HortFlora Research Spectrum, 2(2): 103-108 (April-June 2013) ISSN : 2250-2823

INFLUENCE OF POSITIONS OF BEARING AND METHODS OF HARVESTING ON THE QUALITY OF FRUITS–A REVIEW

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ABSTRACT: India is blessed with varied climatic conditions and is thus the home of various types of fruits. But most of the fruits are highly perishable and show a great decline in quality as well as storage life soon after harvest. This decline is further aggravated if harvesting is not done at the right time and by the correct method. Moreover position of bearing also plays a key role in the quality of fruit. Fruit position on tree is found to influence the fruit size, maturity, skin colour, flesh colour, mineral composition, TSS, acidity and fruit yield. Harvesting fruits with and without pedicel in addition to affecting the storage life of fruits, also affects sugar content, acidity, fruit firmness and colour retention. This review summarises effects of positions of bearing and methods of harvesting on the overall quality of fruits.

Keywords: *Position of bearing, harvesting method, fruit quality.*

In fruits, physical and physiological changes take place over a relatively shorter period of time and exhibit a typical increase in respiration and ethylene production during ripening. Ripening is associated with a change of skin colour from green to yellow. The colour of the flesh changes from white to creamy white, yellowish pink or dark pink or salmon red. Fruits have great morphological and anatomical peculiarities. The position of fruit on tree and the correct method of harvesting is a key aspect for improving the quality of these highly perishable commodities. The individual fruit if timely harvested from appropriate position from the tree canopy with better knowledge of their harvesting method may reduce the physical loss of weight (PLW) from the fruit and retained better quality for longer time. The fruit bearing habit of plants refer to position and type of wood on which flower buds and subsequently fruits occur. It indicates the position of flower bud with respect to vegetative growth of plant after cessation of juvenility. The flower bud may appear terminally on the apex of shoot, laterally in the axils of leaves or adventitiously from any point on stem. For fruit bearing it is important to keep good light exposure throughout the canopy otherwise shaded part fails to form flower buds. Bearing trees should be pruned regularly and lightly a little every year or at least every alternate year. Old bearing trees usually need more pruning than young vigorous trees that have just come into bearing to increase the favourable positions of fruit bearing on these trees. In general, fruits from upper canopy of tree were found to be of good quality but storage quality is better of lower canopy fruits. The size and weight of fruits harvested from lower and middle canopy was higher than the fruits of upper position. Longer shelf lives were observed in fruits with a small stalk. The level of acidity was higher and total sugars were lower in the fruits harvested with pedicels.

Effect of fruit position on tree on maturity and quality : Effect of fruit position on tree on fruit maturity and quality was observed in apple (Patterson *et al.,* 22; Krishnaprakash *et al.,* 19; Baritt *et al.,* 4; Zen, 37), Mineola fruit (Cohen 7), and guava (Dhaliwal and Dhillon, 11). The ripening pattern of 'Delicious' apples in relation to position on the tree showed that the ethylene production of 'Hi Early Red Delicious' apples harvested from primary, secondary and tertiary branches of 4 uniform trees of *Malus domestica* Borkh varied considerably between and within branches (Petterson *et al.,* 22). Regression analysis revealed a linear trend between primary branches from base to apex of the tree. Fruits on terminal shoots mature later. Fruits at the bottom of the tree mature earlier

Received : 8.5.2013 *Accepted : 22.5.2013*

than those at the middle and top (Krishnaprakash, *et al.,* 19). A variation in maturation rate between full coloured and less coloured, interior and exterior fruits and small and large ones on the same bunch and on separate stalks was also observed. In apple, the fruits on the lower shoot had the largest fruit weight among the 9 positions (Zen, 37). Upper inner fruits had the lowest weight and volume but more intensity of red colour. Trees with bearing spurs provided with different solar exposure level ranging from 5% to 95% of full sunlight gives better quality fruits (Baritt *et al.,* 4). As the exposure level of canopy is reduced fruits length, width, weight, soluble solids, total solids were reduced while fruit firmness and total acidity were increased. In Mineola fruit, maturity and taste characteristics measured were better in large, heavy fruit harvested from the upper, external southern side of the tree than in small, light fruit harvested from the lower, internal and northern side of the tree (Cohen, 7). Harvest and storage fruit increased its juice content, while fruit remaining on tree showed an increase in TSS and a decrease in acid levels, resulting in increase in TSS: acid ratio and improved taste. In guava cv. Sardar the fruit size and weight and seeds number per fruit increased with increasing canopy volume. The highest number of fruits was recorded with 107.6 m^3 canopy volume. Fruit acidity increased whereas total soluble solid: acid ratio decreased with increasing tree volume (Dhaliwal and Dhillon, 11).

Effect of the influence of shade within tree position on fruit quality: In apple, the fruits from the outer positions were larger with a higher proportion of skin coloured red and develop core flush than fruits from the inner and lower portions of the trees. Shade reduced the core flush as well as reducing fruit size and colour (Jackson *et al.,* 15). In Cox's Orange Pippin apple fruit, the tree bottom canopy with high shading reduced the fruit size, fruit colour and quality. They have less dry matter and starch per unit fresh weight. But there was no evidence that the concentrations of N, P, K, Ca and Mg differed in fruits of same size produced from upper or bottom canopy. But smaller fruits had higher concentrations of Ca, N and P than the larger one of upper canopy fruits (Jackson *et al.,* 16). There was no difference between vertical fruit distribution in trees in Slender Spindle and trellis system. But the largest tress (interstem hedgerow and pyramid hedgerow) produced twice as much fruits in top half of the canopy as in the bottom half (David, 8). In all cases the fruits from upper canopy of tree are of good quality but storage quality is better of lower canopy fruit. The upper part of the tree canopy intercepted maximum radiation than the middle and lower canopy parts in guava trees cv. Sardar. The size and weight of fruits harvested from the middle and lower layer position of the tree were found significantly higher than the fruits of upper position (Singh and Dhaliwal, 25).

Effect of tree age and canopy position on fruit quality: In guava, fruits from upper canopy have higher TSS (11.85%) and total sugars (7.50%). Vitamin C content was higher from fruits obtained from middle and lower canopies. Minerals were higher in middle and lower canopies fruit rather than the upper canopy (Asrey *et al.,* 2). There is increase in canopy volume, fruit number, yield and quality and dry matter content with increasing cross trunk section whereas fruit size decreased with decrease in trunk cross section in guava cv. Allahabad Safeda (Dinesh *et al.,* 12).

Effect of tree canopy position on fruit yield quality and mineral composition: Kinnow fruits harvested from the inner side of tree were heavier and contained more juice and less rag, whereas outer fruits had higher acid, TSS, reducing sugar and total sugar content and ripened earlier. The yield of inner fruits was 2-3 times greater than that of outer fruits in both weight and number (Jawanda *et al.,* 17). Physico-chemical characteristics also varied with fruit size; medium sized fruits (6-8cms) had the best overall quality. Grape fruit from sunlight positions mature earlier than fruit from shaded positions. So the fruits were more in the most exposed canopy position with higher soluble

solids, yields and juice quality with respect to other different canopy position (Syvertsen and Albrigo, 32). Large sized 'Anna' apples as well as those borne on the tree exterior had significantly lower chlorophyll concentrations and higher anthocynin levels than small or interior fruits. A negative correlation was found between fruit size and both fruit firmness and acidity, while a positive relationship was observed between fruit size and TSS percentages or physiological weight loss. Fruits from the exterior part of the tree showed significantly firmness and acidity values and higher TSS and weight loss percentages than those from the interior. During storage, large and exterior fruits seemed to lose their firmness and acidity at a much higher rate than either small or interior fruits (Ahmed *et al.,* 1). In 'Tai So' Lychee, the fruits from upper position were of lower visual quality, due to high light and dark brown blemishes on the skin, rather than the colour of the red portion of the skin but the yield was higher in upper canopy position (Jones and Sreenivas, 18). Fruits from the lower canopy has lower Brix/acid ratio. Peach fruits of cv. Hamas collected from different parts of the canopy were analysed for total soluble solids and dry matter content were highest in the fruits picked from the upper/apical part of the canopy and lowest in those from lower/outer parts (Morgas and Szymczak, 21). The highest yield per tree was obtained from open centre trees (714 trees/hectare), but the highest total yield per hectare was from pillar shaped trees (2857 trees/hectare). In guava cv. Pant Prabhat fruits from lower tree canopy mature earlier than rest of the canopy (Tamta *et al.,* 34). There was also a variation in chemical as well as mineral composition between different canopy positions on tree. Calcium and potassium were higher in upper canopy positions than lower canopy fruits (Tamta and Kumar, 33).

Relationship between the quality and fruit position on tree: In Satsuma mandarins, colouring on fruit at the lowest site was slower than with the other sites during the first week, but there was no difference in colour by the fourth week of storage (Suzuki and I to, 31). Fruit sweetness for the lowest side was markedly less than for other sites in the first week of storage, but in the second week it was lowest at the lower site and highest at the middle site. However, the contents were very similar by the third week of storage. In sweet orange, a higher percentage of the fruits of young trees were produced at the periphery. Yields were higher on the half of the canopy facing south-west and south-east than on facing north-west and north-east. Fruits inside the canopy were smaller and paler and had a softer rind and higher juice content, but it had lower sugar content and more acid. Fruit produced high on the tree was larger and darker and had a higher TSS content (Dettori *et al.,* 9). Eight commercially grown cultivars of guava were harvested at the colour-break stage during the winter season. The fruits were stored for up to 12 days under ambient conditions (18+2°C and 80-85% RH). The fruits were assessed for ripeness, firmness, physiological weight loss, TSS, titrable acidity, vitamin C and Ca contents. The cultivars Chittidar and Sardar were noted for good shelf life (9 days) compared with a maximum of 6 days in Allahabad Safeda. The cultivars Sardar, Chittidar, Karela and Apple colour were noted for high Ca content relatively good pulp firmness for upto 9 days (Tandon and Chadha, 35). Postharvest changes in mango cv. Nam Dok Mai fruits from different parts of the tree were followed after collection at 3 stages of maturity (14, 15 or 16 weeks after full bloom). Regardless of maturity stage at harvest there were no statistically significant differences in the quality of ripened fruits between upper and lower parts of the tree (Subhadrabandhu *et al.,* 30). However, general quality appeared slightly better in the fruits from the upper part of the canopy; these fruits had a deeper-yellow pulp, higher contents of TSS and reducing sugars and had a higher TSS: titrable acids ratio but lower moisture content, ascorbic acids, flesh firmness, titrable acidity and total non-structural carbohydrates than fruits from the lower canopy of the tree. In cv. Midnight Valencia of orange each tree was divided into 6 fruit zones, comprising 3 vertical positions (upper, middle and

lower) and 2 horizontal positions (inner and outer). The fruit colour was best in the upper zone but there was no significant difference between that of fruits in the inner and outer zones or between the middle and lower zones (De-Vries and Bester, 10). The percentage brix was highest in the upper and outer zones. Fruit sugar content was higher in both upper zones and the middle outer zone.

Biochemical changes during storage of fruits: The guavas were picked at 5 day intervals from 20th November to 25th December. TSS, sugars, ascorbic acids and starch contents were calculated and were average but the specific gravity decreased gradually and its optimum value was observed in 2nd week of December (Tripathi and Gangwar, 36). The ascorbic acid contents of the fruit increased steadily to maximum. Among guava cvs. Gunees gave the largest fruit (220.9g), White Flesh has highest acidity (0.45%) and Lucknow-49 and Behat Coconut had the highest content of soluble sugar and ascorbic acid respectively (Tandon and Chadha, 35). Guava fruits exhibit climacteric patterns of respiratory behaviour and ethylene evolution. The time to attain the climacteric changes was generally not related to fruit maturity at harvest, but rates of production of CO_2 and ethylene were higher at maturity level (Brown and Wills, 5). In Kinnow mandarin irrespective of fruit position on the tree its weight was positively correlated with TSS content. Among different maturity indices, TSS showed positive correlation with reducing and non-reducing sugars. Peel (%) was negatively correlated with juice (%) and fruit shape index. Peel (%) and TSS showed a very high positive correlation but with only in fruits on west side of trees (Singh *et al.,* 26). Guava cv. Lucknow-49 fruit graded according to their specific gravity (1<, 1-2 or >1), were packed in 200 gauge, ventilated polythene bags and stored under ambient condition upto 12 days. Weight loss, firmness, titrable acidity, vitamin C, TSS and reducing sugar content were assessed at 3 days interval. Fruits with higher specific gravity can be stored for longer period than with lower specific gravity fruits (Balkrishnan *et al.,* 3). In Clementine, fruit position also affected juice pH, peel thickness and seed number. In guava cv. Sardar physiological loss in weight reaches a maximum at 12 days of storage and the decay process started on day 4 reaching a maximum of 58.58% on day 16. TSS, total sugar, sucrose, pectin, acidity and ascorbic acid contents in fruits increased gradually during maturation and reached maximum on day 8 of storage and declined thereafter. However, starch, protein, amino acids, total phenols, chlorophyll a and b and mineral composition of fruits started declining from maturation onwards and were lowest on day 16 of storage (Ramchandra, 24).

Storage quality: In guava fruits, the acidity decreased at room temperature while at low temperature, it increased gradually in the initial stages and then decreased (Srivastava *et al.,* 29). The extent of acidity decline varied with cultivars being maximum in Lucknow-49 and minimum in Allahabad Safeda (Chundawat *et al.,* 6). Acidity increased upto 4 days of storage at room temperature and then decreased (Gupta et al., 13). Similar trends were also reported in grapes cultivar Perlette (Kumar, 20). This increase in acidity was probably due to water loss from the fruits during storage (Hifney and Abdel, 14). Maximum titerable acidity content (0.35%) was found with specific gravity <1.0 in 3 days after storage (Balkrishnan *et al.,* 3).

Peduncle effect on fruit quality: In guava cv. Allahabad Safeda fruits kept in natural posture i.e. pedicel end vertically upward showed the lowest physiological loss in weight, ethylene and CO_2 evolution rates, the highest soluble solids and ascorbic acid concentration and were the lowest to ripen during storage (Siqqiqui and Gupta, 28). In mango, the pedicellate fruits showed less infection than non-pedicellate fruits upon ripening during the storage period (Singh and Tandon, 27). Longer shelf life was observed in mango fruits with a small stalk. Pear fruits with pedicel retained very attractive yellow colour, glossy appearance, no shrinkage, and moderately loose texture with good taste at the 10th day of storage (Prakash *et al.,* 23).

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