



Influence of integrated nutrient management under high density plantation in kinnow mandarin

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Abstract: Nutrient management and planting density have become an important consideration in kinnow management. Kinnow planting and nutrition should be planned so that biological and management aspects are interrelated to maximize economic returns. Keeping this in view, the study was initiated to find out the appropriate spacing and nutrition level for Kinnow in arid irrigated region of Bathinda. The effect of tree spacing and nutrition on vegetative performance and yield of 6 years old kinnow mandarins raised on rough lemon rootstocks were studied at Regional Research Station, Bathinda during the year 2012-13. Plants were grown at three different spacing viz. S₁ (6x6m), S₂ (6x5m) and S₃ (6x4m) and given three different levels of nutrition viz. L₁ (75% inorganic + 25% FYM), L₂ (50% inorganic + 50% green manure) and L₃ (100% inorganic only). Maximum plant height was observed under spacing S₃ (3.24 m) and nutrient level L₁ (3.21 m), however, maximum spread (E-W) was noted under S₂ and L₂ and spread (N-S) under S₁ and L₃. Maximum number of fruits per plant (161.66) was counted in L₃ and S₂ (155), whereas maximum average fruit weight was weighed in L₂ (150.80 g) and S₁ (145.19). Maximum fruit yield (22.26 Kg/plant) was observed in L₃ and S₂ (22.40 Kg/plant). Fruit quality in terms of juice and TSS was not affected by any of the spacing and nutrient levels. However, maximum acidity was recorded in L₃.

Key words: Kinnow, High density, Nutrient management, Yield, Growth, Quality

Introduction

Kinnow was evolved as a result of cross between 'king' (*Citrus nobilis*) and 'willow leaf' (*Citrus deliciosa*). The name was derived by combining the first and last words of the two parents i.e. 'kin' from king and 'ow' from willow. It is an important fruit of genus *Citrus* of the family Rutaceae. Its importance is demonstrated by its wide distribution and large-scale production. It is highly prized and economically remunerative fruit. Kinnow fruits have special importance due to their distinct flavors and therapeutic values. These are rich in vitamin-C with fair amounts of vitamins A & B. Besides this, they are rich source of minerals (calcium, phosphorus and iron). The juice is very refreshing, delicious and soothing. Along with their consumption as fresh fruit, a large number of products and byproducts are prepared and marketed with premium price. In Punjab, Kinnow is cultivated over an area of 47,101 hectares with production of 10, 17,725 tons. Kinnow hold first position in area and production in total fruit production of the state. Kinnow is commercially cultivated due to its good yield, high processing quality, fresh consumption, aromatic flavor and better adaptation to agro-environmental conditions of Punjab. Progressive farmers prefer to grow Kinnow because of its high yielding characteristics and its attractive quality that possesses the potential to give the lucrative return in form of profit. But even then, average yield of Kinnow in our state is far less when compared with many other citrus growing countries of world. Kinnow planting should be planned in such a manner so as to get good economic returns. In Punjab a number of changes have occurred which effects returns from Kinnow

production, land values have increased and availability of quality land for citrus have decreased. The shortage of land, energy, water and skilled harvesting labour, together with higher fixed costs, which require a more rapid return on capital, requires intensifying the trend of higher planting densities. The major advantage of close plantation is higher convenience and efficiency of tree care, plant protection operations, harvesting and early production of commercial yields. Moreover, poor soil quality and increase in expenditure for equipments, irrigation and labour is another limiting factor. The tree loss rates require continual evaluation of citrus plantings to establish systems. Because of these changes, it appears that Kinnow production in future must make more efficient use of limited amount of good land in order to provide good economic returns. Kinnow has dominated the citrus industry of Punjab but as the availability of good land and quality soil as a resource is limited, tree spacing and nutrition has become an increasingly important consideration in Kinnow management (Zekri, 2000). By high density plantation we can get earlier returns, better spray coverage at less cost and easy harvesting. Adoption of optimum spacing is intended towards harnessing solar energy, avoiding root competition and efficient exploitation of water and nutrients. The concept of high density is increasing acceptance to optimize productivity (Nasir *et al.*, 2006). On the other hand integrated nutrient management affects growth and yield of Kinnow appreciably (Garhwal *et al.*, 2014). Extensive use of inorganic fertilizers with low doses of organic manures has resulted in deterioration of soil fertility which in turn leads to citrus decline (Srivastava and Singh, 2009). Keeping this in view, the

study was initiated to find out the appropriate nutrient management practice and planting density for Kinnow under arid irrigated conditions of Punjab in Bathinda region.

Materials and Methods

The present studies were conducted at "Regional research station, Bathinda" during the year 2012-13. In the trial, seven year old, uniform and disease free trees of Kinnow mandarins raised on rough lemon rootstocks were selected to study the effect of integrated nutrient management under high density planting in Kinnow mandarin on vegetative performance, yield and quality. The cultural practices and inputs were used as per package of PAU, Ludhiana. Fertilizers were applied as recommended dose of fertilizer whereas, organic manure was added by replacing the nitrogen dose by the FYM and green manuring. The data were analyzed statistically in RBD factorial design as per the procedures of Gomez and Gomez (1984). There were three spacing treatments (S_1 , S_2 and S_3) and three nutrient treatments (L_1 , L_2 and L_3). All the treatments were replicated thrice with nine treatment combinations having a treatment unit of two trees as per following treatment details.

Spacing: S_1 - Recommended spacing (6x6m); S_2 - Reduce the spacing by 70% or 80% (6x5m) and S_3 - Reduce the spacing by 60% (6x4m)

Levels of nutrition: L_1 - 75% N(inorganic) + 25%N (FYM); L_2 - 50% inorganic + 50% (green manure) and L_3 - 100% inorganic only (check)

The height and tree spread of each selected tree was measured with the help of calibrated bamboo stick. To get a tree spread (canopy diameter) two observations, one each on east-west and north-south sides of selected trees were recorded. The circumferential measurement for scion was taken 5 cm above the

bud union and for stock it was taken 5 cm below the bud union. The canopy volume was calculated according to the formula suggested by Castle (1983).

Equation for calculating canopy volume = 0.5236 (canopy height) (canopy diameter)²

Where: Canopy volume = $4/6 \pi r^2 h$, $r = \text{sum (EW+NS)}/4$, $h = \text{height}$

Number of fruits per plant were counted and averaged.

The fruit weight was determined by electronic balance. The percentage of the juice was calculated on fresh weight basis. The chemical characters like TSS, acidity and ascorbic acid were measured as per standard procedures of A.O.A.C (1990).

Results and Discussion

Spacing and nutrient levels alone did not affected plant height, spread (E-W) and canopy volume however, interaction of both showed significant influence over these parameters. Maximum plant height was observed under spacing S_3 (3.24 m) and nutrient level L_1 (3.21 m), however, maximum spread (E-W) was noted under S_2 and L_2 and spread (N-S) under S_1 and L_3 . At closer plant spacing Kinnow plants grow taller than its normal pattern of spreading canopy and it was due to competition among plants for light interception in close spacing, owing to which plants get more height (Nawaz et al. 2007, Rabe and Aubert, 1999).

The rootstock and scion circumference was influenced by spacing levels however nutrient levels only affected rootstock circumference. Maximum canopy volume (15.76 m^3) was found under spacing S_1 (6m x 6m) and nutrient level L_2 (15.77 m^3). Canopy volume reflects the efficient use of nutrients light and water. At wider spacing plants have spherical type canopy because they have enough space for canopy spread. At wider spacing plants received more light around the canopy and lateral buds proliferate effectively

Table-1: Growth Yield and quality of the kinnow plant as affected by high density planting and integrated nutrients management

Planting density (m)	Nutrient level (m)	Plant height (m)	Spread E-W (m)	Spread N-S (m)	Rootstock circumference (cm)	Scion circumference (cm)	Canopy volume (m ³)	No. of fruits/plant	Fruit wt (gm)	Fruit yield (Kg/tree)	Juice (%)	TSS (%)	Acidity (%)
S_1 (6x6m)	L1	3.13	2.92	2.87	37.25	35.65	13.89	146.00	142.72	20.77	48.20	10.4	0.85
	L2	3.2	3	2.95	40.85	36.9	15.02	125.00	155.21	19.38	48.56	10.2	0.83
	L3	3.21	3.25	3.37	39.5	35.53	18.38	170.00	137.65	23.39	48.82	10.5	0.92
Mean		3.18	3.05	3.06	39.2	36.02	15.76	147.00	145.19	21.18	48.53	10.36	0.86
S_2 (6x5m)	L1	3.45	3.06	3.02	37.18	36.23	16.5	157.00	139.26	21.90	47.78	10.5	0.87
	L2	2.81	3.12	2.85	43.65	38.93	13.23	148.00	154.41	22.83	48.87	10.3	0.85
	L3	3.01	3.2	3.08	42.01	38.81	15.59	160.00	140.38	22.48	48.45	10.1	0.86
Mean		3.09	3.11	2.98	40.95	37.99	15.1	155.00	144.68	22.40	48.37	10.30	0.86
S_3 (6x4m)	L1	3.06	2.97	2.9	39.83	39.21	13.89	156.00	142.51	22.22	47.61	10.4	0.86
	L2	3.56	3.22	3.17	38.25	34.4	19.06	133.00	142.77	18.98	48.21	10.4	0.82
	L3	3.1	2.75	2.8	40.12	38.1	12.53	155.00	135.07	20.91	48.10	10.5	0.90
Mean		3.24	2.98	2.95	39.4	37.23	15.16	148.00	140.12	20.70	47.97	10.43	0.86
	L1	3.21	2.96	2.93	38.08	37.03	14.76	153.00	141.50	21.63	47.86	10.43	0.86
	L2	3.19	3.11	2.99	40.91	36.74	15.77	135.33	150.80	20.40	48.55	10.30	0.83
	L3	3.1	3.06	3.08	40.54	37.23	15.5	161.66	137.70	22.26	48.46	10.36	0.89
CD Spacing(s)		NS	NS	NS	0.26	0.7	NS	NS	3.95	NS	NS	NS	NS
Nutrients level (L)		NS	NS	NS	0.26	NS	NS	16.42	3.95	NS	NS	NS	0.04
SXL		0.31	0.23	NS	0.46	1.21	3.21	NS	6.85	NS	NS	NS	NS
C V %		5.67	4.51	8.27	0.67	1.89	12.09	9.50	2.77	9.80	2.34	3.84	5.27
SE ±		0.14	0.08	0.2	0.21	0.57	1.51	11.64	3.23	1.71	0.92	0.31	0.03

leading to lateral branch development. As a response to more light interception at higher branches, the pattern of growth in Kinnow mandarin changed to upright as against spreading (Nawaz *et al.*, 2007).

Meheswarappa *et al.* (2003) also reported that integrated nutrient management practices coupled with adopting high density cropping system results in improvement of tree growth and yield. This may be due to improved water holding capacity and improved nutrient status of soil due to adoption of integrated nutrient management concept. Growing green manure crop in the basin and then incorporating it in the soil results in increase in available P which might be attributed to solubilising capacity of the organic manure. This also helps in increase in K status in soil which helps in improving fruit quality. They further elaborated that imposing the nutrient management practices resulted in the improvement in yield which might be due to improvement in soil health and better growth of trees as reflected by increase in photosynthetic area due to INM and high density planting.

Number of fruits per plant was significant under nutrient levels and non significant under spacing levels. Maximum number of fruits per plant (161.66) was counted in L₃ and S₂ (155), whereas maximum average fruit weight was weighed in L₂ (150.80 g) and S₁ (145.19 g) where both the levels affected it. Maximum fruit yield (22.26 Kg/plant) was observed in L₃ followed by L₁ (22.40 Kg/plant). Similar results of increased yield in Kinnow under INM were also reported by Madarakhandi *et al.* (2015). The results of earlier work on density have indicated that close spacing produces more fruit per acre. The yield in close spacing was more which confirms the findings of the Wheaton *et al.* (1995) and Nawaz *et al.* (2007) who found that there is an inverse relationship between tree spacing and yield. Meheswarappa *et al.* (2003) reported that the application of balanced dose of fertilizer along with organic manure application favoured the growth of plants due to improved soil condition with FYM and green maure.

The fruit weight and juice per cent decreased with decrease in plant spacing. Maximum fruit weight and juice per cent was noticed in spacing 6mx 6m which may be due to more plant growth and more uptake of water as reported by Nasir *et al.* (2006) and Chadha (2001) who found positive correlation between these parameters and planting spacing in mandarin. Maximum acidity was recorded in L₃. In closer spacing, plants also compete for nutrients which may cause lower and inferior quality fruits. Improvement in fruit quality might be attributed to application of organic manures along inorganic which results in higher K availability in soil due to their easy decomposition of mineral constituents and producing exchangeable K into the soil solution as K is directly involved in enhancing better fruit quality. Addition of organic manure and *in situ* growing and incorporation of green manure crop in the tree basin also increases the status of major nutrients in soil and in turn plants resulting in healthy fruit production.

The study concludes that maximum yield is achieved under spacing level S₂ (50% inorganic + 50% green manure) and fruit

quality with nutrient level L₂ (6x5m). Thus, inference can be drawn that both the concept of HDP and INM need to be stressed as at wider spacing number of trees ha⁻¹ are less due to which cumulative yield is low. So a moderate planting distance along with canopy and nutrient management is required for early and more return. On the other hand there is a need to develop well established nutrient management techniques to improve the quality of this crop substantially by using non-conventional approaches alone or in combination with conventional approaches. The combined use of organic and inorganic fertilizers under the concept of integrated nutrient management needs to be emphasized on priority as inadequacy of nutrients at critical stages of plant growth and development adversely affects the bearing and fruit quality.

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