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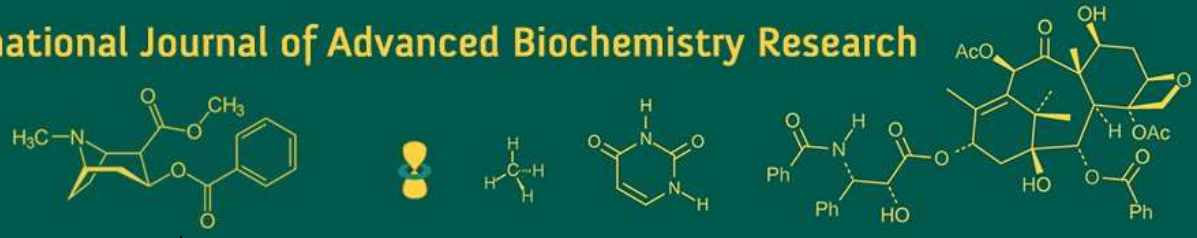

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Influence of liquid, powder and gel-based rhizobium and RDN levels on growth and yield of groundnut

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Abstract
The field experiment was conducted during *Zaid* 2023 at Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj (U.P). The experiment was laid out in Randomized Block Design with ten treatments which are replicated thrice on the basis of one year experimentation. The treatment combinations are T_1 Powder based rhizobium + 50% N, T_2 Liquid based rhizobium + 50% N, T_3 Gel based rhizobium + 50% N, T_4 Powder based rhizobium + 75% N, T_5 Liquid based rhizobium + 75% N, T_6 Gel based rhizobium + 75% N, T_7 Powder based rhizobium + 100% N, T_8 Liquid based rhizobium + 100% N, T_9 Gel based rhizobium + 100% N, T_{10} Control (20:40:40) are used. Results obtained that the application of Powder based rhizobium + 100% N recorded significantly higher Plant height (94.81 cm), Plant dry weight (47.65 g/plant), Significantly maximum number of pods/plant (49.20), Seeds/pod (3.00), Test weight (36.76 g), Seed yield (1966.22 kg/ha), were recorded with the treatment of Powder based rhizobium + 100% N.

Keywords: Groundnut, nitrogen, rhizobium inoculant, response gel

Introduction
Groundnut (*Arachis hypogaea* L.) is a leguminous plant that is widely cultivated in the tropics and subtropics between 40°N and 40°S latitudes. It is valued for its high-oil edible seeds and as such, it is the fourth most important source of edible oil and a third most important source of vegetable protein in the world. Groundnut is not only an important oilseed crop of India but also an important agricultural export commodity. Groundnut is an excellent source of plant nutrients contains 45 - 50% oil, 27 - 33% protein as well as essential minerals and vitamins. Groundnut is an upright or prostrate annual plant. It is generally distributed in the tropical, sub-tropical and warm temperate zones. Ethnological studies of the major Indian tribes of South America document the widespread culture of groundnut and provide indirect evidence for its domestication long before the Spanish Conquest. When the Spaniards returned to europe they took groundnuts with them. Later traders were responsible for spreading the groundnut to Asia and Africa where it is now is grown between the latitudes 40°N and 40°S (Pattee and Young, 1982) [4].
(Nagaraj, 2018) [2] also mentioned that integrated use of chemical fertilizer, organic manure and biofertilizers is the most efficient way of nutrient management for higher sustained crop yield and soil fertility. Groundnut is a leguminous edible oilseed crop. Both in world wide as well as in India share of groundnut to total oilseed is considerable. Among all plant growth promoting rhizobacteria (PGPR), Rhizobium has important role in the form of biofertilizer inoculation in groundnut to improve plant growth and yield attributes and yield. The present study describes details about PGPR, Rhizobium and its influence on groundnut performance, soil fertility and interaction with other microorganisms.

Material and Methods
The experiments on the influence of liquid, powder and gel-based rhizobium and Nitrogen Levels levels on the growth and yield enhancement of groundnut were conducted at *Zaid* season of 2023 at Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, SHUATS, Prayagraj which is located at 250 24 42 N latitude, 810 50 56 E longitude and 98 m altitude above the mean sea level.

This area is situated on the right side of the river Yamuna by the side of Prayagraj Rewa Road about 5 km away from Prayagraj city. A composite soil sample was collected at a depth of 0-30 cm. It was air dried, crushed, and tested for physical and chemical properties. The soil was sandy clay loam in texture with soil reaction of (pH 7.6), 0.69 organic matter (0.72%), available nitrogen (152.7 kg/ha),
phosphorus (10.4 kg/ha), potassium (174.0 kg/ha), sulphur (7.2 mg/kg), Zn (0.72 mg/kg) and available B (0.56 mg/kg). Groundnut (*Arachis hypogea.* L) variety K1812 were selected for sowing. Seeds were sown in line manually on 2023. Seeds were covered with the soil immediately after sowing. The spacing adopted was plant to plant 10 cm and row to row 30 cm according to the treatment details and the seeds were drilled at 3-4 cm depth. All the treatments were applied by balancing to the initial soil test values and crop requirements to justify the crop response to the supplied nutrients in both years.
Influence of liquid, powder and gel-based rhizobium Nitrogen levels on yield and yield parameters of groundnut.

Results and Discussion

Number of pods per plant: Significantly Maximum number of pods per plant (49.20) was recorded with the treatment in application of Powder based rhizobium + 100% N and minimum was recorded in control (20:40:40) (32.00), whereas Liquid based rhizobium + 100% RDN (47.40) was statistically at par with T_7.

Number of kernels per pod: Significantly Maximum number of seeds per pod (3.00) was recorded with the treatment in application of Powder based rhizobium + 100% N and minimum was recorded in control (20:40:40) (2.00), whereas Liquid based rhizobium + 100% RDN (2.87) was statistically at par with T_7.

Test weight (g): The perusal of the data of Test weight was recorded at harvest, is presented in Table 1. The data pertained that there was significant effect among different treatments on Test weight (g). Significantly Maximum test weight (36.76 g) was recorded with the treatment in application of Powder based rhizobium + 100% N and minimum was recorded in control (20:40:40) (31.01 g), whereas Liquid based rhizobium + 100% N (35.22 g) was statistically at par with T_7.

Seed yield (kg/ha): Significantly Maximum seed yield (1966.32 kg/ha) was recorded with the treatment in application of Powder based rhizobium + 100% N and minimum was recorded in control (20:40:40) (1735.85 kg/ha), whereas Liquid based rhizobium + 100% N (1943.91 kg/ha) was statistically at par with T_7. The optimum growth of the plant due to favourable nutritional environment and higher uptake of nutrients might have favoured significant increase in number of pegs per plant and thus a greater number of pods per plant. However, Panwar and Singh (2003) [3], Satpute *et al*. (2021) [6], and Zalate and Padmani (2009) [7] reported same. The important growth and yield contributing characters viz., plant spread, number of branches, dry matter accumulation, number of pods and kernels and their weight and thousand kernel weight were significantly increased with the application of P solubilizer treatments with poultry manure due to additional nitrogen and phosphorous uptake, resulting in increased dry pod yield. Increase in root nodules due to P-solubilizer and nitrifying bacteria also helped in increasing better root development and dry pod yield by fixing more nitrogen and consequently increasing its absorption. These results were found to be in conformity with Raychaudari *et al*. (2003) [5] and Chavan *et al*. (2013) [1].

Influence of liquid, powder and gel-based rhizobium and Nitrogen levels on Economics of Groundnut.

Gross returns, Net returns and Benefit cost ratio were significantly influenced due to different treatments.

Cost of cultivation (₹/ha)

Cost of cultivation (35,910.00 ₹/ha) was found to be highest in the treatment Gel based rhizobium + 100% N, and minimum cost of cultivation (33,850 ₹/ha) was found to be in Powder based rhizobium + 50% N as compared to other treatments.

Gross return (₹/ha)

Gross return (1,17,979.22) was found to be highest in the treatment Powder based rhizobium + 100% N, and minimum gross return (1.04,150.80) was found to be in Control (20:40:40) as compared to other treatments.

Net returns (₹/ha)

Net return (78,129.11) was found to be highest in the treatment Powder based rhizobium + 100% N, and minimum Net return (68,700.00) was found to be in Control (20:40:40) as compared to other treatments.

Benefit cost ratio (B:C)

Benefit cost ratio (1.96) was found to be highest in the treatment Powder based rhizobium + 100% N, and minimum Benefit cost ratio (1.81) was found to be in Powder based rhizobium + 50% N as compared to other treatments.

Table 1: Influence of Bio-fertilizers and Levels of Nitogen levels on yield attributes and yield of groundnut.

S No	Treatments	Number of pods per plant	Number of seeds per pod	Test weight	Seed yield (Kg/ha)	Stover yield (Kg/ha)
1.	Powder based rhizobium + 50% N	39.00	1.27	32.00	1774.90	3348.90
2.	Liquid based rhizobium + 50% N	37.00	1.27	31.28	1780.82	3249.20
3.	Gel based rhizobium + 50% N	37.00	1.93	31.04	1774.46	3332.89
4.	Powder based rhizobium + 75% N	43.07	2.07	34.09	1866.22	3398.20
5.	Liquid based rhizobium + 75% N	41.20	2.07	33.15	1864.51	3443.79
6.	Gel based rhizobium + 75% N	40.20	2.07	32.34	1849.02	3431.30
7.	Powder based rhizobium + 100% N	49.20	3.00	36.76	1966.32	3664.20
8.	Liquid based rhizobium + 100% N	47.40	2.87	35.22	1943.91	3519.80
9.	Gel based rhizobium + 100% N	45.00	2.73	35.00	1930.69	3471.20
10.	Control (20:40:40)	32.00	2.00	31.01	1735.85	3344.73
	F – Test	S	S	S	S	S
	SE m (±)	0.64	0.06	0.52	29.48	52.31
	CD (p=0.05)	1.92	0.20	1.56	87.59	155.43

Table 2: Evaluation of Bio-fertilizers and Levels of RDN on Economics of Groundnut.

S No	Treatments	Total cost of cultivation	Gross Return	Net Return	B:C ratio
1.	Powder based rhizobium + 50% N	37,850	1,06,494.00	68,644.00	1.81
2.	Liquid based rhizobium + 50% N	37,870	1,06,848.98	68,978.98	1.82
3.	Gel based rhizobium + 50% N	37,910	1,06,467.39	68,557.39	1.81
4.	Powder based rhizobium + 75% N	38,850	1,11,973.46	73,123.46	1.88
5.	Liquid based rhizobium + 75% N	38,870	1,11,870.53	73,000.53	1.88
6.	Gel based rhizobium + 75% N	38,910	1,10,941.02	72,031.02	1.85
7.	Powder based rhizobium + 100% N	39,850	1,17,979.11	78,129.11	1.96
8.	Liquid based rhizobium + 100% N	39,870	1,16,634.37	76,764.37	1.93
9.	Gel based rhizobium + 100% N	39,910	1,15,841.49	75,931.49	1.90
10.	Control (20:40:40)	35,450	1,04,150.81	68,700.81	1.94

Conclusion

In conclusion, the study demonstrated significant effects of different rhizobium treatments and nitrogen levels on various growth and yield parameters of groundnut. Powder-based rhizobium with 100% nitrogen application consistently outperformed other treatments, resulting in higher numbers of pods per plant, kernels per pod, test weight, seed yield, and economic returns. These findings align with previous research indicating the positive impact of rhizobium treatments on groundnut growth and yield. Moreover, economic parameters such as cost of cultivation, gross returns, net returns, and benefit-cost ratio were significantly influenced by the treatments, with the powder-based rhizobium with 100% nitrogen application showing the most favorable economic outcomes. Overall, these results underscore the importance of optimizing rhizobium treatments and nitrogen levels for enhancing groundnut productivity and economic efficiency.

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