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Effect of FYM with and without phosphorus on groundnut (GG 20) and soil available phosphorus

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Abstract

The current study was carried out during the *Kharif* seasons as part of the Permanent Plot Experiment at the Main Oilseed Research Station, Junagadh Agricultural University, Junagadh. This experiment, initiated in 1986-87, aimed to evaluate the impact of FYM and phosphorus on groundnut yield, phosphorus content and uptake by groundnut and soil available phosphorus. A total of 15 treatments were evaluated: F0P0 involved control; F0P1 involved application of P₂O₅ during every year (20 kg ha⁻¹); F0P21 involved application of P₂O₅ at alternate two year starting from 1986 to 2024; F0P22 involved application of P₂O₅ at alternate two years starting from 1987 to 2025; F0P31 involved application of P₂O₅ at alternate three years starting from 1986 to 2025; F0P32 involved application of P₂O₅ at alternate three years starting from 1987 to 2023; F0P33 involved application of P₂O₅ at alternate three years starting from 1988 to 2024; F1P0 involved application of only FYM (10 t ha⁻¹); F1P1 involved application of FYM + P₂O₅ during every year (20 kg ha⁻¹); F1P21 involved application of FYM + P₂O₅ at alternate two years starting from 1986 to 2024; F1P22 involved application of FYM + P₂O₅ at alternate two years starting from 1987 to 2025; F1P31 involved application of FYM + P₂O₅ at alternate three years starting from 1986 to 2025; F1P32 involved application of FYM + P₂O₅ at alternate three years starting from 1987 to 2023; F1P33 involved application of FYM + P₂O₅ at alternate three years starting from 1988 to 2024; F0P4 involved application of 10 kg P₂O₅ ha⁻¹ during every year. The findings indicated that the highest haulm yield (3964.89 kg ha⁻¹), phosphorus content in groundnut pod (0.344%) and haulm (0.179%), phosphorus uptake by groundnut pod (7.59 kg ha⁻¹) and haulm (7.04 kg ha⁻¹), soil available phosphorus (55.97 kg ha⁻¹) as well as highest gross returns (146152 Rs ha⁻¹) and net returns (77257 Rs ha⁻¹) along with B:C ratio 2.12 were recorded with application of FYM 10 t ha⁻¹ along with application of phosphorus 20 kg ha⁻¹.

Keywords: FYM, phosphorus fertilizer, groundnut and soil available phosphorus

Introduction

Phosphorus (P) is crucial to life and is an essential major nutrient for plant growth because of its role in increasing yield and improving crop quality. The crop recovery of added P ranges from 10 to 40% and the remainder may accumulate in soil as less soluble and more stable products. Excessive accumulation of residual P in soil may enhance downward movement of P which may eventually reach groundwater. Some residual P in soil may be utilized by succeeding crops and this is influenced by such factors as duration of P contact with soil, prevailing temperature, organic matter content, incorporation of crop residues and nature of fertilizer. Tropical regions have shown that continuous cropping with varied applications of N, P and K fertilizers result in a wide range of soil P values. Information on changes in available P, utilization of P by crops, and crop responses to build-up of P are useful for predicting long-term P dynamics. However, very few long-term P management studies are available from the subtropics. Because of the inherently low P status of these soils, phosphatic fertilizers are regularly applied to field crops to maintain productivity. In addition, there is very little published information on the relationships between long-term applications of P and soil accumulation or depletion from cropping. It is one of the major nutrient elements, which limits the crop growth and it has been the subject of continuous research because of its complex nature as soil P dynamics are characterized by physicochemical (sorption-desorption) and biological processes (immobilization-mineralization). Different soluble sources of P such as manures and fertilizers when added to the soil readily changed into unavailable forms and in time react further to become highly insoluble

soil P fractions and give an idea about the P supplying capacity to plants. To improve the efficiency of P application, to sustain crop productivity, restore soil health and also to meet a part of chemical fertilizer requirement, it is imperative to maximize the recycling of P from crop residues and organic and mineral fertilizers. Integrated use of organic manures and phosphatic fertilizers result in not only improved efficiency of the later but also significantly increase the availability of P. long-term application of fertilizers and manures and its role in mobility and subsequent availability to crop which effects the yield of groundnut.

Materials and Methods

Experimental details

The experiment was carried out at Main Oilseed Research Station, Junagadh Agricultural University, Junagadh from *Kharif* 1986-87. Crop and variety was groundnut (GG-20). The experimental design was factorial randomized block design (FRBD) involving 15 treatments and 4 replication. Net plot size for groundnut was 5.00 m X 2.40 m, with spacing 60 x 10 cm.

The treatment details are given below

F0P0 involved control; F0P1 involved application of P₂O₅ during every year (20 kg ha⁻¹); F0P21 involved application of P₂O₅ at alternate two year starting from 1986, 88, 90, 92, 94, 96, 98, 2000, 02, 04, 06, 08, 10, 12, 14, 16, 18, 20, 22 and 2024; F0P22 involved application of P₂O₅ at alternate two years starting from 1987, 89, 91, 93, 95, 97, 99, 01, 03, 05, 07, 09, 11, 13, 15, 17, 19, 21, 23, and 2025; F0P31 involved application of P₂O₅ at alternate three years starting from 1986, 89, 92, 95, 98, 01, 04, 07, 10, 13, 16, 19, 22 and 2025; F0P32 involved application of P₂O₅ at alternate three years starting from 1987, 90, 93, 96, 99, 02, 05, 08, 11, 14, 17, 20 and 23; F0P33 involved application of P₂O₅ at alternate three years starting from 1988, 91, 94, 97, 2000, 03, 06, 09, 12, 15, 18, 21 and 2024; F1P0 involved application of only FYM (10 t ha⁻¹); F1P1 involved application of FYM + P₂O₅ during every year (20 kg ha⁻¹); F1P21 involved application of FYM + P₂O₅ at alternate two years starting from 1986, 88, 90, 92, 94, 96, 98, 2000, 02, 04, 06, 08, 10, 12, 14, 16, 18, 20, 22 and 2024; F1P22 involved application of FYM + P₂O₅ at alternate two years starting from 1987, 89, 91, 93, 95, 97, 99, 01, 03, 05, 07, 09, 11, 13, 15, 17, 19, 21, 23 and 2025; F1P31 involved application of FYM + P₂O₅ at alternate three years starting from 1986, 89, 92, 95, 98, 01, 04, 07, 10, 13, 16, 19, 22 and 2025; F1P32 involved application of FYM + P₂O₅ at alternate three years starting from 1987, 90, 93, 96, 99, 02, 05, 08, 11, 14, 17, 20, 23; F1P33 involved application of FYM + P₂O₅ at alternate three years starting from 1988, 91, 94, 97, 2000, 03, 06, 09, 12, 15, 18, 21 and 2024; F0P4 involved application of 10 kg P₂O₅ ha⁻¹ during every year.

Collection and preparation of soil sample for analysis

In the experiments, groundnut crop was grown every year in *kharif* season. The soil samples were collected during the harvest of groundnut for analysis. These samples were then ground using a wooden mortar and pestle and passed through a 2 mm sieve to obtain uniform particles. The soil available phosphorus was determined using Olsen's method as described by Jackson (1979) [3]. The chemical studies carried out by taking representative samples of plant and seed from each net plot in all the replications at harvest. All samples were powdered by mechanical mill grinder. Finally, the powdered samples were utilized for estimation phosphorus. The known quantities of

powdered samples were digested in a diacid mixture as per method described by Johnson and Ulrich (1969) [5]. This acid extract was used for the determination of phosphorus. The phosphorus determined by vanadomolybdo phosphoric yellow colour method as described by Jackson (1979) [3]. The collected data were subjected to statistical analysis using the analysis of variance (ANOVA) technique appropriate for a randomized block design (FRBD), as recommended by Panse and Sukhatme (1978) [7].

Results and Discussion

Groundnut pod and haulm yield: The pooled result of 23 years presented in Table 1 showed that significantly higher haulm yield (3964.89 kg ha⁻¹) with treatment F1P1, which was remain at par with treatments F1P0, F1P21, F1P22, F1P31, F1P32 and F1P33. The interaction of FYM and phosphorus were found significant with respect to pod yield and haulm yield in the pooled results. This may be due to adequate supply of P₂O₅ and FYM that played a vital role in physiological and developmental processes in plant life and the favourable effect of these important nutrients might have accelerated the growth processes that in result increased haulm yield of the crop. This finding were supported by Singh *et al*, (2010) [8] who showed that applications of 5 t FYM and 20 kg P₂O₅ ha⁻¹ are essential for obtaining high grain yields as well as net returns of kabuli chickpea. Amruth *et al*, (2017) [2] recorded significant higher pod yield and haulm yield of the groundnut with the treatment T₆ with application 75% of 30 kg P₂O₅ ha⁻¹ through chemical fertilizer + 25% through FYM along with PSB. Jishnu *et al*, (2025) [4] indicated that application of FYM 15 t ha⁻¹ along with Phosphorus 40 kg ha⁻¹ had significantly higher seed yield (2.50 t ha⁻¹), and straw yield (4.32 t ha⁻¹) of chickpea.

Pod and haulm P content: The pooled result of 23 years presented in Table 2 showed that significantly higher pod P content (0.344%) obtained with treatment F1P1, which was remain at par with treatments F0P1, F0P21, F0P22, F1P0, F1P21, F1P22, F1P31, F1P32 and F1P33, whereas significantly higher haulm P content (0.179%) obtained with treatment F1P1, which was remain at par with treatments F0P1, F1P0, F1P21, F1P22, F1P31, F1P32 and F1P33. The interaction of FYM and phosphorus were found significant with respect to pod P content and haulm P content in the pooled results. It was due to decomposition of FYM releases organic acids that lower soil pH, helping to mobilize otherwise immobile nutrients like phosphorus and micronutrients in alkaline soils. Phosphorus application promotes lateral and fibrous root development, which increases the surface area for water and nutrient absorption. Sutaria *et al*, (2010) [9] reported the content of N, P and K in pod and haulm of groundnut were increased with application of FYM 10 t ha⁻¹ and phosphorus 20 kg P₂O₅ ha⁻¹.

Pod and haulm P uptake: The pooled result of 23 years presented in Table 3 showed that significantly higher pod P uptake (7.59 kg ha⁻¹) obtained with treatment F1P1, which was remain at par with treatments F1P21, F1P22, F1P31, F1P32 and F1P33, whereas significantly higher haulm P uptake (7.04 kg ha⁻¹) obtained with treatment F1P1, which was remain at par with treatments F1P21, F1P22, and F1P32. The interaction of FYM and phosphorus were found significant with respect to pod P uptake and haulm P uptake in the pooled results. The favourable effect of FYM on P uptake may be attributed to the greater availability of P to plants in presence of organic manure and to its solubilizing effect on fixed form of P in soil. The results of

Sutaria *et al.*, (2010) ^[9] revealed that the uptake of N, P and K in pod and haulm of groundnut were increased due to application of FYM and phosphorus. Naik *et al.*, (2025) ^[6] indicated that higher nutrient uptake viz., N (99.60 kg ha⁻¹), P₂O₅ (16.68 kg ha⁻¹) and K₂O (58.86 kg ha⁻¹) were recorded in application of 40 kg ha⁻¹ of P+DGRC culture.

Soil available phosphorus: The pooled result of 23 years presented in Table 4 showed that significantly higher soil available P (55.97 kg ha⁻¹) with treatment F1P1. The interaction of FYM and phosphorus were found significant with respect to soil available phosphorus in the pooled results. This increase in available P content of soil could possibly be due to beneficial role of FYM in arresting P fixation in to insoluble form and keeping it in available form for extended period in addition to its own P content. This finding was supported by Aftab *et al.*, (2023) ^[1] who concluded that the combination of FYM at the rate of 10 t ha⁻¹ and fertilizer P at 26 kg ha⁻¹ modestly increased post harvest available P over the control, with a general increase as the P rate increased.

Economics: Economics were work out on basis of current markets price input used and selling price of produce. the pooled results presents in table 5, showed that the highest gross returns (146152 Rs ha⁻¹) and net returns (77257 Rs ha⁻¹) was recorded with treatment T₉ (F1P1:10 t FYM ha⁻¹ + 20 kg P₂O₅ ha⁻¹ every year) along with B:C ratio 2.12. Naik *et al.*, (2025) ^[6] indicated that there was a significant response of pod yield (2457 kg ha⁻¹) and higher economics like gross return (Rs. 1,15,138 ha⁻¹), net return (Rs. 73,115 ha⁻¹) and B:C ratio (2.76) were also profitable with the application of 40 kg ha⁻¹ of P + DGRC culture as compared to other treatments. Jishnu *et al.*, (2025) ^[4] indicated that application of FYM 15 t ha⁻¹ along with Phosphorus 40 kg ha⁻¹ had significantly higher gross return, net return, and benefit cost ratio for chickpeas.

Table 2: Effect of different treatments on phosphorus content in the groundnut pod and haulm in 23 years pooled (2001 to 2023)

Sr. No	Treatments	P content pod (%)	P content haulm (%)
1	F0P0	0.271	0.134
2	F0P1	0.325	0.166
3	F0P21	0.319	0.156
4	F0P22	0.318	0.158
5	F0P31	0.309	0.151
6	F0P32	0.301	0.151
7	F0P33	0.303	0.151
8	F1P0	0.317	0.164
9	F1P1	0.344	0.179
10	F1P21	0.331	0.171
11	F1P22	0.343	0.174
12	F1P31	0.334	0.167
13	F1P32	0.333	0.168
14	F1P33	0.326	0.166
15	F0P4	0.293	0.151
Treatment			
S.Em. ±		0.003	0.002
C.D. at 5%		0.009	0.004
C.V.%		9.561	9.283
Year			
S.Em. ±		0.003	0.002
C.D. at 5%		0.008	0.005
C.V.%		6.977	8.701
Year x T			
S.Em. ±		0.011	0.007
C.D. at 5%		0.031	0.019

Table 3: Effect of different treatments on phosphorus uptake by the groundnut pod and haulm in 23 years pooled (2001 to 2023)

Sr. No	Treatments	P uptake pod (kg ha ⁻¹)	P uptake haulm (kg ha ⁻¹)
1	F0P0	4.40	3.96
2	F0P1	6.01	5.49
3	F0P21	5.91	5.06
4	F0P22	5.65	5.10
5	F0P31	5.69	4.72
6	F0P32	5.43	4.77
7	F0P33	5.43	4.92
8	F1P0	6.06	5.66
9	F1P1	7.59	7.04
10	F1P21	6.98	6.24
11	F1P22	7.14	6.49
12	F1P31	6.78	5.90
13	F1P32	6.63	6.11
14	F1P33	6.44	5.91
15	F0P4	4.81	4.62
Treatment			
S.Em. ±		0.10	0.07
C.D. at 5%		0.29	0.21
C.V.%		15.88	12.89
Year			
S.Em. ±		0.12	0.10
C.D. at 5%		0.34	0.27
C.V.%		15.59	13.70
Year x T			
S.Em. ±		0.47	0.37
C.D. at 5%		1.31	1.04

Table 1: Effect of different treatments on pod and haulm yield of the groundnut in 23 years pooled (2001 to 2023)

Sr. No	Treatments	Pod yield (kg ha ⁻¹)	Haulm yield (kg ha ⁻¹)
1	F0P0	1604.89	3003.99
2	F0P1	1851.08	3353.51
3	F0P21	1814.26	3179.45
4	F0P22	1761.72	3286.77
5	F0P31	1830.22	3151.45
6	F0P32	1763.18	3191.78
7	F0P33	1792.38	3302.00
8	F1P0	1906.15	3515.01
9	F1P1	2163.30	3964.89
10	F1P21	2054.77	3721.90
11	F1P22	2067.80	3768.48
12	F1P31	1996.53	3581.91
13	F1P32	1928.12	3696.41
14	F1P33	1954.35	3601.02
15	F0P4	1631.55	3122.86
Treatment			
S.Em. ±		32.13	43.68
C.D. at 5%		91.71	124.65
C.V.%		16.44	12.22
Year			
S.Em. ±		40.34	54.94
C.D. at 5%		111.96	152.46
C.V.%		16.67	12.41
Year x T			
S.Em. ±		156.25	212.77
C.D. at 5%		NS	590.49

Table 4: Effect of different treatments on soil available phosphorus in 23 years pooled (2001 to 2023)

Sr. No	Treatments	Soil Av. P2O5 (kg ha ⁻¹)
1	F0P0	25.62
2	F0P1	39.23
3	F0P21	35.76
4	F0P22	35.07
5	F0P31	33.37
6	F0P32	33.64
7	F0P33	34.52
8	F1P0	43.58
9	F1P1	55.97
10	F1P21	51.01
11	F1P22	49.37
12	F1P31	46.45
13	F1P32	45.78
14	F1P33	45.41
15	F0P4	38.52
Treatment		
S.Em. ±		0.39
C.D. at 5%		1.12
C.V.%		9.22
Year		
S.Em. ±		0.36
C.D. at 5%		1.00
C.V.%		6.80
Year x T		
S.Em. ±		1.39
C.D. at 5%		3.86

Table 5: Economics of different treatments

Treatments	Pod yield (kg ha ⁻¹)	Haulm yield (kg ha ⁻¹)	Gross returns (Rs ha ⁻¹)	Cost of cultivation (Rs ha ⁻¹)	Net returns (Rs ha ⁻¹)	B:C
1 F0P0	1670	3143	115887	55000	60887	2.11
2 F0P1	1854	3470	128588	56395	72193	2.28
3 F0P21	1835	3425	127251	55698	71554	2.28
4 F0P22	1812	3389	125690	55698	69992	2.26
5 F0P31	1845	3321	127294	55465	71829	2.30
6 F0P32	1790	3401	124391	55465	68926	2.24
7 F0P33	1824	3404	126437	55465	70972	2.28
8 F1P0	1929	3608	133785	67500	66285	1.98
9 F1P1	2109	3923	146152	68895	77257	2.12
10 F1P21	2045	3809	141770	68198	73573	2.08
11 F1P22	2043	3820	141681	68198	73483	2.08
12 F1P31	1974	3740	137156	67965	69191	2.02
13 F1P32	1950	3818	136094	67965	68129	2.00
14 F1P33	2006	3682	138774	67965	70809	2.04
15 F0P4	1658	3237	115646	55698	59948	2.08

Conclusion

It was concluded that application of farmyard manure 10 t ha⁻¹ along with application of phosphorus 20 kg ha⁻¹ produced higher yield, increased phosphorus content and uptake by groundnut, soil available phosphorus as well as economic also.

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