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Effect of Intercropping System of Vegetables on Yield and Economics of Arecanut Plantation

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The on farm trials were conducted to study the effect of intercropping system of vegetables on yield, economics and soil fertility status of Arecanut plantation during the year from 2015-16 to 2016-17 at various villages in Tiptur taluk of Tumkur district, Karnataka state. The three

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intercropping systems involved *viz.,* Treatment T_1- Arecanut as mono-cropping (farmers practice), Treatment T_2 - Arecanut intercrops with vegetable cowpea and Treatment T_3- Arecanut intercrops with vegetable french bean conducted at seven farmers field as replication. The 26 year old Arecanut plantation of Gubbi local variety planted with 2.7 m x 2.7 m spacing. The result reveals that the two year mean data of experiments were recorded. The maximum chali yield of Arecanut was recorded (12.53 q/ha/year) in Arecanut plantation intercrops with vegetable french bean, which is on far with Arecanut plantation (12.25 q/ha/year) intercrops with vegetable cowpea. Whereas, significantly minimum chali yield of arecanut was obtained in Arecanut as mono-cropping system in farmers practice. The cultivation of Arecanut intercrops with vegetable french bean was obtained highest net annual income (Rs. 2,56,832/ha) and B:C ratio (2.85) with additional income of the farmers and high market demand of vegetable beans as compared to cultivation of Arecanut plantation intercrops with vegetable cowpea at Rs. 2,29,083/ha with B:C ratio of 2.72 with less demand of vegetable cowpea at market, whereas, cultivation of Arecanut as monocropping system was recorded lowest net annual income (Rs.1,45,290/ha) with B:C ratio (2.29) and no additional income from arecanut mono-cropping system practices in farmers field.

The soil samples were collected from arecanut plantation before initiated and after the experiment, analyzed the soil fertility status of Nitrogen, Phosphorus and Potash availability, pH and electrical conductivity (EC) in soil. Soil pH and organic matter content of samples were slightly alkaline to neutral and low to high respectively. The soil fertility status of Arecanut plantation intercrops with vegetable French beans was recorded numerical improved ($P<0.05$) in all three major nutrients over the pre-treatment observation in the soil, which is on far with soil fertility status of Arecanut plantation intercrops with vegetable cowpea, whereas, soil fertility status of NPK were found to lowest in Arecanut as mono- cropping system as farmers practices. This might be due to incorporated residue of French bean and cowpea biomass into soil, which fixes atmospheric nitrogen as results in improved of soil fertility status. Arecanut plantation intercrops with vegetable french bean were recorded higher net returns and sustainability of the soil fertility by cultivating more suitable cropping system to enhanced income of farmers.

Keywords: Arecanut; effect; fertility; intercrops; soil; yield.

1. INTRODUCTION

Arecanut (*Areca catechu* L.) is a tropical crop, popularly known as betel nut, it is important commercial plantation crops grown in India and mainly used for chewing and extraction of alkaloid purpose, which contain medicinal properties such as narcotic, antihelmintic, astringent and vermifuge. The India is first place in area (58.00 %) and production (53.00 %) of arecanut in the world. Arecanut is cultivated with an area 4.97 lakh ha and production around 8.33 lakh tones in India, Karnataka and Kerala account for about 70 % of the country's production during 2017-18 [1]. India, China, Indonesia, Thailand and Myanmar are major Arecanut producing countries in the world. The market price of arecanut is unstable in national and international markets, low productivity, lack of value addition facilities, lack of knowledge in adoption of improved production technology in farmers practices *etc*., causes for low annual income of arecanut farmers [2,3]. However, research were conducted to evolving viable technologies to adopt and increase the net return for Arecanut growers by adopting improved production technology such as Arecanut based cropping systems. It is one of the important ways to effectively utilize the natural resources [4,5]. The potential for increasing the productivity per unit area of land, time and inputs through the cultivation of arecanut based intercropping system is considerably higher in perennial crops [6,7].

The Krishi Vigyan Kendra are grass root level to organize the programme, application of technology through the assessment, refinement and demonstration of proven technologies under different micro-farming situations in a district [8]. The KVK also reduce time lag between the release of technology from the research institution and technology transfer to the farmers for enhancing productivity and income of the farmers from the agriculture and allied sectors on sustainable basis. Thus, to conducted on farm trials (OFT) to study the effect of intercropping system of vegetables on yield, economics and soil fertility status of Arecanut plantation as compared to cultivation of arecanut as mono-cropping in farmers practices.

2. MATERIALS AND METHODS

The field experiments were conducted to study the effect of intercropping system of vegetables on yield, economics and soil fertility status of Arecanut plantation during the year from 2015-16 to 2016-17 at Hullihalli, Margondanahalli and Karikere villages in Tiptur taluk of Tumkur district, Karnataka state. The experiments were selected in seven farmers field of 26 year old Arecanut plantation of Gubbi local variety planted with spacing of 2.7 m x 2.7 m in an area of 1.2 ha yearly and laid out three intercropping systems *viz.,* Treatment T_{1-} Arecanut as mono-cropping (farmers practice), Treatment T_2 - Arecanut intercrops with vegetable cowpea (*Arka suman* variety) and Treatment T_3- Arecanut intercrops with vegetable French bean (*Arka suvidha* variety) at seven farmers field as replication. Supplied critical inputs to farmers and applied as per treatment T_2 followed package of practices of University of Agricultural Sciences, GKVK. Bengaluru and treatments T_3 followed the Indian Institute of Horticultural Research (IIHR), Bengaluru with regional station at CHES, Hirehalli as source of technology. The scientists of Krishi Vigyan Kendra were regularly visited and monitored the farmer's fields. Basic data were collected from the farmer's field before the initiation of OFT, the two year mean data of experiments were recorded and analyzed with appropriate statistical procedures.

3. RESULTS AND DISCUSSION

3.1 Effect of Vegetable Intercropping Systems on Chali Yield of Arecanut

The two year Arecanut chali yield data (Table 1.) were observed during the period from 2015-16 to 2016-17. The chali yield of Arecanut plantation was found during the first year (12.10 q/ha/year) and gradually increased to higher ($P<0.05$) chali yield during second year (12.96 q/ha/year) in Arecanut plantation intercrops with vegetable french beans followed by Arecanut plantation intercrops with vegetable cowpea during the first year (11.80 q/ha/year) and gradually increased during second year (12.70 q/ha/year). Whereas, significantly lowest ($P<0.05$) chali yield of arcanut plantation was observed in cultivation of arecanut as mono-cropping in farmers practices during two year as compared to Arecanut plantation with vegetable intercropping system. These findings are in line with reported [9,10].The increased in chali yield of Arecanut might be due to that synergistic effect of crop combination with legumes crop, which enhances soil fertility status of nutrient content by cultivation of arecanut intercropping with vegetable crops. These similar results were found with reported [11,12].

3.2 Effect of Cropping System on Yield of Intercrop Vegetables

The data on yield of the vegetable intercrops in arecanut plantation were collected and presented in Table 2. The yield data of intercrop vegetables were recorded that the vegetable french bean yield 38.45 q/ha during the first year increased to 45.15 q/ha during the second year, which is on far with intercrops vegetable cowpea yield 29.70 q/ha during the first year, which increased to 36.10 q/ha during the second year. Similar results were recorded in the vegetative and reproductive parameters of intercrop vegetables and presented in Table 3. This could be due to that cultivation of vegetable French bean and cowpea as legume crops growing in Arecanut plantation as intercrops, after harvested economic yield and residual incorporated into soils, which enhanced soil the physical, chemical and biological properties. These results were finding with reports [13,14]. Whereas, arecanut as mono-cropping in farmers practices, no intercropping yield was obtained and also no enhancement of soil nutrient content in arecanut garden as a result decreased soil fertility status. These findings are in line with reported [15,16].

3.3 Yield and Economics of Arecanut Based Cropping System with Vegetable Crops

Economics of Arecanut production was worked out by calculating the total cost of chali arecanut production including cost of cultivation, total profit (gross return), net profit (net return) and benefit cost (B:C) ratio of all intercropping treatment. The calculated total cost of cultivation by the total expenditure including preparation of land by cultivation, input cost of seeds, fertilizers, farm yard manures, labours, pest and disease management cost, water management (irrigation), harvesting and *etc.,* for Arecanut and intercrop production. The farmers sold the market price of chali Arecanut at Rs. 25570/q, price of vegetable french beans at Rs. 18/kg and vegetable cowpea at Rs. 15/kg in the farmer field and profitability was calculated based on these prices [17,18]. The economic data of main crop and intercrop data were presented in Table 4.

The maximum net return at Rs. 2,56,832/ha/year and B:C ratio (2.85) were recorded in arecanut plantation intercrops with vegetable French beans followed by arecanut plantation intercrops with vegetable cowpea net return at Rs.2,29,083/ha/year and B:C ratio (2.72). Whereas, minimum net returns at Rs. 1,45,290/ha/year and B:C ratio (2.29) were recorded in cultivation of Arecanut as mono-cropping in farmers practice. This could be due to that the more additional income obtained from cultivation of Arecanut plantation intercrops with vegetable french bean, high market rate of beans and more demand as compared to vegetable cowpea with less demand in market, whereas, no additional income obtained in farmers practices by cultivation of arecanut as mono-cropping, which is similar results were finding with reports [19,20].

3.4 Effect of Soil Fertility Status of Arecanut Plantation by Intercropping System

The soil samples were collected from arecanut plantation before initiated and after the experiment, analyzed the soil fertility status of Nitrogen, Phosphorus and Potash availability, pH and electrical conductivity (EC) in soil. Soil pH and organic matter content of samples were slightly alkaline to neutral and low to high respectively. The soil fertility status of Arecanut plantation intercrops with vegetable French beans was recorded numerical improved ($P<0.05$) in all three major nutrients of the available N (282 kg/ha), P (22 kg/ha), K (198 kg/ha) status over the pre-treatment observation in the soil, which is on far with soil fertility status of Arecanut plantation intercrops with vegetable cowpea. Whereas, soil fertility status of Nitrogen (262 kg/ha), Phosphorus (17 kg/ha), and Potash (189 kg/ha) were found to lowest in Arecanut plantation as mono- cropping system in farmers practices [21]. This might be due to incorporated residue of French bean and cowpea biomass into soil, which fixes atmospheric nitrogen as results in improved of soil fertility status [22]. Enhanced soil fertility and sustainability of the soil by cultivation of Arecanut plantation intercrops with vegetables.

Table 1. Effect of vegetable intercropping systems on chali yield of arecanut plantation

Treatments	Details of technology	Arecanut chali yield (Q/ha/year)		Cumulative 2- year mean Arecanut chali yield (Q/ha/year)
		2015-16	2016-17	
T_1	Arecanut as mono-cropping (Farmers practice)	10.08	10.06	10.07
T_2	Arecanut intercropping with vegetable cowpea	11.80	12.70	12.25
T_3	Arecanut intercropping with vegetable french bean	12.10	12.96	12.53

Table 2. Effect of cropping system on yield of intercrop vegetables

Treatments	Details of technology	Vegetable yield (q /ha)		Cumulative 2-year mean vegetable yield (q/ha)
		2015-16	2016-17	
T_1	Arecanut as mono-cropping (Farmers practice)	Arecanut as sole crop		Arecanut as sole crop
T_2	Arecanut intercropping with vegetable cowpea	29.70	36.10	32.90
T_3	Arecanut intercropping with vegetable french bean	38.45	45.15	41.80

Table 3. Effect of cropping system on vegetative and reproductive parameters of intercrop vegetables

Treatments	Details of technology	Vegetative and reproductive parameters of vegetable crops						
		Germination percent (%)	Plant height (cm)	No. of branches	No. of harvest	No. of pods/plant	Length of pod (cm)	Yield (q/ha)
T_1	Arecanut as mono-cropping (Farmers practice)	--	--	--	--	--	--	--
T_2	Arecanut intercropping with vegetable cowpea	75	72	24	4	65	17	32.90
T_3	Arecanut intercropping with vegetable french bean	78	64	21	3	56	14	41.80

Table 4. Yield and economics of Arecanut based cropping system with vegetable crops

Treatments	Details of technology	Yield of Arecanut (q/ha/yr)	Yield of vegetable (q/ha)	Gross income (Rs./ha)	Cost of production (Rs./ha)	Net Return (Rs./ha/yr)	B:C ratio
T_1	Arecanut as mono-cropping (Farmers practice)	10.07	--	2,57,490	1,12,200	1,45,290	2.29
T_2	Arecanut intercropping with vegetable cowpea	12.25	32.90	3,62,583	1,33,500	2,29,083	2.72
T_3	Arecanut intercropping with vegetable french bean	12.53	41.80	3,95,632	1,38,800	2,56,832	2.85

(Market rate of chali Arecanut @ Rs. 25570/q, Price of vegetable beans @ Rs. 18/kg, vegetable cowpea @ Rs. 15/kg)

Fig. 1. Assessment of vegetable as intercrops in arecanut plantation

Table 5. Soil fertility status of Arecanut plantation by intercropping system

Soil fertility status	Arecanut mono-crop(FP)		Arecanut with cowpea		Arecanut with French bean	
	Pre-treatment (2015-16)	Post treatment (2016-17)	Pre-treatment (2015-16)	Post treatment (2016-17)	Pre-treatment (2015-16)	Post treatment (2016-17)
N (Kg/ha)	268	262	268	278	268	282
P (Kg/ha)	19	17	19	21	19	22
K (Kg/ha)	192	189	192	195	192	198
pH	7.1	7.2	7.1	7.0	7.1	7.1
EC(ds/m)	0.30	0.31	0.30	0.29	0.30	0.28

4. CONCLUSION

Field experiment concluded that the highest chali yield of Arecanut and intercrop yield of vegetable French bean was found to gradually increased during the first year and second year followed by Arecanut plantation intercrops with vegetable cowpea. The cultivation of Arecanut intercrops with vegetable french bean was obtained highest net annual return and B:C ratio with additional income and high market demand of vegetable beans as compared to cultivation of Arecanut plantation intercrops with vegetable cowpea with less demand of vegetable cowpea at market. Whereas, cultivation of Arecanut as mono-cropping system was recorded lowest net annual income with B:C ratio and no additional income from arecanut mono-cropping system practices in farmers field. The soil fertility status of Arecanut plantation intercrops with vegetable French beans was recorded numerical improved ($P<0.05$) in all three major nutrients over the pre-treatment observation in the soil, which is on far with soil fertility status of Arecanut plantation intercrops with vegetable cowpea. Arecanut plantation intercrops with vegetable french bean might be recommended for higher net returns and sustainability of the soil fertility by cultivating more suitable cropping system to enhanced income of farmers.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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