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Short communication

Relationship of trunk cross-sectional area with growth, yield, quality and leaf nutrient status in Kinnow mandarin

R.P.S. Dalal* and J.S. Brar
Punjab Agricultural University, Regional Station, Bathinda 151001, Punjab

ABSTRACT

An experiment was on five-year-old Kinnow trees, planted at a spacing of 6 m × 6 during the year 2008-10. Plants receiving uniform management practices were selected during September and classified into five different trunk cross-sectional area groups. The canopy volume, leaf area, yield and production efficiency increased gradually with the increase in trunk cross-sectional area. The maximum canopy volume (10.34 m^3) was recorded at the highest trunk cross-sectional area (97.45 cm^2). A positive and significant correlation was observed between TCSA and fruit yield (+0.953) and TSS (+0.872).

Key words: Kinnow, correlation, trunk cross-sectional area.

Out of the total area under fruit cultivation in Punjab, about 50% is occupied by Kinnow. During extensive survey, great variation in the growth and yield of Kinnow mandarin has been observed at the farmer's field mainly due to biotic and abiotic factors, faulty selection of the planting material as well as improper canopy management during the early growth stages. Rootstock, crop nutrition, irrigation, cultural practices and restriction of the root system can limit growth of any fruit crop. Thus, orange tree of equal age can differ in size, biomass and N content (Morgan *et al.*, 9). The differences in the tree size have shown difference in their performance in respect of growth and fruit yield.

A positive and linear relationship have been found with increasing trunk cross-sectional area for growth, yield and quality in different fruit crops (Dhaliwal and Dhillon, 4; Kumar *et al*., 8) in guava and Kumar and Pandey (7) in banana. Hence, trunk cross-sectional area of tree fruit crops may be a useful index for estimation of growth, yield and quality of fruits (Kumar *et al.*, 8). The ability to develop a relationship between trunk cross sectional area, which directly relates to the tree size and yield contributing parameters will improve our understanding of predicting the yield in Kinnow, but, data describing the growth, yield, and quality and leaf nutrients status as a function of the trunk cross sectional area are not readily available. Hence, the present investigation was undertaken on Kinnow tree on vegetative growth, fruit yield, quality and leaf nutrients content under semi-arid irrigated conditions of south-western Punjab.

The experiment was conducted on five-year-old Kinnow trees, planted at a spacing of 6 m x 6 m at PAU, RS, Bathinda, during the year 2008-10. The soil of experimental site is classified as loamy sand, with pH = 8.2, EC = 0.28 dS/m, OC = 0.46%, P = 14 kg/ha and K = 252 kg/ha. Thirty plants receiving uniform management practices were selected during September and classified into five different trunk cross-sectional area groups (60.16, 66.90, 76.45, 86.63 and 97.45 cm^2) measured at five cm above the bud union. One tree in each group with uniform trunk cross-sectional area were marked for recording observation in Randomized Block Design with six replications. The trunk cross-sectional area (TCSA) was calculated by using formula (TCSA= $Girth^2/ 4\pi$) given by Kumar *et al*. (8). Observations on plant height, spread, canopy volume, leaf area, yield and productive efficiency were recorded at harvesting, *i.e.* during January. Plant height and spread were measured by metre scale and measuring tape, and canopy volume by the formula given by Castle (2), *i.e.* Tree volume = 0.5238 × canopy height (m) × [canopy diameter (m)]^2. Productive Efficiency (PE) was worked out by using the formula suggested by Castle (2), *i.e.* PE = Number of fruits per plant/TCSA (on trunk cross-sectional area basis).

Seven-month-old fully developed 20 leaves from spring season growth were collected randomly from trees for the estimation of leaf area using leaf area meter. Ten fruits were randomly selected from each tree and pooled as per replication in all the treatments for quality analysis. To estimate TSS the juice was extracted and was measured by hand refractometer. Titratable acidity was estimated by titrating 2 ml juice against N/10 NaOH using phenolphthalein as an indicator and expressed in terms of percent of citric acid. Leaf nutrients analysis was made by collecting the fully mature spring season leaves from non-

*Corresponding author's E-mail: dalal08@rediffmail.com

fruiting shoots in the month of September (Bhargava, 1). Different nutrients were estimated following the method suggested by Chapman (3). Total nitrogen was estimated with Nessler's Reagent method. Phosphorus was determined with vandomolybdo-phosphoric acid yellow colour method (Jackson, 6). The data were analyzed statistically and interpreted to develop the linear correlation between trunk cross-sectional area and growth, yield, quality and leaf nutrients status.

The canopy volume, leaf area, yield and production efficiency increased gradually with the increase in trunk cross-sectional area (Table 1). The maximum canopy volume (10.34 m^3) was recorded at the highest trunk cross-sectional area (97.45 cm^2) and significant over 60.16 and 66.90 cm^2 trunk cross-sectional area. The leaf area increased with increase in trunk cross-sectional area and maximum leaf area (15.17 cm^2) was measured with highest trunk cross-sectional area. However, positive but non-significant correlation was observed between trunk cross sectional area and canopy volume (+0.779) and leaf area (+0.736). The trees with maximum trunk cross-sectional area gave the highest yield (32.01 kg/ tree), whereas, the minimum yield was recorded with the lowest trunk cross-sectional area. A positive and significant correlation was observed between TCSA and fruit yield (+0.953). Productive efficiency of the trees increased with the increase in trunk cross-sectional area. The maximum productive efficiency (2.32 fruits/ cm^2) was observed with highest TCSA, which was significant over 60.16 and 66.90 cm^2, but, correlation was found positively non significant (+0.731). The TCSA of the plant was positively correlated with transport of nutrients from root to different aerial parts of the plant and the distribution of photosynthates from site of production to site of utilization, which ultimately influence the vegetative growth and also fruit yield (Hartmann and Kester, 5). Similar increase in growth and yield with the increase in TCSA was earlier reported by Dhaliwal and Dhillon (4), and Kumar *et al.* (8) in guava, and Kumar and Pandey (7) in banana.

Trunk cross-sectional area also influenced the fruit quality in terms of TSS, acidity and leaf nutrients contents. Maximum TSS was determined from trees having maximum trunk cross-sectional area. However, positive but non-significant correlation was found between TCSA and TSS (+0.872). Similar results were also reported by Salvador *et al*. (10) in apple, and Kumar and Pandey (7) in banana. The fruit acidity decreased with increase in trunk cross-sectional area of the tree and there was a negative but non-significant correlation between trunk cross-sectional area and acidity (-0.718). These results are in accordance with the earlier results reported by Kumar *et al.* (8) in Allahabad Safeda guava. The N and P contents of the leaves increased significantly with the increase in trunk cross-sectional area. The maximum nitrogen (2.45%) and phosphorus (0.133%) contents were recorded with TCSA and minimum with lowest TCSA. However, positive but non-significant correlation was found between trunk cross-sectional area and leaf N & P contents. The increase in leaf area and canopy as evident from the present study exert more pressure for absorption of nutrients, moreover, more TCSA facilitates translocation of nutrients from the roots to aerial parts, thus resulting in better leaf nutrients status. Increase in leaf N, P & K contents with increase in trunk cross-sectional area of banana pseudostem has been earlier reported by Turner and Barkus (11), and Kumar *et al.* (7).

It could be concluded from the study that there was a gradual increase in canopy volume, leaf area,

Table 1. Effect of trunk cross-sectional area (TCSA) on growth, yield, productive efficiency, quality and leaf nitrogen and phosphorus contents in Kinnow mandarin.

TCSA (cm^2)	Canopy volume (m^3)	Leaf area (cm^2)	Yield (kg/ tree)	Productive efficiency (fruits/cm^2)	TSS (%)	Acidity (%)	Leaf nitrogen (%)	Leaf phosphorus (%)
60.16	6.99	14.76	17.56	1.84	10.17	0.934	2.21	0.112
66.90	7.62	14.95	20.24	1.97	10.32	0.899	2.28	0.114
76.45	9.32	15.06	24.16	2.16	10.67	0.853	2.30	0.119
86.63	9.88	15.12	27.39	2.19	11.12	0.837	2.39	0.125
97.45	10.34	15.17	32.01	2.32	11.17	0.795	2.45	0.133
CV	11.37	0.77	7.50	7.83	2.29	5.94	3.42	4.33
CD at 5%	1.21	0.14	2.19	0.2	0.29	0.062	0.1	0.006
r with TCSA	0.779	0.736	0.953	0.731	0.872	-0.718	0.758	0.84

r = Co-efficient of correlation; * p = 0.05

yield, productive efficiency, fruit TSS, and leaf N & P contents with increase in trunk cross-sectional area, whereas, acidity decreased. A positive and significant correlation was observed between trunk cross-sectional area and yield. However, a positive but non-significant correlation was found between trunk cross-sectional area and growth parameters, TSS, and leaf N & P contents, while acidity content showed a negative correlation. Therefore, it is inferred that trunk cross-sectional area of the Kinnow tree should be considered over conventional method, *i.e.* tree size to improve and predicting the fruit yield and quality.

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