

Effects of phosphorus application on bunch and spreading genotypes of groundnut



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Summary

Farm of Afghanistan National Agricultural Sciences and Technology University (ANASTU), Kandahar, Afghanistan to find out most suitable groundnut variety and their phosphorus levels in the study region. The treatments combination was of two groundnut varieties (Kormaki and Paparri) and four levels of phosphorus as P_2O_5 ($P_0= 0 \text{ kg } P_2O_5 \text{ ha}^{-1}$, $P_1=40 \text{ kg } P_2O_5 \text{ ha}^{-1}$, $P_2= 60 \text{ kg } P_2O_5 \text{ ha}^{-1}$ and $P_3= 80 \text{ kg } P_2O_5 \text{ ha}^{-1}$), were tested in a split plot design. Result revealed that Paparri variety produced significantly higher growth attributes (plant height, dry matter accumulation and number of main branches plant⁻¹) and yield attributes (number of pods plant⁻¹, pods dry weight plant⁻¹, 100 kernel weight and shelling percentage) over Kormaki variety. Likewise, paparri variety produced significantly higher pods yield, kernel yield, haulm yield and biological yield over kormaki variety. In the like manner, significantly higher gross return, net return and benefit cost ratio was recorded from Paparri variety, whereas residual nitrogen was found significantly higher in kormaki variety. Among phosphorus levels, 60 kg $P_2O_5 \text{ ha}^{-1}$ recorded higher values for growth parameters, yield attributes viz. number of pods plant⁻¹, pods weight plant⁻¹, 100 kernel weight and shelling percentage, and yields (including pods yield, kernel yield, haulm yield and biological yield).

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Keywords: Groundnut; Phosphorous; Kormaki variety; Nutrient management; Paparri variety

INTRODUCTION

Legumes are important crops in human nutrition, since these are rich source of protein, certain minerals and vitamins.¹⁸ Groundnut (*Arachis hypogaea* L) is a crucial legume oilseed crop, and is also known as peanut, earth nut, monkey nut and goober. Locally it is called *Pali* and *Mumpali* in Pashto and *Badam-e-zamini* in Dari language. It is thirteenth most important crop of the world, fourth important source of vegetable oil and third important source of vegetable protein (Choudhary et al. 2015). Groundnut seed contains nearly 50% high quality edible oil, 25% digestible protein and 20% carbohydrates (Choudhary et al. 2015).²⁶ The crop contain valuable source of E, K and B vitamin (it is the richest plant source of thiamin, B1). The groundnut protein consists of two type's proteins, namely, arachin and conarachin.²⁶ Amino

Acid analysis shown that the main amino acid was glutamic acid (22-27) %, arginine (11-13%), aspartic acid (8-13%).¹⁵

Groundnut is cultivated worldwide in tropical, sub-tropical and warm temperature regions between 40° N and 40° S latitude. The global area under groundnut cultivation is 31.57 million hectare with total product 53.64 million tones, the average production is 1.691 ton ha⁻¹.¹⁶ Declining soil fertility due to continuous land cultivation with little fertilizers inputs is a major threat to crop production.⁸ Phosphorus deficiency has been implicated as possible cause of the low yield problem in legumes, including groundnut.¹⁷ Phosphorus is an important nutrient for legumes in particular, It is a key constituent of adenosine triphosphate (ATP) in plants and also plays various roles in seed formation.²⁵ A recent study indicate that 49.3% of cultivated land is deficient in available phosphorous, phosphorous deficiency is coming in different soil type as only 1-3% of total phosphorous available for plant nutrition, phosphorous deficiency can reduce nodule formation, leaf area, biomass and grain development in legumes.^{17, 20, 32}

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Moreover, Phosphorus deficiency is the most frequent nutrient stress for growth and development of grain legumes including groundnut.^{17, 25} The deficiency of P supply and availability remains a severe limitation to nitrogen fixation and symbiotic interactions, as nodules themselves are strong sinks for P.⁶ The absence of the required *Rhizobia* species and optimal phosphorus level can limit legume production.²⁸

Biological nitrogen fixation is becoming more attractive and economically viable nitrogen input, substitute of inorganic fertilizers for resource poor farmers, and is an environmentally friendly agricultural input (Choudhary et al. 2015).²⁸ Although, there is generally an inter and intra-specific variation in the amount of N₂ fixed by legumes due to several reasons including nodulation efficiencies, genotype and maturity period, etc. The ability of legumes to fix N₂ allows farmers to grow them with minimal inputs of N fertilizer.²⁹ Groundnut offers an opportunity to increase the supply of N from symbiotic association with effective strains of *Rhizobia*. Nitrogen fixation in groundnut is about 150-250 kg N/ha which offers strong residual benefits to following crops (Choudhary et al. 2015). Groundnut is being grown on a large scale in Afghanistan and phosphorus is a major nutrient deficient in most soil of the country, but still research on this crop and P level not has been reported. So, the present study was therefore undertaken to determine the response of two groundnut genotypes to phosphorus levels and their

effect on economic yield, biological yield and soil residual nitrogen.

Result and Discussion

Mean data illustrated that the application of different levels of phosphorus shown significant effects for growth parameters (plant height, leaf area index and plant dry matter accumulation) (Table 1). Application of 60 kg P₂O₅ ha⁻¹ resulted in significantly higher plant height, leaf area index at 90 DAS and plant dry matter accumulation as compared to control. However, the phosphorus levels failed to affect number of main branches plant⁻¹ significantly, but application of 60 kg P₂O₅ ha⁻¹ produced slightly higher main branches plant⁻¹. Among the two varieties, Paparri variety (spreading type) resulted in significantly higher plant height, plant dry matter accumulation and number of main branches plant⁻¹. There were no significant differences for leaf area index among both varieties. Maximization in plant growth might have been due to phosphorus that initiates root development and growth in the seedling stage and thereby it contributes to establish the seedling rapidly.^{11, 17, 2} Better nutrition ultimately leads to luxurious root growth to extract nutrients and moisture more efficiency from deeper soil layer resulting better growth and development of plants, more leaf area and greater dry matter accumulation.^{12, 3, 21}

Table 1: Effect of different phosphorus levels on growth of groundnut varieties

Treatment	Plant height (cm)	Plant dry weight (g plant ⁻¹)	Number of main branches plant ⁻¹	Leaf area index at 90 DAS
Varieties				
Kormaki-V ₁	29.5	17.8	4.2	2.4
Paparri-V ₂	29.9	26.6	4.9	2.6
CD (P≤0.05)	NS*	1.6	0.34	NS*
Phosphorus doses				
P ₀	29.3	20.2	4	2.1
P ₄₀	29.3	21.7	4.5	2.3
P ₆₀	30.1	24	4.7	3.1
P ₈₀	30.1	22.9	4.7	2.6
CD (P≤0.05)	NS*	0.9	NS*	0.5
Interaction (V×P)				
CD (P≤0.05)	NS*	NS*	NS*	NS*

*NS= Non-significant

Mean data from the experimental plots expressed significant improvement in yield attributes and yield with P application as compared to control (Table 2 and Table 4). Application of 60 kg P₂O₅ ha⁻¹ significantly increased yield attributes (number of pods plant⁻¹, pods weight

plant⁻¹, 100 kernel weight and shelling percentage) as well as pods yield, kernel yield, haulm yield and biological yield. Among the two varieties, Paparri variety (spreading type) recorded significantly higher yield attributes (pods plant⁻¹, pods weight plant⁻¹ and 100 kernel weight) and

yield (pods yield, kernel yield, haulm yield and biological yield). This result is closely related with finding of Meena et al. 2014; Sepat et al. 2019; Bana et al. 2022a and Ankit et al. 2022.^{22, 30, 9, 1} Interaction effect of variety and phosphorus levels was found significant with respect to

shelling percent and 100-kernel weight (Table 3). In Kormaki variety maximum 100-kernel weight was recorded with 60 kg P₂O₅ ha⁻¹, whereas, greatest 100-kernel weight of Paparri variety was found with 80 kg P₂O₅ ha⁻¹.

Table 2: Effect of different phosphorus levels on yield attributes of groundnut varieties

Treatment	Number of pods plant ⁻¹	Pods weight plant ⁻¹	100 kernel weight (g)	Shelling percentage
Varieties				
Kormaki-V ₁	14.1	9.6	42.2	71.2
Paparri-V ₂	20.9	44.7	77.1	69.4
CD (P≤0.05)	6.4	6.6	8.0	0.8
Phosphorus doses				
P ₀	16.1	24.4	56.9	68.6
P ₄₀	16.9	27.3	59.2	69.6
P ₆₀	19.0	29.2	61.3	72.2
P ₈₀	17.9	27.6	61.1	70.1
CD (P≤0.05)	1.13	1.6	0.6	0.9
Interaction (V×P)				
CD (P≤0.05)	NS*	NS*	S [#]	S [#]

*= Non-significant; #=Significant

The increase in seed yield with increased phosphorus levels resulted in higher number of branches having pods, total pods of a single plant, weight of hundred seeds and biological yield which was due to maximization of photosynthesis, respiration, energy storage, transfer, cell division and cell elongation which come out in enhancement in seed production (Choudhary et al.

2021).^{17, 27} The highest increase in biological yield was obtained under 60 kg P₂O₅ ha⁻¹ treatment. Probable reason of such results may be increased seed germination, early growth, root development and also increased responses to nutrient fertilizer application that is why biological yield was increased.^{10, 4}

Table 3: Interaction effect of groundnut varieties and phosphorus levels on yield attributes

Varieties	100 kernel weight (g)				Shelling percentage (%)			
	Phosphorus doses kg ha ⁻¹				Phosphorus doses kg ha ⁻¹			
	P0	P40	P60	P80	P0	P40	P60	P80
Kormaki-V ₁	39.2	42.1	44.4	42.9	69.2	70.1	74.3	71.4
Paparri-V ₂	74.5	76.4	78.3	79.3	68.1	69.2	70.3	70.1
P at the same level of V	1.7				1.4			
V at the same level of P	8.0				1.3			

It revealed from data that the varieties and P levels significantly affected soil residual nitrogen (Table 4). Significantly higher residual nitrogen was recorded from Kormaki variety (102.7 kg ha⁻¹). Among the P levels, application of 60 kg P₂O₅ ha⁻¹ resulted in higher residual nitrogen (100.5 kg ha⁻¹). The result from Table 4 illustrated that the interaction effect of variety and P level on residual nitrogen was significant, the variety Kormaki

in 40 kg P₂O₅ ha⁻¹ recorded significantly higher residual nitrogen (120.2 kg ha⁻¹) over all other treatment combination, the variety Paparri in 80 kg P₂O₅ ha⁻¹ resulted the lowest residual nitrogen (94.8 kg ha⁻¹). The result was in similar pattern with those reported by Meena et al. 2013; Kumar et al. 2015; Bamboriya et al. 2017b; and Shirzad et al. 2020.^{23, 19, 5, 31}

Table 4: Effect of different phosphorus levels on yield of groundnut varieties and residual nitrogen in soil

Treatment	Pods yield (t ha ⁻¹)	kernel yield (t ha ⁻¹)	Haulm yield (t ha ⁻¹)	Biological yield (t ha ⁻¹)	Harvest index (%)	Residual nitrogen (kg ha ⁻¹)
Varieties						
Kormaki-V ₁	1.8	1.3	3.9	5.8	31.7	102.7
Paparri-V ₂	3.5	2.5	5.9	9.4	36.7	80.6
SEm±	0.3	0.27	0.05	0.37	2.3	0.9
CD (P≤0.05)	1.1	0.7	0.35	2.4	NS	5.7
Phosphorus doses						
P ₀	2.1	1.4	4.5	6.6	31.4	51.3
P ₄₀	2.6	1.7	4.8	7.4	34.0	83.4
P ₆₀	3.1	2.3	5.3	8.4	36.1	100.5
P ₈₀	2.9	2.1	5.1	8.0	35.2	96.3
SEm±	0.17	0.1	0.06	0.18	1.13	1.1
CD (P=0.05)	0.5	0.3	0.3	0.56	NS	3.4
Interaction (V×P)						
CD (P=0.05)	NS*	NS*	NS*	NS*	NS*	S#

*= Non-significant; #=Significant

Data expressed in Table 5 exhibiting that the P application significantly influenced gross return, net return and benefit cost ratio. Significantly higher gross return (299,179 AFG ha⁻¹) was obtained with application of 60 kg P₂O₅ ha⁻¹ over control. Likewise, significantly higher net return and benefit: cost ratio was also recorded from 60 kg P₂O₅ ha⁻¹ (232,750 AFG ha⁻¹; and 3.5 respectively). Among the two varieties Paparri variety

(spreading type) recorded significantly higher gross return (339,591 AFG ha⁻¹), net return (273,162 AFG ha⁻¹) and benefit cost ratio (4.1) as compared to Kormaki variety (bunch type) (187,252 AFG ha⁻¹), (120,823 AFG ha⁻¹) and 1.8 respectively. The interaction effect among the P levels and varieties found to be non-significant, the result found in a close agreement those reported by.^{7, 22, 20, 24}

Table 5: Effect of different phosphorus levels on economics of groundnut cultivation

Treatment	Gross return (AFG ha ⁻¹)	Net return (AFG ha ⁻¹)	Benefit: cost ratio
Varieties			
Kormaki-V ₁	187,252	120,823	1.8
Paparri-V ₂	339,591	273,162	4.1
CD (P≤0.05)	25708	25708	2.1
Phosphorus doses			
P ₀	211,714	145,285	2.2
P ₄₀	258,622	192,193	2.9
P ₆₀	299,179	232,750	3.5
P ₈₀	284,171	217,742	3.3
CD (P=0.05)	43,058	43,058	0.6
Interaction (V×P)			
CD (P=0.05)	NS*	NS*	NS*

*=Non-significant

Conclusion

It can be concluded from the result that application of 60 kg P₂O₅ ha⁻¹ resulted in significantly higher growth attributes, yield attributes, yield and economics in groundnut. Among the two varieties Paparri variety recorded significantly higher growth attributes, yield

attributes, yield and economic returns. Interaction effects showed that Paparri variety with application of 60 kg P₂O₅ ha⁻¹ showed significant effects for all recorded observations. Therefore, for Afghanistan conditions above findings may be taken to the level of recommendation in groundnut cultivation regions. For future research, interaction of phosphorus with other

nutrients may be taken up for studies in a cropping system mode. Further, diverse nutrient sources, including organic manures, composts and bio-fertilizers may be tested in conjunction with mineral fertilizers.

Declaration of interests

The authors have no conflict of interest to declare.

Data sharing

All relevant data are within the manuscript.

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