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Impact of Inoculation of Different Rhizobium Strains on Growth and Yield of Groundnut

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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Short Research Article

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ABSTRACT

A field experiment was conducted to study the "Impact of inoculation of different rhizobium strains on growth and yield of groundnut". The experiment was designed with taking inoculation of different strains of *rhizobium*. Inoculation with *rhizobium* had significant impact on plant morphology, yield and yield attributing character over control. The inoculation of Rhizo5(DGR35) produced the maximum plant height/plant (48.1cm), highest number of branches/plant (5.80), numbers of leaves/plant (108.92) at harvest**.** Higher yield and yield attributing characters that is Hundred kernel weight (37.36 g/ha), Pod/plant (19.8), shelling percentage (73.13%), pod yield (1876 kg/ha), haulm yield (3706 kg/ha)**,** with the harvest index (36.1) recorded in Rhizo5(DGR35) inoculation. Thus, kernel inoculation with Rhizo5(DGR35) recommended for higher productivity and profitability in *kharif* groundnut.

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1. INTRODUCTION

Groundnut is a major oil seed crop in Odisha, accounting for more than two-thirds of oilseeds production. The area under groundnut cultivation in Odisha is 68.03 thousand hectares with 110.34 tonnes of production and 1622 kg of productivity per hectare (DGFP, 2020). Despite being one of India's most important crops, groundnut productivity in the heavily cultivated area is constantly decreasing due to the use of imbalanced, high-analytical chemical fertilizers, and limited use of organic fertilizers and manures. This not only reduces soil nutrients, but also worsens soil health and productivity. By incorporating organic sources into nutrient management strategies, it not only increases the macronutrient and micronutrient sources, but also increases the effectiveness of inorganic fertilizers [1] and ultimately ensures long-term soil health and productivity [2]. Symbiotic relationships, also known as legume symbiosis, are well-documented in the leguminous plant. Since groundnut is a leguminosae plant, it is well-known to form a symbiotic relationship with the Rhizobium bacterium. Nitrogen is an essential nutrient for the growth and development of plants. To produce groundnut to its full potential, the efficiency of the biological nitrogen fixation is closely linked to the symbiotic interactions of the plant and the soil dwelling nitrogen fixing bacteria, especially those of the genus Rhizobium. The amount of nitrogen bound to the soil corresponds to the amount of nitrogen of commercial fertilizer [3]. Chemical fertilizers directly affect the nodules of peanut plants, reducing overall production. Therefore, rhizobia cultures are an opportunity to supplement chemical fertilizers with organic fertilizers. Several studies have shown that the gram-negative N-fixing soil bacterium Rhizobium is beneficial to legumes [4]. Its inoculation is a simple and cost-effective technique to increase the productivity of groundnut plants. Rhizobium species living in root nodules have a unique ability to convert atmospheric nitrogen into ammonia, which is readily absorbed by host plants. The host plant in turn provides these bacteria with carbohydrates and protection, forming a mutually beneficial exchange. Nitrogen, as an important component in the production of proteins, enzymes, nucleic acids and chlorophyll, is required for plant growth [5] (Gopalkrishnan et al., 2015), which affects the vegetative growth of peanut plants. Sufficient availability of nitrogen promotes healthy leaf development, root growth and overall plant vitality. However, the genus Rhizobium includes a large number of different bacterial strains, each of which is characterized by its genetic and physiological diversity. These strains have different preferences and efficiencies in establishing symbiotic relationships with specific host plants. Thus, inoculation of the groundnut crop with suitable and compatible rhizobia ensures maximum Biological Nitrogen Fixation. Growth hormones, including indoleacetic acid (IAA), which has beneficial effects on plant growth and is crucial for root nodulation, are secreted by Rhizobium strains [6]. Groundnut is cultivated in one or more (kharif, rabi and summer) seasons, but nearly 90% of acreage and production comes from kharif crop (June-October). Keeping these considerations in mind, a field experiment was conducted to evaluate the effect of different rhizobium inoculations on growth and yield of kharif groundnut.

2. MATERIALS AND METHODS

The Field experiments were conducted at AICRP on groundnut, inside Horticulture Research Station (HRS), Odisha University of Agriculture and Technology, Bhubaneswar, during *Kharif* 2022 to study the effect of seed treatments with different strains of Rhizobia viz Rhizo1 (DGR23), Rhizo2 (DGR24), Rhizo3 (DGR25), Rhizo4 (DGR26), Rhizo5(DGR35), Rhizo6 (TAL1000), Rhizo7(IGR6), Local strain (KHDEB-15). The cultures were procured from Directorate Groundnut Research, Junagarh, Gujarat and one local strains of Odisha. For each treatment were sown at spacing of 30 cm x10 cm on 6^{th} July, 2022. 9 treatments were replicated thrice with randomized complete block design. Soils of the experimental area were light textured with organic carbon and nitrogen content of 0.39% and 255.5kgN/ha respectively for fertilizer application and irrigation schedule Package and Practices were followed.

2.1 Preparation of Solution of Culture and Seed Treatment

About an hour prior to the start of planting, rhizobium inoculations were completed. A 10% jaggery or sugar solution was made with water. Approximately one liter of this solution was used to cure 100 kg of groundnut seeds. To create a slurry, two hundred grams of rhizobium carrierbased culture, comprising 10^{10} cells/g of carriers, was added. The mixture was then combined with a 10% cold solution of jaggery or sugar. Spread out on a firm surface, such as a polythene sheet, the seeds were well mixed with an inoculant strain slurry. Treating small quantities of seed can ensure consistent inoculation.

2.2 Growth and Yield Attributes

Five plants were selected randomly from each plot. Measurements included plant height and the number of main and secondary branches on each plant. Symbiotic effectiveness of the *rhizobial* Strains were seen and significant differences have been recorded for the plant height and number of primary and secondary branches, leaf number with inoculations at 60 DAS after sowing. At the time of harvest, the number of ripe or fully grown pods, immature pods, and gynophores were counted from five randomly chosen plants from each treatment. The kernels were extracted from the pods upon harvesting. Each replication had one hundred kernels removed at random, and the weight of each was recorded in grams (g). At harvest, the pod yield was measured from the net area (4 x 3 m) and reported as kg/ha.

3. RESULTS AND DISCUSSION

3.1 Growth Attributes

Number of leaves per plant, branches and plant height were highest with inoculation treatment Rhizo5(DGR35) followed by Rhizo3(DGR25) (Table 1).

3.2 Yield and Yield Attributes

Plant height improved with the inoculation treatments also the number of branches on per plant basis varied significantly at physiological maturity. Inoculation with *rhizobium* had significant impact on plant morphology, yield and yield attributing character over control. The inoculation of Rhizo5(DGR35) produced the maximum plant height/plant (48.1 cm), highest number of branches/plant (5.80), numbers of leaves/plant (108.92) at harvest.

Higher yield and yield attributing characters that is hundred kernel weight (37.36 g/ha), pod/plant (19.8), shelling percentage (73.13%), pod yield (1876 kg/ha), haulm yield (3706 kg/ha) along with the harvest index (36.1) recorded in Rhizo5(DGR35) inoculation (Table 2). The treatments comprising of different strains of rhizobia had a pronounced effect on yield and attributes plant^{-1} in kharif groundnut. *Rhizobium* inoculated strains recorded higher yield attributes, pod and haulm yield compared to control. Groundnut kernel inoculated with Rhizo5 (DGR35) incurred 18.3% more pod and 28.7% haulm yield compared to control. It also recorded maximum pod and haulm yield compared to different strains of rhizobia. The increased number of bacteria due to synthetic inoculation, which resulted in more leaves and shoots/plant. As per the source sink relationship, more carbohydrates were produced due to a greater number of leaves, sank into the root zone and hence more production. The emergence of gynophore increased depending on the formation of flowers and thus the number of pod per plant

Table 1. Effect of different strains (*rhizobium)* inoculation on plant height(cm), number of branches, number of leaves, in *kharif* groundnut at 60 DAS (days after sowing)

Treatment (T)	Plant height (cm)	No. of Branches	No. of leaves
T_1: Control	25.3	3.80	3.80
T_2:Rhizo1(DGR23)	40.5	4.40	4.40
T_3: Rhizo2(DGR24)	27.9	4.60	4.60
T_4:Rhizo3(DGR25)	43.2	4.70	4.70
T_5:Rhizo4(DGR26)	39.4	4.40	4.40
T_6:Rhizo5(DGR35)	43.9	5.10	5.10
T_7:Rhizo6(TAL1000)	38.7	4.20	4.20
T_8:Rhizo7(IGR6)	26.4	4.10	4.10
T_9: Local strain (KHDEB-15)	39.0	4.30	4.30
SEm(±)	1.67	0.11	0.11
CD (p=0.05)	5.00	0.3421	0.3421

Table 2. Effect of different strains of *rhizobium* inoculation on yield and yield attributes in *kharif* groundnut

Treatment	Total no. of pods/ plant	100 kernel wt.(g)	Shelling %	Pod yield (kg/ha)	Haulm Yield (kg/ha)	Harvest Index %
T_1 : Control	0.24	35.12	70.8	1580	2879	28.7
T_2:Rhizo1(DGR23)	18.5	36.03	71.9	1680	3566	34.2
T_3 :Rhizo2(DGR24)	19	36.15	72.3	1759	3628	34.5
T_4:Rhizo3(DGR25)	19.6	36.23	72.5	1793	3632	35.6
T_5:Rhizo4(DGR26)	17.6	35.87	71.4	1673	3159	33.9
T_6:Rhizo5(DGR35)	19.8	37.36	73.1	1876	3706	36.1
T_7:Rhizo6(TAL1000)	14.6	35.44	71.1	1620	3031	32.7
T_8:Rhizo7(IGR6)	0.77	35.33	70.9	1615	3023	31.2
T_9:Local strain (KHDEB-15)	17.5	35.70	71.3	1629	3044	33.1
SEm(±)	19.80	0.341	2.62	54.1	134.3	1.2
CD (P=0.05)	19.60	1.022	7.94	164.1	407.1	3.5

increased. It also enhanced nutrient availability up to the maturity of crop which increases the synthesis of protein in different parts of plant and ultimately translocate to the developing seeds. Ultimately, yield increase was due to increase in number of mature pods per plant. *rhizobium* inoculation in groundnut positively affected pod weight and shelling% in groundnut. The increased availability of other nutrients with inoculation of *rhizobium* could presumably be attributed to the beneficial effect of *rhizobium* in combination with *rhizobium* on overall growth of the plant owing to the balanced plant nutrition that accordingly resulted into a better crop yield and oil yield [7,8,9,10,11,12,13] (Sajid *et al.,* 2011).

4. CONCLUSION

Rhizobium inoculant strains were effectively competitive or more precisely, and the indigenous rhizobia were already maximally effective. Rhizo5 (DGR35) treated plot gave the optimum growth and yield as compared to any other treatment and control condition. Further research will determine the effectiveness of alternative inoculant strains and conditions for improving groundnut production.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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