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Effect of intercropping on plant and soil of jackfruit grown in New Alluvial soil of West Bengal

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ABSTRACT

An intercropping trial was conducted on 8 years old jackfruit orchard planted at 10 x 10m spacing and grown under rainfed new alluvial soil to indentify the suitable and profitable intercrops during 2011-13. The intercrops grown were black gram, cowpea, chick pea, french bean and lentil. The results from investigation indicated that fruit yield was highest in jackfruit withy cowpea followed by chick pea. Maximum fruit weight was with cowpea followed by french bean. Fruit quality did not vary significantly except total sugar content which was highest in fruit of the trees intercropped with chickpea. Nitrogen content in leaves of jackfruit was highest with cowpea intercropping but P and K content did not vary among the treatments. Soil P and K content in different intercropped plots also not varied significantly. However, nitrogen content in soil was higher in all the intercropped plots as compared to sole plot. Highest bio-mass was obtained from cowpea (44.18 q ha^{-1}) followed by French bean (40.88 q ha^{-1}). Highest net return was calculated from jackfruit with cowpea (Rs. 1, 35,911.00 ha^{-1}) followed by French bean (Rs. 1,01,293.00 ha^{-1}).

Keywords : Intercropping, jackfruit, net profit, new alluvial soil, rainfed

Jackfruit (*Artocarpus heterophyllus* Lam) is one of the most important minor fruit crops in tropical and sub-tropical regions and perhaps the most widespread and useful tree in South and Southeast Asian countries. Every part of the tree and fruit is used for various purposes. The green fruit is consumed as vegetable while ripe one is used as fresh fruit due to its nutritional value and delicious taste. Systematic jackfruit plantation in the country is very rare. Most of the cases it is found in homestead garden and in roadside plantation. Jackfruit starts fruiting 3-4 years after planting in vegetative propagated trees while seedlings start 5-6 years after planting. Jackfruit is planted at 8-10 m spacing in both ways as such there is ample scope for growing of short duration crops during initial years. Growing of crops in the interspaces of the orchard not only generates extra income but the practice also helps to check the soil erosion through ground coverage and improves the soil physic-chemical condition. Selection of suitable intercrops in jackfruit orchard for maximum return as well as to improve the soil fertility status mainly depends on agro-climatic condition of the cultivation area. Although there are many reports of intercropping models in many fruit crops under different agro-climatic condition (Sarkar *et al.*, 2004; Ghosh and Pal, 2010) but in jackfruit such information is scantly and no report is available under new Gangetic Alluvial Zone of West Bengal. Therefore, an investigation was undertaken in this direction.

MATERIALS AND METHODS

The experiment was conducted on 8 years old seedling jackfruit trees planted at 10 x 10m spacing having uniform growth at the Horticultural Research Station of BCKV, Mondouri, Nadia, West Bengal during 2011-2013. The site is situated at 23.5^0 North latitude and 80^{0}34' East longitude having an altitude of 9.75 m above mean sea level. The experimental site has gangetic new alluvial soil with sandy clay loam in texture. Available N, P and K of the soil were 178.2, 19.7 and 302.2 kg ha^{-1} and pH was 6.60. The climatic condition of the research station was humid sub-tropical. The intercrops grown were : cowpea (*Vigna sinansis*)- dwarf type (spacing = 30 x 5 cm); french bean (*Phaseolus vulgaris*) – dwarf type (spacing = 30 x 5 cm); lentil (*Lens culinaris*) – broadcasting ; chickpea (*Cicer arietinum* (spacing = 20 x 5 cm) and black gram (*Vigna mungo*) broad casting. All the intercrops were sown during last week of September in each year. The experiment was laid out in a randomized block design with four replications. Before sowing of intercrops in between the rows of jackfruit trees (10 x 10m), ploughing of soil was done followed by levelling and a small plot size of 4 x 4m was made in between the interspace of jackfruit trees and the sowing of the intercrops was done. No irrigation was provided during the investigation. Weed control and plant protection measures for jackfruit as well as intercrops were taken as and when it was needed. Yearly fertilizers dose of 20 kg cowdung manures, 200 N, 100 g P_2O_5 and 100 g K_2O were given per tree. The data on the fruit yield tree^{-1} were recorded at harvest in all the two years and were statistically analysed. Physio-chemical analysis of fruits was done as per standard procedure. Marketable produce of intercrops and main crop (jackfruit) in terms of per hectare and their salable

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values were worked out. Bio-mass obtained from the intercrops were weighed and their NPK contents were estimated. NPK content in leaves of jackfruit was also estimated. Fertility status in terms of NPK content of the orchard soil was estimated after the experiment.

RESULTS AND DISCUSSION

Fruit yield

Fruit yield in jackfruit was found to improve markedly by growing of intercrops (Table 1). Highest fruit yield was (61.3 kg tree^{-1}) was recorded from the tree with cowpea in the interspace followed by chickpea (52.2 kg tree^{-1}). Lowest fruit yield (24.6 kg tree^{-1}) was recorded from the tree where no intercrop was grown. Increase in fruit yield due to intercropping with cowpea or chickpea or other intercrops may be explained from the fact that intercrops which were leguminous type, have capacity of fixing atmospheric nitrogen that added to the soil and thereby main crop may get additional nitrogen. Similar beneficial effect of intercropping in production was also observed in sweet orange by Ghosh and Pal (2010) and Swain *et al.* (2012) in mango.

Physico-chemical characteristics

Physico-chemical analysis of jackfruit from the intercropped plot (Table 1) revealed that fruit weight was significantly improved due to growing of intercrops and it was measured highest (5.89 kg) in trees with cowpea followed by french bean (5.51 kg). Lowest fruit weight (5.05 kg) was measured from the sole trees. Edible flake and seed content of the fruit did not vary significantly due to intercropping. Fruit quality in respect of TSS, acidity and Vitamin C content was also not varied due to intercropping. However, total sugar content was significantly improved due to intercropping and it was maximum in trees with chickpea (20.0%) and minimum in sole trees (17.3%). Similar effect of intercropping on fruit quality was also noted by Kanwar *et al.* (1993) in citrus and mango, Ghosh (2001) in guava and Ghosh and Pal (2010) in sweet orange.

Leaf nutrient content

The NPK content in leaves of jackfruit was found higher in all the trees with intercrops as compared to sole tree but the variation between the treatments was statistically non- significant except in case of nitrogen. Significantly highest foliar N value was estimated from the tree with cowpea (1.59%) and lowest from the sole tree (1.53%). Higher foliar N value in intercropped tree as compared to sole tree may be due to availability of more nitrogen from the intercropped plots. Sarkar *et al.* (2004) also observed that NPK content in leaves of mango did not vary due to intercropping practices in young orchard.

Effect of intercropping on soil fertility

In addition to extra income, another objective of intercropping is either to improve the soil fertility or to exert least harmful effect on soil and plant (main crop). From the data in table 2, it is clear that soil N, P and K content has been improved in the intercropped plots as compared to sole plot (monocrop) irrespective of the intercropping treatment. Highest soil nitrogen content 181.2 kg ha^{-1} was estimated from the plot with cowpea closely followed by black gram (180.3 kg ha^{-1}) and french bean (180.1 kg ha^{-1}) and they were statistically *at par* in variation. At though, P_2O_{-5} and K_2O content in different intercropped plots were on higher as compared to sole plot but the variation as not statistically significant. Lowest available soil N was estimated from the sole plot (177.0 kg ha^{-1}). Higher available soil nitrogen in the intercropped plots was due to nature of the intercrops which are able to fix atmospheric nitrogen in the soil and thereby improve the soil N status. The findings are in close conformity with the results of Bengum *et al.* (1999) and Ghosh and Pal (2010). Ghosh and Pal (2010) from an intercropping experiment in sweet orange clearly showed that there was a depletion of soil N, P and K in the sole plot while in intercropped plots with leguminous crops like cowpea, black gram, cluster bean *etc*. there was an addition of nitrogen in the soil. Soil pH in the different intercropped plot did not vary significantly (Table 2).

Bio-mass from intercrop and nutrient content

It was observed from the data presented in table 3 that intercrops itself resulted in good amount of bio-mass which may be helpful for improvement of physico-chemical properties of the orchard soil if we incorporate them, Highest amount of bio-mass was obtained from the cowpea (52.68 q ha^{-1}) followed by chick pea (44.18 q ha^{-1}). It was observed that bio-mass of the different intercrops, contained good amount of N, P and K. However, the variation of the nutrients contain in different intercrops did not vary significantly. In an intercropping experiment in sweet orange, Ghosh and Pal (2010) also recorded highest biomass from the plot with cowpea and biomass of different intercrops contained a fair amount of N, P, K.

Intercrop yield and return from intercropping

The average yield of intercrop was recorded highest in cowpea (44.18 q ha^{-1}) followed by french bean (40.88 q ha^{-1}) and lowest from the lentil (15.75 q ha^{-1}) (Table

Table 1: Effect of intercropping on fruit yield and physico-chemical composition of jackfruit (Average of 2 years)

Treatment	Fruit yield (kg tree^{-1})			Fruit weight (kg)	Edible flake (%)	Seed content (%)	TSS (^{0}B)	Acidity (%)	Total sugar (%)	Vitamin C (mg $^{-100}$ g)
	2012	2013	Pooled							
Jackfruit + Black gram	40.2	45.3	42.8	5.30	40.3	11.7	22.6	0.21	18.7	9.5
Jackfruit + Cowpea	50.9	71.7	61.3	5.89	40.7	10.2	23.4	0.25	19.6	10.6
Jackfruit + Chickpea	48.1	56.3	52.2	5.31	40.3	10.6	23.4	0.24	20.0	10.2
Jackfruit + French bean	33.6	45.1	39.4	5.51	38.8	11.4	22.8	0.23	19.6	9.2
Jackfruit + Lentil	35.1	51.6	43.4	5.40	39.6	10.0	22.7	0.22	19.0	9.8
Jackfruit (Monocrop)	23.8	25.4	24.6	5.05	39.7	11.4	21.8	0.26	17.3	8.6
SEm (±)	**2.77**	**3.78**	**2.40**	**0.81**	**1.02**	**1.17**	**0.55**	**0.02**	**0.35**	**0.29**
L.S.D. (0.0 5)	**5.90**	**8.04**	**5.10**	**0.37**	**N.S.**	**N.S.**	**N.S.**	**N.S.**	**0.75**	**N.S.**

Table 2: Effect of intercropping on leaf soil nutrient status and soil pH (Average of 2 years)

Treatment	Leaf nutrient status (Dry weight basis)			Soil nutrient status (kg ha^{-1})			Soil pH
	Nitrogen (%)	Phosphorus (%)	Potassium (%)	N	P_2O_5	K_2O	
Jackfruit + Black gram	1.55	0.35	0.73	180.3	17.3	292.6	6.4
Jackfruit + Cowpea	1.59	0.38	0.74	181.2	17.0	293.2	6.4
Jackfruit + Chickpea	1.55	0.37	0.76	179.3	17.8	289.8	6.4
Jackfruit + French bean	1.57	0.34	0.79	180.1	17.9	290.4	6.4
Jackfruit + Lentil	1.57	0.39	0.75	178.3	17.2	290.8	6.3
Jackfruit (Monocrop)	1.53	0.39	0.78	177.0	17.0	288.3	6.5
SEm (±)	**0.02**	**0.02**	**0.03**	**0.85**	**1.12**	**4.32**	**1.13**
L.S.D. (0.05)	**0.04**	**N.S.**	**N.S.**	**1.81**	**N.S.**	**N.S.**	**N.S.**

Table 3: Yield and biomass of intercrops obtained from intercropping in jackfruit orchard and nutrient status in bio-mass (Average of 2 years)

Treatment	Yield of intercrop (q ha^{-1})	Biomass of intercrop (q ha^{-1})	Nutrient status in biomass (%)		
			N	P_2O_5	K_2O
Jackfruit + Black gram	17.81	33.04	3.09	0.19	1.10
Jackfruit + Cowpea	44.18	52.68	3.23	0.19	1.17
Jackfruit + Chickpea	29.31	44.18	3.00	0.18	1.17
Jackfruit + French bean	40.88	35.58	3.13	0.18	1.12
Jackfruit + Lentil	15.75	23.28	3.14	0.17	1.20
Jackfruit (Monocrop)	-	-	-	-	-
SEm (±)	-	-	**0.01**	**0.02**	**0.03**
L.S.D. (0.05)	-	-	**N.S.**	**N.S.**	**N.S.**

Table 4: Economic analysis of intercropping in jackfruit orchard (Average of 2 years)

Treatment	Yield of jackfruit (q ha^{-1})	Yield of intercrop (q ha^{-1})	Selling price of intercrop (Rs. kg^{-1})	Return from intercrop (Rs. ha^{-1})	Cost of production of intercropping (Rs. ha^{-1})	Net return from intercrop (Rs. ha^{-1})	Value of jackfruit (Rs. ha^{-1})	Net return from jackfruit + Intercrops (Rs. ha^{-1})	Net return over jackfruit (Monocrop) (Rs. ha^{-1})
Jackfruit + Black gram	42.80	17.81	34.00	60,554	47,921	12,663	64,200	76,863	39,963
Jackfruit + Cowpea	61.30	44.18	24.00	1,06,032	62,071	43,961	91,950	1,35,911	99,011
Jackfruit + Chickpea	52.20	29.31	22.00	64,482	50,221	14,261	78,300	92,561	55,661
Jackfruit + French bean	39.40	40.88	28.00	1,14,464	72,271	42,193	59,100	1,01,293	64,393
Jackfruit + Lentil	43.40	15.75	40.00	63,000	49,471	13,529	65,100	78,629	41,729
Jackfruit (Monocrop)	24.60	-	-	-	-	-	36,900	36,900	-

4). The cost of expenditure for growing intercrops and their income has been presented in table 4. It appeared from the data that the highest expenditure (Rs. 72, 271.00 ha^{-1}) was incurred from the French bean intercropping followed by cowpea (Rs. 62,071) and lowest in black gram (Rs. 47,921). Highest net return (Rs. 43,961 ha^{-1}) was obtained from cowpea closely followed by French bean (Rs. 42,193 ha^{-1}) and lowest from black gram (Rs. 12,633 ha^{-1}). Considering the total cost and monetary return from the main and intercrops, it was found that jackfruit with cowpea gave highest net return of Rs. 1,35,911 ha^{-1} with an additional income of Rs. 99,011 ha^{-1} over sole crop. The next profitable combination was jackfruit with French bean which resulted in net return of Rs. 1,01,293 ha^{-1} which estimated additional income of Rs. 64,393 ha^{-1}. It was revealed that all the intercrops selected for the study were suitable for the jackfruit orchard under rainfed condition in new gangetic alluvial soil as they gave an additional net return from Rs. 39,963 (black gram) to Rs. 99,011 ha^{-1} (cowpea).

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