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Effect of biofertilizers and spacing on growth parameters of groundnut (*Arachis hypogaea* L.)

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Abstract
An experiment was conducted during the *kharif* season 2021, at the Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, Sam Higgin bottom University of Agriculture, Technology and Sciences (SHUATS), Prayagraj (U.P.) to study the effect of biofertilizers and spacing on growth and yield of groundnut (*Arachis hypogaea* L.). Seed inoculation with biofertilizers VAM (*Vesicular Arbuscular Mycorrhiza*) - 1.5g/kg seed, PSB (*Phosphate Solubilising Bacteria*) – 5g/kg seed, *Rhizobium* – 20g/kg seed and *Trichoderma* – 5g/kg seed. Seeds were sown at a depth of 5cm with (25cm × 20cm and 30cm × 15cm) - two different spacings maintaining row to row and plant to plant distance. The Trichoderma + 30cm x 15cm significantly increased the growth attributes *viz*., plant height (46.47cm), no. of nodules/ plant (92.84), dry weight (27.56g/plant), CGR (60-90 DAS) (7.57g/m^2/day), RGR (60-90 DAS) (0.017g/g/day).

Keywords: Spacing, biofertilizers, groundnut and growth

Introduction
Groundnut is considered to be the most important food legume and oilseed crop of India, which is cultivated in 4.91 million ha area with the production of 9.18 million tonnes and average productivity of 1.86 t/ha (DES, 2018). Groundnut oil is composed of mixed glycerides and contains a high percentage of unsaturated fatty acids, such as oleic (50 to 65 percent) and linoleic acid (18 to 30 percent). Groundnut contains amino acids including cysteines which are essential for animal growth. Biofertilizers (PSB) can play an important role in meeting the phosphorous requirement of crops solubilization of insoluble phosphorous sources. Plant growth promoting bacteria (PGPB) are a group of free living microorganisms that use different methods to increase plant growth (Glick and Bashan, 1997) [4]. Growth promotion is attributed to vesicular-arbuscular mycorrhizal (VAM) fungal association in some situations, where mycorrhizal plants grow better than non-mycorrhizal plants (Gerdeman 1968; Salomes *et al.* 1983) [3, 12] because of increased nutrient acquisition (particularly phosphorus) from soil (Gerdeman 1968) [3], better water uptake (Mosse 1981), the presence of growth promoting substances and biological control of soil-borne pathogens (Jalali and Chand 1988) [5], imparting resistance to the host against disease (Dehne and Schon-Beck 1975). Spacing reduces the risk of disease spread from one plant to another, so plants growing too closely together are not as healthy as plants with enough space. Spacing is determined by the species of the plant and by soil fertility.

Materials and Methods
The present investigation was conducted during the *Kharif season* 2021, at the Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences (SHUATS), Prayagraj (U.P.) to study the effect of Effect of biofertilizers and spacing on growth and yield of groundnut (*Arachis hypogaea* L.) which is located at 25º 39’ 42’’N latitude, 81º 67’ 56” E longitude and 98 m altitude above the mean sea level (MSL). This area is situated on the right side of the Yamuna River by the side of Prayagraj-Rewa road about 12 km from the city. The soil of the experimental field constituting a part of central Gangetic alluvial is neutral and deep. Pre- sowing soil samples were taken from 5 different places with a depth of 15 cm with the help of an auger. The composite samples were used for the chemical and mechanical analysis. The soil was sandy loam in texture, low in organic carbon and medium in available nitrogen, phosphorous and low in potassium. Kadiri Lepakshi 1812: 115 to 120 days duration in kharif and suitable for both rainfed as well as irrigated situations.

It is bunchy type. Released from ARS (Agriculture Research Station) in Kadiri, Anantpur. Seed treatment with biofertilizers VAM (Vesicular *Arbuscular Mycorrhiza*) - 1.5g/kg seed, PSB (*Phosphate Solubilising Bacteria*) – 5g/kg seed, *Rhizobium* – 20g/kg seed and *Trichoderma* – 5g/kg seed) was done. Seeds were sown at a depth of 5cm with spacing (25cm × 20cm and 30cm × 15cm) - two different spacing maintaining row to row and plant to plant distance. The experiment was laid out with randomized block design consisting 9 treatment combination which are as follows: VAM + 25cm x 20cm, VAM + 30cm x 15cm, PSB + 25cm x 20cm, PSB + 30cm x 15cm, Rhizobium +25cm x 20cm, Rhizobium + 30cm x 15cm, Trichoderma + 25cm x 20cm, Trichoderma + 30cm x 15cm and Control: RDF:25 kg N/ha: 60 kg P_2O_5/ha: 40 kg K_2O/ha, each replicated thrice. Treatments were randomly arranged in each replication, divided into twenty seven plots. A net plot size of 3 m x 3 m was kept. Sowing date was on 29-06-2021 by hand. The observations on growth *viz*., plant height (cm), number of nodules/plants, dry weight/plant (g/plant), crop growth rate (g/m^2/day), relative growth rate (g/g/day). The data recorded for different characteristics were subjected to statistical analysis by adopting the method of analysis of variance (ANOVA) as described by Gomez and Gomez (1984).

Results and Discussion

The response of different biofertilizers and spacing levels on growth attributes of *kharif* groundnut. Data pertaining growth parameters at harvest 120 DAS of groundnut there was a significant and non-significant influence on plant height (cm), number of nodules per plant, dry weight (g) per plant, crop growth rate (g/m^2/day) 90-120 DAS at harvest and relative growth rate (g/g/day) 90-120 DAS at harvest as seen in table 1 was observed from at harvest 120 DAS showing some significant and non-significant impact on the effect of biofertilizers *viz.*, (VAM, PSB, Rhizobium and Trichoderma) and spacing (30cm×15cm and 25cm×20cm) on growth attributes of groundnut. Among the different biofertilizers *viz.*, (VAM, PSB, Rhizobium and Trichoderma and spacing level (30cm×15cm and 25cm×20cm) under in treatment of Trichoderma 5g/kg seed+30cmx15cm, recorded maximum plant height (cm) (62.34), number of nodules per plant (69.48), dry weight (g) per plant (39.53) which was at par with VAM 1.5g/kg seed+25cmx20cm, PSB 5 g/kg seed +25cmx20cm and PSB5 g/kg seed+30cmx15cm crop growth rate (g/m^2/day) (10.76) and relative growth rate (g/g/day) (0.015), whereas the lowest value plant height (cm) (51.26), number of nodules per plant (45.83), dry weight (g) per plant (30.38), crop growth rate (g/m^2/day) (5.94) and relative growth rate (g/g/day) (0.009) was found in Control (RDF) N25: P60: K40. Several studies reported that secondary metabolites produced by Trichoderma had positive effects as plant growth promoters and negative effects as inhibitors to the plants Keswani *et al.*, (2014) [6]. Roots colonized by Trichoderma could increase the root biomass and enhance nutrient availability for plants. The plant-Trichoderma interaction may also influence remarkable changes in plant metabolism, which triggered plant growth. Furthermore, Trichoderma secondary metabolites such as auxin-like compounds might influence better plant growth Vinale *et al.*, (2008) [13]. The Biofertilizers stimulate the growth, yield and chemical constituents. It has been reported that inoculation chickpea of with both Pseudomonas fluorescense and Rhizobium enhances stem height; root length and dry weight (Kumar *et al.*, 2001) [8]. Mekki and Amel (2005) [9] also claimed that application of biofertilizer increases plant height and dry weight of soybean. In respect of individual bio-fertilizer inoculation, Rhizobium spp. treatment recorded superiority over PSB inoculation. These results are similar to those reported by More *et al.* (2002) [10] and Zaltate and Padmani (2009) [14]. These results indicated that the current Trichoderma tested was promising to improve vegetative growth of groundnuts cultivated on saline soil, and this effect might be related to its ability to induce resistance to salinity and also to produce a growth stimulant Abdullah and Eriyanto (2020) [1]. This might be due to increased plant spread and availability of space for the plant. The results are in conformity with findings of Ramesh and Sabale (2001) [11]. Spacing differences regarding 100 seed weight might be due to the competition for light, water and other essential requirements among the plants. Ahmad *et al.* (2007) [2] and Konlan *et al.* (2013) [7] reported that 100 seed weight decreased with increasing plant density in peanut.

Table 1: Effect of Biofertilizers and Spacing on growth attributes of groundnut

Treatment No.	Treatment Details	Growth attributes at harvest (120DAS)				
		Plant height (cm)	Number of nodules per plant	Dry weight (g) per plant	Crop growth rate (g/m2/day) 90-120 DAS at harvest	Relative growth rate (g/g/day) 90-120 DAS at harvest
1	VAM 1.5g/kg seed+25cmx20cm	52.41	45.86	35.05	7.42	0.013
2	VAM1.5 g/kg seed+30cmx15cm	52.62	50.85	37.72	7.64	0.015
3	PSB 5 g/kg seed +25cmx20cm	52.36	60.20	35.58	7.32	0.012
4	PSB5 g/kg seed+30cmx15cm	52.66	52.84	35.89	7.82	0.011
5	Rhizobium 20g/kg seed+25cmx20cm	53.55	49.96	36.47	8.66	0.010
6	Rhizobium 20g/kg seed+30cmx15cm	57.19	60.22	36.44	9.40	0.011
7	Trichoderma 5g/kg seed+25cmx20cm	57.41	64.73	37.37	6.66	0.011
8	Trichoderma 5g/kg seed+30cmx15cm	62.34	69.48	39.53	10.76	0.015
9	Control (RDF) N 25: P60: K 40	51.26	45.83	30.38	5.94	0.009
F-Test		S	S	S	NS	NS
C.D.at 0.5%		2.669	7.852	4.211	-	-
S.Ed. (+)		1.259	3.704	1.986	2.205	0.003
S.Em		0.890	2.619	1.405	1.559	0.002
CV		2.822	8.166	7.677	33.934	35.950

Conclusion

It is concluded that for obtaining highest yield in groundnut during *kharif* season, application of trichoderma 5g/kg seed at 30cm × 15cm spacing (Treatment 8) recorded higher plant height, maximum number of nodules, higher dry weight, maximum CGR, maximum RGR.

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