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SOIL HEALTH AND LEAF NUTRIENT STATUS AS INFLUENCED BY INM AND HDP IN KINNOW MANDARIN.

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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). The high density planting (HDP) is one of the recent and novel concepts of increasing productivity without affecting the quality of fruits. This system has been successfully implicated in fruit crops such as mango, citrus, guava and banana, since it results in the optimum utilization of natural resources. The planting density needs to be designed to intercept the solar radiation effectively. An ideal density of plants is determined by complex integration of factors like cultivars, soil fertility and management practices. Extensive use of chemicals fertilizers with low doses of organic manures have resulted in deterioration of soil fertility and soil health as well which in turn lead to citrus decline (Srivastava and Singh, 2009). Biological routes of improving soil fertility and health for optimum crop production form vital component of integrated nutrient management along high density planting. These routes are operated through the use of FYM and green manures along chemical fertilizers. Choosing the correct system of spacing and optimum nutrition is considered very important for maximizing the yield per unit area, apart from maintaining soil helath and leaf nutrient status. Keeping this in view, the study was initiated to find out the best spacing and nutrition practice under arid irrigated conditions of Punjab in Bathinda region which can retain soil health and leaf nutrient status.

The present studies were conducted at citrus block of 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 soil health and leaf nutrient status. 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 in factorial RBD. All the treatments were replicated thrice with nine treatment combinations having a treatment unit of two trees. The treatment details were three spacing levels (S_1, Recommended spacing (6x6m), S_2 - Reduced spacing by 70% or 80% (6x5m) and S_3 - Reduced spacing by 60% (6x4m) and three 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).Organic carbon was determined using the Walkey and Black's rapid titration method (Walkley and Black, 1934). Available soil phosphorus was determined by Olsen's method (Olsen *et al*, 1954). Total N in soil was determined by the Kjeldhal method of Bremner (1996). Potassium was estimated by flame photometer as described by Chapman and Pratt (1961) while calcium and magnesium were determined by atomic absorption spectrophotometer.

Soil health improved with L_1 {75% N (inorganic) + 25%N (FYM)} and L_2 {50% inorganic + 50% (green manure)} treatments which were significantly better than L_3 {100% inorganic only} in terms of organic carbon and phosphorus content. Leaf N, P, K and Ca contents were affected significantly with the different nutrients levels but non significant difference was seen in Mg content. Treatments L_3 {100% inorganic only} and L_1 {75% N (inorganic) + 25%N (FYM)} were non-significant in terms of N content over L_2. Whereas, P and K contents were observed more in LI {75% N (inorganic) + 25%N (FYM)} and L_2 {50% inorganic + 50% (green manure)} as compared to level L_3 {100% inorganic only}. Calcium content under treatment L_2 {50% inorganic + 50% (green manure)} was significantly different from L_1 {75% N (inorganic) + 25%N (FYM)} and L_3 {100% inorganic only}. Meheswarappa *et al.* (2003) also reported that integrated nutrient management practices coupled with adopting high density cropping system results in improvement in plant nutrients. This may be due to improved water holding capacity and improved nutrient status of soil due to adoption of integrated nutrient management concept. Garhwal *et al.* (2014)

Table 1: Soil health and plant leaf nutrient standard of Kinnow leaves as affected by high density planting and integrated nutrient management

Planting density (m)	Nutrient level	O.C (g kg-^{1})	Phosphorus (kg ha^{-1})	Plant leaf nutrient status (%)				
				N	P	K	Ca	Mg
	L1	4.1	8.40	2.75	0.21	1.65	2.63	0.37
S1(6x6m)	L2	4.5	9.01	2.26	0.18	1.77	2.94	0.32
	L3	3.8	7.90	2.60	0.14	1.58	2.67	0.33
Mean		4.1	8.44	2.54	0.17	1.66	2.74	0.34
	L1	4.6	8.46	2.69	0.20	1.73	2.80	0.40
S2(6x5m)	L2	4.8	9.09	2.31	0.15	1.73	2.87	0.42
	L3	3.8	8.07	2.80	0.15	1.52	2.37	0.38
Mean		4.4	8.54	2.60	0.16	1.66	2.68	0.40
	L1	4.3	8.09	2.80	0.19	1.82	2.92	0.35
S3(6x4m)	L2	4.7	9.03	2.35	0.17	1.68	2.78	0.38
	L3	3.5	8.19	2.62	0.14	1.55	2.48	0.32
Mean		4.2	8.44	2.59	0.16	1.68	2.73	0.35
	L1	4.3	8.32	2.74	0.20	1.73	2.78	0.37
	L2	4.6	9.04	2.31	0.16	1.73	2.92	0.37
	L3	3.7	8.05	2.67	0.14	1.55	2.78	0.34
CD Spacing(S)		NS	NS	NS	NS	NS	NS	0.03
CD Nutrient level (L)		0.04	0.25	0.16	0.03	0.06	0.11	NS
SXL		NS	NS	NS	NS	0.10	0.19	NS
CV%		9.96	3.05	6.53	9.50	3.67	4.17	9.22

also reported improved leaf nutrient content with application of organic manure in Kinnow mandarin which might be due to improved soil texture, structure and moisture level facilitating the absorption of mineral nutrition from the soil. The soil chemical properties (Table 1) indicate that the status of organic carbon and available P of the soil under S_2 {Reduced spacing by 70% or 80% (6x5m)} and L_2 {75% N (inorganic) + 25%N (FYM)} was higher compared to other treatments. The spacing level S_2 {Reduced spacing by 70% or 80% (6x5m)} resulted in 4.4 gKg-^{1} cent organic carbon and 8.54 kg ha-^{1} available phosphorus in soil which was highest compared to other levels whereas, nutrition level L_2 {50% inorganic + 50% (green manure)} resulted in 0.46 % organic carbon and 9.04 kg ha^{-1} available phosphorus in soil which was at peak in comparison to other nutrition levels. Growing green manure crop in the basin and then incorporating it in the soil results in addition of green biomass resulting in addition of major nutrients as reported by Maheswarappa *et al.* (2003) in basins. On the other hand increase in available P might be attributed to incorporation of green manure crop in L_2 followed by L_1 {75% N (inorganic) + 25%N (FYM)} with P solubilising capacity of the organic manure. Improvement in soil chemical characters like build up of P status and increase in organic carbon content has been reported in high density planting (Khader *et al.*, 1992). Similar results were given by Arif Khan and Begum (2007). The increase in the leaf nutrient status might be attributed to adoption of integrated nutrient management practices. *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 in plants. The plants grown under integrated management practices might have absorbed the available nutrients from the soil and resulted in higher concentration of nutrients. This is attributed to higher retention of moisture content in soil by organic matter and higher uptake of moisture and nutrients like K by the plant tissue due to green manures. Due to the added benefits of organic matter, improves the soil structure, penetration, retention of moisture etc. and root proliferation are improved. Loss of organic matter will lead to the collapse of soil physical properties, the water balance and nutrient reserves. To remedy the situation, organic matter should be applied to the soil along inorganic fertilizers if we have to practice high density planting because final citrus fruit production depends upon soil on which plants are grown (Avais *et al.*, 2011). Because Kinnow is a tree and, it has growth in cycles, therefore until or unless, fertilizer application program is properly designed according to growth cycle, it not possible to improve the soil and plant health along fruit production (Alva *et al.*, 2006; Zaman and Schumann, 2006).

Thus, it can be concluded both the concept of HDP and INM need to be stressed as the enhancement and maintenance of soil fertility and conservation of the soil's health through these components will be a vital role and occupy significant concern for many of researcher in the future as a unique key for sustainable agriculture in developing countries.

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