Available online at www.ijpab.com

DOI: http://dx.doi.org/10.18782/2582-2845.8176

ISSN: 2582 – 2845

Ind. J. Pure App. Biosci. (2020) *8*(4), 184-189

Indian Journal of Pure & Applied Biosciences

Peer-Reviewed, Refereed, Open Access Journal

Research Article

Evaluation of Yield and Quality of Groundnut under High Density Plantations with Graded Levels of Phosphorus

Sunilkumar, T.[*], Sumathi, V., ReddiRamu, Y., Nirmal Kumar, A. R. and Karuna Sagar, G.

Department of Agronomy, S. V. Agricultural College, Tirupati, Andhra Pradesh 517 502, India

*Corresponding Author E-mail: suniltammi7082@gmail.com

Received: 15.05.2020 | Revised: 24.06.2020 | Accepted: 29.06.2020

ABSTRACT

A field experiment was laid out in randomized block design with factorial concept during rabi, 2019-20 to study the evaluation of yield and quality of groundnut under high density planting (22.5 x 10 cm -4.44 lakh ha^{-1}; 20 x 7.5 cm - 6.66 lakh ha^{-1}; 22.5 x 5 cm - 8.88 lakh ha^{-1} with graded levels of phosphorus (25, 37.5, 50 and 62.5 kg P_2O_5 ha^{-1}). The investigation disclosed that dry matter production and phosphorus uptake of groundnut at different crop growth stages increased with graded increase in plant density from 4.44 to 8.88 lakh ha^{-1} and graded increase in phosphorus application from 25 to 62.5 kg P_2O_5 ha^{-1}. All yield parameters i.e., number of pods plant^{-1}, pod yield, kernel yield and shelling percentage was higher at plant density of 4.44 lakh ha^{-1}. Among phosphorus levels, application of 50 kg P_2O_5 ha^{-1} recorded higher pod yield and kernel yield. Haulm yield was higher at plant density of 8.88 lakh ha^{-1} and decreased with decrease in plant density. Pod yield was significantly influenced by interaction between plant densities and phosphorus levels, it was higher at plant density of 4.44 lakh ha^{-1} in conjugation with 50 kg P_2O_5 ha^{-1}. The experimental results showed that groundnut grown at plant density of 4.44 lakh ha^{-1} with 50 kg P_2O_5 ha^{-1} resulted in higher yield and economic returns. However, when farmers are opting for high density planting, maintenance of groundnut population of 6.66 lakh ha^{-1} in conjugation with 62.5 kg P_2O_5 ha^{-1} will be optimum for better returns.

Keywords: *Groundnut, Plant density, Phosphorus*

INTRODUCTION

Groundnut (*Arachis hypogaea* L.) is an important annual legume and protein-rich source oil seed crop grown in tropical and subtropical agro-climatic areas of Asia, Africa, and America. In India, groundnut holds a predominant position in the national edible oil economy. It is cultivated over an area of 4.887 million hectares with a production of 9.252 million tonnes with an average productivity of 1493 kg ha^{-1}. In Andhra Pradesh, groundnut is grown in 0.735 million hectares with an annual production of 1.048 million tonnes and average productivity of 1426 kg ha^{-1} (*www.indiastat.com*, 2018).

Cite this article: Sunilkumar, T., Sumathi, V., ReddiRamu, Y., Nirmal Kumar, A.R. & Karuna Sagar, G. (2020). Evaluation of Yield and Quality of Groundnut under High Density Plantations with Graded Levels of Phosphorus, *Ind. J. Pure App. Biosci. 8*(4), 184-189. doi: http://dx.doi.org/10.18782/2582-2845.8176

In the coastal sands of the Nellore district (Andhra Pradesh), the groundnut is raised at very closer spacing with a higher seed rate. Groundnut yields are escalated with rise in population but when an individual plant is studied the number of pod plant^{-1}, kernel yield plant^{-1}, LAI, number of branches are decreased. Hence, a similar trend of research on plant densities of groundnut should be focussed on *alfisols*. Most of the Indian soils, where groundnut is grown are deficient in phosphorus due to its fixation and low availability. Phosphorus stimulates the setting of pods, decreases unfilled pods and hastens maturity. Higher doses of phosphorus are required in nodulating legumes compared to non-nodulating crops. Even though higher doses are employed it is unavailable because of its immobile nature in soil due to the transformation of phosphorus into unavailable form in the soil. Hence, the response of phosphorus to groundnut is not consistent. Therefore, research is requisite to probe the issues of yield and yield components under varied plant densities and phosphorus nutrition in alfisols of Southern Agro-Climatic zone of Andhra Pradesh.

MATERIALS AND METHODS

The field experiment was conducted during *rabi*, 2019-20 at field number 138, dryland farm of S. V. Agricultural College, Tirupati campus of Acharya N.G. Ranga Agricultural University, which is geographically situated at 13.5°N latitude and 79.5°E longitude, with an altitude of 182.9 m above the mean sea level, which falls under Southern Agro-climatic Zone of Andhra Pradesh and according to Trolls classification, it falls under Semi-Arid Tropics. The experiment was laid out in Randomized Block Design with factorial concept, with three replications. The treatments comprised of three plant densities *viz*., 22.5 cm x 10 cm (D_1), 20 cm x 7.5 cm (D_2) and 22.5 cm x 5.0 cm (D_3) and four phosphorus levels *viz*., 25.0 kg P_2O_5 ha^{-1} (P_1), 37.5 kg P_2O_5 ha^{-1} (P_2), 50.0 kg P_2O_5 ha^{-1} (P_3) and 62.5 kg P_2O_5 ha^{-1} (P_4). Groundnut was sown on 11th December, 2019 and variety tested was 'Dharani'. The recommended dose of fertilizer for groundnut crop was 30 - 50 - 50 N, P_2O_5 and K_2O kg ha^{-1}. Uniform dose of nitrogen and potassium was applied as basal and gypsum was applied @ 500 kg ha^{-1} at flowering. The experimental soil was sandy loam in texture, neutral in reaction, low in organic carbon and available nitrogen and, medium in available phosphorus and available potassium. The rainfall received during crop growing period was 25.6 mm in 4.0 rainy days. Hence, eight irrigations each with 5 cm depth were scheduled to compensate water requirement of crop. Recommended agronomic practices and plant protection aspects were carried out as per guidelines. The crop was harvested on 24th March, 2020. Five plants at random from the border rows leaving the extreme row were destructively sampled at 25, 50, 75 DAS and at harvest. The plant samples were shade dried in green house initially and later dried in hot air oven at 60°C, to a constant weight and expressed as kg ha^{-1} to obtain dry matter production. The tri-acid digested plant samples of groundnut at harvest were analysed for phosphorus content by vanado-molybdo phosphoric acid method (Jackson, 1973). The intensity of yellow colour developed was measured at 420 nm using spectrophotometer. The phosphorus uptake was calculated by multiplying the phosphorous content (%) with the respective dry matter production and expressed in kg ha^{-1}.

The observations with respect to yield and yield components were recorded and subjected to statistical analysis.

RESULTS AND DISCUSSION

Effect of plant densities

Dry matter production (Table 1) was significantly higher at plant density of 8.88 lakh ha^{-1} when compared to 6.66 and 4.44 lakh ha^{-1}. An increase in dry matter may be attributed to increase in plant density though dry matter production plant^{-1} was higher in lower plant density (Bhargavi et al., 2016). The higher number of pods plant^{-1} (Table 1) was recorded with a plant density of 4.44 lakh ha^{-1} which was significantly higher than number of pods plant^{-1} resulted due to 6.66 lakh ha^{-1} and 8.88 lakh ha^{-1} population. These results might be due to enough space available for individual plants at plant density of 4.44 lakhs ha^{-1} to meet the plant demand to grow vigorously and produce more branches, pegs and more pods plant^{-1} (Kumar, 1992).

The higher pod yield, kernel yield and shelling percentage (Table 1) was recorded with plant density of 4.44 lakh ha^{-1} and it was significantly higher than other two plant densities *i.e.*, 6.66 and 8.88 lakh ha^{-1}. Maintenance of plant density from 4.44 to 8.88 lakh ha^{-1} decreased pod yield. The better availability of nutrients under lower planting density aided plants to grow profusely. Similarly, rapid initiation and expansion of leaves augmented photosynthesis besides vigorous growth of individual plants and better filling of pods (Zagade et al., 2007). The higher plant density increased the competition between plants and created a stress for plant growth resulted in improper filling and ill filled pods, ultimately reduced pod yield. Similar findings were reported by Gunri et al. (2010) and Konlan et al. (2013). Non uniformity in production of yield with densities might be due to the reason that the reduced number of pods plant^{-1} with increased plant population. Haulm yield increased with increase in plant density from 4.44 to 8.88 lakh ha^{-1}. Similar results was reported by Hirwe et al. (2006). The decrease in haulm yield from higher to lower plant density is mainly attributed to the higher plant population unit area^{-1} resulted at closer spacing. Though individual plant weight was the highest at wider spacing, it could not compensate to loss in haulm yield due to less number of plants unit area^{-1} (Jyothi et al., 2004).

There was significant disparity among plant densities in uptake of phosphorus at harvest. Graded increment in plant densities from 4.44 lakh ha^{-1} to 8.88 lakh ha^{-1} resulted in significant increase in phosphorus uptake by groundnut, at all stages of plant growth. The probable reason may be increase in plant population at higher plant densities which might have removed more phosphorus. Higher benefit-cost ratio was attained with cultivation of groundnut at lower plant density of 4.44 lakh ha^{-1} followed by 6.66 lakh ha^{-1} density.

Effect of phosphorus levels

Dry matter production (Table 1) significantly increased with additional level of phosphorus fertilization. Among phosphorus levels, higher dry matter production and number of pods plant^{-1} and haulm yield was obtained with application of 62.5 kg P_2O_5 ha^{-1}. The results revealed that number of pods plant^{-1} increased with increasing phosphorus levels. Increasing phosphorus rates aids in developing more extensive root system and thus enabling plants to extract water and nutrients from more depth resulted in assimilation of higher biomass (Yadav et al., 2015).

Pod yield, kernel yield and shelling percentage was higher with 50 kg P_2O_5 ha^{-1} and it was comparable with 62.5 kg ha^{-1} P_2O_5. Increment in phosphorus might have promoted the growth of roots, nodulation and efficient functioning of nodule bacteria for fixation of nitrogen to be utilized during pod development stage as well as functional activity resulting in higher extraction of nutrients from soil environment to aerial plant parts which led to increase in pod yield. Results endorse the finding of Kamara et al. (2011). The improvement of pod and kernel weight of groundnut under higher doses of phosphorus and could be attributed to enhanced synthesis of carbohydrates, fats, proteins and building phospholipids and nucleic acid constituting the kernels which accentuated shelling percentage at higher phosphorus levels (Hasan & Ismail 2016).

Higher phosphorus uptake by groundnut at harvest was obtained with the application of 62.5 kg P_2O_5 ha^{-1}, which was significantly higher than other phosphorus levels tried. Phosphorus uptake by groundnut increased with quantity of phosphorus applied to the crop (Balasubramanian et al., 1980). The potency of phosphorus in accelerating root development and proliferation, nodule formation and N_2 fixation might have resulted in higher uptake of phosphorus (Yakadri & Satyanarayana 1995). This might be due to the beneficial effect of phosphorus application on nutrient content of legume crop due to the formation of greater number of nodules and increase in cation exchange capacity of the roots which would enable the plant to extract more nutrients from soil (Loganathan & Krishnamoorthy 1977). Benefit-cost ratio of groundnut cultivation was significantly higher in plots received 50 kg P_2O_5 ha^{-1} and it was followed by application of 62.5 kg P_2O_5 ha^{-1}.

Interaction of plant densities and phosphorus levels

Pod yield (Table 2) and benefit-cost ratio (Table 3) were significantly influenced by interaction of plant densities and phosphorus levels. Pod yield was higher with plant density of 4.44 lakh ha^{-1} in conjugation with 50 kg ha^{-1} P_2O_5 and it was at with 6.66 lakh ha^{-1} with 62.5 kg ha^{-1} P_2O_5. Lower pod yield was obtained at 8.88 lakh ha^{-1} with 25 kg ha^{-1} P_2O_5. These are in line with results of Raghavaiah et al. (1995). Benefit-cost ratio of groundnut cultivation grown at lower plant density of 4.44 lakh ha^{-1} along with 50 kg P_2O_5 ha^{-1} registered higher BCR which was on par with plant density of 4.44 lakh ha^{-1} in conjugation with 37.5 kg P_2O_5 ha^{-1}. Among different treatments, lower plant densities with varied phosphorus levels yielded better BCR when compared to other treatment combinations. Lower BCR was recorded with groundnut grown at plant density of 8.88 lakh ha^{-1} with 25 kg P_2O5 ha^{-1}. These observations indicated reduction in BCR was due to increase in seed cost and reduced pod yield at higher plant density. Similar results were also noticed by Basak et al. (1995) and Hirwe et al. (2006).

Table 1: Biometric observations, phosphorus uptake and economics of groundnut at harvest as influenced by plant densities and phosphorus levels

Treatments	Dry matter production at harvest (kg ha^{-1})	Number of pods $plant^{-1}$	Pod yield (kg ha^{-1})	Kernel yield (kg ha^{-1})	Haulm yield (kg ha^{-1})	Shelling percentage	B:C ratio	Phosphorus uptake at harvest (kg ha^{-1})
Plant Densities (D)								
D_1 : 4,44,444 (22.5 x 10 cm)	3945	13.7	3451	2686	4312	78	3.60	32.4
D_2 : 6,66,666 (20 x 7.5 cm)	5622	9.5	3189	2298	4709	72	2.97	48.7
D_3 : 8,88,888 (22.5 x 5 cm)	6331	8.8	2748	1960	6499	71	2.32	64.9
SEm±	86.13	0.37	60.61	42.17	129.90	0.34	0.059	0.16
CD (P = 0.05)	254	1.1	179	124	381	1	0.17	0.5
Phosphorus levels (P)								
P_1 : 25 kg P_2O_5 (50 % RDP)	5016	9.0	2780	1981	4425	71	2.67	47.4
P_2 : 37.5 kg P_2O_5 (75 % RDP)	5121	10.3	3093	2265	5055	73	2.94	48.0
P_3 : 50 kg P_2O_5 (100 % RDP)	5511	11.1	3365	2520	5598	75	3.18	49.1
P_4 : 62.5 kg P_2O_5 (125 % RDP)	5549	12.2	3278	2493	5615	76	3.07	50.1
SEm±	99.46	0.42	69.99	48.69	149.99	0.39	0.068	0.18
CD (P = 0.05)	294	1.3	207	143	440	1	0.20	0.5
Interaction (D x P)								
SEm±	172.27	0.73	121.23	84.34	259.79	0.68	0.118	0.32
CD (P = 0.05)	NS	NS	358	NS	NS	NS	0.34	NS

Table 2: Pod yield (kg ha^{-1}) of ground nut at harvest as influenced by plant densities, phosphorus levels and their interaction

TREATMENTS	**Phosphorus levels**				
Densities	P_1	P_2	P_3	P_4	MEANS
D_1	3215	3444	3737	3405	3451
D_2	2680	3013	3386	3675	3189
D_3	2442	2821	2972	2754	2748
MEANS	2780	3093	3365	3278	

Treatments	**SEm±**	**CD**
Plant Densities	60.61	179
Phosphorus levels	69.99	207
D X P	121.23	358

Table 3: Benefit cost ratio of groundnut as influenced by interaction of plant densities and phosphorus levels

TREATMENTS	**Phosphorus levels**				
Plant Densities	P_1	P_2	P_3	P_4	MEANS
D_1	3.40	3.61	3.88	3.51	3.60
D_2	2.53	2.82	3.15	3.39	2.97
D_3	2.08	2.39	2.50	2.30	2.32
MEANS	2.67	2.94	3.18	3.07	

Treatments	**SEm±**	**CD**
Plant Densities	0.059	0.17
Phosphorus levels	0.068	0.20
D X P	0.118	0.34

CONCLUSION

Overall, the present study disclosed that growing of groundnut at plant density of 4.44 lakh ha^{-1} with 50 kg P_2O_5 ha^{-1} resulted in higher yield and economic returns. However, when farmers are opting for high density planting, maintenance of groundnut population of 6.66 lakh ha^{-1} in conjugation with 62.5 kg P_2O_5 ha^{-1} will be optimum for better returns. Beyond this, neither increase in plant density nor phosphorus levels are not remunerative for groundnut cultivation.

REFERENCES

Balasubramanian, V., Singh, L., & Nnadi, A. (1980). Effect of long term fertilizer treatment on groundnut yield, nodulation and nutrient uptake at Samaru Nigeria. *Plant and Soil*. *55*, 171-180.

Basak, N.C., Chowdhury, M.K., & Mia, F.U. (1995). Effect of spacing on the yield and economics of groundnut. *Legume Research*. *18*(1), 45-49.

Bhargavi, H., Srinivasareddy, M., Tirumalareddy, S., Kavitha, P., Vijayabhaskarreddy, U., & Rameshbabu, P.V. (2016). Productivity of groundnut (*Arachis hypogaea* L.) as influenced by varieties and plant densities. *Journal of Oilseeds Research*. *33*(1), 79-82.

Gunri, S.K., Biswas, T., Mandal, S., Nath, R., & Kundu, C.K. (2010). Effect of spacing on improved cultivars of summer groundnut (*Arachis hypogaea* L.) in red and laterite zone of West Bengal. *Karnataka Journal of Agricultural Sciences*. *23*(5), 687-688.

Hasan, M., & Ismail, B.S. (2016). Effect of phosphorus fertilizer on growth and yield of groundnut. *AIP Conference Proceedings 1784*, 060018.

Hirwe, N.A., Ulemale, R.B., Paslawar, A.N., Thakur, M.R., & Anokar, D.N. (2006). Productivity and economics of groundnut influenced by plant density under polythene film mulch. *Annuals of Plant Physiology*. *20*(1), 148-149.

Jackson, M.L. (1973). *Soil Chemical Analysis*. Prentice-Hall of India Pvt. Ltd., New Delhi. 134-204.

Jyothi, R.M., Radha Kumari, C., Obulamma, U., & Lingam, B. (2004). Response of early rabi groundnut, Arachis hypogeal L. to spacing, irrigation and plant protection levels. *Journal of Oilseeds Research*. *21*(1), 171-172.

Kamara, A.Y., Ekeleme, F., Kwari, J.D., Omoigui, L.O., & Chikoye, D. (2011). Phosphorus effects on growth and yield of groundnut varieties in the tropical savannas of northeast Nigeria. *Journal of Tropical Agriculture*. *49*(1-2), 25-30.

Konlan, S., Sarkodies, A., Asare, E., & Kombiok, M.J. (2013). Groundnut (*Arachis hypogaea* L.) varietal response to spacing in the humid zone of Ghana. *Asian Research Publishing Network Journal of Agricultural and Biological Science*. *8*(9), 642-650.

Kumar, S.A. (1992). Response of groundnut (*Arachis hypogaea* L.) varieties to varying plant densities. *M.Sc. (Ag) Thesis*, Andhra Pradesh Agricultural University, Rajendranagar, Hyderabad.

Loganathan, S., & Krishnamoorthy, K.K. (1977). Total uptake of nutrients at different stages of the growth of groundnut and the ratios in which various nutrient elements exist in groundnut plant. *Plant and Soil*. *46*, 565-570.

Raghavaiah, C.V., Padmavathi, P., & Prasad, M.V. (1995). Response of groundnut genotypes to plant density and phosphorus nutrition in alfisols. *Journal of Oilseeds Research*. *12*(2), 295-298.

www.indiastat.com, 2018.

Yadav, G.S., Datta, M., Babu, S., Saha, P., & Raghavendrasingh. (2015). Effect of sources and levels of phosphorus on productivity, economics, nutrient acquisition and phosphorus-use efficiency of groundnut (*Arachis hypogaea* L.) under hilly ecosystems of North-East India. *Indian Journal of Agronomy*. *60*(2), 307-311.

Yakadri, M., & Satyanarayana, V. (1995). Dry-matter production and uptake of nitrogen, phosphorus and potassium in rainfed groundnut (*Arachis hypogaea* L.). *Indian Journal of Agronomy*. *40*(2), 325-327.

Zagade, M.V., Chavan, S.A., Thorat, S.T., Shaikh, M.S.I., & Bhagat, S.B. (2007). Effect of irrigation levels, polythene mulch and plant populations on yield and economics of *rabi* groundnut. *Journal of Maharashtra Agricultural Universities*. *32*(2), 198-201.