



STUDY ON ECONOMIC FEASIBILITY OF INTERCROPPING OF KINNOW (*CITRUS RETICULATA* BLANCO) WITH LEGUME CROPS IN THE SUB TROPICAL REGION OF PUNJAB

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ABSTRACT

An experiment was carried out to study the production potential and economic feasibility of intercropping kinnow and legume crops at the nursery of Department of Horticulture, Khalsa College, Amritsar during 2016-2017. The productivity of the intercropping systems was found to differ significantly. The highest gross return was obtained from the kinnow + pea intercropping system and the lowest gross return was obtained from kinnow + coriander. The highest benefit - cost ratio (2.41) was recorded in kinnow + pea intercropped followed by T4 (2.05) and T5 (1.79). From the present investigation, it was apparent that the kinnow + pea intercropping system was found to be the best from the view point of equivalent yield and economics.

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INTRODUCTION

Citrus occupies a prominent place among the extensively grown subtropical fruits. It belongs to family Rutaceae and order Geraniales. It is the third major commercial cultivated fruit crop of India after mango and banana (Hnamte *et al.*, 2013). Citrus covers a large group of fruits, characterized by the fruit type Hesperidium containing varied number of segments composed of many juice sacs. Kinnow is a popular mandarin hybrid which is a cross between *Citrus nobilis* × *Citrus deliciosa* cultivated commercially. Kinnow mandarin (easy peel citrus) has assumed special economic importance and export demand is being acknowledged for its high juice content, special flavour, delicious taste and as a rich source of vitamin-C. In per capita terms, annual availability of citrus is nearly 12.5 kg of which share of Kinnow is about 8 kg. A consumption of 8 kg per capita implies the availability of 1206 mg of vitamin-C, 1520 mg of calcium, 684 mg of phosphorous and nearly 16 mg of iron per head during the citrus production season (Melendez *et al.*, 2007).

The citrus fruits are mainly processed for pure orange juice that does not contain fibre (Altaf *et al.*, 2008). It is exceptionally nutritious as 354.84 ml of orange juice contains approximately 110 percent of recommended dietary allowance (RDA) of vitamin-C. Additionally, it also provides vitamin A, B1, B2, calcium, folic acid, iron, magnesium and potassium (Ahmed *et al.*, 2007). An average orange fruit yields 60 calories. Besides these functional ingredients, oranges are also rich in β -carotene and bioflavonoids which are essential elements of a healthy diet (Lee *et al.*, 1993). Intercropping, the agricultural practice of cultivating two or more crops in the same space at the same time, is an old and commonly used cropping practice which aims to match efficiently crop demands to the available growth resources and labor (Lithourgidis *et al.*, 2011). The quality of fruits is not affected due to the growing of intercrops respectively. Many crops such as fruits, vegetables, pulses, leguminous crops and fodder crops have been found suitable for intercropping in kinnow orchards. Keeping in view the above considerations an experiment was therefore conducted to determine the best intercropping combination in between kinnow and other profitable crops

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MATERIALS AND METHODS

The experiment was laid out at the experimental plot of nursery, Department of Horticulture, Khalsa College, Amritsar. Geographically, Amritsar is situated at 31° 38' N latitude 70° 52' longitude and at an altitude of 236 m above mean sea level. It is characterized by sub tropical climate with average maximum temperature of about 45-48°C. During the whole period of research the rainfall range was from 44.0 mm – 3.0 mm. The highest rainfall of 44.0 mm was recorded in the month of January which was decreased in the later period. There was an adequate amount of rainfall during the months of March and April. The highest maximum temperature of 36.3°C was recorded in the month of April and the lowest 18.3°C in January. The temperature started decreasing from the month of October till January and again it was in increasing range from February to April. The highest minimum temperature of 18.7°C was recorded in the month of October which then started to decrease in the next months. During winter the minimum temperature ranged from 6.6 to 8.7 in the months of December to February which again showed an increasing range in the months of March and April. To assess the basic physico-chemical properties of soil, soil samples were taken randomly from 15-30 cm depth before the sowing of crop. The samples collected from field were first air dried in the shade and then sieved through 2.0 mm sieve for physico chemical analysis (Table 2). The soil of experimental field was categorised as sandy loam. The experimental field tested was low in organic carbon and available nitrogen. However available phosphorus and potassium status were high. The soil pH and electrical conductivity values were within the normal range. Previously, the experimental field was kept fallow both in kharif and rabi season, since 2015. The study was carried out on productivity of intercropping of kinnow with five crops viz. pea, coriander, lentil, gram and brinjal. The design adopted for the experiment was randomized block design (RBD) with three replications.

There were five plots representing five treatments (T1 – kinnow+pea, T2 – kinnow+coriander, T3 – kinnow+ lentil, T4 – kinnow+gram, T5 – kinnow+ brinjal in each replication, measuring 6 x 6 m each, covering four kinnow plants planted 1 year. Five treatments were allotted randomly in each replication. The intercrops were grown in the interspaces presents between the kinnow rows, leaving one meter from the base of the kinnow plant. Manures and fertilizers were applied to the different crops as per recommendation given in the package of practices prepared by Punjab Agriculture University. Five sample plants from each plot were selected randomly and ten plant parts were selected from each plant for observing different growth and yield attributing characters and the average was calculated. The parameters used for the study of productivity of intercrops were total yield and benefit-cost ratio. The yield of different legume crops (intercrops) were recorded and expressed in kilograms per hectare.

RESULTS AND DISCUSSION

It was observed from the study that among the different intercropping systems, kinnow + brinjal intercropped (T6) showed the highest productivity (157.76 kg/day/ha) with an average economic yield of 24453 kg/ha in both the years of study. The second highest economic yield was observed in kinnow intercropped with pea (T1) with 12800 kg/ha respectively. During the course of investigation, the lowest economic yield (660 kg/ha) was found in intercropping of coriander (T2) respectively. Productivity is mainly dependent on yield and duration of crops. Pea took 95 days to give 128 quintals of yield whereas brinjal took 155 days to give 244.53 quintals of yield. Although pea took lesser number of days but this far higher yield of brinjal made it high in giving the higher productivity than the pea. Similar results have been reported by Ndungu *et al.*, (2003) in citrus orchards and Aziz *et al.*, (2008) in sweet orange orchards. Since, the yield of vegetables and legumes were not comparable as such; it was the net profit which could form the basis of remunerative advantages of

Table 1. Meteorological data recorded during the year 2016-17

Month	Mean	Temperature (°C)		Relative humidity (%)	Wind speed (km/hr)	Rainfall (mm)
		Maximum	Minimum			
Oct.	25.8	32.9	18.7	75	2.5	0.0
Nov.	19.35	27.4	11.3	70	2.7	3.0
Dec.	15.0	22.7	7.3	86	1.8	0.0
Jan.	12.45	18.3	6.6	92	3.8	44.0
Feb.	16.1	23.5	8.7	79	4.9	0.0
Mar.	19.45	27.3	11.6	72	5.2	19.4
Apr.	27.3	36.3	18.3	45	9.0	41.8

Table 2. Soil Analysis

Soil property	Soil depth (cm)	Rating	Method used
Mechanical analysis	0-15		
Sand (%)	72.3		International Pipette method (Piper, 1996).
Silt (%)	13.5		
Clay (%)	14.2		
Texture class		Sandy loam	
Chemical analysis			
Electrical conductivity at 25°C (in mmhos/cm)	0.4	Normal	1:2 soil:water suspension with solubridge conductivity meter (Jackson, 1967).
pH	7.7	Normal	Beckman's Ph meter using glass electrode in 1:2 soil water suspension.
Organic carbon (%)	0.36	Low	Walkley and Black's rapid titration method (Piper, 1996).
Available N (Kg ha ⁻¹)	168	Low	Modified alkaline potassium permanganate method (Subbiah and Asija, 1956).
Available P (Kg ha ⁻¹)	28.5	High	0.5 Sodium bicarbonate extractable P by Olsen's method (Olsen <i>et al.</i> , 1954).
Available K (Kg ha ⁻¹)	335	High	1 N ammonium acetate extractable K (Jackson and Parihar, 1967)

Table 3. Productivity of different intercropping systems (average of two years)

Crops	Duration (days)	Economic yield (kg/ha)	Harvest index (%)	Productivity (kg/day/ha)
Kinnow + Pea	95	12800	28.98	134.73
Kinnow+Coriander	170	660	33.33	3.88
Kinnow+Lentil	152	938	31.14	6.17
Kinnow+Gram	162	1520	31.25	9.38
Kinnow+Brinjal	155	24453	33.48	157.76

Table 4. Economic analysis of different intercropping systems (average of two years)

Crops	Cost of cultivation (Rs/ha)	Gross returns(Rs/ha)	Net returns (Rs/ha)	B.C. ratio	Cost of production/quintal (Rs/q)
Kinnow+Pea	37,519.4	1,28,000	90,480.6	2.41	293.12
Kinnow+Coriander	23,938.8	46,200	22,261.2	0.92	3,627.09
Kinnow+Lentil	24,295.97	51,590	27,294.03	1.12	2,590.18
Kinnow+Gram	24,849.64	76,000	51,150.36	2.05	1,634.84
Kinnow+ Brinjal	43,721.38	1,22,265	78,543.62	1.79	178.79

intercrops for farmers acceptance. The cost of cultivation was almost similar in lentil (Rs 24,295.97/ha) and gram (Rs 24,849.64/ha) whereas coriander also showed almost the same cost i.e Rs 23,938.8/ha. The gross returns was the highest in pea (Rs 1,28,000/ha) followed by brinjal (Rs 1,22,265/ha). The highest net returns of Rs 90,480.6/ha and benefit cost ratio (2.41) was obtained in pea. Similar results have also been reported by Aulakh (2004) in intercropping in kinnow orchard. The net returns of coriander (Rs 22,261.2/ha) and lentil (Rs 27,294.03/ha) and also the B.C. ratio (0.929) and (1.12) respectively, were almost similar than other crops. Hnamte *et al.* (2013) reported that growing of leguminous vegetables like pea as intercrop has beneficial effect on mandarin orange which increased the leaf nitrogen content of mandarin orange and thereby vigour and yield also increased. Kinnow orchard takes time for economic fruiting and on the other hand the initial expenditure in establishment of kinnow orchard is pretty high. Intercropping system in kinnow orchard can help a great deal in supplementing the initial expenditure needed for establishment of new orchard and becomes a regular source of income in initial years for the maintenance of orchard and farm family.

In the evaluation of different intercrops for their suitability, the economic analysis is by for the most important index due to great variation in the remunerative capacity. The simple yield assessment cannot be considered the selection criterion. Results of this study revealed that the net returns were high in pea (90,480.6 Rs/ha) due to suitable combination of satisfactory yield and market prevailing sale rate. Brinjal (78,543.62 Rs/ha), gram (51,150.36 Rs/ha) stood at second and third position, respectively. The cost of cultivation of coriander (23,938.8 Rs/ha), lentil (24,295.97 Rs/ha) and gram (24,849.64 Rs/ha) was almost the same, but the net returns of gram were higher than the other two crops which ultimately showed that the gross returns of gram were also higher than the other two crops. The highest benefit cost ratio was obtained in pea (2.41) followed by gram (2.05) and brinjal (1.79) while the lowest B.C. ratio was obtained in coriander (0.929). The highest B.C. ratio was recorded in pea due to the cost of cultivation comparably less to net return. Shweta *et al.*, (2015) concluded that the intercropping of legumes helped the farmers to get an additional output and hence increased the income. According to Kilcher *et al* (2005) in kinnow orchard, intercropping of vegetables gave good net returns as well as B.C. ratio. It is therefore apparent that cultivation of pea in kinnow orchard offered better scope for the realization of maximum profit as compared to investment. After pea, gram, brinjal, lentil and coriander could be grown as an intercrop in kinnow orchard.

Conclusion

It has been seen from the present study that the vacant space present between the adjacent rows of citrus including kinnow can be successfully utilized for cultivation of seasonal vegetables and legumes. There are several advantages in growing of intercrops in orchard. Besides providing income to the growers, it controls weed population, check soil erosion, conserve soil moisture and organic matter and protects the soil from leaching of nutrients. But this practice is not always considered to be ideal in all the fruit crops as there may be competition for soil moisture and plant food with the main crop.

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