

## Impact of intercropping on yield, fruit quality and economics of young Kinnow mandarin plants

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### Abstract

Intercropping practices in orchard not only generate an extra income but the practice also helps to check the soil erosion through ground coverage and improves the physico-chemical properties of the soil. The effect of intercrops on vegetative performance and quality of 5 years old Kinnow mandarins raised on Rough Lemon rootstocks at 6x6m spacing was studied at RRS, Bathinda during the year 2011-12 and 2012-13. An intercropping experiment comprising of seven treatments such as T<sub>1</sub>: guara (Summer) + wheat (winter), T<sub>2</sub>: guara (summer) + barley (winter), T<sub>3</sub>: guara (summer) + fenugreek (winter), T<sub>4</sub>: moong (summer) + wheat (winter), T<sub>5</sub>: moong (summer) + barley (winter), T<sub>6</sub>: moong (summer) + fenugreek (winter) and T<sub>7</sub>: control (fallow: no intercrop) was laid out in Randomized Block Design with four replications to assess the effect of various intercrops on the performance of Kinnow in arid irrigated region of Bathinda, Punjab. The results of the study revealed that guar + wheat intercropping system exhibited better performance which has been reflected in the form of plant height (3.31 cm), gross income (Rs. 41180/-), fruit number (175) and Total Soluble Solids(TSS) per cent (10.8) of Kinnow fruit. The work concludes that intercropping in Kinnow mandarin helps to improve yield, fruit quality and economic aspect.

**Keywords:** Fruit quality, Income, Intercrop, Plant growth, Yield

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## INTRODUCTION

Intercropping is one of the techniques of land utilization for optimum production (Bhatnagar *et al.*, 2007). The leguminous intercrops were the most effective crop because of their desirable impact on improvement of nutrient status of soil and fruit plant of orchard. Experimental evidences have also proved that yield stability is greater with intercropping than sole cropping. Intercropping can provide substantial yield advantages compared with sole cropping. However, the success of intercropping system depends mainly on selection of suitable intercrop as the pre harvest management practices influence the Kinnow growth (Din *et al.*, 2012).

Intercropping in orchards is a common practice in many countries. It has been observed that intercropping of mustard with bananas and cucumber with citrus (mandarin) orchards improved the yields yield of banana and citrus in India (Ouma and Jeruto, 2010). Intercropping of legumes in citrus orchards is beneficial for the citrus produc-

tion. Intercrop improves fruit production of orchard as compared to non-intercropped orchard. Such crops help increase the yield of the main crop by fixing nitrogen biologically in the soil (Aziz *et al.*, 2008; Srivastava *et al.*, 2007). Furthermore, intercrops used in organic citrus orchards suppress weeds and thus improve the yield of citrus fruit (Linares *et al.*, 2008). Similarly, French-beans intercropped with lemon (citrus) proved to be the best combination in India (Hnamte *et al.*, 2013). The optimum sowing time of intercrops ensures the complete harmony between the vegetative and reproductive phases on one hand and the climatic rhythm on the other and help in realizing the potential yield. It was observed that sowing maize in citrus orchard helped to improve the predators' population that controls citrus leaf miner (Ahmed *et al.*, 2013).

Wrong choice of intercrops like berseem in citrus orchards, affects the yield of citrus adversely (Ijaz *et al.*, 2014). This is due to the competition for light and nutrients and different water and fertilizer requirements of the both crops, e.g. berseem re-

quires irrigation weekly while citrus requires less water. The excessive use of water deoxygenates the root system of citrus plants that affects yield and growth. Similarly, at harvesting time of wheat, irrigation is stopped but orchards require irrigation at that time which adversely affects yield and growth of citrus (Srivastava *et al.*, 2007 and Sarwar *et al.*, 2012). Thus, there is need to identify suitable intercrop which remains compatible throughout the growth of main crop. The present study aims to assess the impact of intercropping on Kinnow yield, fruit quality and economic aspect.

### MATERIALS AND METHODS

The experiment was conducted on five years old Kinnow mandarins plants raised on rough lemon rootstocks at 6x6m spacing at RRS, Bathinda during the year 2011-12 and 2012-13 to find out the feasibility of suitable intercrop in young Kinnow mandarin in arid irrigated region of Bathinda and to study effect of intercrops on main crop. There were seven treatments with six crop rotation practices for intercropping in non bearing Kinnow orchard having four replications. The cultural practices were given as per schedule recommended by PAU, Ludhiana.

The tree vigor of Kinnow mandarin was measured on the basis of increment in height, spread and scion girth at the start (March) and after termination of the experiment (January). The height and tree spread of each selected tree was measured with the help of calibrated bamboo pole. 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 was taken 5 cm above the bud union in the budded plants for trunk girth.. The percentage of the juice was calculated on fresh weight basis. The chemical characters like TSS and acidity were measured as per standard procedures of A.O.A.C (1990). The statistical analysis was done using Randomized Block Design (Gomez and Gomez, 1984).

### RESULTS AND DISCUSSION

Among growth parameters, the maximum increase in plant height (3.05 cm and 3.31 cm) during both the years was found in crop rotation guar + wheat however, minimum plant height (2.08 cm and 2.40 cm) was found in crop rotation guar + fenugreek during both the years as shown in table

**Table 1.** Treatment details.

T <sub>1</sub>	: Guara (Summer) + Wheat (winter)
T <sub>2</sub>	: Guara (summer) + Barley (winter)
T <sub>3</sub>	: Guara (summer) + Fenugreek (winter)
T <sub>4</sub>	: Moong (summer) + Wheat (winter)
T <sub>5</sub>	: Moong (summer) + Barley (winter)
T <sub>6</sub>	: Moong (summer) + Fenugreek (winter)
T <sub>7</sub>	: Control (Fallow : No intercrop)

**Table 2.** Effect of different intercrops on the growth of Kinnow mandarin and gross income.

Crop rotations	Plant Height (m)			Plant spread (m)			Canopy volume (m <sup>3</sup> )			Grain yield (q/acre)			Gross income	
	2011-12	2012-13	2011-12	2012-13	2011-12	2012-13	2011-12	2012-13	2011-12	2012-13	2011-12	2012-13	2011-12	2012-13
Guar+ Fenugreek	2.08	2.40	2.96	3.20	2.20	2.71	3.92	10.95	3.7+3.30	3.6 + 3.10	25900+19500=45400	25200 + 11780 = 36980		
Guar+ Barley	2.53	2.87	2.26	2.65	1.86	2.22	3.52	8.95	3.7+11.9	3.5 + 11.1	25900+13685=39585	24500 + 11988 = 36488		
Guar+ Wheat	3.05	3.31	2.56	2.88	1.81	2.16	3.25	11.01	4.0+11.7	3.8 + 10.8	28000+15034.5=43034.5	26600 + 14580 = 41180		
Moong + Fenugreek	2.41	2.75	2.71	3.11	2.51	3.01	4.70	13.53	4.3+3.8	4.1 + 3.9	16985+22800=39785	16195 + 14820 = 31015		
Moong + Barley	2.37	2.70	2.15	2.50	1.80	2.11	4.12	7.49	3.9+12.1	3.7 + 11.8	15405+15548.5=30953.5	14615 + 12744 = 27359		
Moong + Wheat	2.32	2.65	2.58	2.93	2.08	2.58	3.15	10.59	3.8+12.2	3.9 + 12.0	15010+15677=30687	15405 + 16200 = 31605		
Control (Fallow: No intercrop)	2.15	2.50	2.18	2.61	1.97	2.28	3.00	8.37	-	-	-	-		
<b>CD (p=0.05)</b>	<b>0.16</b>	<b>0.16</b>	<b>0.21</b>	<b>0.17</b>	<b>0.22</b>	<b>0.17</b>	<b>0.79</b>	<b>1.35</b>	-	-	-	-		
<b>CV%</b>	<b>4.62</b>	<b>4.17</b>	<b>5.76</b>	<b>4.12</b>	<b>7.34</b>	<b>4.91</b>	<b>14.57</b>	<b>9.03</b>	-	-	-	-		

Rate in year 2011-12: Guara Rs.2000/q, Moong Rs.4200/q, Fenugreek Rs.2000/q, Barley Rs.1100/q and Wheat Rs.1170/q, Rate in year 2012-13: Guara Rs.7000/q, Moong Rs.3950 /q, Fenugreek Rs.3800 /q, Barley Rs.1080 /q and Wheat Rs.1350 /q

**Table 3.** Effect of intercrops on fruit quality of kinnow mandarin.

Crop rotations	Fruit number/plant		Average fruit wt.(g)		Yield (Kg/tree)		Juice (%)		TSS (%)		Acidity (%)	
	2011-12	2012-13	2011-12	2012-13	2011-12	2012-13	2011-12	2012-13	2011-12	2012-13	2011-12	2012-13
Guar+ Fenugreek	156	150.17	140.64	150.72	21.94	22.63	47.35	46.80	10.2	10.30	0.83	0.84
Guar+ Barley	164	154.02	138.16	155.17	22.65	23.89	47.87	47.37	10.7	10.70	0.82	0.83
Guar+ Wheat	175	155.37	128.45	152.20	18.24	23.64	47.24	47.47	10.8	10.90	0.84	0.83
Moong+ Fenugreek	170	157.02	133.35	159.92	19.33	25.10	46.95	48.65	10.7	10.80	0.85	0.85
Moong+ Barley	161	153.52	140.25	152.50	19.35	23.41	46.80	47.13	10.6	10.40	0.84	0.84
Moong+ Wheat	163	155.72	140.0	155.00	19.6	24.21	46.65	48.26	10.2	10.20	0.84	0.85
Control (Fallow: No intercrop)	149	148.12	141.38	150.08	21.06	24.22	46.60	46.37	10.3	10.30	0.85	0.85
<b>CD (p=0.05)</b>	<b>5.83</b>	<b>4.61</b>	<b>6.68</b>	<b>6.05</b>	<b>1.55</b>	<b>1.30</b>	<b>NS</b>	<b>0.76</b>	<b>0.31</b>	<b>0.23</b>	<b>NS</b>	<b>NS</b>
<b>CV%</b>	<b>2.42</b>	<b>2.03</b>	<b>3.22</b>	<b>2.65</b>	<b>5.15</b>	<b>3.68</b>	<b>2.04</b>	<b>1.08</b>	<b>2.01</b>	<b>1.48</b>	<b>1.79</b>	<b>1.96</b>

2. Among the different crop rotations, the moong + fenugreek crop rotation showed positive response on plant spread (N-S) having values 2.51 cm and 3.01 cm and canopy volume (7.70 m<sup>3</sup> and 13.53 m<sup>3</sup>), respectively in table 2. Singh *et al.*(2016) reported that better growth of guava trees intercropped with tuber crops resulted in better plant height and spread which may be due to better orchard floor management . The minimum plant spread E-W (2.15 cm and 2.50 cm) and N-S (1.80 cm and 2.11 cm) during 2011-12 and 2012-13 as depicted in table 2 was found in crop rotation moong + barley. The lowest canopy volume was calculated under control. However, maximum gross income (Rs. 41180/-) was earned during 2012-13 in crop rotation guar + wheat followed by guar + fenugreek (36980/-) which has been depicted in table 2. However, minimum gross income was earned from crop rotation moong + barley.

Adoption of intercropping systems in orchard helps in efficient utilization of natural resources as well as it improves the input use efficiency in the system (Panda *et al.*, 2003). This might be the reason for increase in growth parameters of main crop. Similar findings on increase in tree height, girth and canopy area due to intercropping were reported by Mishra and Swain (2001), Vishal Nath *et al.* (2003) and Swain and Patro (2007) in mango. Intercropping with legume crops in orchard was more effective which might have helpful in substantial increase in nitrogen content of the soil as well as other physico-chemical properties of soil resulting in better vegetative growth in main crop. This corroborates with the findings of Vishal Nath *et al.* (2003) and Swain and Patro (2007) in mango. The higher yield advantages particularly average fruit weight(g) and fruit yield(kg/tree) under intercropping systems were mainly attributed to efficient utilization of natural resources like solar radiation, soil moisture and nutrients because of complementary interaction between the component crops.

The maximum number of fruits per plant (175) (Table 3) was observed under crop rotation guar + wheat whereas minimum number of fruits per plant (148.12) were counted under control. The increase in fruit number as observed under different systems may be explained from the fact that some leguminous intercrops like guar have the capacity of fixing the atmospheric nitrogen to the soil and there by main crop would have got additional nitrogen, which agrees well to the findings of Ghosh (2001) in guava in terms of number of fruits per plant. Moreover, intercrops help the main crop through indirect way like creating a micro climate that may have resulted in improvement of fruit number and fruit yield. Sahoo (2016) reported that the average mango yield was higher in the intercropping systems than the sole mango crop. Besides, floor management for the intercrops like

land preparation for sowing, weeding, etc. seemed to be beneficial for higher production of fruits. The intercropping that helped to improve the fruit production of the mango crop was also reported by Ghosh (2001) in guava and Rath and Swain (2006) in mango. The guar+wheat intercropping system resulted in maximum TSS per cent (10.8 and 10.9) in both the years as per Table 3. Similar results in terms of fruit quality were reported by Swain (2016) in mango.

### Conclusion

The study showed that guar + wheat intercropping system resulted in enhanced performance which has been depicted in the form of plant height (3.31 cm), gross income (Rs. 41180/-), fruit number (175) and total soluble solids per cent (10.8) of Kinnow fruit. The work concludes that intercropping in Kinnow mandarin helps to improve yield, fruit quality and economic aspect. Lack of knowledge about intercropping in citrus may result in low yield and short life span of main crop. Thus, the more suitable intercrops should be identified keeping in view the supplementary and complimentary relationships among the citrus and the intercrops such as legumes.

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