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Research Communication

Organic manures and nutrient solubilizers for organic cultivation of summer groundnut (*Arachis hypogaea*) in black calcareous soil

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ABSTRACT

A field experiment was conducted during summer 2015 at Junagadh, Gujarat, to evaluate different nutrient sources and nutrient solubilizers for production of organic groundnut (*Arachis hypogaea* L.) in black calcareous soil. Results revealed that, though recommended dose of fertilizers (RDF) resulted in significantly higher growth and yield attributes, and yield of summer groundnut, but higher net returns were achieved with application of FYM @ 5 t/ha owing to premium price. Similarly, higher available P and K after harvesting was recorded with RDF but the maximum available soil N, S, DTPA-extracted Fe, Mn, Zn, and B, soil enzymatic activities (dehydrogenase, acid and alkaline phosphatase) at 90 days after sowing (DAS) were found with FYM @ 5 t/ha. Significantly maximum growth and yield attributes, pod yield, available nutrient in soil (N, P, K and S), and soil enzymatic activities at 90 DAS were observed with all-nutrient solubilizers @ 2.5 L/ha. However, significantly maximum DTPA-extracted Fe, Mn, Zn, and B were recorded with micronutrient solubilizers @ 2.5 L/ha.

Key words: Enriched compost, Farmyard manure, Neemcake, Nutrient solubilizers, Organic farming, RDF

During recent years serious concerns have been expressed about the sustainability of Green Revolution era-based production systems due to adverse impacts on soil, environment as well as human health caused by intensive use of chemical fertilizers and pesticides. Organic agriculture is being promoted as an alternative sustainable production system in several countries of the world including India. Organic groundnut market is increasing day by day owing to increasing demand for organic groundnut-based products by health conscious people. However, there is concern about the availability of sufficient organic nutrient sources at affordable rates to enhance area under organic cultivation. Farmyard manure (FYM) is widely used as organic nutrient source but due to declining number of farm animals with mechanization and increasing area under cultivation only a small quantity of FYM per ha is available (Chavan *et al.*, 2014). Therefore, there is a need to evaluate technical and economical suitability of other organic nutrient sources such as enriched compost and neemcake which are concentrated plant nutrient sources. Neemcake not only supplies plant nutrients but also is effective against insect-pests and diseases. Recently, liquid multi-bio-nutrient solubilizers have been made available in the market which have longer self-life, however, their efficiency in enhancing nutrient availability needs to be evaluated in groundnut.

A field experiment was conducted during summer 2015 at Instructional Farm, Department of Agronomy, College of Agriculture, Junagadh Agricultural University, Junagadh (21.5° N and 70.5° E) on clayey and slightly alkaline soil (*p*H 7.8 and electrical conductivity 0.33 dS/m), low in available nitrogen (237.0 kg/ha) and sulphur (17.5 kg/ha), medium in available phosphorus (22.5 kg P_2O_5/ha) and high in available potassium (284.0 kg/ha). The DTPA-extractable Fe in soil was 5.35 ppm, Mn 4.8 ppm, Zn 0.78 ppm and B 0.66 ppm. The experiment comprising nutrient sources in main plot, i.e. recommended dose of fertilizer (RDF) @ 25 : 50 : 50 kg/ha, FYM @ 5 t/ha, neemcake @ 1 t/ha and enriched compost @ 1.5 t/ha, and nutrient solubilizers in subplot, i.e. phosphate-solubilizing bacteria (PSB) @ 1 L/ha, all-nutrient solubilizers @ 2.5 L/ha and micro-nutrient solubilizers @ 2.5 L/ha, was carried out in split-plot design with 3 replications. The quantity of organic manures was decided on equal nitrogen basis, i.e. 25 kg N/ha. The FYM, neemcake and enriched compost con-

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tained 0.5, 2.5 and 1.6% nitrogen respectively. Recommended dose of N was supplied through urea and diammonium phosphate (DAP), P through DAP and K through muriate of potash (MOP). All-nutrient solubilizers were used to evaluate their unique ability to fix atmospheric nitrogen, and solubilize the unavailable forms of other nutrients like P, K and micronutreints, which are sold in the market. Similarly, micro-nutrient solubilizers were used to solubilize micronutrients in the soil. Fertilizers and manures were applied before sowing while nutrient solubilizers were mixed in soil, applied in respective plots and irrigated. Groundnut 'GJG 31' was sown at 30 cm × 10 cm spacing on 9 February 2015 and harvested on 8 June 2015. Total 8 irrigations were applied for raising the crop. The maximum and minimum temperature ranged between 28.1 and 41.1 and 12.0 and 26.0°C respectively, and total rainfall received during the crop season was 35.9 mm. Total chlorophyll content was estimated from the leaf tissues by acetone method developed by Sadasivam and Manickam (1992). For calculating net returns, the prevailing market rate of inputs, farm operations and produce was considered. A premium price of ₹5/kg pod was considered for organically produced groundnut over groundnut produced with RDF. Available nutrients in soil were estimated following standard methods. Available N was estimated following Kjeldahl method, available P_2O_5 by Olsen method, available K_2O by flame photometric method, available S by turbidimetric method, Fe, Mn, Zn by DTPA-extractable method and B by azomethine H method. Dehydrogenase, and acid and alkaline phosphate activities were estimated following Tabatabai (1982), and Tabatabai and Bremmer (1969) respectively. Analysis of variance was worked out using standard statistical procedures as described by Panse and Sukhatme (1985).

Plant height, dry-matter accumulation/plant, and total chlorophyll content were found significantly maximum with RDF (Table 1). This might be attributed to quick release of nutrients in adequate quantity by fertilizers during early stage of plants when nutrients are required for proper root growth and establishment. Effects of FYM on plant height and chlorophyll content; and enriched compost on dry-matter production/plant; were found at par with RDF. Among the organic nutrient sources, significantly higher plant height and total chlorophyll content were found with FYM, being at par with enriched compost, and dry matter accumulation with enriched compost. These results indicate FYM and enriched compost are more efficient in improving plant growth which could be owing to their

Table 1. Effect of organic manures and nutrient-solubililzers on growth and yield attributes, and economics of groundnut

Treatment	Plant height at harvesting (cm)	Dry-matter accumulation at harvesting (g)	Total chlorophyll content at harvesting (mg/g)	Mature pods/plant (Nos.)	Immature pods/plant (Nos.)	Shelling out-turn (%)	100-kernel weight (g)	Pod yield (t/ha)	Net returns (× 10^3 ₹/ha)	Benefit: cost ratio
Nutrient source										
RDF @ 25 : 50 : 50 kg/ha NPK	31.9	30.9	2.0	6.9	1.7	74.0	49.9	1.84	54.7	2.4
FYM @ 5 t/ha	30.7	28.7	1.8	6.4	1.3	72.5	46.0	1.69	55.2	2.2
Neemcake @ 1 t/ha	28.7	26.4	1.2	5.9	1.1	70.1	44.3	1.65	42.6	1.8
Enriched compost @ 1.5 t/ha	30.5	30.3	1.6	6.3	1.3	72.5	45.3	1.57	45.2	2.3
SEm±	0.5	0.5	0.1	0.05	0.04	0.6	0.6	0.04	–	–
CD (P=0.05)	1.7	1.6	0.4	0.2	0.2	2.0	2.1	0.13	–	–
Nutrient solubilizer										
PSB	29.6	28.5	1.5	6.2	1.2	71.4	45.7	1.65	49.0	2.3
All-nutrient solubilizers	31.0	30.2	1.8	6.6	1.4	72.8	47.3	1.71	52.1	1.8
Micronutrient solubilizers	30.7	28.6	1.7	6.4	1.3	72.6	46.1	1.70	50.8	2.1
SEm±	0.3	0.5	0.1	0.1	0.05	0.4	0.4	0.02	–	–
CD (P=0.05)	1.0	1.4	0.2	0.2	0.1	1.1	1.2	0.05	–	–

Price (₹) of urea, 6/kg; DAP, 26/kg; MoP, 16/kg; FYM, 1/kg; neemcake, 16/kg; enriched compost, 9/kg; PSB (Phosphate-solubilizing bacteria), 70/L; all-nutrient solubilizer, 300/L; micro-nutrient solubilizer, 425/L; groundnut pod, 45/kg (conventional) 50/kg (organic), haulm, 5/kg favourable effects on physical, chemical and biological properties of soil (Chavan *et al.*, 2014).

Among the nutrient solubilizers, significantly maximum plant height, dry-matter accumulation/plant and total chlorophyll content were observed with all-nutrient solubilizers over PSB (Table 1). The effect of application of all-nutrient solubilizers was found at par with micronutrient solubilizers on plant height and total chlorophyll content. The increased availability of multi-nutrients with the application of nutrient solubilizers could be attributed for better growth over PSB which enhances availability of phosphorus only (Chavan *et al*., 2014).

Number of mature and immature pods/plant, shelling out-turn, 100-kernel weight, and pod yield were recorded significantly higher with RDF (Table 1). The RDF resulted in 8.6, 11.5, and 17.3% higher pod yield than FYM, neemcake and enriched compost respectively. Among the organic nutrient sources, FYM resulted in significantly higher number of mature and immature pods/plant and shelling out-turn over neemcake, but various organic nutrient sources were indifferent to significantly affect 100-kernel weight and pod yield. Though neemcake did not favour better growth, it resulted in considerably higher yield over enriched compost owing to higher plant stand compared to all other nutrient sources (data not given here). This is attributed to least plant mortality by collar rot with the application of neemcake as compared to other nutrient sources. The efficacy of neemcake and enriched compost to favourably affect soil qualities and supplying plant nutrients matching plant demand resulted in pod yield at par with FYM (Jat and Ahlawat, 2010).

Application of all-nutrient solubilizers, being at par with micro-nutrient solubilizers, significantly improved number of mature and immature pods/plant, shelling out-turn, 100-kernel weight, and pod yield over PSB. The improvement in growth attributes with all-nutrient and multi-nutrient solubilizers led to higher values of yield attributes and ultimately more pod yield (Chavan *et al*., 2014).

Significantly maximum available P and K in soil after harvesting were observed with RDF while available N and S, and DTPA-extracted Fe, Mn, Zn and B were found with FYM (Table 2). Since FYM contains both macro and micronutrients and it supplies only partial amount of contained nutrients to the first crop (Chavan et *al.*, 2014), maintains higher nutrient status of soil than chemical fertilizers. Among the nutrient solubilizers, significantly highest available N, K and S in soil were found with all-nutrient solubilizers, available P with PSB, while DTPA extracted Fe, Mn, Zn and B were recorded with micronutrient solubilizers. This might be attributed to solubilization and mobilization of native nutrients present in the soil

Table 2. Effect of organic manures and nutrient solubilizers on available nutrient status in soil after harvesting of groundnut and enzyme activities (90 DAS)

Treatment	Nutrient status								Dehydrogenase (µ mole TPF/kg/ day)	Acid phosphatase (µ mole PNP/g fw/h)	Alkaline phosphatase (µ mole PNP/g fw/h)
	Available N (kg/ha)	Available P_2O_5 (kg/ha)	Available K_2O (kg/ha)	Available S (kg/ha)	DTPA extracted						
					Fe (ppm)	Mn (ppm)	Zn (ppm)	B (ppm)			
Nutrient source											
RDF @ 25 : 50 : 50 kg/ha NPK	222.1	23.1	259.2	15.3	4.11	3.43	0.61	0.54	171.7	241.8	182.8
FYM @ 5 t/ha	234.1	22.4	227.1	17.3	4.55	4.16	0.69	0.65	195.0	269.1	212.7
Neemcake @ 1 t/ha	224.0	20.3	223.4	15.4	4.48	3.62	0.62	0.60	176.6	249.8	184.7
Enriched compost @ 1.5 t/ha	222.9	20.9	222.8	16.8	4.54	3.94	0.67	0.64	189.2	260.4	195.8
SEm±	2.2	0.4	7.2	0.4	0.06	0.13	0.01	0.02	0.8	4.7	5.7
CD (P=0.05)	7.5	1.3	24.9	1.5	0.21	0.46	0.05	0.06	2.7	16.3	19.8
Nutrient solubilizer											
PSB	220.4	22.1	224.2	15.4	4.08	3.58	0.61	0.57	181.1	249.1	188.0
All nutrient solubilizers	231.9	21.9	247.5	17.2	4.37	3.85	0.65	0.60	184.7	263.0	203.7
Micronutrient solubilizers	225.0	21.0	227.7	15.9	4.81	3.93	0.68	0.64	183.6	253.7	190.2
SEm±	1.8	0.3	5.6	0.5	0.09	0.09	0.02	0.01	0.4	3.7	3.5
CD (P=0.05)	5.6	0.9	16.9	1.4	0.27	0.28	0.05	0.04	1.2	11.1	10.4

PSB, Phosphate solubilizing bacteria; PNP, *P*-nitrophenol; TPF, 2, 3, 5-triphenyl formazon; Fw, fresh weight by nutrient solubilizers (Amutha and Reginald, 2011).

The activities of dehydrogenase, acid and alkaline phosphatase in the soil at 90 DAS were observed significantly highest with the application of FYM followed by enriched compost and neemcake (Table 2). The higher supply of organic matter by organic manures led to higher microbial population, and more enzymatic activities in the soil (Chavan *et al.*, 2014). Among the nutrient solubilizers, significantly higher activities of all the 3 enzymes in soil at 90 DAS were recorded with all-nutrient solubilizers.

The maximum cost of cultivation was incurred with neemcake while the least with RDF. The highest net returns (₹55.2 × 10^3/ha) were obtained with the application of FYM which were marginally higher over that with RDF, while least value of net returns was obtained with neemcake (Table 1). The maximum benefit: cost ratio (BCR, 2.4) was obtained with RDF. The premium price obtained with organically produced groundnut is attributed for higher net return with FYM.

Among nutrient solubilizers, highest net returns (₹52.1 × 10^3/ha) was obtained with the application of all-nutrient solubilizers over PSB. This could be attributed to higher pod yield of groundnut with all-nutrient solubilizers (Amutha and Reginald, 2011).

Thus, application of neemcake and enriched compost resulted in similar yield levels as compared to FYM but due to their higher cost, the net returns are considerably lower than the groundnut produced with FYM. Further, application of all-nutrient and micro-nutrient solubilizers gave higher yield and economic returns over PSB.

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