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Effect of NPK and biofertilizers on germination of lentil (*Lens culinaries*) in sandy loam soil of Jharkhand

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Abstract
The present experiment entitled 'Effect of Biofertilizers on germination of Lentil (Lens culinaris) in sandy loam soils of Jharkhand' was conducted at the research field of Jharkhand Rai University, Ranchi, Jharkhand during the Rabi season of 2022-23. The experiment was carried out in randomized block design using 8 treatments with 3 replications in net experimental field size of 144 m^2. The experiment was conducted to study the effect of Rhizobium, PSB, VAM on germination parameters of Lens culinaries var. K-75(Mallika). Application of RDF (25:50:25:20:1:: N:P:K:S:B kg/ha) showed the highest germination percentage and germination index, it also recorded the shortest time to germinate. No effect was observed in the germination of lentil due to the influence of biofertilizers (PSB, VAM or Rhizobium).

Keywords: Germination, lentil, rhizobium, PSB, RDF, VAM

Introduction

The role of pulses in human vegetarian diets as a major source of protein and in building and restoring soil fertility is well known. According to the Niti Ayog Working Group on Demand and Supply Projections Towards 2033, the demand for pulses is expected to increase from 26.72 million tonnes in 2021-22 to 32.64 million tonnes in 2029-30. The current production of pulses is 29.96 million tonnes. (PIB, Government of India.) The resilient legume crop, Lentil (*Lens culinaris*) which is grown during the Rabi season, has long been a staple of the human diet. Lentil show hypogeal germination with the root developing out of the seed first followed by shoot emergence. The lentil plant is slender, semi-erect, and bushy annual. The plants normally range from 30-45 cm in height. Flowering begins at lower branches and gradually moves upwards. Flowers are lilac or pale blue. It is grown in Europe, Asia, and North America and is a member of the Fabaceae family. A 24-26% of protein content is seen. India placed first in the world in terms of area, providing 39.79%, and second in terms of production, contributing 22.7% (Directorate of Pulses Development, 2017). Lentils contain amino acids, rich in vitamin A, thiamin, folate, and β- carotene (Bhatty, 1988) [3].

Legumes can fix atmospheric nitrogen, depending on management practices, genetic types, inoculation practices, etc. Nitrogen fixation by legumes is influenced by native soil, rhizobium populations, water availability, soil organic matter content, pH, etc. Effective Rhizobia inoculants and starter fertilizer optimize legume production with appropriate nitrogen management. (Huang *et al*., 2017) [4]. Response to Rhizobium inoculation in lentil is influenced by soil type, cultivars, and Rhizobium strain efficacy.

Phosphorus is the second most important nutrient after nitrogen. Phosphorus is essential for root formation in legume crops, as well as the establishment of an ideal root system and plant growth (Mitran *et al*., 2018) [6].

Many studies indicate that nodule containing legumes have a greater phosphorus demand than non-symbiotic plants, and that a higher phosphorus concentration boosts nitrogen fixation rates in plants (Rotaru *et al.*, 2009) [11]. Phosphorus-soluble bacteria (PSB) inoculants play an important role in making phosphorus available to cultures. Phosphate Solubilizing Bacteria (PSB) as an inoculant improves the availability of phosphorus to the crop and boosts its yield (Zaidi *et al.*, 2017) [14]. Phosphate Solubilizing Bacteria has a significant influence on plant growth parameters such as plant height, number of root nodules/plant, root length, and yield and yield attributing parameters (Singh *et al.*, 2011) [12]. Root inoculation with Vascular-arbuscular mycorrhizae (VAM) contributes in increasing the yield of the plant with better nodulation and increased dry matter production. It increases the uptake surface of the roots and extends beyond the zone of root failure and facilitates the uptake of nutrients such as phosphorus and zinc; promotes the growth of associated plants through the production of auxins and antibiotics and provides a physical barrier to pathogens. The fungi colonize the root and extend hyphae into the soil, which can increase root-soil contact, exploration in micropores, water extraction, and improve water holding capacity. (Auge *et al*. 2003) [2].

Materials and Methods

A field experiment was conducted in Rabi 2022-23 at the research field of Jharkhand Rai University, Ranchi, Jharkhand, India. The soil of the experimental field was sandy loam in texture. There were 8 treatments carried out in the experiment. The treatments were T_1- Control (no nutrient and no biofertilizer), T_2- RDF (25:50:25:20:1 kg NPKSB/ha), T_3 – 75%N+Recommended dose of P,K,S,B + biofertilizer(Rhizobium) @ 200 g/10 kg of seed, T_4-75%P+Recommended dose of N,K,S,B+ Biofertilizer (PSB) @ 10 kg/ha, T_5-75%P+ Recommended dose of N,K,S,B+ Biofertilizer (VAM) @ 10 kg/ha, T_6- 50%N +Recommended dose of P,K,S,B + Biofertilizer (Rhizobium) @ 200 g/10 kg of seed, T_7- 50% P+Recommended dose of N,K,S,B+ Biofertilizer (PSB) @ 10 kg/ha, T_8-50%P + Recommended dose of N,K,S,B +Biofertilizer (VAM) @ 10 kg/ha. The experiment was laid out in RBD design with 3 replications. The gross area of the experimental field was 239.39 m^2 and the net plot size was 3×2 m^2. Row to row distance was 15 cm and plant to plant distance was 10 cm.

- The germination percentage was calculated by

$$\text{Germination \%} = \frac{\text{No.of seeds germinated}}{\text{Total no.of seeds sown}} \times 100$$

- Germination Index was calculated by

Germination Index (GI) = (10 x n1) + (9 x n2) + … + (1 x n10)

where n1, n2 … n10 = No. of germinated seeds on the first, second, and subsequent days until the 10^{th} day; 10, 9 …1 are weights measured of germinated seeds on the first, second, and subsequent days, respectively (Kader, 2005) [5].

Table 1: Initial physio-chemical properties of the experimental soil.

Sl. No.	Soil Properties	Values in 2022-23	Natural Value		
			Low	Neutral	High
1	Soil texture Class	Sandy Loam	-	-	-
1.1	Sand (%)	65.28	-	-	-
1.2	Silt (%)	20.28	-	-	-
1.3	Clay (%)	14.44	-	-	-
2	pH	5.70	<6.0 (Acidic)	6.0-8.5 (Saline)	>9.0 (Alkaline)
3	EC (dS/m)	0.07	-	-	-
4	Organic Carbon (%)	0.16	<0.5%	0.5-7.5 %	>0.75%
5	Available Nitrogen (Kg/ha)	87	<240 kg	480 Kg/ha	>480 Kg/ha
6	Available Phosphorus (Kg/ha)	31.8	<11 kg/ha	11-22 Kg/ha	>22 Kg/ha
7	Available Potassium (Kg/ha)	363.8	<110 Kg/ha	110-280 Kg/ha	>280 Kg/ha
8	Available Sulphur (Kg/ha)	8.74	<10	10-15	>15
9	Available Boron (Kg/ha)	0.42	<0.5	0.5-1.0	>1.0

Results

Germination percentage (%): The seeds in T_2 - RDF (25:50:25:20:1:: N:P:K:S:B kg/ha) showed the highest germination % of 97.87% which was at par with T_3, T_4, T_5, T_6, T_7, T_8 . The least no. of plants germinated in T_1 (control) with 95.03%.

Germination Index: Application of RDF (25:50:25:20:1:: N:P:K:S:B kg/ha) (T_2) showed the best results for germination index with a value of 888.33 which was at par with T_5, T_4, T_7 whereas the least value was seen in T_1 (Control) with value 495.3.

No. of days taken for Germination: There was not much difference in the number of days for germination among the treatments. It is clear from the Table that germination was fastest in T_2 - RDF (25:50:25:20:1:: N:P:K:S:B kg/ha) in which the plants germinated earlier than the other treatments with a mean value of 8.67 days whereas the longest time in germination was recorded in T_1 (control) plot with a mean value is 11.67 days.

Discussion

The germination parameters were influenced by NPK because its effect begins after application (Peram, 2018), as a result application of RDF (25:50:25:20:1 kg NPKSB/ha) (T_2) has taken the shortest period for germination and resulted in higher germination percentage and maximum germination index. Recommended NPK was present in all treatments, hence there was no variation in the number of days for germination among treatments T_2 to T_8 but control (T_1) took the longest of all treatments to germinate due to the absence of any fertiliser. A balanced supply of N, P, and K leads to high seed production and rapid germination, whereas imbalance NPK supply like shortage in P and K combined with a high N supply resulted in limited seed germination ability and rapid germination (Wenjie Yang, 2018). The germination index was significantly improved by the combined application of NPK at recommended doses, in comparison to lower doses. This is because higher rates of nutrients may have stimulated the development of proteins and enzymes in adequate quantities, which acted on the metabolites in the seeds. This resulted in better seed quality and development, ultimately leading to a higher seed vigour index A similar discovery has been reported by Narayanan (2006) [7] and Ramteke *et al* (2012) [8].

Table 2: Effect of biofertilizers on germination.

Treatments	Germination %	Germination Index (GI)	No. of days taken for Germination
T_1 - Control (no nutrient)	95.03	495.33	11.67
T_2 - RDF (25:50:25:20:1 kg NPKSB/ha)	96.87	888.33	8.67
T_3 - 75%N+Recommended dose of P,K,S,B + biofertilizer (Rhizobium) @ 200 g/10 kg of seed	97.87	546.67	9.33
T_4 -75% P+Recommended dose of N,K,S,B+ Biofertilizer (PSB) @ 10 kg/ha	97.17	668.67	9.67
T_5 - 75% P+ Recommended dose of N,K,S,B+ Biofertilizer (VAM) @ 10 kg/ha	97.30	734.67	9.33
T_6 - 50% N +Recommended dose of P,K,S,B + Biofertilizer (Rhizobium) @ 200 g/10 kg of seed	97.00	618.00	10.67
T_7 - 50% P+Recommended dose of N,K,S,B+ Biofertilizer (PSB) @ 10 kg/ha	96.87	705.00	10.33
T_8 - 50% P + Recommended dose of N,K,S,B +Biofertilizer (VAM) @ 10 kg/ha	96.03	535.00	10.00
Sem±	0.31	45.54	0.33
CV	0.98	20.29	8.73
CD (0.05)	1.67	230.57	1.52

Conclusion

The study showed that the treatments given were effective in germinating the seeds rather than the control plot in the plateau region of Jharkhand. The application of a balanced dose of NPK with biofertilizers will help the farmers in better and earlier germination of Lentil which will correspondingly increase the yield.

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