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Short communication

Relationship between orchard soil management practices, fruit drop and economic aspects in Kinnow mandarin

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ABSTRACT

The study comprised of eight orchard floor management practices *viz*., rotavation, disc harrowing and chemical method of weed control singly and their combinations on Kinnow mandarin. Determinations were made to compare effectiveness of the management practices in terms of fruit set, fruit drop, fruit harvest, fruit weight, yield, expenditure incurred and economic aspects. The data indicated that all the growth parameters responded significantly to management practices.The results indicated superiority of mowing over conventional orchard floor management practices giving higher yield and economic returns per unit area. The maximum yield (112.39 kg/ plant) was found in T_8 (mowing of weeds) with 6.64 per cent fruit set and 612 fruits per plant. The cost of intercultural operations in this treatment came out to be Rs 1,200/- and net income Rs. 1,59,884/-.

Key words: Orchard floor management, fruit quality, yield, economic return.

Citrus is a major fruit crop in Punjab among all fruit crops, Kinnow mandarin comprises 62.4% area of total fruit crop area in the state. Generally, citrus trees particularly 'Kinnow' bear large number of flowers and fruits, all of which are unable to carry to full maturity. Besides other factors, fruit drop has been considered a major cause of low fruit yield in citrus. Fruit drop is a common phenomenon that occurs in many crop plants in response to developmental and environmental causes, leading to significant crop losses (Marcelis *et al*., 3). There are usually three periods of fruit abscission (Racsko *et al*., 5). The most of the fruit set (80-91%) was dropped during the first month after final fruit set (Saleem *et al*., 6). Only 5-7 percent of flowers develop into mature fruits. Various management options include clean cultivation, mulching, herbicide application and mowing etc. Management practices are essential to keep weeds suppressed below a critical threshold level (Skroch and Shribs, 8. Therefore, to avoid the economic loss as well as to maintain the health of the orchards it is imperative to manage excessive fruit drop by adopting integrated approach (Hogue and Neilsen, 1). The present investigation was carried out to examine the extent of different types of fruit drop in relation to soil disturbance or inter-cultivation and their economic impact on fruit yield and quality.

The present investigations were carried out at Punjab Agricultural University, Regional Research Station, Bathinda,. In the experiment, seven-year-old, uniform and disease-free trees of Kinnow mandarin raised on rough lemon rootstock were selected to study the relationship between orchard soil management practices, fruit drop and economic aspects. There were eight treatments replicated thrice, *viz.* T_1 (clean cultivation with disc harrow), T_2 (clean cultivation with rotavator), T_3 (alternative clean cultivation with disc harrow and rotavator), T_4 (alternative chemical and mechanical floor management with rotavator), T_5 (chemical floor management), T_6 (alternative chemical floor management and mowing of weeds), T_7 (alternative mechanical floor management and mowing of weeds) and T_8 (mowing of weeds).

Under clean cultivation, the orchard floor was kept free of weeds throughout the year mechanically using disc harrow and rotavator. Chemical weed management was carried out by spraying Glycel 41 SL (glyphosate) @ 1.6 l per acre as post emergence herbicide during second fortnight of March and July. Under mowing, the weeds were mowed down throughout the year whenever these attained the height of about 9 inches. Similarly, combinations of these practices were also carried out for comparison. The other cultural practices and inputs were used as per package and practices for cultivation of citrus in Punjab by PAU, Ludhiana. The number of flowers, fruit set, fruit drop (early, June and pre-harvest), final fruit harvest was calculated by tagging the braches on the all sides of experimental trees. Fruit weight of randomly selected 10 fruits from each replication was recorded and average was worked out. The yield in terms of kg/ plant was calculated by multiplying the average fruit weight and number of fruits per plant.

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The costs on the different floor management aspects were calculated on the basis of prevailing market rates, *viz*. disc harrowing @ Rs. 500/ acre/ time, cultivation with rotavator @ Rs. 600/- per acre/ time, spray of weedicide along with chemical @ Rs. 775 per acre/spray and mowing of weeds @ Rs. 300/-per acre/mowing. The cost on cleaning of tree basins depends upon the orchard floor management practices and the cost incurred on this purpose was calculated (Table 1).

Similarly, the quantum of dead wood or pruned wood also vary with the orchard floor management practices and the cost incurred on pruning and removal of dead wood was calculated as per the man day required to prune the trees under different floor management practices as listed below (Table 2).

The costs on intercultural practices, cleaning of tree basins and pruning of trees was accounted in total costs on orchard floor management practices and the expenditure incurred on the other general management practices or inputs for citrus orchards under all treatments remained constant. The MD was calculated as per the prevailing rate, *i.e.* Rs. 275/- per day for laborer employed for pruning and basin cleaning works. The fruit yield and gross income was calculated on the basis of prevailing market rate, *i.e.* Rs. 14.0 per kg of fruit.

The data in Table 3 clearly indicates that maximum number of flowers (262.33) was observed in treatment T_6 (alternative chemical floor management and mowing of weeds) and maximum fruit set per cent (6.64%) was noted in T_8 (mowing of weeds) and minimum fruit set per cent (5.87%) was noted in T_3 (alternative clean cultivation with disc harrow and rotavator). Higher fruit set may be attributed to least disturbance to orchard floor and mulching effect of mowed weeds. Maximum early fruit drop per cent (8.62%) was counted in T_5 (chemical floor management) and minimum (7.29%) in T_1 (clean cultivation with disc harrow). Lesser floral density

Table 1. Effect of different orchard-soil-management practices (man day and cost) in Kinnow cultivation.

Floor management practice	No. of basins cleaned per man day (MD)	No. of plants per acre	Man Day (MD) per acre	Cost/acre@ Rs. 275/- per Man Day (MD)
Rotavation	20	110	4.5	1237.5
Disc harrowing	16	110	4.6	1265.0
Mowing	15	110	5.1	1402.5
Chemical management	32	110	3.5	962.50

Table 2. Man day requirement for management of Kinnow mandarin orchards.

Orchard floor management practice	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8
No. of plants pruned/ MD	5.25	5.60	6.70	7.50	7.50	7.70	7.50	7.80
MD required for pruning one acre	20.95	19.64	16.42	14.67	14.67	14.29	14.67	14.10

Table 3. Economic aspects of different orchard soil management practices and pruning of 'Kinnow' orchard.

Treatment	Costs on intercultural operations (Rs.)	Pruning of plants/acre		Basin cleaning /acre (4 times)		Total expenditure on OSM and pruning (Rs.)	Income/ plant (Rs.) @ Rs 14/ kg fruit	Gross income/ acre (Rs.)	Net income/ acre (Rs.)
		Man days (MD) required	Expenditure @ Rs. 275 / MD	Man days (MD) required	Expenditure @ Rs. 275/ MD				
T_1	2,000	20.95	5,762	6.875	7,563	15,325	1,290	1,41,900	1,26,575
T_2	2,100	19.64	5,402	6.524	7,176	14,678	1,328	1,46,080	1,31,402
T_3	2,200	16.42	4,515	6.189	6,808	13,523	1,275	1,40,250	1,26,727
T_4	2,750	14.67	4,033	4.469	4,916	11,699	1,453	1,59,852	1,48,153
T_5	2,975	14.67	4,033	3.953	4,348	11,356	1,480	1,62,800	1,51,444
T_6	2,150	14.29	3,929	5.385	5,924	12,003	1,488	1,63,680	1,51,677
T_7	1,500	14.67	4,033	6.876	7,564	13,097	1,540	1,69,400	1,56,303
T_8	1,200	14.10	3878	7.335	8,068	13,146	1,573	1,73,030	1,59,884

results lesser early fruit drop (EFD) under treatments involving rotavation and disc harrowing. However, maximum 'June' drop and 'pre-harvest drop of 1.07 and 3.55% was counted in T_1 (clean cultivation with disc harrow), respectively. This may be attributed to more soil disturbance leading to injury to feeder roots and higher soil surface temperature under treatments involving cultivation practices. The 'June' and 'pre-harvest fruit drop' was lowest, *i.e.* 0.50 and 2.73% in T_6 (alternative chemical floor management and mowing of weeds), respectively, due to conserved moisture and optimized soil temperature under mowed or dried weeds flora. Similarly, maximum total fruit drop percent (12.69%) was noted in T_5 and minimum (11.30%) in T_6. To elucidate the precise impact of orchard floor management practices on physical and chemical characteristics of single fruit, weight per fruit was measured.

Maximum fruit weight (190.66 g) was noted in T_1 and minimum (183.66 g) in T_7 (alternative mechanical floor management and mowing of weeds). The higher fruit weight under treatments of mowing may be due to improved soil moisture and temperature conditions compared to treatments involving soil cultivation. However, all the treatments were non-significant in terms of fruit weight. Highest fruit yield (112.39 kg/ plant) was found in T_8 followed by 110.01 in T_7, while, the yield was lowest (91.10 kg/ plant) in T_3 (alternative clean cultivation with disc harrow and rotavator. Higher yields in mowed treatment may be attributed to improved fruit size, more shoot growth and canopy spread. In this context results are consistent with Sanchez *et al*. (7). Tree growth showed a positive response to mowing than clean cultivation probably because of improved soil physical conditions and increased nutrient availability. These results are in agreement with the findings of Yao *et al.* (9) who reported that tree health and yield increased with the ground management.

Orchard growers generally prefer the use of herbicides, however; cultivation in the tree row is currently the most common management practice in fruit orchards. It provides weed control but is costly and impairs soil quality and N availability (Sanchez *et al*., 7). The obtained results for both fruit set and total fruit drop percentages confirmed those of Lin (2) on Satsuma variety. There has been increased interest in using other methods of orchard floor management to reduce the use of chemicals in fruit production (Merwin *et al*., 4).

The expenditure incurred on the floor management practices and associated cultural practices, *i.e.* intercultural operation, basin cleanliness and pruning of dead wood was taken into consideration. The Table 3 clearly depicts that the orchard soil management treatment with respect to inter-cultural operation in T_5 (chemical floor management) was most costly (Rs. 2,975/-) and minimum cost (Rs. 1,200/-) was incurred in T_8 treatment. Likewise, maximum (7.8) plants pruned per man day (MD) as there was less dead or dried branches under this treatment hence; only Rs. 3,838/- were incurred by employed 14.1 MD per acre. However, in T_1 maximum (20.95 MD) man days per pruning were required to prune trees @ 5.25 trees per MD and total of Rs.5,762/- was incurred on pruning in this treatment. Similarly, expenditure of Rs. 5,402/- was incurred on pruning of trees under T_2 treatment. For cleaning of tree basins maximum labour and cost (Rs. 7,563/-) in T_1 treatment followed by Rs.7,176/- in T_2 treatment. Minimum cost of Rs.4348/- on this aspect was incurred in T_5 followed by Rs. 4,916/- in T_4 treatment. Likewise, highest cost (Rs. 15,325/-) on orchard soil management practices was also incurred in T_1 treatment followed by Rs. 14,678/- in T_2 treatment, while, in T_6 treatment it was least (Rs. 11,356/-) followed by 11,699/- in T_4 treatment.

The results indicated superiority of mowing practice over conventional cultivation towards plant growth, yield and improvement in soil physical properties. Similarly, fruit yield were increased with higher farm returns.

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