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Effect of phosphorus management in high phosphorus soils on groundnut (*Arachis hypogea*) under different land configurations

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Abstract
Groundnut in different land configurations and phosphorus management in high phosphorus soils influenced the growth and yield. A field experiment was carried out at ARS, Karimnagar. PJTSAU in *rabi*, 2019-20 to investigate the impact of land configurations and phosphorus management in high phosphorus soils on the performance of groundnut. This was laid out in strip-split plot design and replicated four times. The main plots treatments were raised and flatbeds in the subplot, various phosphorus levels *viz*., as S_1: 100% RDP (60 kg ha^{-1}), S_2: 75% RDP (45 kg ha^{-1}), S_3: 50% RDP (30kg ha^{-1}), S_4: 25% RDP (15 kg ha^{-1}) and S_5: 0% RDP (0 kg ha^{-1}) applied to kharif maize and were sub divided into sub-sub plots to study residual effect of as P_1: 75% RDP (30kg ha^{-1}) and P_2: 50% RDP (20kg ha^{-1}) applied to groundnut. Study revealed that phosphorus management in high phosphorus soils under raised beds resulted significantly higher in plant growth (plant height, number of branches/plant), yield attributes (Number of pods plant^{-1}, shelling percentage), and pod yield. The experiment led to a notable increase in plant growth (plant height and number of branches per plan), yield attributes (pods per plant, shelling percentage) and pod yield. The higher pod yield (2654 kg/ha) recorded under raised beds over flatbeds (2203 kg/ha). Among the phosphorus management S_1 (100% RDP) has recorded higher pod yield (2638 kg/ha) which was on par with S_2 (2535 kg/ha) followed by S_3 (2448 kg/ha) which was on par with S_2. The lowest pod yield was recorded with S_5 (2190 kg/ha) followed by S_4 (2333 kg/ha). In groundnut application of P_2 (50% RDP) produced comparable growth, yield attributes and pod yield with that of application of P_1 (75% RDP) in high phosphorus soils.

Keywords: Groundnut, land configuration, phosphorus management, raised bed, pod yield

Introduction
Groundnut (*Arachis hypogea* L.) the most important oilseed crop with high content of edible oil (47-53%) and with vegetable protein (26%) to both human and animals (Rajitha *et al*. 2018, Hussainy *et al.* 2020) [8, 3]. In India, groundnut occupies 40% of the total area under oilseeds cultivation. Nearly 70% of the groundnut area is cultivated as rainfed and irrigated dry situations. A good crop stand requires optimum moisture in the root zone is the major constraint under rainfed situation which needs *in-situ* moisture conservation, agronomic manipulations to soil which improves soil moisture conservation. In cropping systems phosphorus management becomes an important and limiting nutrient especially for legumes. it is crucial to use phosphorus as efficiently as possible on a global scale to conserve this limited resource base and, when necessary, enhance agricultural productivity. The continuous application of phosphatic fertilizers with the belief that they become fixed led to an accumulation of phosphorus in the soil. As a result of adding phosphorus through fertilizers and organic materials, it is accumulated in both readily available and less readily available pools of phosphorus and the reports indicate that even the available P fraction in the soil has increased considerably due to the release of fixed P by phosphorus solubilizing bacteria (PSB) and organic acids of root exudates (Nautiyal *et al*., 2000) [7]. Soil test reports of Soil Testing Laboratories showed that in Telangana alone 82 mandals were found to have developed a high available P over the period (Annual report of STCR, 2011-12). Phosphorus could produce changes composition of fatty acids resulting in lower seed viability and nutritional quality (Krueger *et al*., 2013) [6]. Based on this, field experiment was conducted to study the effect of phosphorus management in high phosphorus soils on the growth, yield attributes and pod yield of groundnut under raised and flatbeds.

Material and Methods

The experiment was carried out at Agricultural Research Station, Karimnagar, Prof. Jayashankar Telangana State Agricultural University, Telangana State. The type of soil is sandy loam in texture, alkaline, with low organic carbon content, medium in available nitrogen, high in available phosphorus (79 kg ha^{-1}) and high in available potassium. The design of the experiment was strip-split plot. Field experiment conducted in *rabi* 2019-20, under raised beds and flat beds as main plot treatments and in phosphorus management, there were five levels of phosphorus as S_1: 100% RDP (60 kg ha^{-1}), S_2: 75% RDP (45 kg ha^{-1}), S_3: 50% RDP (30kg ha^{-1}), S_4: 25% RDP (15 kg ha^{-1}), S_5: 0% RDP (Control) and sub plots are divided into two more sub-sub plot treatments (phosphorus levels) replicated four times.

Results and Discussion

Data pertaining to groundnut as influenced by phosphorus levels under raised beds, and flats beds were presented in table.1.

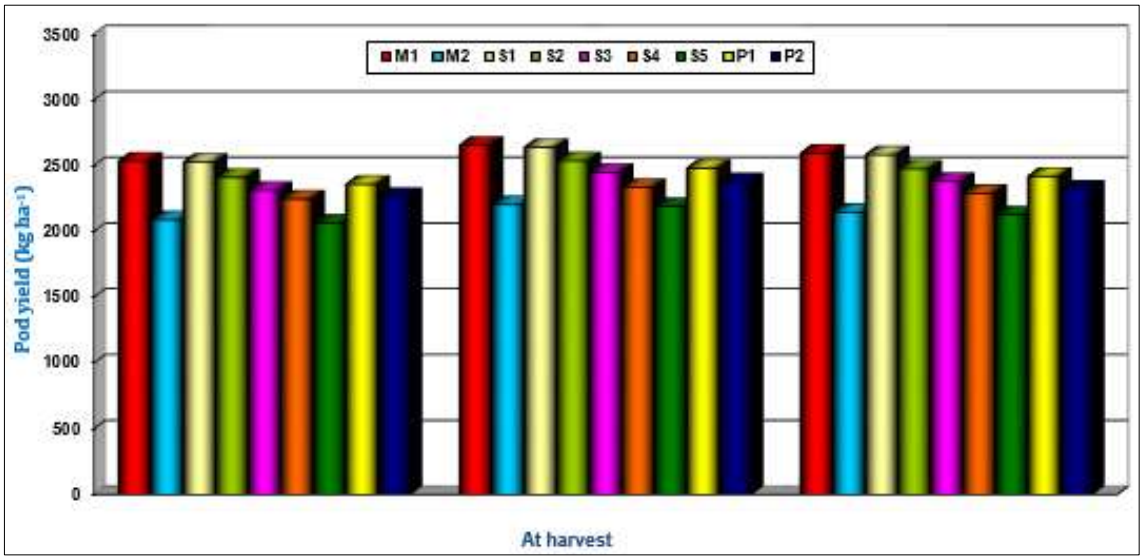
Perusal of data indicated that groundnut recorded significantly higher plant height sown on raised beds (M_1) (27.7 cm) over faltbeds (M_2) (18.7 cm) at harvest. This might be due to dense surface soil layer in flat beds (Saravanan *et al.* 2022) [10]. At harvest, significantly higher plant height recorded with S_1 (29.0 cm) over S4 and S_5 followed by S_2 (24.6 cm). Both S_2 and S_3 were found on par with each other. Lowest plant height was with S_5 (19.5 cm) and S_4 recorded. Among two phosphorus levels ($P_1$and P_2) studied on groundnut, they were found to be non significant. However, P_2 recorded on par plant height (22.7 cm) as compared to P_1 (23.8 cm). Highest the number of branches $plant^{-1}$ sown on raised beds (M_1) (11.7) over faltbeds (M_2) (10.0) at harvest. Among the five phosphorus levels, higher branches $plant^{-1}$ recorded with S_1 (12.0) and was on par with S_2 (11.2). Both S_2 (11.2) and S_3 (10.8) were found on par with each other and subsequently lowest with S_5 (9.9) at harvest followed by S_4. Among two phosphorus levels ($P_1$and P_2) studied on groundnut, they were found to be non significant.

Groundnut sown on raised beds (M_1) higher number of pods $plant^{-1}$ (25.99) recorded over faltbeds (M_2) (19.92) (Sathiya *et al.* 2020) [9]. Withfive phosphorus levels, number of pods $plant^{-1}$ was significantly higher with S_1: 100% RDP applied to maize (26.72) and was on par with the lower phosphorus levels *viz*., S_2: 75% RDP (24.58), both S_2: 75% RDP (24.58) and S_3: 50% RDP (23.71) were on par with each other and significantly higher over S_5: 0% RDP and S_4: 25% RDP which were at par with each other. Among two phosphorus levels (P_1: 75% RDP and P_2: 50% RDP) studied on groundnut, they were found to be non significant. However, 50% RDP recorded on par number of pods $palnt^{-1}$ (21.75) as compared to 75% RDP (24.16). Groundnut crop sown under raised beds (M_1) recorded significantly higher shelling per centage of 66.98%, followed by under flat beds (M_2) (58.60%). Among the phosphorus levels S_1 recorded significantly higher shelling per centage (68.13%) which was significantly on par with S2 (65.88%), whereas S_2 and S3 (64.00%) were on par with each other. With respect to application two phosphorus levels ($P_1$and P_2) studied on groundnut, they were found to be non significant. Pod yield of groundnut recorded higher under raised beds (M_1) (2654 kg ha^{-1}) over the flat beds (M_2) (2203 kg ha^{-1}) depicted in figure 1. The per centage increase in pod yield under raised bed over flatbed was 20.47. The raised bed situations might be congenial for easy peg penetration, pod development and there by pod yield (Kamble *et al.* 2016) [4]. Among the five phosphorus levels, the higher pod yield of groundnut with S_1 (2638 kg ha^{-1}) which was on par with the S_2 (2535 kg ha^{-1}). Both S_2 and S_3 were found on par with each other and lowest pod yield recorded with S_5. With respect to application of two phosphorus levels ($P_1$and P_2) studied on groundnut, they were found to be non significant. However, P_2 recorded pod yield (2377 kg ha^{-1}) which comparable to P_1 (2480 kg ha^{-1}). Which implies that the pod yield was not boosted by higher phosphorus applied (P_1:75% RDP) probably due to the initial high phosphorus in soils. Which might be due to phosphorus influenced pod yield with higher root growth, photosynthesis, metabolic activities which increased production of assimilates and absorption of metabolites resulted higher pod yield. (Kumar *et al.* 2016 and Bekele *et al.* 2019) [5, 2].

Table 1: Plant height, yield attributes and pod yield of groundnut as influenced by phosphorus levels in high phosphorus soils under raised and flat beds

	Plant height (cm)	Number of branches $plant^{-1}$	Number of pods $plant^{-1}$	Shelling percentage (%)	Pod yield (kg ha^{-1})
Main treatments (Beds)					
M1: Raised beds	27.7	11.7	25.99	66.98	2654
M2: Flat beds	18.7	10.0	19.92	58.60	2203
SE m (±)	0.1	0.08	0.28	0.36	20
CD (P=0.05%)	0.3	0.36	1.18	1.60	92
Sub treatments (Phosphorus levels to maize)					
S1: 100% RDP (60 kg ha^{-1})	29.0	12.0	26.72	68.13	2638
S2: 75% RDP	24.6	11.2	24.58	65.88	2535
S3: 50% RDP	22.4	10.8	23.71	64.00	2448
S4: 25% RDP	20.7	10.3	20.00	60.88	2333
S5: 0% RDP (Control)	19.5	9.9	19.77	55.06	2190
SE m (±)	0.8	0.41	0.93	0.96	40
CD (P=0.05%)	2.4	NS	2.84	2.95	125
Sub-Sub treatments (Phosphorus levels to groundnut)					
P1: 75% RDP (30 kg ha^{-1})	23.8	11.0	24.16	63.38	2480
P2: 50% RDP (20 kg ha^{-1})	22.7	10.7	21.75	62.20	2377
SE m (±)	0.3	0.2	0.3	0.43	29
CD (P=0.05%)	NS	NS	NS	NS	NS
Interactions					

Main treatments x Sub treatments					
SE m (±)	0.7	0.74	1.17	1.30	129
CD (P=0.05%)	NS	NS	NS	NS	NS
Main treatments x Sub-Sub treatments					
SE m (±)	0.3	0.23	0.39	0.56	35
CD (P=0.05%)	NS	NS	NS	NS	NS
Sub treatments x Sub-Sub treatments					
SE m (±)	0.3	0.23	0.39	0.56	35
CD (P=0.05%)	NS	NS	NS	NS	NS
Main treatments x Sub treatments x Sub-Sub treatments					
SE m (±)	0.4	0.33	0.46	0.68	46
CD (P=0.05%)	NS	NS	NS	NS	NS



M1: Raised beds
M2: Flat beds
P1: 75% RDP
P2: 50% RDP
S1: 100% RDP
S2: 75% RDP
S3: 50% RDP
S4: 25% RDP
S5: 0% RDP (Control)

Fig 1: Pod yield (kg ha^{-1}) of groundnut as influenced by phosphorus levels in high phosphorus soils under raised and flat beds

Conclusions

Among planting methods, higher pod yield of groundnut was recorded under raised bed method and found superior over flat beds. While among phosphorus levels studied, 50% RDP and 75% RDP recorded on par performance to that of 100% RDP which indicated that phosphorus levels can be reduced to even 50% RDP to get equal yield of 100% RDP particularly in high phosphorus soils.

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