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Review/Overview

Production potential, nutrient-use efficiency and economics of groundnut (*Arachis hypogaea*)–onion (*Allium cepa*) cropping system under organic nutrient management

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ABSTRACT

A field experiment was conducted during 2010–11 and 2011–12 at Bengaluru, Karnataka to study the effect of organic nutrient management practices on the production potential, nitrogen-use efficiency and economics of groundnut (*Arachis hypogaea* L.)–onion (*Allium cepa* L.) cropping system. Application of source of enriched biodigested liquid organic manure (EBDLM) at 25 kg N equivalent/ha + 3 sprays of *panchaga*vya (PG) at 3% resulted in significantly higher pod and kernel yields and total system productivity (2.34, 1.78, 10.1 and 12.4 t/ha, respectively) and yield attributes like number of pods/plant and shelling outturn (47.2 and 76.0% respectively) of groundnut. The bulb yield of onion (37.78 t/ha) and yield parameters, viz. bulb diameter (6.10 cm), bulb length (5.52 cm), bulb size index (33.7), scale leaves/bulb (11.60), fresh weight (110.1 g) and specific gravity of bulb (1.41 g/cc), were significantly higher with EBDLM at 125 kg N equivalent/ha + 3 sprays of PG at 3%. Significantly higher total uptake of N, P and K (183.7, 66.0 and 117.2 kg/ha respectively) by groundnut and onion was recorded with EBDLM at 25 (groundnut)/125 (onion) kg N equivalent/ha + 3 sprays of PG at 3% and nitrogen-use efficiency in groundnut (29.6 kg/ha) and in onion (131.6 kg/ha) was also higher with EBDLM at 25 (groundnut)/125 (onion) kg N equivalent/ ha + 3 sprays of PG at 3%. At the end of 2 cropping cycles, application EBDLM at 25 (groundnut)/ 125 (onion) kg N equivalent/ ha + 3 sprays of PG at 3% resulted in higher balance of N, P and K than recommended practice. Net returns (₹426.6 × 10^3/ha) and benefit: cost ratio (4.13) were more with EBDLM at 25 (groundnut)/125 (onion) kg N equivalent/ha + 3 sprays of PG at 3%.

Key words: Crop production, Groundnut–onion Cropping system, Biodigested liquid manure, *Panchaga*vya, Vermiwash

Groundnut and onion are the underground economic parts. The physico-chemical and biological properties of the soil determine the production potential. Keeping this in view, large quantity of organic manure is recommended for groundnut and onion crop. But the use of organic manures has been continuously declining in Indian agriculture due to several reasons. Decrease in cattle population in recent years and utilization of agricultural wastes into valuable by-products have made the availability of organic manure in agriculture questionable both in time and quantity. Non-availability of sufficient quantity of farmyard manures drawn the attention of researchers and cultivators to utilize the on-farm wastes, green biomass of *Gliricidia maculata, Pongamia pinnata* etc., and ubiquitous weeds, viz. parthenium, euphotorium, lantana, calatropis etc., for biodigested liquid manure production which can substitute the farmyard manure and compost. Most of the research on groundnut and onion was mainly concentrated on the use of FYM, compost, green manure, oil cakes etc. There is need to generate efficient organic manurial sources using on-farm available organic substrates in addition to integrated use of vermicompost, *panchaga*vya, *dashagavya*, *jeevamruta*, *beejambruta*, vermiwash, mycorrhizae culture, neem-cake/neem-seed extractants in organic farming. Further, there are evidences of enriched biodigested liquid manure use in enhancing the yields of fingermillet, groundnut, pigeonpea and soybean (Reddy *et al.,* 2011). There is a need to enhance nitrogen, phosphorus and potassium content of biodigested liquid manure by enriching with neem, pongamia, jatropa cake *etc.* and these enriched sources need to be evaluated for their effect on productivity of crops. Further, there is also need to evaluate the beneficial effects of cow urine,

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panchagavya, vermiwash in conjunction with enriched biodigested liquid manure. Hence a study on production potential, nutrient-use efficiency, balance and their economics is needed in groundnut–onion cropping system on *Alfisols* of southern India.

MATERIALS AND METHODS

A field experiment was conducted during 2010–11 and 2011–12 at Gandhi Krishi Vigyana Kendra, University of Agricultural Sciences, Bengaluru. The soil was sandy clay and classified as Typic Oxichaplustalf, having pH 5.6 and electrical conductivity 0.13 dS/m. The available nitrogen, phosphorus and potassium were 244.4, 21.9 and 128.3 kg/ha, respectively. The organic carbon content of the soil was 0.47%. The bulk density and porosity of the surface (0–15 cm) soil were 1.47 Mg/m^3 and 42.11% respectively. Total annual rainfall received during 2010 and 2011 was 549.7 and 613.5 mm respectively. There were 10 treatments comprising of 3 types of organic liquid manures, viz. biodigested liquid manures, enriched biodigested liquid manures and cow urine along with foliar spays of *panchaga*vya (3%) and vermiwash (3%) and recommended fertilizers for irrigated groundnut and onion as detailed in Table 1 and 2. The treatments were laid out in randomized complete block design with 3 replications. The gross plot was 3.0 m × 3.3 m. The bio-digested liquid manure was prepared in a 200 l cement tank by adding 15 kg cowdung, 20 l cow urine, 30 kg of pongamia green biomass and 100 l water by frequent stirring. The liquid manure was incubated for 45 days. Then it was enriched with 10% *Pongamia pinnata* cake, biodigested liquid manure contains 0.78, 0.21, 0.27, 0.08, 0.03 and 0.26% N, P, K, Ca, Mg and S respectively. While enriched biodigested liquid manure contains 1.14, 0.27, 0.47, 0.14, 0.05 and 0.30% N, P, K, Ca, Mg and S respectively. The required quantity of liquid manures on nitrogen equivalent was applied to the soil in 2 equal splits at 20 and 60 days after sowing (DAS) for groundnut and 3 equal splits at 20, 60 and 90 DAS for onion.

*Panchaga*vya (PG) was prepared by using 5 products of *desi* cow, viz. cow urine, dung, milk, curd and *ghee*. Vermiwash was prepared by dipping adult earthworms in luke warm water. Three per cent *panchaga*vya and vermiwash solutions were prepared by mixing 30 ml each *panchaga*vya and vermiwash in 1,000 ml water separately. Three sprays of 3% *panchaga*vya/vermiwash was applied to foliage at 30, 60 and 75 days after sowing to groundnut and onion as per treatments. Treatments 1 to 9 (Table 1) were supplied by recommended FYM and vermicompost at 50% each based on N equivalent and treatment T_{10} received FYM at 10 t/ha (groundnut) and 30 t/ha for onion 2 weeks before sowing and recommended dose of fertilizer 25:75:37.5 kg N, P_2O_5, K_2O kg/ha for groundnut and 125:50:75 kg N, P_2O_5, K_2O kg/ha for onion was incorporated into the soil at the time of sowing. Nitrogen was applied in 2 split doses, 50% as basal and 50% at 30 days after sowing as top-dressing with full dose of P and K as basal for onion. The nutrients were applied in the form of urea, single superphosphate and muriate of potash.

The groundnut cultivar 'TMV 2' was sown on 16 July 2010 and 16 June 2011 and harvested on 12 November 2010 and 15 October 2011 respectively. Onion cultivar 'Agrifound Light Red' was sown on 15 November 2010 and 3 November 2011 and harvested on 22 April 2011 and 10 April 2012 respectively. The spacing adopted was 30 cm × 15 cm for groundnut and 20 × 10 cm for onion. Six irrigations at 5 cm depth were provided during the dry spell of the cropping period. Onion was irrigated immedi-

Table 1. Effect of different liquid organic manures on yield attributes and yield of groundnut (pooled data of 2 years)

Treatment	Pods/plant	Shelling outturn (%)	Pod yield (t/ha)	Kernel yield (t/ha)	Haulm yield (t/ha)
T_1, BDLM at 25 kg N equivalent/ha	37.0	69.1	2.08	1.44	3.12
T_2, BDLM at 25 kg N equivalent/ha + 3 sprays of VW at 3%	37.8	69.2	2.10	1.45	3.20
T_3, BDLM at 25 kg N equivalent/ha + 3 sprays of PG at 3%	38.6	69.7	2.14	1.49	3.32
T_4, EBDLM at 25 kg N equivalent/ha	43.5	71.0	2.17	1.54	3.34
T_5, EBDLM at 25 kg N equivalent/ha + 3 sprays of VW at 3%	44.5	75.2	2.28	1.72	3.39
T_6, EBDLM at 25 kg N equivalent/ha + 3 sprays of PG at 3%	47.2	76.0	2.34	1.78	3.41
T_7, CU at 25 kg N equivalent/ha	30.7	63.3	1.74	1.10	2.75
T_8, CU at 25 kg N equivalent/ha + 3 sprays of VW at 3%	36.4	66.6	1.91	1.27	3.01
T_9, CU at 25 kg N equivalent/ha + 3 sprays of PG at 3%	36.7	67.1	2.01	1.35	3.04
T_{10}, Rec.FYM at 10 t+ 25:75:37.5 kg N:P_2O_5:K_2O / ha	30.3	52.6	1.60	0.84	2.36
SEm±	1.62	2.09	0.08	0.09	0.09
CD (P=0.05)	4.64	6.29	0.23	0.26	0.28

BDLM, Biodigested liquid Manure; EBDLM, Enriched biodigested liquid manure; PG, *Panchaga*vya; VW, Vermiwash; CU, Cowurine; FYM, Farmyard manure

ately after sowing. Subsequently, 15 irrigations were given at 3 cm depth at an interval of 4 to 5 days and ceased 15 days before prior to harvesting of bulbs. Groundnut plots were irrigated immediately after sowing. Thrips and aphids were controlled by spraying 4% neem-seed kernel extract twice during crop-growth period of groundnut.

The yield attributes and yield of groundnut and onion crops were recorded at harvesting. Further, groundnut pod-equivalent yield of onion, system productivity and economics of groundnut–onion copping system were computed. The soil samples (0–15 cm depth) were collected at the end of the cropping cycle and analysed for available N, P, K and nutrient concentration in the plant were estimated by adopting standard methods. The total crop uptake and actual nutrient balance were worked out in the cropping system.

RESULTS AND DISCUSSION

Yield attributes and yield of groundnut

In general, the productivity of crops (groundnut and onion) was more in the second year (2011–12) than during first year (2010–11) but response to different treatments was similar in both the years. On an average, application of enriched biodigested liquid manure (EBDLM) at 25 kg N equivalent/ha + 3 sprays of *Panchagavya* (PG) at 3% resulted in significantly higher pod, kernel and haulm yield of groundnut, followed by EBDLM at 25 kg N equivalent/ha + 3 sprays of Vermiwash (VW) at 3% EBDLM at 25 kg N equivalent/ha than all other treatments. Significantly lower pod, kernel and haulm yields of groundnut was observed with recommended practice (Table 1). Similarly, yield attributes of groundnut like pods/plant and shelling outturn were higher with of EBDLM at 25 kg N equivalent/ha + 3 sprays of PG at 3%, which was on a par with EBDLM at 25 kg N equivalent/ha + 3 sprays of VW at 3% and EBDLM at 25 kg N equivalent/ha as compared to the other treatments. The increase in yield in BDLM and EBDLM along with 3 sprays of *Panchaga*vya and Vermiwash at 3% may be owing to biodigested liquid manures and its enrichment with pongamia cake which supplied secondary and micronutrients along with major nutrients besides improving the soil condition, which enhanced the root proliferation and source to sink relationship. In case of *Panchaga*vya and Vermiwash spray, the easy transfer of nutrients to plant through foliar spray and the quantities of indole acetic acid and gibberlic acid present in *Panchaga*vya could have created the stimuli in the plant system which in turn increased the production of growth regulators in cell system. Hence stimulated the necessary growth and development in plants leading to better yield. The significant effect of *Panchaga*vya was mainly attributed to its nutrient content, higher biological activity and plant growth promoting substances. Hazarika *et al.* (2006) also reported similar beneficial effect of *Panchaga*vya. These results confirm the findings of Mamarali and Lopez (1997) in sweet pepper and of Somasundaram (2003) in greengram.

Yield attributes and yield of onion

Significantly higher bulb yield of onion was recorded with the application of EBDLM at 125 kg equivalent/ha + 3 sprays of PG at 3% and it was on a par with EBDLM at 125 kg N equivalent/ha + 3 sprays of VW at 3% and EBDLM at 125 kg N equivalent/ha (Table 2). However,

Table 2. Yield attributes and yield of onion as influenced by different liquid organic manures (pooled data of 2 years)

Treatment	Bulb diameter (cm)	Bulb length (cm)	Bulb size index (cm^2/ bulb)	Scale leaves/ bulb (No.)	Fresh weight of bulb (g/plant)	Specific gravity of bulb (g/cc)	Bulb yield (t/ha)
T_1, BDLM at 125 kg N equivalent/ha	5.21	4.66	23.6	10.98	92.2	1.20	30.47
T_2, BDLM at 125 kg N equivalent/ha + 3 sprays of VW at 3%	5.41	4.75	25.2	11.21	93.2	1.21	32.63
T_3, BDLM at 125 kg N equivalent/ha + 3 sprays of PG at 3%	5.45	4.88	26.6	11.30	92.4	1.21	32.99
T_4, EBDLM at 125 kg N equivalent/ha	5.50	4.88	26.9	11.25	96.3	1.25	34.96
T_5, EBDLM at 125 kg N equivalent/ha + 3 sprays of VW at 3%	5.52	5.29	29.2	11.35	104.0	1.35	36.01
T_6, EBDLM at 125 kg N equivalent/ha + 3 sprays of PG at 3%	6.10	5.52	33.7	11.60	110.1	1.41	37.78
T_7, CU at 125 kg N equivalent/ha	4.86	4.44	22.3	10.78	85.4	1.12	26.60
T_8, CU at 125 kg N equivalent/ha + 3 sprays of VW at 3%	4.90	4.57	23.1	10.93	85.8	1.13	29.12
T_9, CU at1 25 kg N equivalent/ha + 3 sprays of PG at 3%	5.08	4.60	23.3	10.95	90.5	1.19	30.30
T_{10}, Rec.FYM at 30 t + 125:50:75 kg N:P_2O_5:K_2O/ha	4.23	4.31	18.2	9.95	72.6	0.96	25.59
SEm±	0.22	0.21	2.27	0.10	4.51	0.05	1.56
CD (P=0.05)	0.62	0.65	6.75	0.28	14.00	0.17	4.46

BDLM, Biodigested liquid Manure; EBDLM, Enriched biodigested liquid manure; PG, *Panchaga*vya; VW, Vermiwash; CU, Cowurine; FYM, Farmyard manure

these treatments were significantly superior to recommended practice (FYM 30 t + 125:50:75 kg N:P_2O_5:K_2O/ha). Higher yields obtained with EBDLM at 125 kg N equivalent/ha + 3 sprays of PG at 3%, EBDLM at 125 kg N equivalent/ha + 3 sprays of VW 3% and EBDLM at 125 kg N equivalent/ha could be attributed to significantly superior yield parameters, viz. bulb diameter, bulb length, bulb-size index, scale leaves/bulb, fresh weight and specific gravity of bulb with EBDLM at 125 kg N equivalent/ha + 3 sprays of PG at 3% and was on a par with EBDLM at 125 kg N equivalent/ha + 3 sprays of VW 3% and EBDLM at 125 kg N equivalent/ha. The possible reason may be the slow and steady release of N into soil solution to match the required absorption pattern of onion. Significant increase in the yield and yield components with the application of EBDLM along with *Panchaga*vya and Vermiwash spray as against recommended practice might be due to more supply of gibberlic acids, auxins and other growth-promoting hormones with EBDLM and *Panchaga*vya spray. Application of *Panchaga*vya increased the bulb size which is the consequence of supply of required metabolites, nutrients and plant growth promoters to the source and further greater accumulation of assimilates in the sink. Our results confirm with Boomiraj (2003), who found increase in fruit weight of *Okra* with *Panchaga*vya spray.

System productivity and economics

Groundnut–onion sequence cropping system with EBDLM at 25(groundnut)/125(onion) kg N equivalent/ha + 3 sprays of PG at 3% recorded significantly higher system productivity and groundnut pod equivalent yield (Table 3)and these where at par with EBDLM at 25 (groundnut)/125 (onion) kg N equivalent/ha + 3 sprays of VW at 3% and EBDLM at 25 (groundnut)/125 (onion) kg N equivalent/ha + 3 sprays of PG at 3%. The differential productivity was due to differences in response in these treatments in obtaining higher productivity of individual crops.

The highest net returns and benefit: cost ratio were recorded with EBDLM at 25 (groundnut)/125 (onion) kg N equivalents/ha + 3 sprays of PG at 3%. The economic returns and benefit: cost ratio followed with marginal differences with EBDLM 25(groundnut)/125 (onion) kg N equivalent/ha + 3 sprays of VW at 3% and resulted in higher net returns and benefit: cost ratio. This was attributed to higher pod and haulm yield of groundnut and bulb yield of onion. The higher benefit: cost ratio might be owing to higher net returns. Similar results of higher gross and net returns were obtained with the application of *panchagavya* by Yadav and Lourduraj (2006) in rice and Somasundaram (2003) in greengram.

Table 3. Effect of different liquid organic manures on groundnut pod equivalent yield, system productivity and economics (Mean of 2 cropping cycles)

Treatment	Groundnut pod equivalent yield (t/ha)	System productivity (t/ha)	Cost of cultivation (× 10^3₹/ha)	Gross returns (× 10^3₹/ha)	Net returns (×10^3₹/ha)	Benefit: cost ratio
T_1, BDLM at 25 (groundnut)/125 (onion) kg N equivalent/ha	8.1	10.2	125.4	463.4	337.9	3.69
T_2, BDLM at 25 (groundnut)/125 (onion) kg equivalent/ha + 3 sprays of VW at 3%	8.7	10.8	128.8	490.2	361.4	3.81
T_3, BDLM at 25 (groundnut)/125 (onion) kg N equivalent/ha + 3 sprays of PG at 3%	8.8	10.9	129.7	496.8	367.1	3.83
T_4, EBDLM at 25 (groundnut)/125 (onion) kg N equivalent/ha	9.3	11.5	131.5	521.9	390.4	3.97
T_5, EBDLM at 25 (groundnut)/125 (onion) kg N equivalent/ha + 3 sprays of VW at 3%	9.6	11.9	133.6	539.4	405.8	4.04
T_6, EBDLM at 25 (groundnut)/125 (onion) kg N equivalent/ha + 3 sprays of PG at 3%	10.1	12.4	136.4	562.9	426.6	4.13
T_7, CU at 25 (groundnut)/125 (onion) kg N equivalent/ha	7.1	8.8	121.8	401.1	279.3	3.29
T_8, CU at 25 (groundnut)/125 (onion) kg N equivalent/ha + 3 sprays of VW at 3%	7.8	9.7	125.9	439.3	313.5	3.49
T_9, CU at 25 (groundnut)/125 (onion) kg N equivalent/ha + 3 sprays of PG at 3%	8.1	10.1	128.0	458.2	330.2	3.58
T_{10}, Rec. FYM at 10 t + 25:75:37.5 (groundnut)/Rec.FYM at 30 t + 125:50:75 (onion) kg N:P_2O_5:K_2O / ha	6.8	8.4	130.0	382.2	252.2	2.94
SEm±	0.42	0.62				
CD (P=0.05)	1.19	1.85				

BDLM, Biodigested liquid Manure; EBDLM, Enriched biodigested liquid manure; PG, *Panchagavya*; VW, Vermiwash; CU, Cowurine; FYM, Farmyard manure

Nutrient uptake and utilization efficiency

Significantly higher total uptake of nitrogen, phosphorus and potassium recorded with EBDLM at 25(groundnut)/125(onion) kg N equivalent/ ha + 3 sprays of PG at 3% and was on par with EBDLM at 25(groundnut)/125(onion) kg N equivalent/ ha + 3 sprays of VW at 3% and EBDLM at 25 (groundnut)/125 (onion) kg N equivalent/ha (Table 4). Similarly, nitrogen-utilization efficiency of groundnut and onion was significantly higher with EBDLM at 25 (groundnut)/125 (onion) kg N equivalent/ha + 3 sprays of PG at 3% and was on a par with EBDLM at 25 (groundnut)/125 (onion) kg N equivalent/ha + 3 sprays of VW at 3% for groundnut and onion and EBDLM at 25 (groundnut)/125 (onion) kg N equivalent/ha in groundnut and onion. Increase in uptake of nitrogen and its utilization efficiency could be due to increase in dry-matter production and content. Since the nitrogen added through liquid manure was in organic form which might have released throughout the crop growth and thus contributed for higher concentration in onion. These results are in conformity with the findings of Yamagata and Otani (1996) from Tsukuba, Japan, who revealed that nitrogen uptake by upland rice and potato supplied with organic nitrogen was higher than the control. Higher phosphorus uptake could be attributed to conversion of fixed phosphorus into readily available form by organic acids released during the decomposition of FYM and BDLM and consequent improvement in the available P in soil and better biochemical activity in the crop plants. The results corroborates with the findings of Praveen Kumar (2010). Higher potassium uptake due to application of EBDLM along *Panchaga*vya spray was attributed to increase in the concentration of potassium in plants. Moreover, there was adequate supply of water throughout the crop growth either through rain or irrigation and this improved potassium content and uptake as

Table 4. Nutrient added, uptake, actual soil balance (kg/ha) and nitrogen-use efficiency at the end of groundnut–onion cropping cycle

Treatment	Added			Crop uptake			Actual soil balance at the end of second cropping cycle			Nitrogen-use efficiency	
	N	P	K	N	P	K	N	P	K	Groundnut	Onion
T_1, BDLM at 25 (groundnut)/125 (onion) kg N equivalent/ha	603.8	82.40	245.00	152.1	44.9	85.1	317.3(30)	31.5(42)	145.0(13)	26.3	106.2
T_2, BDLM at 25 (groundnut)/125 (onion) kg equivalent/ha + 3 sprays of VW at 3%	605.6	82.62	255.08	149.6	45.3	81.3	321.4(32)	31.8(43)	153.3(19)	26.5	113.7
T_3, BDLM at 25 (groundnut)/125 (onion) kg N equivalent/ha + 3 sprays of PG at 3%	605.6	82.62	257.08	158.8	46.9	90.3	323.6(32)	32.4(46)	156.1(22)	27.1	114.9
T_4, EBDLM at 25 (groundnut)/125 (onion) kg N equivalent/ha	614.9	81.27	271.33	165.9	50.2	96.3	336.1(38)	33.1(49)	163.4(27)	27.5	121.8
T_5, EBDLM at 25 (groundnut)/125 (onion) kg N equivalent/ha + 3 sprays of VW at 3%	627.9	82.58	272.25	171.2	53.6	102.0	358.5(47)	34.5(55)	165.8(29)	28.9	125.5
T_6, EBDLM at 25 (groundnut)/125 (onion) kg N equivalent/ha + 3 sprays of PG at 3%	645.0	83.76	274.67	183.7	66.0	117.2	366.5(50)	35.9(61)	169.3(32)	29.6	131.6
T_7, CU at 25 (groundnut)/125 (onion) kg N equivalent/ha	562.9	63.41	346.50	127.4	32.3	64.4	287.0(17)	26.9(21)	135.8(6)	22.0	92.7
T_8, CU at 25 (groundnut)/125 (onion) kg N equivalent/ha + 3 sprays of VW at 3%	577.8	64.80	348.17	137.2	34.8	70.4	294.0(20)	28.6(29)	138.0(8)	24.1	101.4
T_9, CU at 25 (groundnut)/125 (onion) kg N equivalent/ha + 3 sprays of PG at 3%	581.5	65.11	349.00	138.5	38.7	77.2	298.5(22)	29.1(31)	140.9(10)	25.5	105.6
T_{10}, Rec.FYM at 10 t + 25:75:37.5 (groundnut)/Rec. FYM at 30 t + 125:50:75 (onion) kg $N:P_2O_5:K_2O$/ha	562.9	115.46	292.75	106.7	27.0	60.7	275.0(13)	26.8(21)	135.2(5)	20.3	89.1
SEm±		6.3	1.1	5.2	16.8	0.9	4.7	1.6	7.6		
CD (P=0.05)		19.5	3.1	15.8	48.1	2.5	12.9	4.7	22.7		

Intial soil status : N = 244.4 kg/ha; P = 21.9 kg/ha ; K = 128.3 kg/ha

*Figures in parantheses are percentage increase in nutrients as compared to their initial status in soil

BDLM, Biodigested liquid Manure; EBDLM, Enriched biodigested liquid manure; PG, *Panchaga*vya; VW, Vermiwash; CU, Cowurine; FYM, Farmyard manure

it is mainly absorbed through diffusion. Further the losses as well as fixation of K in the soil were lower which favored higher K uptake by plants.

Net change in soil fertility

In general, soil available nutrients increased progressively from the initial status of groundnut and onion cultivation in sequence (Table 4). Significantly higher available nitrogen, phosphorus and potassium and their increase over initial status (50, 61 and 32% N, P and K, respectively) was noticed with EBDLM at 25 (groundnut)/125 (onion) kg N equivalent/ha + 3 sprays of PG at 3% and it followed the order: EBDLM at 25 (groundnut)/125 (onion) kg N equivalent/ha + 3 sprays of VW at 3% > EBDLM at 25 (groundnut)/125 (onion) kg N equivalent/ha. Significantly higher available nutrients with EBDLM at 25(groundnut)/125(onion) kg N equivalent/ha + 3 sprays of PG at 3% was attributed to slow release of nitrogen from organics which might have reduced the N loss from soil. The increase in available P might be due to the release of organic acids during cropping cycle promoted the solubility of native phosphates as a result of which the available P content increased in the soil. The increase in available potassium might be related to the release of K from EBDLM and also to the solubilization of mineral bound K or native K. Further, it may also be due to the prevention of leaching loss owing to retention of more K by organic colloids as they possess higher cation-exhange capacity (CEC) than mineral colloids. The availability of K in soil was higher because of beneficial effect of organic manures on the potassium fixation and addition of potassium through manures, higher CEC and exchangeable K. Bulluck *et al*. (2002) also reported that potassium concentration in soil amended with organic waste increased compared to soils fertilized with chemical fertilizers. Ramesh *et al. (*2008) also reported similar results in soybean–Durum wheat cropping system.

It can be concluded that the application of enriched liquid organic manure at equivalent to 100% recommended dose of nitrogen with foliar spray of *Panchaga*vya or Vermiwash at 3% on 30, 60 and 75 DAS is the best option for higher productivity of groundnut–onion sequence cropping system, besides improving soil fertility, total nutrient uptake, utilization efficiency and also higher economic returns.

REFERENCES

Boomiraj, G.S. 2003. Effect of *panchaga*vya foliar spray on fruit yield and quality of okra. *Indian Journal of Agronomy* **45**(2): 12–18.

Bulluck, L.R., Brosius, M., Evanylo, G.K. and Ristaino, J.B. 2002. Organic and synthetic fertility amendment influence soil microbial, physical and chemical properties on organic and conventional farms. *Applied Soil Ecology* **19**:147–60.

Hazarika, U.K., Munda, G.C., Bujorboruah, K.M., Das, A., Patel, D.P., Prasad, K., Rajeshkumar, Danwar, A.S., Tomar, J.M.S., Bordoloi, J., Sharma, M. and Girin, G. 2006. Components of nutrient management. *Nutrient Management Organic Farming* pp.15–53.

Mamarali, J. C. and Lopez, A. M. 1997. The effect of coconut water growth hormones (CWGH) on the growth, development and yield of sweet pepper (*Caspicum annum* L.). *The Philippines Journal of Coconut Studies* **221**(1): 18–24.

Praveen Kumar, D. A., 2010. Studies on organic farming practices in onion (*Allium cepa*). *M.Sc. (Agric.) Thesis*, University of Agricultural, Sciences, Dharwad, Karnataka.

Ramesh, P., Panwar, N. R., Singh, A. B. and Ramana, S. 2008. Effect of organic manures on productivity, soil fertility and economics of soybean (*Glycine max*)–durum wheat (*Triticum durum*) cropping system under organic farming in vertisols. *Indian Journal of Agricultural Sciences* **78**(12): 121 –28.

Reddy, V.C., Jayaram Reddy, M., Shivanandam, V.N., Yogananda, S.B., Govandaraju, C. and Jagadeesh, B.R. 2011. Developing package of practices for production of finger millet through compost and bio digester liquid manure. (In:) *Annual Progress Report*, Research Institute on Organic Farming, University of Agricultural Sciences, Bengaluru, Karnataka, India pp. 13–21, 23–26, 30–34 and 47–48.

Somasundaram, E. 2003. Evaluation of organic sources of nutrients and *Panchaga*vya spray on the growth and productivity of maize–sunflower–greengram system. Ph.D. Thesis, Tamil Nadu Agricultural University, Coimbatore, India.

Yadav, B.K. and Lourduraj, C.A., 2006. Effect of organic manures and *Panchagavya* spray on yield attributes, yield and economics of rice (*Oryza sativa* L.). *Crop Research* **32**(1): 1–5.

Yamagata, M. and Otani, T., 1996. Nitrogen uptake and response of crops to organic nitrogen. *Japanese Journal of Soil Sciences and Plant Nutrition* **67**(4): 345–53.