage was affected by pruning of citrus trees. Peel thickness of fruits taken from pruned orchards was less as compared to orchards with less pruning rate. Peel thickness is inversely correlated with total soluble solids as indicated in present results. Similar results have also been reported by Sites and Reitz (29).

Total soluble solids (°Brix): The data (Fig. 4) exhibited major differences in TSS of fruits collected within lots of three tehsils which was due to variation in pre-harvest management practices. The total soluble solids in five lots of each sampled orchard ranged from 11.3 to 12.11 °Brix in case of Sillanwali, 11.2 to 12.57 in fruit taken from Sargodha and 10.57 to 12.66 °Brix in the fruits collected from Bhalwal. The higher TSS in fruit harvested from Bhalwal might be due to comparatively higher levels of macronutrients in these soils

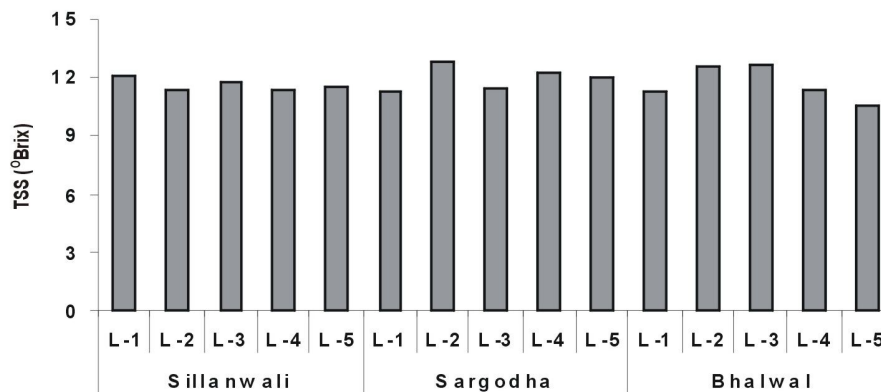


Fig. 4. Total soluble solids (° brix) of Kinnow fruit in orchards of three citrus growing areas.

as compared to other locations. The lowest TSS: TA (total acidity) ratio was exhibited by fruits harvested from Bhalwal may be due to imbalance in soil nutritional status where crop husbandry was ignored by growers. The concentration of TSS and TSS:TA ratio in citrus juice decreased slightly by increase in K, while TA increased. In an earlier study (12) it was found that decrease in TSS and TSS: TA ratio and increase in TA was primarily an effect of fruit size. The optimum level of N, P and K in the leaves of Kinnow

mandarin trees had been reported to improve the fruit quality parameters at harvest such as total sugars, reducing and non-reducing sugars (18).

Acidity (%): The results showed that acidity was also affected by various orchard management practices. Acidity in five lots ranged from 1.01 to 1.18 percent in case of Sillanwali, 1.06 to 1.20 percent in fruit taken from Sargodha and 1.08 to 1.21 percent in the fruits of Bhalwal (Fig. 5). Citric acid

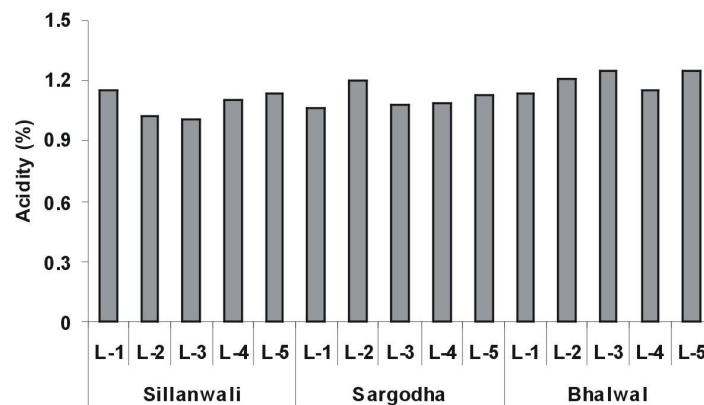


Fig. 5. Acidity of Kinnow fruit in orchards of three citrus growing areas.

content of Valencia orange juice was consistently higher in less frequently irrigated treatments, regardless of rainfall. Age of tree and type of cultivar influenced the juice content, TSS, acidity, and ripeness index of oranges (13). Juice yield, soluble solids, citric acid, suspended solids, and pH of Marrs and Valencia cultivars are affected by irrigation plus rainfall (32). Vitamin-C, juice yield, pH, and suspended solids are occasionally affected by irrigation treatment where rainfall contributes about half of annual water requirement (9).

pH: The data (Fig. 6) showed that pH ranged from 3.85 to 4.30 in three tehsils of Sargodha district. The samples collected from Bhalwal tehsil had the highest value (4.30) followed by samples collected from Sillanwali (3.85 to 4.26). The data further showed that samples obtained from Sargodha tehsil had little bit less pH values (3.85 to 4.25) as compared to the other two tehsils.

Brix:acid ratio, total acidity, citric, malic and isocitric acid contents, citric:isocitric ratio, K, PO₄, Mg and Ca, and glucose: fructose ratio are affected by the harvesting time (31). The acidity and pH of Kinnow mandarin is inversely proportional to each other. The factors responsible for the decrease in pH and increase in acidity include irrigation, fertilization, age of



Fig. 6. pH of Kinnow fruit in orchards of three citrus growing areas.

tree, date of harvesting and total fruit load in tree. Another reason for inferior quality of Kinnow mandarin was sources of nursery and intercropping practices in the orchards. Many diseases and wrong selection of rootstock and scion combination had adversely affected the fruit quality. During survey it was observed that generally wheat, fodder and vegetables crops were planted inside the Kinnow mandarin. Every crop has different nutritional, irrigation and plant protection requirements, so this was another major factor for low quality of Kinnow fruit.

CONCLUSION

The variations in quality attributes were observed to be originated from poor pre-harvest management practices. The quality variation has negative impact on fruit marketing. It is, therefore, suggested to adopt recommended agricultural practices like proper irrigation, time of fertilizer application, application of organic manure to enhance the production and improve/maintain the fruit quality. This will also help the growers meet the international standard, which in turn will lead to increased citrus export worldwide.

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