Indian Journal of Agronomy **47** (2) : 234—241 (June 2002)

Effect of organic manure, phosphorus and gypsum on groundnut (*Arachis hypogaea*) production under rainfed condition

S.S. RAO[1] AND M.S. SHAKTAWAT

Department of Agronomy, Rajasthan College of Agriculture, Rajasthan Agriculture University, Udaipur

Received: May 2001

ABSTRACT

A field experiment was conducted during 1997–99 to evolve the nutrient-management practice for high yield of groundnut (*Arachis hypogaea* L .) under rainfed condition. Application of farmyard manure (FYM) @ 10 tonnes/ha and poultry manure @ 5 tonnes/ha. Increased mature pods/plant, pod weight/plant, sound mature kernel (%) and 100- kernel weight as compared with the control. Pod yield of groundnut increased by a mean of 14.0 and 11.3% owing to FYM and poultry manure application respectively, over the control (16.2 q/ha). Phosphorus at 60 kg/ha significantly improved mature pods/ plant, pod weight/ plant, filled pods (%), sound mature kernel and 100-kernel weight over 20 kg P_2O_5/ha, and thereby pod yield of groundnut also. Significant improvement in yield attributes and pod yield was also noticed where gypsum was applied at 250 kg/ha either full at sowing or half at sowing or half at sowing + half at 35 DAS. Interaction effect of organic manure and gypsum treatments was significant. Maximum pod yield was obtained with application of FYM + gypsum in 2 splits. The economic optimum dose of phosphorus was computed under the application of FYM + gypsum in 2 splits as 54.0 kg P_2O_5/ha and at this level. 21.47 q/ha pod yield was predicted.

Key words : Organic manure, Phosphorus, Gypsum, Yield attributes, Yield

The low level of productivity of groundnut in India has been ascribed to several constraints. Soils low in organic matter content and poor in fertility status are considered to be the major problem. The ever-increasing cost of chemical fertilizers has made it to be realised once again that organic material will have to be utilized judiciously to maintain and improve the soil fertility and productivity. Groundnut being a legume-oilseed crop, its P, S and Ca requirement is quite high.

*A part of Ph. D. Thesis of first author submitted to RAU, Bikaner; in 2000

Present address : [1]Regional Research Station, CAZRI, Pali, Marwar, Rajasthan

Kanwar *et al.* (1983) reviewed the work done in India on the nutrient and fertilizer response of groundnut and concluded that with balanced use of fertilizer, groundnut production can be increased considerably. Hence an attempt was made to investigate the effect of organic manure, phosphorus and gypsum on yield of groundnut under rainfed condition.

MATERIALS AND METHODS

A field experiment was conducted at Rajasthan College of Agriculture, Udaipur, during 1997–99. The soil was sandy clay loam, with pH 7.6, low in available N (247.8 kg/ha), medium in available P (16.4 kg/ha) and K (278.9 kg/ha) content. The experiment was laid out in split-plot design with 4 replications. The combinations of 3 levels of organic manure (0 and 5 tonnes through poultry manure and 10 tonnes through FYM/ha) and 3 levels of P (20, 40 and 60 P_2O_5 kg/ha) were allotted to main plot. The 2 modes of gypsum application at 250 kg/ha, i.e. full at sowing (single) and half at sowing + half at 35 DAS (split) along with control (0 kg/ha) were placed in subplot.

The groundnut crop was raised rainfed and sowing was done with the onset of monsoon rains A seed rate of 100 kg kernel/ha of 'JL 24' was used at a spacing of 30 cm ×10 cm. The FYM and poultry manure were applied 15 days before sowing. Phosphorus was applied through diammonium phosphate (DAP) at sowing. Gypsum was applied in the crop-root zone at sowing and 35 days after sowing (DAS) on both sides of rows at 5 cm depth as per treatment. All the plots were uniformly fertilized with 24 kg N/ha at sowing by addition of urea, after compensating N supply through DAP. The plant samples at harvest were collected and analysed separately for haulm, kernel and shell for total uptake of N, P, K, S, Ca and Mg following the standard methods.

RESULTS AND DISCUSSION

Yield attributes

Farmyard manure @ 10 tonnes/ha and poultry manure @ 5 tonnes/ha increased the pods/plant, pod weight/plant, sound mature kernel % and 100-kernel weight compared with the control. Two organic manures proved equally effective (Table 1). Lourduraj *et al.* (1996) also reported similar results for 100-kernel weight and sound mature kernel (%). An increased rate of P application variably increased yield attributes of groundnut. The effect of P at 40 and 60 kg P_2O_5/ha being at par, significantly increased the pod weight/plant and 100-kernel weight over 20 kg P_2O_5/ha, while mature pods/plant, filled pods % and sound mature kernel % increased significantly only at 60 kg P_2O_5/ha (Table 1). Application of P fertilizers significantly increased the percentage of pegs that had pods at harvest (Enyi, 1977). Gypsum @ 250 kg/ha applied full at sowing or half at sowing + at 35 days after sowing (DAS) recorded significantly higher number of pods/plant, pod weight/plant, filled pods %, 100-kernel weight, sound mature kernel (%) and shelling % compared with the control. The difference between 2 modes of gypsum application was not significant (Table 1). Gypsum supplies S and Ca to the crops, Sulphur provides sink strength

Table 1. Effect of organic manure, phosphorus and gypsum on yield attributes of groundnut

Treatment	Pods/ plant		Pod weight/ plant (g)		Filled pods (%)		Kernels/ pod		Sound mature kernels		100-kernel weight (g)	
	1997	1998	1997	1998	1997	1998	1997	1998	1997	1998	1997	1998
Organic manure/ha												
Control	17.4	18.5	16.2	17.3	77.4	82.3	2.00	1.99	75.5	68.8	34.1	33.6
FYM 10 tonnes	18.5	20.4	18.8	19.2	79.5	82.5	2.09	2.04	79.6	74.5	35.9	35.8
PM 5 tonnes	18.6	20.5	17.9	18.7	79.4	83.4	2.03	2.03	81.5	78.0	35.7	36.0
CD (P=0.05)	0.98	0.86	0.92	0.91	NS	NS	NS	NS	3.93	3.79	1.16	1.46
Phosphorus (kg P_2O_5/ha)												
20	17.4	19.1	16.5	17.2	76.3	80.6	2.01	1.99	75.3	71.1	34.3	33.4
40	18.3	19.9	17.8	18.5	78.9	83.0	2.01	2.02	78.6	73.9	35.6	35.7
60	18.9	20.4	18.7	19.4	81.0	84.6	2.10	2.06	82.5	76.3	35.8	36.2
CD (P=0.05)	0.98	0.86	0.92	0.91	2.03	2.08	NS	NS	3.93	3.79	1.19	1.46
Gypsum (250 kg/ha)												
Control	17.4	19.0	16.5	17.2	76.9	79.6	1.99	2.00	74.2	70.6	34.1	34.1
Full at sowing	18.5	20.1	18.2	18.9	79.5	84.3	2.07	2.07	80.5	74.4	35.6	35.4
Half at sowing + half at 35 DAS	18.6	20.3	18.2	19.1	79.8	84.3	2.06	2.01	81.9	76.2	36.1	35.9
CD (P=0.05)	0.95	0.84	0.64	0.53	1.43	2.01	NS	NS	3.52	2.49	1.15	1.42

FYM, Farmyard manure; PM, poultry manure; DAS, days after sowing

through development of reproductive structure and production of assimilates to fill economically important sink. Calcium plays an important role in the reproductive development of groundnut. This is probably because in the absence of both xylem and phloem supply of Ca, the penetrating gynophores have modified themselves into absorbing organs of Ca from the immediate fruiting zone.

Pod and haulm yields

Application of organic manures significantly increased pod and haulm yields of groundnut. Pod yield of groundnut increased by a mean of 14.0 and 11.3 % owing to 10 tonnes FYM and 5 tonnes poultry manure/ha over the control respectively. Alike pod yield, haulm yield also increased significantly (Table 2). The significant increases in yield attributes under organic

Table 2. Effect of organic manure, phosphorus and gypsum on yield, harvest index and shelling (%) of groundnut

Treatment	Pods yield (q/ha)		Haulm yield (q/ha)		Harvest index (%)		Shelling (%)	
	1997	1998	1997	1998	1997	1998	1997	1998
Organic manure/ha								
Control	15.45	17.00	29.06	29.98	34.73	36.16	69.4	70.4
FYM 10 tonnes	17.82	19.17	31.79	32.56	35.84	36.97	71.2	71.4
PM 5 tonnes	17.21	18.89	31.55	32.51	35.29	36.76	71.3	71.7
CD (P=0.05)	0.995	1.117	1.779	1.589	NS	NS	NS	NS
Phosphorus (kg P_2O_5/ha)								
20	15.47	17.17	29.66	30.82	34.31	35.77	70.0	70.4
40	17.20	18.61	30.70	31.50	35.89	37.14	70.8	71.2
60	17.81	19.27	32.05	32.74	35.66	36.99	71.1	71.9
CD (P=0.05)	0.995	1.117	1.779	NS	NS	NS	NS	NS
Gypsum (250 kg/ha)								
Control	15.82	17.35	29.90	31.16	34.60	35.73	69.4	69.9
Full at sowing	17.39	18.77	31.23	31.95	35.75	36.99	70.9	71.7
Half at sowing + half at 35 DAS	17.26	18.94	31.28	31.95	35.51	37.17	71.6	71.9
CD (P=0.05)	0.729	0.748	1.033	NS	NS	1.133	1.35	1.35

FYM, Farmyard manure; PM, poultry manure; DAS, days after sowing

Table 3. Combined effect of organic manure and gypsum on pod yield of groundnut (q/ha)

Treatment	1997 Gypsum (250 kg/ha)			1998 Gypsum (250 kg/ha)		
	Control	Single	Split	Control	Single	Split
Organic manure/ha						
Control	14.67	16.10	15.57	15.94	17.51	17.54
FYM 10 tonnes	16.00	18.41	19.04	17.35	19.70	20.46
PM 5 tonnes	16.80	17.67	17.17	18.75	19.10	18.81
CD (P=0.05)		1.263			1.295	

manure application resulted in additional improvement in pod and haulm yields. Such a conducive effect of organic manure could be attributed to the supply of nutrients through mineralization and improvement of physico-chemical properties of the soil (Dosani *et al.*, 1999).

Application of P significantly increased pod yield of groundnut. The effect of 40 and 60 kg P_2O_5/ha, being at par, increased pod yield of groundnut significantly over 20 kg P_2O_5 representing mean increase of 9.7 and 13.6% respectively. However, haulm yield increased significantly only during 1997 with 60 kg P_2O_5/ha by 8.05% over 20 kg P_2O_5/ha (Table 2). The observed improvement in yield ascribed and yield under P application might be attributed to improved root environment. Phosphorus plays important role in formation of roots, their proliferation and improvement in their functional activity (Samanta *et al.*, 1993).

Gypsum application was found effective in boosting the yield of groundnut. Gypsum @ 250 kg/ha when applied either full at a sowing or in 2 splits increased mean pod yield of groundnut by 9.9 and 9.1 % over the control respectively (Table 2). The significant increase in yield attributes and yield observed owing to above treatments seem to have resulted on account of improvement in rhizosphere environment. Deva Kumar and Giri (1998) reported similar results. Its application significantly increased harvest index of groundnut during 1998. This is a further testimony to the fact that plant performance was improved not only in respect of photosynthetic capacity but the mobilization of photosynthesis for yield formation was also greatly favoured. A significant and positive correlation between pod yield and harvest index lends further support to the above fact (r=0.91**).

The significant improvement in pod yield of groundnut in our study seems to have accrued owing to improvement in various yield attributes of groundnut. As pod yield was positively correlated with number of mature pods/plant (r=0.86**), pod weight/plant (r=0.76**), The 100-kernel weight (r=0.86**) and sound mature kernel % (r=0.83**). To assess the yield dependence on yield components, partial regression equation was worked out on mean data. The regression equation is given below with $R^2 = 0.80$**.

$$Y = -25.789 + 0.641\ X_1 - 0.237\ X_2 + 0.550\ X_3 + 0.002\ X_4 - 0.0009\ X_5 + 0.234\ X_6$$

where X_2, X_3, X_4, X_5 and X_6 stand for mature pods/plant, weight of pods/plant, 100-kernel weight, filled pods % and SMK (%) respectively. Based on the testing of individual regression terms or jointly to group of recession terms, that gives significant contribution to the variation in the dependent variable is estimated. And the multiple regression equation that retained is written as $Y = -12.025 + 0.723\ X_1 + 0.450\ X_3$ with $R^2 = 0.79$ **, i.e. number of mature pods/plant and 100-kernel weight, were the most important variables having strong bearing with pod yield.

Interaction effect

Interaction effect of organic manure and gypsum treatments was significant for pod yield. Maximum pod yield was obtained with combined application of FYM + gypsum (splits), followed by FYM +

Table 4. Effect of organic manure, phosphorus and gypsum on total uptake of N, P, K, S, Ca and Mg by groundnut

Treatment	Nitrogen (kg/ha)		Phosphorus (kg/ha)		Potassium (kg/ha)		Sulphur (kg/ha)		Calcium (kg/ha)		Magnesium (kg/ha)	
	1997	1998	1997	1998	1997	1998	1997	1998	1997	1998	1997	1998
Organic manure/ha												
Control	93.3	101.0	14.3	15.3	54.8	60.7	11.5	12.8	44.0	44.4	23.9	30.5
FYM 10 tonnes	112.3	121.1	16.8	17.9	62.9	70.1	13.1	14.6	50.9	51.4	26.8	35.1
PM 5 tonnes	109.6	119.1	16.5	17.9	62.6	69.2	13.2	14.2	50.8	52.2	26.3	34.7
CD (P=0.05)	4.89	6.29	0.67	0.85	3.08	3.92	0.58	0.62	2.92	2.17	1.31	1.89
Phosphorus (kg P_2O_5/ha)												
20	95.9	103.9	14.5	15.7	56.1	62.6	11.8	13.1	45.5	46.2	24.6	31.2
40	106.3	115.7	16.1	17.2	60.4	66.3	12.8	13.9	48.6	49.1	25.6	33.7
60	112.9	121.5	17.1	18.2	63.5	71.1	13.5	14.5	51.6	52.7	26.6	35.5
CD (P=0.05)	4.89	6.29	0.97	0.85	3.08	3.92	0.58	0.62	2.92	2.17	1.31	1.89
Gypsum (250 kg/ha)												
Control	97.7	104.3	14.8	16.0	57.3	61.5	11.9	13.1	45.7	46.0	24.3	31.9
Full at sowing	108.7	117.2	16.4	17.4	61.2	68.8	13.1	14.2	49.9	50.4	26.2	34.2
Half at sowing + half at 35 DAS	108.8	119.8	16.4	17.7	61.8	69.7	13.2	14.3	50.2	51.6	26.4	34.3
CD (P=0.05)	3.26	3.91	0.49	0.62	1.66	2.91	0.38	0.49	1.75	1.90	0.91	1.39

FYM, Farmyard manure; PM, poultry manure; DAS, days after sowing

gypsum (single) and poultry manure + gypsum (single) (Table 3). Poultry manure contains higher Ca and S than FYM. It appears that the effect of gypsum, which is used mainly to supply S and Ca, was either not evident or masked by the stronger effect of poultry manure, In either case, the net effect of combined application of poultry manure + gypsum treatment would be tantamount to their sole effect. The overall effect of poultry manure was not better than of FYM in increasing pod yield of groundnut despite its higher nutrient content. This may be explained by the alkaline reaction of groundnut despite its higher nutrient content. This may be explained by the alkaline reaction of poultry manure and acidic reaction of FYM as well as differences in their release behaviour of nutrients in soil. Sims (1986) reported that addition of broiler litters (pH 8.5 to 8.9) raised the pH of loamy sand soil from 6.5 to 7.5 immediately after application, but the final pH after 20 weeks was about 5.5. The initial high pH could reduce micronutrient availability and finally more acidic pH caused phytotoxicity.

Nutrient uptake

Application of FYM @ 10 tonnes/ha and poultry manure @5 tonnes increased uptake of N, P, K, S, Ca and Mg significantly over the control (Table 4). The magnitude of increase in mean uptake of N, P, K, S, Ca and Mg due to FYM was 20.1, 17.2, 15.1, 13.9, 15.7 and 13.7 % over the control. The corresponding increase with poultry manure was 17.7, 16.6, 14.0, 12.9, 16.4 and 12.1 %. It appears that availability of these nutrients increased in soil under organic manure application as reflected by higher pod and haulm yields that have resulted

Table 5. Response of groundnut to phosphorus as influenced by application of organic manure and gypsum treatments

Treatment	Regression equation	R	Economic dose (x) (kg/ha)	Optimum yield (q/ha)	Response over 20 kg P_2O_5/ha (q/ha)	Net return over 20 kg P_2O_5/ha (Rs/Rs spent)
No organic manure						
No gypsum	Y = 1,326.50+5.087 x	0.79*				
Gupsum (single)	Y = 1,514.33+4.137 x	0.65*		Linear response		
Gypsum (split)	Y = 1,488.33+4.187 x	0.56*				
Farmyard manure (10 tonnes/ha)						
No gypsum	Y = 1,251.50+18.137 x - 0.166 x^2	0.78*	54.60	17.47	0.93	2.14
Gupsum (single)	Y = 1,280.00+24.887 x - 0.198 x^2	0.90**	62.79	20.62	4.07	5.88
Gypsum (split)	Y = 1,062.00+40.275 x - 0.374 x^2	0.93**	53.85	21.46	4.92	8.49
Poultry manure (5 tonnes/ha)						
No gypsum	Y = 1,270.50+22.087 x - 0.202 x^2	0.72*	54.64	18.74	1.73	4.00
Gupsum (single)	Y = 1,529.00+14.360 x - 0.142 x^2	0.61*	50.60	18.92	1.90	3.52
Gypsum (split)	Y = 1,479.50+14.737 x - 0.144 x^2	0.58*	51.06	18.56	1.53	3.95

into more uptake of these nutrients.

The increased rate of P application increased the uptake of macronutrients. The P at 60 kg P_2O_5/ha significantly increased uptake of N, P, K, S, Ca and Mg in plant at harvest. Application of gypsum either in single or split dose significantly increased the accumulation of N, P, K, S, Ca and Mg in the plants at harvest. This could be ascribed to their greater availability in root environment along with extraction and transportation towards plant system.

Response function

Further, owing to increased availability of P in soil with the application of organic manure, response of groundnut to phosphorus application rate was quadratic. However, without organic manure it was linear up to the highest level of P tested (Table 5). A dose of 54.0 kg P_2O_5/ha was computed as economic optimum under the application of FYM + gypsum (splits) which gave the highest net return over 20 kg P_2O_5/ha and at this level 21.47 q/ha pod yield was predicted.

REFERENCES

Devakumar, M. and Giri, G. 1998. Influence of weed control and doses and time of gypsum application on yield attributes, pod and oil yields of groundnut (*Arachis hypogaea*). *Indian Journal Agronomy* **43** (3) : 453–458.

Dosani, A.A.K., Talashilkar, S.C. and Mehta, V.B. 1999. Effect of poultry manure applied in combination with fertilizers on the yield, quality and nutrient uptake of groundnut. *Journal of Indian Society of Soil Science* **47** (1) : 166–169.

Enyi, B.A.C. 1977. Physiology of grain yield in groundnut (*Arachis hypogaea* L.). *Experimental Agriculture* **13** : 101–110.

Kanwar, J.S., Nijhawan, H.L. and Raheja, S.K. 1983, *Groundnut nutrition and fertilizer response in India.* Indian council of Agricultural Research, New Delhi.

Lourduraj, A.C., Geethalakshmi, V., Devsnapathy, P. and Nagarajan, P. 1996. Drought management in rainfed groundnut. *Madras Agriculture Journal* **83** (4) : 265–266.

Samanta, M., Bhardoria, P.B.S. and Ghosh, B. 1993. Effect of lime and phosphorus on phosphate availability and yield of groundnut (*Arachis hypogaea* L.) in oxisol. *Indian Journal of Agronomy* **39**(4) : 692–693.

Sims, J.T. 1986. Phosphorus fractionation, adsorption and description studies with heavily manured and fertilized atlantic coastal plain soils. *Agronomy Abstracts,* p. 172 (fide *Advances in Agronomy* **52**, 1994).