



Effect on Integrated Nutrient Management on Productivity, Quality and Nutrient Uptake on Summer Groundnut (*Arachis hypogaea* L.)

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

A field experiment was conducted to study the effect of integrated nutrient management on productivity, quality and nutrient uptake in summer groundnut (*Arachis hypogaea* L.) during summer 2018 at Dantiwada, Gujarat. The treatment consisted of ten different integrated nutrient management treatments practices. The integration of inorganic fertilizers along with seed inoculation of biofertilizers viz., *Rhizobium* and phosphates solubilising bacteria (PSB) recorded significantly higher pod and haulm yield of summer groundnut as compared to rest of the treatments. Combined application of 75 % recommended dose of nitrogen (RDN) and 25 % RDN through vermicompost or farm yard manure (FYM) along with seed inoculation of *Rhizobium* and phosphates solubilising bacteria (PSB) recorded higher pod and haulm yield and also higher net returns and B- C ratio in summer groundnut.

Keywords: *Groundnut; INM; Bio-fertilizer; RDN, Vermicompost; FYM.*

1. INTRODUCTION

Groundnut is unique and important legume cum oilseed crop in India. It is largely grown in Gujarat, Andhra Pradesh, Tamil Nadu, Karnataka and Maharashtra. The kernels of groundnut are used in many culinary preparations due to its high content of oil and protein. Groundnut naturally enriches the soil through biological nitrogen fixation. Cultivation of groundnut during summer season is increasing owing to controlled moisture condition through irrigation, abundant sunshine and less infestation of pest and disease. The continuous and imbalanced use of chemical fertilizers affects production potential of summer groundnut. Use of chemical fertilizers in combination with organic manures results in the higher productivity of groundnut crop and improves the soil health. Organic manures are good complimentary sources of nutrients. They also improve the efficiency of applied mineral nutrients through chemical fertilizers and improve the physical and biological properties of the soil. A judicious and complementary use of organic and inorganic sources of plant nutrients plays an important role in decreasing the cost of production through reducing the cost of nutrient inputs. The present experiment was carried out to study the effect of organic and inorganic manures on yield and economics of summer groundnut.

2. MATERIALS AND METHODS

A field experiment was conducted during summer season of 2018 at Agronomy Instructional Farm, Chimanbhai Patel College of Agriculture, Dantiwada Agricultural University, Sardarkrushinagar, to study effect of integrated nutrient management on productivity, quality and nutrient uptake in summer groundnut (*Arachis hypogaea* L.). The experiment was conducted on loamy sand soil having slightly alkaline pH (7.42), low in organic carbon (0.23%) and available nitrogen (158 kg/ha), high in available phosphorus (37 kg/ha) and high in available potassium (286 kg/ha) in 0-15 cm soil depth. There were ten treatment combinations viz., 100% recommended dose of fertilizers (RDF) (25 kg N : 50 kg P₂O₅ /ha) (T₁), 50% recommended dose of nitrogen through fertilizers (RDN) + 50% N through farm yard manure (FYM) (T₂), 75% RDN + 25% N through FYM (T₃), 50% RDN + 50% N through vermicompost (T₄), 75% RDN + 25% N through vermicompost (T₅), 50% RDN + 50% N through FYM + *Rhizobium* + phosphate solubilising bacteria (PSB) (T₆), 75% RDN + 25% N through FYM + *Rhizobium* + PSB (T₇),

50% RDN + 50% N through vermicompost + *Rhizobium* + PSB (T₈), 75% RDN + 25% N through vermicompost + *Rhizobium* + PSB (T₉), 100% RDF + *Rhizobium* + PSB (T₁₀). They were evaluated in randomised block design with four replications. The nutrient sources viz. FYM (0.5 % N, 0.25 % P₂O₅ and 0.5 % K₂O) and vermicompost (3 % N, 1.0 % P₂O₅ and 1.5 % K₂O) as well as required quantity of nitrogen and phosphorus in the form of urea and single super phosphate, respectively were applied as per treatments at the time of sowing. The organic sources of nutrients viz., FYM and vermicompost were applied 15 days before sowing.

Groundnut variety TG 37 was sown with 100 kg/ha seed rate at inter row spacing of 30 cm and intra row spacing of 10 cm on 19th February 2018. All the cultural operations were carried out as per the recommended package of practices for summer groundnut. Five plants per net plot were selected randomly from the net plot area and tagged for recording the growth and yield attributes each treatment.

The crop was manually uprooted, pods were separated and pod yield was recorded. The cost of cultivation and returns were calculated on the basis of prevailing cost of inputs and price of produce.

The soil samples were collected from each plot after harvesting groundnut crop at 0-15 cm depth and analysed as per standard procedures. The total nitrogen content of kernel and haulm of groundnut plants was analysed by micro Kjeldahl method and phosphorus by Vanado molybdophosphorus acid yellows colour methods [1]. Total nitrogen values thus obtained were multiplied with a factor of 6.25 to obtain protein content. The estimation of oil content was done by Soxhlet extraction methods following standard procedure [2]. The total oil yield per hectare was also worked out by multiplying kernel yield (kg/ha) with oil percent in kernel and divided by 100. The uptake of nitrogen and phosphorus in kernel and haulm were determined by using following formula.

$$\text{Nutrients uptake (kg/ha)} = \frac{\text{Nutrient content (\%)} \times \text{Kernel yield (kg/ha)}}{100}$$

3. RESULTS AND DISCUSSION

3.1 Yield Attributes and Yield

Significantly higher number of pods per plant and dry weight of pods per plant were recorded

by the application of RDF + *Rhizobium* + PSB. It was followed by 75% RDN + 25% N through vermicompost + *Rhizobium* + PSB and 75% RDN + 25% N through FYM + *Rhizobium* + PSB. The plants were healthy with the application of combination FYM, vermicompost and biofertilizers and it was reflected in their yield attributes viz. number of pods and dry weight of pods per plant. The lower number of pods per plant and dry weight of pod per plant were recorded by 50% RDN + 50% N through FYM. Application of fertilizer along FYM and vermicompost increased the number of pods and dry weight of pods per plant significantly and further increased the pod and haulm yield of summer groundnut. Mohapatra and Dixit [3] also reported that pod and haulm yield were significantly higher with the application of FYM, vermicompost and biofertilizers.

Application of recommended dose of nutrients through different sources (viz. chemical fertilizers, FYM, vermicompost etc.,) along with biofertilizers (viz., *Rhizobium* and PSB) significantly increased the pod and haulm yield of summer groundnut. Application of RDF along with biofertilizers (*Rhizobium* + PSB) resulted in significantly higher pod and haulm yield and it was closely followed by 75% RDN + 25% N through vermicompost + *Rhizobium* + PSB and 75% RDN + 25% N through FYM + *Rhizobium* + PSB. In case of pod and haulm yield, the latter two treatments in combination with FYM and vermicompost were found statistically at par. The increase in pod yield was 22.8, 22.0 and 20.9 per cent (Table 1) than that of 50% RDN + 50% N through FYM.

This might be attributed to rapid mineralization of chemical nitrogen and slow supply of nitrogen from FYM and vermicompost along with biofertilizers which might have met the nitrogen requirement of crop at critical stages of growth. Further, FYM and vermicompost act as nutrient reservoirs and upon decomposition produce organic acids, thereby absorbed ions are released slowly during entire growth period leading to improvement in crop yield attributes and ultimately pod and haulm yield of groundnut. The percent increase in pod yield by fertilizing the crop with 100% RDF + *Rhizobium* + PSB (T₁₀), 75% RDN + 25% N through vermicompost + *Rhizobium* + PSB (T₉) and 75% RDN + 25% N through FYM + *Rhizobium* + PSB (T₇) was tune to the tune of 22.8, 22.0 and 20.9 per cent, respectively over 50% RDN + 50% N through FYM. Similar trend was observed by Abraham

and Thenua [4]. Dhadge and Satpute [5] also reported significantly higher the pod and haulm yield due to integration of inorganic and organic sources of nutrients.

3.2 Quality

The protein content in summer groundnut was influenced markedly by different integrated nutrient management treatments (Table 2). As nitrogen is the basic constituent of protein and with the increase in the availability of nitrogen by the application of organic manures and *Rhizobium* inoculants, the uptake of nitrogen increased which resulted in higher protein content in kernel. Oil content was not significantly influenced by different integrated nutrient management treatments, as oil content is a genetic character and is not much influenced by agronomical practices. But oil yield was influenced by different integrated nutrient management treatments due to higher kernel yield of the groundnut. Lowest oil content and oil yield was recorded in 50% RDN + 50% N through FYM. Similar trend was observed by Thorave and Dhonde. Bhosale et al. [6] also reported higher oil content and oil yield under organically manured plots.

3.3 Soil Fertility

Integrated nutrients management treatments had a marked effect on available nitrogen and phosphorus in soil but they were at par in available potassium. Application of 50 % RDN + 50 % nitrogen through FYM along with biofertilizers (*Rhizobium* + PSB) resulted in significantly higher available nitrogen (151 kg/ha) and available phosphorus (38.63 kg/ha) followed by 50 % RDN + 50 % nitrogen through FYM along with biofertilizers (*Rhizobium* + PSB) and 50 % nitrogen through vermicompost. Application of 100 % RDF recorded significantly lower content of available nitrogen and phosphorus as compared to organic manured plots. This might be due to the fact that in organically manured plots microbial population might have be increased and as a result soil aggregation and decomposition have resulted in increased organic content in soil leading to higher available nitrogen in soil. The higher uptake of nitrogen by groundnut with the incorporating of manured with *Rhizobium* + PSB may be due to release of higher amount of nitrogenous compounds by root nodules at early stage of growth and their subsequent decomposition at lower stages. Moreover, FYM

Table 1. Effect of integrated nutrient management practices on yield parameters and yield of summer groundnut

Sr. No.	Treatments	Number of pods per plant			Dry weight of pods (g/plant)	Pod yield (kg/ha)	Haulm yield (kg/ha)	Shelling (%)
		Filled	Unfilled	Total				
T ₁	100% RDF (25 kg N : 50 P ₂ O ₅ kg/ha) (T ₁)	17.0	6.2	23.2	12.15	2751	4878	68.03
T ₂	50% RDN + 50% N through FYM (T ₂)	13.0	5.4	18.4	10.66	2543	4201	65.24
T ₃	75% RDN + 25% N through FYM (T ₃)	15.0	5.5	21.0	11.90	2726	4634	67.25
T ₄	50% RDN + 50% N through vermicompost (T ₄)	13.9	5.4	19.3	10.76	2576	4301	65.46
T ₅	75% RDN + 25% N through vermicompost (T ₅)	15.7	5.8	21.5	12.14	2737	4742	67.86
T ₆	50% RDN + 50% N through FYM + <i>Rhizobium</i> + PSB (T ₆)	14.4	5.5	19.9	11.47	2603	4422	65.62
T ₇	75% RDN + 25% N through FYM + <i>Rhizobium</i> + PSB (T ₇)	18.4	6.4	24.8	12.90	3075	5100	68.22
T ₈	50% RDN + 50% N through vermicompost + <i>Rhizobium</i> + PSB (T ₈)	14.6	5.5	20.1	11.76	2723	4607	66.91
T ₉	75% RDN + 25% N through vermicompost + <i>Rhizobium</i> + PSB (T ₉)	18.3	6.9	25.1	13.01	3104	5236	69.09
T ₁₀	100% RDF + <i>Rhizobium</i> + PSB (T ₁₀)	19.4	7.2	26.6	13.43	3122	5438	70.82
	S.Em. ±	0.98	0.28	0.97	0.43	124	192	2.36
	CD at 5 %	2.85	0.81	2.81	1.26	360	558	NS

Table 2. Effect of integrated nutrient management practices on quality parameters of summer groundnut

Sr. No.	Treatments	Protein content (%)	Oil content (%)	Oil yield (kg/ha)
T ₁	100% RDF (25 kg N : 50 kg P ₂ O ₅ /ha) (T ₁)	22.9	47.63	892
T ₂	50% RDN + 50% N through FYM (T ₂)	20.9	44.96	752
T ₃	75% RDN + 25% N through FYM (T ₃)	22.0	46.81	850
T ₄	50% RDN + 50% N through vermicompost (T ₄)	21.3	45.22	769
T ₅	75% RDN + 25% N through vermicompost (T ₅)	22.7	47.11	876
T ₆	50% RDN + 50% N through FYM + <i>Rhizobium</i> + PSB (T ₆)	21.4	46.02	791
T ₇	75% RDN + 25% N through FYM + <i>Rhizobium</i> + PSB (T ₇)	23.6	47.95	999
T ₈	50% RDN + 50% N through vermicompost + <i>Rhizobium</i> + PSB (T ₈)	21.6	46.33	849
T ₉	75% RDN + 25% N through vermicompost + <i>Rhizobium</i> + PSB (T ₉)	23.9	48.22	1029
T ₁₀	100% RDF + <i>Rhizobium</i> + PSB (T ₁₀)	24.0	48.52	1074
	S.Em. ±	0.45	1.49	54.6
	CD at 5 %	1.30	NS	158.5

Table 3. Effect of integrated nutrient management practices on N, P and K uptake by kernel and haulm

Sr. No.	Treatments	Nutrient uptake by kernel (kg/ha)			Nutrient uptake by haulm (kg/ha)		
		N	P	K	N	P	K
T ₁	100% RDF (25 kg N : 50 kg P ₂ O ₅ /ha) (T ₁)	67.87	8.62	11.79	27.55	3.67	12.37
T ₂	50% RDN + 50% N through FYM (T ₂)	56.34	7.20	10.07	20.39	2.92	10.16
T ₃	75% RDN + 25% N through FYM (T ₃)	64.89	8.26	11.51	26.05	3.45	11.64
T ₄	50% RDN + 50% N through vermicompost (T ₄)	57.56	7.41	10.27	21.71	3.00	10.55
T ₅	75% RDN + 25% N through vermicompost (T ₅)	67.08	8.40	11.66	26.91	3.54	11.92
T ₆	50% RDN + 50% N through FYM + <i>Rhizobium</i> + PSB (T ₆)	58.67	7.55	10.60	23.25	3.09	10.69
T ₇	75% RDN + 25% N through FYM + <i>Rhizobium</i> + PSB (T ₇)	79.10	9.67	13.21	31.15	4.23	13.89
T ₈	50% RDN + 50% N through vermicompost + <i>Rhizobium</i> + PSB (T ₈)	63.14	8.16	11.40	25.41	3.34	11.49
T ₉	75% RDN + 25% N through vermicompost + <i>Rhizobium</i> + PSB (T ₉)	82.28	10.07	13.62	32.24	4.42	14.38
T ₁₀	100% RDF + <i>Rhizobium</i> + PSB (T ₁₀)	85.14	10.56	14.29	33.39	4.72	14.83
	S.Em. ±	4.37	0.49	0.70	1.53	0.26	0.70
	CD at 5 %	12.68	1.43	2.04	4.45	0.74	2.03

Table 4. Effect of integrated nutrient management practices on economics of summer groundnut

Sr. No.	Treatments	Gross realization (₹/ha)	Cost of cultivation (₹/ha)	Net realization (₹/ha)	BCR
T ₁	100% RDF (25:50 N and P ₂ O ₅ kg/ha)	143307	55565	87742	2.57
T ₂	50% RDN + 50% N through FYM	131239	56892	74347	2.31
T ₃	75% RDN + 25% N through FYM	141206	56229	84977	2.51
T ₄	50% RDN + 50% N through vermicompost	133124	57892	75232	2.30
T ₅	75% RDN + 25% N through vermicompost	142133	56729	85404	2.51
T ₆	50% RDN + 50% N through FYM + <i>Rhizobium</i> + PSB	134823	57132	77691	2.36
T ₇	75% RDN + 25% N through FYM + <i>Rhizobium</i> + PSB	158775	56469	102306	2.81
T ₈	50% RDN + 50% N through vermicompost + <i>Rhizobium</i> + PSB	140963	58132	82831	2.43
T ₉	75% RDN + 25% N through vermicompost + <i>Rhizobium</i> + PSB	160624	56969	103655	2.82
T ₁₀	100% RDF + <i>Rhizobium</i> + PSB	162242	55805	106437	2.91

increase the absorptive power of the soil for cations and anions particularly phosphates and nitrates. The increase in available phosphorus might be due to organic acids which are released during microbial decomposition of organic matter which helped in solubilisation of native phosphorus as a result of which the availability of phosphorus content in soil increased. The beneficial effects of organic manures and biofertilizers on increased availability of nitrogen and phosphorus to soil were also reported by Choudhary et al. [7].

3.4 Nitrogen, Phosphorus and Potassium Content and Uptake

Marked differences were observed in nitrogen and phosphorus content and uptake in kernel and haulm of groundnut. Significantly higher content and uptake of nitrogen and phosphorus was recorded with the application of 100% RDF along with biofertilizers (*Rhizobium* + PSB) followed by 75% RDN + 25% N through vermicompost + *Rhizobium* + PSB and 75% RDN + 25% N through FYM + *Rhizobium* + PSB. Integrated application of nutrients failed to reach the level of significance with respect to potassium content in kernel and haulm (Table 3). The content and uptake of nitrogen and phosphorus was more in vermicompost treated plots, than that of FYM treated plots owing to better availability of phosphorus in crop root zone resulting from solubilisation caused by the organic acids, produced from decaying organic matter and also increased uptake by the groundnut roots due to their association with microrrhizal filaments increasing in the active area of roots. The increase in nitrogen uptake might be due to enhanced activity of nitrogenase and nitrate reductase enzyme in the soil. Choudhary et al. [7] also recorded higher content and uptake of nitrogen and phosphorus with the application of 100% RDF + *Rhizobium* + VAM + PSB.

3.5 Economics

Significantly higher net realization and net return per rupee invested (BCR) were obtained from the crop fertilized with RDF + *Rhizobium* + PSB followed by 75% RDN + 25% N through vermicompost + *Rhizobium* + PSB and 75% RDN + 25% N through FYM + *Rhizobium* + PSB. The lowest net realization and net return per rupee invested (BCR) were recorded in the 50% RDN + 50% N through FYM. High cost of FYM

and vermicompost resulted in increased the cost of cultivation without too much increase in net returns, thus overall effect of FYM and vermicompost reflected in net returns per rupee increased. The 50% RDN + 50% N through FYM recorded significantly lower net realization and net return per rupee invested. This result confirms the finding of Datta et al. [8-9].

4. CONCLUSION

It may be concluded that application of 100% RDF + *Rhizobium* + PSB resulted in significantly higher pod and haulm yield, protein content, oil yield and also higher net realization and B: C ratio of summer groundnut. .

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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