Indian Journal of Agronomy **46** (3) : 516–522 (September 2001)

Integrated nutrient management in rainy-season groundnut (*Arachis hypogaea*)

N.A. KACHOT, D.D. MALAVIA, R.M. SOLANKI[1] AND B.K. SAGARKA

Department of Agronomy, College of Agriculture, Gujarat Agricultural University, Junagadh 362 001

Received : August 2000

ABSTRACT

A field experiment was conducted at Junagadh during the rainy season of 1996 and 1997 to study the effect of organic, inorganic and biological sources of nutrients on yield, quality, nutrient content and uptake of semi-spreading groundnut (*Arachis hypogaea* L.) as well as nutrient status of soil. Combine application of FYM @ 20 tonnes/ha + 100% recommended dose of fertilizer + *Azotobacter* spp. + *Pseudomonas striata* recorded significantly higher shelling (%), protein content and yield, oil yield, mean yield of pod and haulm as well as gross returns than the control, at application of only FYM @ 10 tonnes/ha, *Azotobacter* spp. + *Pseudomonas striata*, 50% N of recommended dose of fertilizer + *Pseudomonas striata*, 50% P_2O_5 of recommended dose of fertilizer + *Azotobacter* spp. and 50% recommended dose of fertilizer, while net returns were obtained maximum when crop was fertilized with only 100% recommended dose of fertilizer. Similar trend was also observed for N, P, K content and uptake. Available nitrogen and phosphorus in soil was also improved with combined application of organic, inorganic and biofertilizers.

Key words : INM, Semi-spreading, Groundnut, FYM, Biofertilizers, Recommended dose of fertilizer

Groundnut stands first by contributing 29% area and 36% production of oilseeds in India (DOES, 1998). It is an exhaustive crop and removes large amount of macro- and micro-nutrients. No single source of nutrient is capable of supplying plant nutrients in adequate amount and balanced proportion. Therefore to maintain soil fertility and to supply plant nutrients in balanced proportion for optimum growth, yield and quality of crop in an integrated manner in a specific agro-ecological situation is to practice integrated nutrient supply system through the combined use of organic, biological and chemical sources of plant nutrients. Hence an experiment was conducted to study the effect of organic, inorganic and biological sources of nutrients on yield,

Present address : [1]Oilseeds Research Station, GAU, Junagadh

quality, nutrient content, uptake and nutrient status of soil in groundnut crop.

MATERIALS AND METHODS

The field experiment was conducted at the Instructional Farm, College of Agriculture, Gujarat Agricultural University, Junagadh, during rainy season of 1996 and 1997. Twelve treatments consisting of 3 different sources of nutrients, viz. organic (FYM 20 and 10 tonnes/ha), inorganic (50% N of recommended dose of fertilizer, 50% P_2O_5 of recommended dose of fertilizer, 50% recommended dose of fertilizer and 100% RDF) and biofertilizers (*Azotobacter* spp. and *Pseudomonas striata*), either alone or in combination with each other, were tested in randomized block design with 4 replications. The recommended dose of fertilizer were 12.5, 25.0, 0.0 kg N, P, K /ha. The soil was medium black clayey in texture with pH 7.9, containing 0.63% organic carbon; 269, 21 and 263 kg/ha available N, P_2O_5 and K_2O respectively. Semi-spreading groundnut cv. 'GG 20' was sown at 45 cm × 10 cm spacing on 15 and 17 June in 1996 and 1997 respectively. The FYM was applied before sowing in previously opened furrows as per treatment. The chemical fertilizers as per treatments through urea and single superphosphate were applied at the time of sowing, whereas groundnut kernels were treated with *Azotobacter* spp. and seeds were treated with *Pseudomonas striata* @ 10 ml/kg.

Chemical analysis of plants was carried out in random plants from each plot at harvest. Nitrogen, phosphorus and potash contents were determined by modified Kjeldahl, Vandomolybdo-phosphate yellow colour and flame photometer method respectively. The soil samples from 0–30 cm depth were drawn after harvest of crop from each plot and were used for analysing the available nitrogen, phosphorus and potassium.

RESULTS AND DISCUSSION

Quality parameters

The shelling (%), protein content, protein and oil yield recorded 3.9%, 13.3, 74.0 and 56.8% higher over the control, correspondingly during individual years as well as in pooled results with combined application of FYM @ 20 tonnes/ha + 100% RDF + *Azotobacter* spp. + *Pseudomonas striata* which was found at par with 100% RDF + *Azotobacter* spp. + *Pseudomonas striata*, FYM @ 10 tonnes/ha + 50% RDF + *Azotobacter* spp. + *Pseudomonas striata* and 100% RDF application only (Table 1). While oil content was not influenced significantly different treatments, because oil biosynthesis is a complex process. Hence it is always difficult to modulate its content in plant through management practices. Probable reason for increase in protein content, as the nitrogen is an integral part of protein and phosphorus is structural element of certain co-enzymes involved in protein synthesis. The increase in yield of protein and oil is mainly due to cumulative effect of pod yield. The similar results were also observed by Chawale *et al.* (1995)

Content and uptake of nutrients

Mean data of 2 years revealed that the N, P and K content and uptake were significantly increased by application of FYM @ 20 tonnes/ha +100% RDF + *Azotobacter*

Table 1. Effect of different treatments on quality parameters in groundnut

Treatment	Protein content (%)			Protein yield (kg/ha)			Oil content (%)			Oil yield (kg/ha)		
	1996	1997	Pooled	1996	1997	Pooled	1996	1997	Pooled	1996	1997	Pooled
T_1, Control	20.5	20.1	20.3	237	247	242	49.8	49.3	49.6	577	605	591
T_2, FYM @ 20 tonnes/ha	21.7	21.4	21.5	315	327	321	50.3	50.5	50.4	732	770	751
T_3, *Azotobacter* spp. + *Pseudomonas striata*	20.9	20.6	20.7	273	281	277	49.7	49.6	49.7	647	680	664
T_4, 50% N of RDF + *Pseudomonas striata*	20.8	20.7	20.8	279	288	284	49.8	49.8	49.8	669	680	680
T_5, 50% P_2O_5 of RDF + *Azotobacter* spp.	20.9	20.6	20.7	283	293	288	49.9	49.6	49.7	674	702	688
T_6, 50% RDF	21.1	20.9	21.0	308	322	315	49.9	49.8	49.8	727	760	744
T_7, 100% RDF	22.4	22.9	22.6	377	411	394	50.5	50.4	50.5	850	905	878
T_8, $T_3 + T_6$	21.4	21.3	21.4	329	354	342	50.3	49.9	50.1	775	829	802
T_9,T_6+10 tonnes FYM/ha	22.0	22.2	22.1	354	377	366	50.5	49.9	50.2	814	848	831
T_{10}, $T_3 + T_9$	22.0	22.3	22.1	367	393	380	50.7	50.6	50.7	847	894	871
T_{11}, $T_3 + T_7$	22.4	23.4	22.8	380	416	398	50.7	50.8	50.7	858	908	883
T_{12}, $T_2 + T_3 + T_7$	22.6	23.3	23.00	400	442	421	50.7	50.7	50.7	895	958	927
CD (P=0.05)	1.35	1.24	0.90	53.59	68.59	42.64	NS	NS	NS	116.0	137.2	81.8

spp. + *Pseudomonas striata* and remained at par with the application of 100% RDF + *Azotobacter* spp. + *Pseudomonas striata*, FYM @ 10 tonnes/ha + 50% RDF and only 100% RDF (Table 3). The combined application of chemical fertilizers along with enough bulk of FYM has always stimulated the uptake of N (Anandswarup *et al.* 1998) and partly because of stimulated microbes flush and improved root growth due to congenial soil physical condition created by addition of heavy bulk of FYM (Golakiya, 1988). Increase in uptake of nutrients might be the outcome of increased availability of nutrients to the plant by decomposition of applied FYM. Application of N-fixing biofertilizers enhances the soil N, and PSM produces the organic acids which may partly be responsible for quick release of nutrients, resulting in more content of nutrients. The increase in uptake of nutrients by groundnut crop appears to be due to cumulative effect of increased yield of pod and haulm. The results substantiated the findings of Chawale *et al.* (1995), Trivedi *et al.* (1995) and Ramesh *et al.* (1997) with combined application of chemical fertilizers with FYM and/or biofertilizers.

Residual soil nutrient status

Available N and P in soil after harvest of groundnut was increased significantly when crop received FYM @ 20 tonnes/ha + 100% RDF + *Azotobacter* spp. + *Pseudomonas striata* and remained statistically at par with the application of 100% RDF +

Table 2. Effect of different treatments on shelling, yield and economic of groundnut (mean data of 1996 and 1997

Treatment	Shelling (%)			Yield (kg/ha)			Net returns (Rs/ha)
	1996	1997	Pooled	Haulm	Pod	Gross	
T_1, Control	71.0	71.2	71.1	2,598	1,674	24,894	18,562
T_2, FYM @ 20 tonnes/ha	72.7	72.9	72.8	3,102	2,047	30,387	20,986
T_3, *Azotobacter* spp. + *Pseudomonas striata*	71.0	71.2	71.1	2,847	1,875	27,842	21,487
T_4, 50% N of RDF + *Pseudomonas striata*	71.9	71.6	71.7	2,894	1,905	28,276	21,802
T_5, 50% P_2O_5 of RDF + *Azotobacter* spp.	72.0	72.2	72.1	2905	1,918	28,472	21,783
T_6, 50% RDF	72.2	72.7	72.4	3,090	2,060	30,558	23,822
T_7, 100% RDF	73.4	73.9	73.6	3,391	2,362	34,974	27,906
T_8, $T_3 + T_6$	72.4	72.6	72.5	3,229	2,204	32,672	25,914
T_9, T_6+10 tonnes FYM/ha	73.0	73.9	73.4	3,270	2,253	33,366	24,987
T_{10}, $T_3 + T_9$	73.2	73.5	73.4	3,368	2,340	34,649	26,247
T_{11}, $T_3 + T_7$	73.6	73.8	73.7	3,409	2,363	34,990	27,900
T_{12}, $T_2 + T_3 + T_7$	73.9	73.9	73.9	3,547	2,472	36,603	26,444
CD (P=0.05)	NS	1.66	1.36	3,20.9	2,111	2,956	2,954

RDF, Recommended dose of fertilzer

Table 3. Nutrient content and uptake as well as nutrient status of soil as influenced by various treatments (mean data of 1996 and 1997)

Treatment	N		P		K		Available nutrients		
	Content (%)	Uptake (kg/ha)	Content (%)	Uptake (kg/ha)	Content (%)	Uptake (kg/ha)	N	P_2O_5	K_2O
T_1, Control	2.251	95.85	0.246	10.47	1.055	44.85	210.9	28.8	221.0
T_2, FYM @ 20 tonnes/ha	2.405	12..79	0.254	13.08	1.189	61.13	260.3	37.5	242.4
T_3, *Azotobacter* spp. + *Pseudomonas striata*	2.258	106.73	0.249	11.73	1.053	49.62	221.1	29.5	224.2
T_4, 50% N of RDF + *Pseudomonas striata*	2.268	108.71	0.251	12.03	1.060	50.91	225.8	30.1	224.2
T_5, 50% P_2O_5 of RDF + *Azotobacter* spp.	2.237	107.65	0.252	12.15	1.065	51.47	221.5	30.8	226.2
T_6, 50% RDF	2.433	125.73	0.263	13.53	1.211	62.46	243.1	34.0	236.5
T_7, 100% RDF	2.527	145.57	0.281	16.16	1.324	76.14	246.6	35.9	237.9
T_8, $T_3 + T_6$	2.435	132.54	0.265	14.41	1.212	65.80	245.9	35.1	237.1
T_9,T_6+10 tonnes FYM/ha	2.503	138.28	0.271	14.97	1.259	69.63	261.9	38.1	244.9
T_{10}, $T_3 + T_9$	2.510	143.29	0.273	15.59	1.265	72.05	264.6	38.8	246.4
T_{11}, $T_3 + T_7$	2.529	146.32	0.281	16.20	1.313	75.53	259.9	36.9	242.5
T_{12}, $T_2 + T_3 + T_7$	2.541	153.18	0.283	17.02	1.333	80.07	267.2	39.4	246.4
CD (P=0.05)	0.152	16.24	0.009	1.53	0.077	7.19	13.55	2.54	NS

biofertilizers, FYM @ 10 tonnes/ha + 50% RDF + biofertilizers, FYM @ 10 tonnes/ha +50% RDF and FYM @ 20 tonnes/ha (Table 3). The increase in available nitrogen and phosphorus was 26.7 and 36.8% over the control. Improvement in N and P_2O_5 status in soil after harvest of crop was due to addition of these nutrients through the application of FYM, chemical and biofertilizers. Besides, carbondioxide and organic acids released during the process of decomposition which increase the availability of nutrients from native as well as applied fertilizers. *Azotobacter* fixes the atmospheric nitrogen and phospho-bacteria solubilizes the fixed phosphate by secretion of organic acids and phosphate enzymes. These all might have contributed towards increased available status of soil. The results confirmed reports of Trivedi *et al.* (1995).

Yield and economics

Combined application of FYM @ 20 tonnes/ha + 100% RDF + *Azotobacter* spp. + *Pseudomonas striata* resulted in significantly highest pod and haulm yields being 47.7 and 36.5% higher over the control and remained comparable with the application of 100% RDF +*Azotobacter* spp. + *Pseudomonas striata*, FYM @ 10 tonnes/ha + 50% RDF + *Azotobacter* spp + *Pseudomonas striata* and 100% RDF in respect of pod and haulm yields. While haulm yield was also found statistically on a par with 50% RDF, 50% RDF + *Azotobacter* spp. + *Pseudomonas striata* and FYM @ 10 tonnes/ha + 50% RDF (Table 2). Groundnut yield is an output of sequential metamorphosis from store to sink. Partitioning of photosynthates in vegetative and reproductive parts goes simultaneously in the later growth phases. The combined effect of FYM, chemical and biofertlizers played very important role due to their synergistic effect. Application of FYM increased the supply of easily assimilated major as well as micronutrients to plants, besides mobilizing unavailable nutrients into available form. Moreover, biofertilizers also perform better when soil is well supplied with nutrients particularly nitrogen and phosphorus. The results confirm the findings of Ramesh *et al.* (1997).

The maximum gross returns were recorded with application of FYM @ 20 tonnes/ha + 100 RDF + *Azotobacter* spp. + *Pseudomonas striata*, however it did not differ statistically with the application of 100% RDF + *Azotobacter* spp. + *Pseudomonas striata*, 100% RDF and FYM @ 10 tonnes/ha + 50% RDF + *Azotobacter* spp. + *Pseudomonas striata* (Table 2). However, the highest net returns were recorded with the 100% RDF only which was statistically equal to the combine application of 100% RDF + *Azotobacter* spp. + *Pseudomonas striata*, FYM @ 20 tonnes/ha + 100% RDF + *Azotobacter* spp. + *Pseudomonas striata*, FYM @ 10 tonnes/ha + 50% RDF + *Azotobacter* spp. + *Pseudomonas striata* and FYM @ 10 tonnes/ha + 50% RDF.

REFERENCES

Anandswarup, A., Reddy, D. and Prasad, R.N. 1998. *Long-term Soil Fertility Management through Integrated Plant Nutrient Supply.* Bulletin, All-India Co-ordinated Research Project on Long-term Fertilizer Experiment, Indian Institute of Soil Science, Bhopal.

Chawale, V.V., Bharad, G.M., Kohle, S.K. and Nagdeve, M.B. 1995. Effect of N and FYM on

yield, quality and nitrogen uptake of summer groundnut under micro sprinkler irrigation. *Research Journal, Punjabrao Krishi Vidyapeeth* **19**(2) : 171–172.

DOES. 1998. *Agricultural Statistics at a Glance*. Directorate of Economics and Statistics, Department of Agriculture and Co-operation, Ministry of Agriculture, Government of India, New Delhi.

Golakiya, B.A. 1988. A system approach to resolve PX Zn antagonism in different soil water conditions. Ph. D. Thesis, Gujarat Agricultural University, Sardar Krushi nagar.

Ramesh, R., Shanthamullaiah, N.R., Jayadeva, H.H. and Hiremath, R.R. 1997. Growth and yield of irrigated groundnut as influenced by phosphorus, farmyard manure and phosphate solubilizing micro-organisms. *Current Research* **26**(1) : 196–198.

Trivedi, B.S. Bhatt, P.M., Patel, J.M. and Gami, R.C. 1995. Increased efficiency of fertilizer P through addition of organic amendment in groundnut. *Journal of Indian Society of Soil Science* **43**(4) : 627–629.