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EFFECT OF BIO-DIGESTED LIQUID MANURES ON SOIL FERTILITY, PRODUCTIVITY AND QUALITY OF GROUNDNUT (*ARACHIS HYPOGAEA* L.)

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ABSTRACT
Present investigation was conducted during 2010-11 and 2011-12 at Gandhi Krishi Vigyana Kendra, University of Agricultural Sciences, Bengaluru to study the effect of bio-digested liquid manures on soil fertility, productivity and quality of groundnut (*Arachis hypogaea* L.). Application of enriched biodigested liquid organic manure (EBDLM) at 25 kg N equivalent ha^{-1} + 3 sprays of panchagavya (PG) at 3 % produced significantly higher pod and kernel yield (2335 and 1775 kg ha^{-1}, respectively), organic carbon (0.61 %), available nutrients *viz.*, N, P_2O_5, K_2O and S (321.1, 69.21, 84.4 and 32.7 kg ha^{-1}, respectively) and uptake of N, P, K and S (112.0, 16.9, 69.5 and 16.0 kg ha^{-1}, respectively). Further, higher protein and oil yield of groundnut (875 and 364 kg ha^{-1}) was recorded with EBDLM at 25 kg N equivalent ha^{-1} + 3 sprays of PG at 3 % as compared to other treatments.

INTRODUCTION

Groundnut is one of the major oil seed crops of the world which occupies 26.62 m ha with a production of 35.66 m t. In India it is grown over an area of about 4.19 m ha with 5.62 m t production at productivity of 1341 kg ha^{-1}. Groundnut is a major crop of central dry zone of Karnataka, grown in an area of about 8.5 lakh ha and contributes 7.4 lakh t productions with a productivity of 921 kg ha^{-1} (Anon., 2013). Being a leguminous crop it has an inherent capacity to fix atmospheric nitrogen. It can explore the soil of nutrients. Organic sources which are good for improvement of soil properties, besides supplying nutrients for longer period of time without leaving ill effects on soil has been realized. Further, there is a possibility of substituting fertilizers by organic nutrient sources. Groundnut is 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 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 *Glyricidia 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 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, panchagavya, 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 and Somasundaram, 2003). Dung and cattle urine slurry or biodigested slurry application in rice improved the growth and yield of rice (Gnanamani and Kasturi Bai,1992). Jeyabal and Kuppuswamy (1999) reported that nitrogen supply at 50 kg through biogas slurry along with 2 kg *Azospirillum* obtained significantly higher rice grain (5.98 t ha^{-1}) as compared to N through fertilizers (5.57 g ha^{-1}). Further, Liquid cattle manures could supplement the nitrogen requirements of crops. This was demonstrated by Zhang *et al.* (2006) in broom grass and oat and Lithourgidis *et al.* (2007) in maize improvement in soil fertility was observed

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 groundnut. Further, there is also need to evaluate the beneficial effects of cow urine, *panchagavya,* vermiwash in conjunction with enriched biodigested liquid manure. The basic idea of the research is to find out best nutrient management practices using on-farm generated organic waste and ubiquitous weeds for their effectiveness. Hence the investigation carried out with an objective to study the efficacy of biodigested liquid manures on yield potential, nutrient uptake and quality on groundnut crop on alfisols of southern India.

MATERIALS AND METHODS

Present investigation was conducted during 2010-11 and 2011-12 at Gandhi Krishi Vigyana Kendra, University of Agricultural Sciences, Bengaluru. The soil of the experimental site was sandy clay in texture 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^{-1}, respectively. The organic carbon content of the soil was 0.47 %. Total annual rainfall received during 2010 and 2011 was 549.7 and 613.5 mm, respectively. The soil texture, pH, EC, organic carbon, available nitrogen, phosphorous and potassium were analyzed using standard methods (Jackson, 1973). Six irrigations at 5 cm depth were provided during the dry spell of the cropping period. There were ten treatments comprising of three types of organic liquid manures *viz*. biodigested liquid manures(BDLM), enriched biodigested liquid manures(EBDLM) and cow urine (CU) along with foliar spays of 3% panchagavya (PG) and 3% vermiwash (VW) and recommended fertilizers for irrigated groundnut as detailed below T_1: BDLM @ 25 kg N equivalent ha^{-1} , T_2: BDLM @ 25 kg N equivalent ha^{-1} + VW spray @ 3 %, T_3: BDLM @ 25 kg N equivalent ha^{-1} + PG spray @ 3 %, T_4: EBDLM @ 25 kg N equivalent ha^{-1} T_5: EBDLM @ 25 kg N equivalent ha^{-1} + VW spray @ 3 % , T_6:EBDLM @ 25 kg N equivalent ha^{-1} + PG spray @ 3 %, T_7: CU@ 25 kg N equivalent ha^{-1} , T_8: CU@ 25 kg N equivalent ha^{-1} + VW spray @ 3 %, T_9: CU@ 25 kg N equivalent ha^{-1} + PG spray @ 3 % , T_{10}: Rec.FYM 10 t + 25:75:37.5 kg N:P_2O_5:K_2O ha^{-1}. The treatments were laid out in randomized complete block design with three replications. The gross plot was 3.0 m x 3.3 m. The bio-digested liquid manure was prepared in a 200 litre cement tank by adding 15 kg cow dung, 20 litre cow urine, 30 kg of pongamia green biomass and 100 litre 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 has 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. Liquid manures were applied in two equal splits at 20 and 60 days after sowing for groundnut.

Panchagavya was prepared by using five products of desi cow *viz*. cow urine, dung, milk, curd and ghee. Vermiwash was prepared by dipping adult earth worms in luke warm water. Three per cent panchagavya and vermiwash solutions were prepared by mixing 30 ml each panchagavya and vermiwash in 1000 ml of water separately. Three sprays of 3% panchagavya/vermiwash was foliar applied at 30, 60 and 75 days after sowing to groundnut as per treatments. Treatment 1 to 9 were supplied by recommended FYM and vermicompost at 50% each based on N equivalent and treatment T_{10} received FYM at 10 t ha^{-1} two weeks before sowing and recommended dose of fertilizer 25:75:37.5 kg N, P_2O_5, K_2O kg ha^{-1} for groundnut was incorporated in to the soil at the time of sowing. The nutrients were applied in the form of urea, single super phosphate and muriate of potash.

The groundnut cultivar TMV 2 was sown during *kharif* of 2010 and 2011. The spacing adopted was 30 x 15 cm for groundnut. Thrips and aphids were controlled by spraying 4 per cent neem seed kernel extract twice during crop growth period of groundnut.

The yield of groundnut crop was recorded at harvest. Further, protein and oil yield and economics of groundnut were computed. The soil samples (0-15 cm depth) were collected at the end of groundnut crop and analyzed for organic carbon, available N, P, K and S and also their nutrient concentration in haulm by adopting standard methods and total crop uptake was worked out.

RESULTS AND DISCUSSION

Soil chemical fertility

Organic carbon content and nutrient status increased in the soil over the years in groundnut cultivation. Significantly higher organic carbon, available nitrogen, phosphorus, potassium and sulphur (0.63 %, 355.1, 78.3, 190.8 and 36.3 kg ha^{-1}, respectively) was noticed with the application of EBDLM @ 25 kg N equivalent ha^{-1} + PG spray @ 3 % and it was followed by EBDLM @ 25 kg N equivalent ha^{-1} + VW spray @ 3 %, (0.61 %, 342.6, 75.3, 187.1 & 32.7 kg ha^{-1}, respectively) and EBDLM @ 25 kg N equivalent ha^{-1} (0.60 %, 324.9, 72.1, 185.2 and 32.2 kg ha^{-1}, respectively) (Table 2). Significantly higher organic carbon with the application of EBDLM @ 25 kg N equivalent ha^{-1} + PG spray @ 3 % was attributed to the contribution of carbon to soil through EBDLM. Rajnish and Subhash (2011) observed that organic carbon was 13 per cent higher with organic nutrient management (0.91 %) than with synthetic fertilizer use (0.80 %). Further, significantly higher available nutrients with T_6 was attributed to slow release of nitrogen from organics which might have reduced the N loss from soil, since organic carbon in the soil is higher than that from inorganic fertilizer application. High available soil phosphorus could be attributed to increased solubility of native P by means of organic acids produced during the course of decomposition. The increase in available potassium might be related to release of K from EBDLM and also to the solubilisation of mineral bound K or native K. Application of different bio-digested liquid organic manures significantly increased the soil available nutrients indicating their build up in treated soil. The increase in available nutrients may due to the effect of enrichment of bio-digested liquid manure with *pongamia* cake that was more pronounced in increasing the post harvest soil available nutrients. Reddy *et al*. (2011) reported that at Mandya and Nagenahalli, soil nutrients and organic carbon status was improved by the application of FYM and bio-digester liquid manure to rice crop.

Table 1: Soil fertility status after harvest of groundnut as influenced by different liquid organic manures

Treatments	Organic carbon (%)			Available N (kg ha^{-1})			Available P_2O_5 (kg ha^{-1})			Available K_2O (kg ha^{-1})			Available S (kg ha^{-1})		
	2010	2011	Pooled	2010	2011	Pooled	2010	2011	Pooled	2010	2011	Pooled	2010	2011	Pooled
T_1	0.54	0.55	0.55	275.4	307.7	291.6	53.6	69.6	61.6	148.1	169.8	158.9	23.2	30.2	26.7
T_2	0.55	0.56	0.55	277.4	310.8	294.1	53.8	70.1	62.1	159.9	178.9	169.4	24.2	31.5	27.8
T_3	0.55	0.57	0.56	283.5	311.8	297.6	53.8	71.0	62.5	162.1	181.5	171.8	24.6	32.0	28.3
T_4	0.56	0.60	0.58	286.9	322.8	304.9	55.4	72.1	63.9	169.3	189.5	179.4	28.2	32.3	30.3
T_5	0.59	0.62	0.60	288.5	343.1	315.8	57.7	75.3	66.4	170.3	191.6	180.9	28.5	32.4	30.5
T_6	0.61	0.63	0.62	291.5	350.7	321.1	60.0	78.3	69.2	173.1	195.8	184.4	28.4	36.9	32.7
T_7	0.47	0.50	0.49	255.2	281.4	268.3	46.3	60.2	53.4	144.9	160.0	152.5	22.1	28.8	25.4
T_8	0.50	0.51	0.50	269.7	286.3	278.0	49.0	63.7	56.3	145.0	162.3	153.7	22.7	29.5	26.1
T_9	0.50	0.53	0.52	273.3	290.1	281.7	49.5	64.6	57.0	146.0	165.4	155.7	23.0	29.9	26.5
T_{10}	0.47	0.48	0.47	251.9	269.6	260.7	46.3	60.2	53.4	143.1	160.2	151.6	18.6	24.2	21.4
S. Em. ±	0.03	0.02	0.02	8.2	7.8	7.8	3.0	3.0	2.0	7.1	7.8	4.2	1.1	1.3	0.9
C. D. at 5 %	0.09	0.07	0.05	24.5	23.6	23.3	8.5	8.5	5.7	21.0	23.2	12.6	3.3	4.0	2.5

Intial soil status : OC-0.47 %, N-244.4 kg ha^{-1} ; P_2O_5-50.86 kg ha^{-1} ; K_2O-154 kg ha^{-1}

Table 2: Nitrogen, phosphorus, potassium and sulphur uptake (kg ha^{-1}) by groundnut as influenced by different liquid organic manures

Treatments	N			P			K			S		
	2010	2011	Pooled	2010	2011	Pooled	2010	2011	Pooled	2010	2011	Pooled
T_1	89.4	108.5	98.7	11.3	12.5	11.9	48.2	57.5	52.8	12.4	12.9	12.6
T_2	98.3	104.9	101.6	11.4	12.5	11.9	54.0	53.0	53.5	12.4	13.1	12.8
T_3	101.0	110.8	105.9	11.7	12.6	12.1	50.6	59.9	55.2	12.6	14.2	13.4
T_4	102.0	111.9	106.9	12.4	14.4	13.4	53.9	61.9	57.9	13.2	13.9	13.6
T_5	104.1	114.2	109.1	12.9	14.9	13.9	55.9	65.1	60.5	14.9	15.0	15.0
T_6	106.6	117.6	112.0	16.4	17.4	16.9	64.6	74.5	69.5	15.6	16.4	16.0
T_7	76.8	90.4	83.5	8.0	8.4	8.2	42.8	41.3	42.1	10.7	10.7	10.7
T_8	86.9	98.6	92.7	8.4	9.2	8.8	44.5	45.6	45.1	11.0	11.7	11.4
T_9	90.3	99.0	94.6	9.4	10.4	9.9	44.6	52.0	48.3	11.4	12.7	12.0
T_{10}	66.2	77.0	71.5	6.6	7.2	6.9	38.5	42.2	40.4	9.7	10.1	9.9
S. Em. ±	2.0	2.0	1.9	0.7	0.9	1.2	3.2	3.1	4.1	1.2	0.9	0.8
C. D. at 5 %	6.1	6.0	5.5	2.1	2.8	3.6	9.5	9.2	12.0	3.4	2.6	2.5

Table 3: Pod yield, kernel yield and quality of groundnut as influenced by different liquid organic manures

Treatments	Pod yield kg ha^{-1}			Kernel yield kg ha^{-1}			Oil yield kg ha^{-1}			Protein yield kg ha^{-1}		
	2010	2011	Pooled	2010	2011	Pooled	2010	2011	Pooled	2010	2011	Pooled
T_1	2063	2096	2080	1412	1463	1438	636	681	658	262	308	285
T_2	2083	2111	2097	1426	1474	1450	667	704	685	283	292	288
T_3	2143	2141	2142	1479	1507	1493	707	720	713	291	305	298
T_4	2158	2189	2174	1517	1570	1544	728	753	740	299	318	309
T_5	2251	2318	2284	1675	1759	1717	803	854	828	332	359	345
T_6	2317	2353	2335	1736	1814	1775	837	914	875	348	380	364
T_7	1678	1798	1738	1051	1149	1099	470	527	499	190	228	209
T_8	1878	1934	1906	1238	1301	1269	575	616	595	231	258	244
T_9	1982	2041	2012	1317	1384	1351	625	659	642	253	273	263
T_{10}	1628	1577	1603	848	838	843	387	382	384	153	166	160
S. Em. ±	123.7	119.9	86.1	122.5	122.7	86.7	65	65	46	23	26	22
C. D. at 5 %	367.5	356.4	247.0	364.0	364.5	248.5	192	192	136	70	78	65

Nutrient uptake

Significantly higher uptake of N, P, K and S was recorded with EBDLM @ 25 kg N equivalent ha^{-1} + PG spray @ 3 % (112.0, 16.9, 69.5 and 16.0 kg ha^{-1}, respectively) being on par with that of application of EBDLM @ 25 kg N equivalent ha^{-1} + VW spray @ 3 % (109.9, 13.9, 60.5 & 15.0 kg ha^{-1}, respectively) and EBDLM @ 25 kg N equivalent ha^{-1} (106.9, 13.4, 57.9 & 13.6 kg ha^{-1}, respectively) (Table 2). This may be attributed to higher dry matter production. Since uptake is the positive function of dry matter yield. This might be attributed to enhanced nutrient availability and increased microbial activity might be responsible for quick release of nutrients which resulted in to more uptake of nutrients (Asha *et al.,* 1996). This might be due to slow and steady release of nutrients from BDLM or EBDLM had a role in uptake of nutrients by the crop. These results corroborate with the findings of Suresh Naik (2011) in maize. With respect to Panchagavya, ammonia and nitrite oxidizers were found to colonize the leaves and increased the uptake and total N (Papen *et al*. 2002) and the presence of indole acetic acid (IAA) stimulated the growth of adventitious roots which arise from the base of the stem and it also made root tips to work more actively. This might have helped in higher uptake of nutrients available in the soil. Further, these results are in line with the findings of Shepherd

and Withers (1999), Abdulkadir (2000), Neeraja *et al*. (2000) and Muthuramalingam *et al*. (2001).

Yield and quality

In general, the productivity of groundnut 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 of experimentation hence, pooled data is discussed. On an average, application of EBDLM at 25 kg N equivalent ha^{-1} + 3 sprays of PG at 3 % produced significantly higher pod and kernel yield of groundnut (2335 and 1775 kg ha^{-1}, respectively) followed by EBDLM at 25 kg N equivalent ha^{-1} + 3 sprays of VW at 3 % (2284 and 1717 kg ha^{-1}, respectively), EBDLM at 25 kg N equivalent ha^{-1} (2174 and 1544 kg ha^{-1}, respectively) and BDLM at 25 kg N equivalent ha^{-1} + 3 sprays of PG at 3 % (2142 and 1493 kg ha^{-1},respectively) than all other treatments. Significantly lower pod and kernel yield of groundnut (1603 and 843 kg ha^{-1}, respectively) was observed with recommended practice (Table 3). The increase in yield in BDLM and EBDLM along with three sprays of panchagavya and vermiwash at 3 per cent may be due to biodigested liquid manures and its enrichment with *pongamia* cake which contributed secondary and micronutrients along with major nutrients besides improving the soil condition, which enhanced the root proliferation and source to sink relationship similar resuts were obtained by Sudheendra saunshi *et al*. (2014). Foliar application of panchagavya and vermiwash readily supplied nutrients and growth hormones *viz*. IAA and GA present in panchagavya which might have stimulated the production of growth regulators in cell system 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 greengramThe significant effect of panchagavya was mainly attributed to its nutrient content, higher biological activity and presence of plant growth promoting substances, which was confirmed by Hazarika *et al*. (2006). Quality parameters *viz*., oil and protein yield of groundnut were significantly higher (875 and 364 kg ha^{-1}, respectively) with the application of EBDLM at 25 kg N equivalent ha^{-1} + 3 sprays of PG at 3 % as compared to other treatments (Table 3). This may be attributed to higher kernel yield with higher oil and protein content. This is in conformity with the findings of Kamdi *et al*. (2014) and Naveen Kumar (2009).

It can be concluded from the study that the application of enriched liquid organic manure at equivalent to 100 per cent recommended dose of nitrogen with foliar spray of panchagavya or vermiwash at 3 per cent on 30, 60 and 75 DAS is the best option for higher productivity of groundnut, beside improving protein and oil yield as well as soil fertility and total nutrient uptake.

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