Indian Journal of Agricultural Sciences **86** (10): 1361–5, October 2016/Article

Effect of integrated nutrient management practices on growth and yield of vegetable crops grown as intercrops in coconut (*Cocos nucifera*) garden

K S NAVEEN KUMAR[1], H P MAHESWARAPPA[2] and T B BASAVARAJU[3]

Horticulture Research and Extension Station, AICRP on Palms, UHS, Arasikere, Karnataka 573 103

Received: 22 October 2015; Accepted: 11 July 2016

ABSTARCT

Investigation was carried out at Horticulture Research and Extension Station, Arasikere, Karnataka, during *kharif* and summer seasons of 2012-14 to study the performance of different cropping sequences with vegetable crops and effect of integrated nutrient management practices on growth, and yield of vegetable crops under coconut (*Cocos nucifera* L.) based cropping system (CBCS). The experiment consisting of three cropping sequences of vegetable crops and four integrated nutrient management (INM) practices was carried out in FRBD with 5 replications. The study revealed that growth and yield of all the vegetable crops grown under coconut were significantly influenced by INM practices. Among the INM practices, pooled analysis of yield data indicated that, S3 treatment (5 tonnes FYM + 50% NPK + 25% N by vermicompost + 25 % N by composted coir pith (CCP)+ IIHR micronutrient spray) recorded significantly higher yield in okra (9.85 tonnes/ha), baby corn (4.55 tonnes/ha), gherkin (74.87 tonnes/ha) and cucumber (6.51 tonnes/ha) when grown as intercrop in coconut plantation.

Key words: Coconut, Cropping sequence, Integrated nutrient, Intercropping, Vegetables

Vegetables contribute towards food and nutritional security of the people. With the focused attention given to the vegetable sector, there has been spectacular change in terms of production and availability. In today's era of diversification of agriculture, farmers are now shifting from traditional subsistence agriculture to commercial agriculture. Owing to small holding in our country, farmers are forced to take up vegetable production in different cropping systems.

Cropping systems aim at crop diversification and intensive cropping in the inter space available in the coconut and results in increase in palm productivity as well as productivity per unit holding in a system approach wherein the available natural resources like soil, water, light and other inputs such as fertilizers, labour etc. are efficiently utilized to produce nuts, food and non-food products in a profitable way. Coconut based cropping system is a very intensive type of cultivation and hence, special attention should be paid to soil fertility maintenance. The number of combinations of crops that can be grown in a coconut based cropping system is greater than in any other cropping system. Hence, the present investigation was carried out with the objective to know performance of vegetable crops grown in sequence under coconut based cropping system as influenced by integrated nutrient management practices.

[1]Assistant Horticulture Officer (e mail: naveenkshankar@gmail.com), Department of Horticulture, Tiptur, Karnataka 572 201. [2]Project Coordinator (Palms) (e mail: maheswarappa.hp@icar.gov.in), AICRP on Palms, ICAR-CPCRI, Kasaragod, Kerala 671 124. [3]Head (e mail: tbbasavaraju@gmail.com), Horticulture Research Station, Arasikere, Karnataka 573 103.

MATERIALS AND METHODS

Investigations were carried out at Horticulture Research and Extension Station, Arasikere, Hassan District, Karnataka (UHS, Bagalkot), during 2012-13 and 2013-14. The experimental station is situated at 13^{o} 15' N latitude and 76^{o} 15' E longitude with an altitude of 808 m above mean sea level (MSL). The experimental site represents black soil with physical and chemical properties, viz. bulk density (1.56 g/cc), pH (8.36), EC (0.58 dS/m at 25^{0} C), organic carbon (0.43 %), available nitrogen (315.78 kg/ha), available phosphorus (35.34 kg/ha) and available potassium (325.56 kg/ha). The experimental area receives an annual rainfall of 815.7 mm distributed mainly during April to October. There are two peaks in rainfall distribution, one in May and the other during October. The mean minimum temperature ranges from 11.0^{o}C (January) to 19.3^{o}C (June) and the maximum temperature ranges from 27.9^{o}C (December) to 35.4^{o}C (March). The mean relative humidity ranges from 49.1% (March) to 75.0% (August). The experiment consisting of two factors was laid out in a Factorial Randomized Complete Block Design (FRBD) with 5 replications. The seeds/ seedlings of vegetable crops (okra, baby corn, cucumber, gherkin and tomato) were planted as intercrop in coconut (Tiptur tall) garden aged 45 years, planted at a spacing of 10 m × 10 m. For growing intercrops, plots were prepared by leaving two meters radius from the bole of the coconut and

accordingly 60 per cent of the land was utilized to grow intercrops. The vegetables were cultivated as per the recommendations of package of practices of UHS, Bagalkot under irrigated condition. The fertilizer N was applied 50% at planting and 50% as top dress. Recommended dose of IIHR vegetable special was sprayed at 30 DAS and 60 DAS. Vermiwash was sprayed by diluting 1:10 ratio with water at 30 DAS and 60 DAS. *Azotobacter* was applied at the rate of 2 kg/ha after thoroughly mixed with FYM.

Treatments details

Factor 1: Vegetable intercropping (Cropping sequence)

	Kharif (2012)	Summer (2013)	*Kharif* (2013)	Summer (2014)
M1 :	Okra	Fallow	Tomato	Fallow
M2 :	Green manure (Mucuna)	Cucumber	Green manure (Mucuna)	Cucumber
M3 :	Baby corn	Gherkin	Baby corn	Gherkin

Factor 2 : Integrated nutrient management practices- S1: Inorganic fertilizer alone (100%), S2: 5 tonnes FYM + 75% NPK + 25% N by Vermicompost, S3: 5 tonnes FYM + 50% NPK + 25% N by Vermicompost + 25 % N by composted coir pith (CCP) + IIHR micronutrient spray, S4: 5 tonnes FYM + 50% N by Vermicompost + 50 % N by composted coir pith (CCP) + Vermiwash spray + *Azotobacter*

Treatment combinations: M1S1, M1S2, M1S3, M1S4, M2S1, M2S2, M2S3, M2S4, M3S1, M3S2, M3S3, and M3S4.

Control: Coconut monocropping was maintained as check plot with recommended package

Replications: Five

Design: Factorial RBD

RESULTS AND DISCUSSION

Performance of vegetable crops as influenced by different nutrient management practices when grown as intercrops in coconut plantation is described below;

Okra (Kharif 2012)

Among the growth parameters, number of leaves differed significantly as influenced by INM practices at 30 DAS and did not differ significantly at 90 DAS (Table 1). At 30 DAS, the number of leaves were significantly the highest under S3 treatment (6.2) and was on par with S2 and S4, whereas significantly the lowest number of leaves were recorded under S1 treatment (5.0). INM practices had significant influence on dry weight at harvest, and S3 treatment recorded significantly the highest dry weight (132.4 g/plant) and it was on par with S4 treatment (124.9 g/plant), whereas S1 treatment recorded significantly the lowest dry weight (119.7 g/plant). More leaves production and dry matter/plant is attributed to better crop growth which might be due to

Table 1 Effect of INM practices on growth parameters of vegetable crops grown as intercrop in coconut plantation

Treatment	Number of leaves/plant		Weight of dry biomass	Plant height (cm)		Weight of dry biomass	Number of branches/plant		Weight of dry biomass	Number of leaves/plant		Weight of dry biomass
	30 DAS	90 DAS	(g/plant)	30 DAS	90 DAS	(g/plant)	30 DAS	90 DAS	(g/plant)	30 DAS	90 DAS	(g/plant)
	Okra (Kharif 2012)			*Baby corn (Kharif 2012)*			*Gherkin (Summer 2013)*			*Cucumber (Summer 2013)*		
S1	5.0	25.4	119.7	25.2	228.6	350.1	3.1	7.6	19.23	14.7	70.0	161.9
S2	6.0	24.9	121.5	24.3	224.1	356.4	2.9	6.6	18.30	16.1	70.8	172.1
S3	6.2	26.0	132.4	23.9	226.1	354.4	3.8	5.8	17.38	13.0	72.2	162.8
S4	5.4	25.2	124.9	23.2	216	348.4	3.5	6.5	16.53	14.6	61.6	153.9
SEm ±	0.25	0.72	2.63	0.3	10.4	5	0.17	0.76	1.38	0.97	3.17	2.68
CD (P=0.05)	0.8	NS	8.4	0.99	NS	NS	0.54	NS	NS	NS	NS	1.1
	Tomato (Kharif 2013)			*Baby corn (Kharif 2013)*			*Gherkin (Summer 2014)*			*Cucumber (Summer 2014)*		
S1	12.2	66.7	199.2	23.2	224.2	377.1	3.4	6.8	16.69	16.7	73.6	158.9
S2	13.0	67.1	184.7	23.8	217.5	377.9	3.6	7.6	17.66	16.2	64.3	153.5
S3	12.4	64.6	199.3	24.3	233.6	373.9	3.7	6.6	23.71	16.4	75.4	167.1
S4	11.4	71.5	170	23.5	234.8	377.8	2.9	6.8	17.79	13.0	71.4	144.1
SEm ±	0.63	1.87	19.64	0.7	12.4	1.1	0.3	0.28	0.86	0.98	3.79	8.5
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	2.76	NS	NS	NS
				Pooled data			*Pooled data*			*Pooled data*		
S1				24.2	226.4	363.6	3.3	7.2	17.96	15.7	71.8	160.4
S2				24.0		367.1	3.2	7.1	17.98	16.2	67.6	162.8
S3				24.1	229.8	364.2	3.8	6.2	20.54	14.7	73.8	165.0
S4				23.3	225.4	363.1	3.2	6.7	17.16	13.8	66.5	149.0
SEm ±				0.1	11.2	2.4	0.22	0.44	0.95	0.83	2.42	5.21
CD (P=0.05)				NS	NS	NS	NS	NS	NS	NS	NS	NS

DAS: Days after sowing.

supply of N by the combination of organic manures and inorganic manures, an essential plant nutrient for growth. Akande *et al*. (2010) have reported increase in growth parameters with the application of organic manure in combination with inorganic fertilizer. INM practices had a significant impact on the yield of intercrop, and S3 treatment recorded significantly the highest yield per hectare as intercrop (9.85 tonnes/ha) and it was on par with S1 treatment (8.77 tonnes/ha) (Table 2), whereas the lowest yield was recorded in S4 treatment (7.35 tonnes/ha). The beneficial role in improving soil physical, chemical and biological role is well known, which in turn helps in better nutrient absorption by plant and resulting in higher yield in coriander (Prabhu *et al.* 2002). The results are in the conformity with the findings of Yadav *et al.* (2006), Bodanwad *et al.* (2006) and Akande *et al*. (2010).

Tomato (Kharif 2013)

The growth, fruit parameters and yield as intercrop did not differ significantly among the INM treatments (Table 1 and 2), however tomato fruit yield realized was to the tune of 68.50 to 72.95 tonnes/ha. The availability of the nutrients through the application of organic sources or inorganic sources of nutrients resulted in higher yield of tomato. Bahadur *et al.* (2004) also reported that application of organic manures combined with recommended dose of inorganic fertilizers showed superior performance in yield attributing characters in tomato. This might be due to the availability of higher amount of nutrients to plant from the soil and thereby higher uptake of the essential nutrients by plant as also ascribed by Adekiya and Agbede (2009) in tomato.

Baby corn (Kharif 2012 and 2013)

During *kharif* 2012, among the INM practices, S1 treatment recorded significantly the highest plant height (25.2 cm) at 30 DAS and was on par with S2 (24.3 cm), whereas at 90 DAS, plant height did not differ significantly. During *kharif* 2013, nutrient management practices did not influence the height and dry matter production (Table 1). Integrated nutrient management had positive effect on growth parameters of maize such as leaf area and plant height (Kannan *et al*. 2013). It was also reported that, the INM practices had significant effect on growth parameters of maize crop in a field trial conducted at ICAR research field at Umiam, Meghalaya (Panwar 2008). INM practices had significant influence on number of cobs during *kharif* 2013 and significantly the higher number of cobs (2.1) was recorded under S3 treatment and was on par with S1 and S2 treatments, whereas, S4 treatment recorded the lowest number of cobs (1.5) (Table 2). Baby corn weight was also differed significantly among INM practices, and the highest corn weight (16.3 and 18.1 g) was observed under S3 treatment and the lowest corn weight (14.5 g) was recorded under S2 treatment. In the pooled analysis of both the years also, S1 treatment recorded significantly the highest number

Table 2 Effect of INM practices on yield parameters of vegetable crops grown as intercrop in coconut plantation

Treatment	Number of fruits/ plant	Yield/ha (tonnes)	Number of cobs/ plant	Baby corn weight (g)	Yield/ ha (tonnes)	Number of fruits/ plant	Yield/ ha (tonnes)	Number of fruits/ plant	Yield/ ha (tonnes)
	Okra (Kharif 2012)			*Baby corn (Kharif 2012)*		*Gherkin (Summer 2013)*		*Cucumber (Summer 2013)*	
S1	21.4	8.77	1.9	15.2	3.54	69.1	64.42	6.1	5.43
S2	19.8	7.58	1.9	14.5	3.77	69.8	68.54	6.7	5.64
S3	21.8	9.85	2.0	16.3	4.75	70.2	74.04	6.6	6.55
S4	20.1	7.35	1.7	15.1	3.40	61.3	58.34	6.4	4.67
SEm ±	0.73	0.49	0.16	0.35	0.27	2.0	1.74	0.12	0.2
CD (P=0.05)	NS	1.58	NS	1.08	0.82	6.18	5.37	0.37	0.63
	Tomato (Kharif 2013)			*Baby corn (Kharif 2013)*		*Gherkin (Summer 2014)*		*Cucumber (Summer 2014)*	
S1	114.4	71.73	1.9	16.2	4.07	70.1	65.74	8.2	4.90
S2	118.0	72.95	1.9	15.9	3.72	69.0	72.14	8.6	5.59
S3	105.7	69.18	2.1	18.1	4.36	74.2	75.69	8.4	6.48
S4	96.0	68.51	1.5	15.7	3.68	57.1	64.52	7.9	4.58
SEm ±	6.11	5.09	0.06	0.43	0.17	2.04	2.42	0.14	0.2
CD (P=0.05)	NS	NS	0.19	1.33	0.51	6.28	7.45	0.45	0.63
				Pooled data		*Pooled data*		*Pooled data*	
S1			2.1	15.7	3.80	69.1	65.08	7.1	5.17
S2			2.0	15.2	3.75	69.8	70.34	7.6	5.61
S3			2.0	17.2	4.55	72.2	74.87	7.5	6.51
S4			1.6	15.4	3.54	59.3	61.43	7.1	4.63
SEm ±			0.1	0.33	0.14	1.79	1.13	0.09	0.20
CD (P=0.05)			0.32	1.03	0.42	5.51	3.50	0.30	0.62

of cobs (2.1) and was on par with S2 (2.0) and S3 (2.0) treatments, whereas, S4 recorded the lowest (1.6). This confirms the significance of conjunctive use of chemical and organic fertilizers than the individual one which might be due to the solubilization effect of plant nutrients by the addition of FYM and vermicompost leading to increased uptake of NPK. This is also in line with the findings of Kannan *et al*. (2013) with the combination of vermicompost and recommended dose of NPK. During both the years, significantly the highest yield/ha as intercrop (4.75 and 4.36 tonnes/ha) was observed under S3 treatment and the lowest yield per hectare (3.40 and 3.68 tonnes/ha) was recorded under S4 treatment. In the pooled analysis of both the years also, significantly the highest yield per hectare as intercrop (4.55 tonnes) was under S3 treatment and the lowest was under S4 treatment (3.54 tonnes). Application of different organic manures + 1/3rd NPK recorded significantly higher cob yield in baby corn when grown as intercrop in coconut garden and was on par with organic manures alone treatment (Maheswarappa *et al.* 2013). The beneficial role of integrated nutrient management in improving soil physical, chemical and biological properties which in turn helps in better nutrient absorption by plant and resulting in higher yield has been reported (Prabhu *et al.* 2002).

Gherkin (Summer 2013 and 2014)

Number of branches at 30 DAS during 2013 was significantly influenced by INM practices, and it was the highest under S3 treatment (3.8) and the lowest was recorded in S2 treatment (2.9). During 2014, dry weight per plant at harvest was significantly the highest under S3 treatment (23.7 g) and the lowest was recorded under S1 treatment (16.7 g). During 2013 and 2014, significantly the highest number of fruits per plant (70.2 and 74.2, respectively) was recorded under S3 treatment and was on par with S4 and S2 treatments.

During 2013 and 2014, fruit yield/ha as intercrop (74.04 and 75.69 tonnes/ha, respectively) was significantly the highest under S3 treatment and was on par with S2 during 2014 and the lowest yield (58.34 and 64.52 tonnes/ha, respectively) was recorded under S4 treatment. In the pooled analysis also, S3 recorded significantly higher yield (74.87 tonnes/ha). The results are in agreement with the findings of Kumaran *et al*. (1995), who recorded an increase in fruit yield by the application of NPK with FYM and Vermicompost. Besides supplying plant nutrients, vermicompost contains plant growth regulators and humic acid which probably have additive effect on plant growth (Tomati *et al.* 1988).

Cucumber (Summer 2013 and 2014)

Production of leaves did not differ significantly among the INM treatments during 30 and 90 DAS, but at 60 DAS during 2014 significantly the highest number of leaves/ plant were produced under S2 treatment (39.7) and the lowest number of leaves were produced in S4 treatment (35.0). During 2013, significantly the highest dry weight per plant (172.2 g) was recorded in S2 treatment and the lowest dry weight/plant (153.9 g) was recorded in S4 treatment. During 2013 and 2014, significantly higher number of fruits per plant (6.7 and 8.6, respectively) was observed in S2 treatment and the lowest number of fruits per plant (6.1) was recorded in S1 treatment. Combination of organic, inorganic and biofertilizers helped in enhanced uptake of nutrients which promotes faster plant growth leading higher plant height, higher number of leaves and number of branches. These results are in conformity with the findings of Nirmala *et al.* (1999) in cucumber and Singh *et al.* (1995) in muskmelon.

During 2013 and 2014, significantly the highest yield per hectare as intercrop was observed under S3 treatment (6.55 and 6.48 tonnes/ha, respectively) and the lowest yield per hectare (4.67 and 6.48 tonnes/ha, respectively) was recorded in S4 treatment. Higher yield of cucumber in present study could be due to the influence of combination of organic and inorganic sources of nutrients which enhanced the synthesis of photosynthates by increasing the synthesis of growth regulators like IAA, GA, amino acids, and vitamins. More number of fruits per plant and fruit weight per plant in present study ultimately resulted in more fruit yield per hectare. The number of fruits per vine, fruit length and fruit yield were significantly higher in cucumber with the combined application of organic manures + biofertilizers + ½ RDF (INM- Treatments) compared to RDF (Narayanamma *et al.* 2010).

This study confirmed that above vegetable crops can be successfully cultivated in a sequence in the coconut gardens by adopting different INM practices. Among the INM practices S3: 5 tonnes FYM + 50% NPK + 25% N by Vermicompost + 25 % N by composted coir pith (CCP)+IIHR micronutrient spray proved to be the best combination for higher yield of the vegetable crops.

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