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Effect of levels of Vermi-compost and bio-fertilizers on growth and yield of organic lentil (*Lens culinaris* Medik)

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Abstract
A field research was directed during Rabi Season of 2020 at investigational field of the Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology & Sciences, Prayagraj, and Uttar Pradesh, India, to study the "Effect of Levels of Vermi-compost and Bio-fertilizers on growth and yield of Lentil (*Lens culinaris* Medik). The experiment comprises of 3 Levels of Vermi-compost @ (75%,100%, 125%) and Bio-fertilizers (Rhizobium & PGPR) at 20g/kg seed and was carried out through a statistical design of Randomized Block Design (RBD) with 3 replications. Variety used was K-73. Description of the study indicate that, among the three different levels of Vermicompost and Bio-fertilizers the application of Vermicompost @125% + Rhizobium + PGPR) treated plots produced significantly Dry weight/plant (5.7 g), Number of Pods/plant (58.7), Number of Seeds/Pod (1.7), Test weight (19.2 g), Seed Yield (2520 kg/ha) and Harvest index (33.4). Treatment combination with Vermicompost @125% + Rhizobium+ PGPR has upstretched highest Gross returns (201600.00 INR/ha), Net returns (144110.00 INR/ha) and Benefit Cost ratio (2:5) when compared to the control (RDF).

Keywords: Bio-fertilizers, benefit cost ratio, PGPR, *Psuedomonas fluorescence*

Introduction
Pulses have been considered important rudiments of cropping systems. Their inference in the agricultural manufacture system lies in the fact that they are natural nitrogen fixers and help maintain soil fertile. Lentil crop broadly grown in India during Rabi season. Lentil is one of the prime pulse crops cultivated in semi-arid region of the world, particularly In India sub-continent and the dry areas of Middle East (Malik, 2005) [16]. India being first in area and second in production of lentil. global production of lentils was 6.3 million tonnes.

Bio-fertilizers are living Microorganisms of Bacterial, Fungal and Algal origin. They solubilize the insoluble forms of phosphates like Tricalcium, Iron and Aluminium Phosphates into accessible forms. They scavenge phosphate from soil layers and produce hormones and antimetabolites which promote root growth. (Kumar, 2008) [15]

Rhizobium is comparatively more effective and widely used Bio-fertilizer. Effective nodulation of leguminous crop by rhizobium largely depends on the obtainability of a well-matched stain for a particular legume. Rhizobium population in the soil is hooked on the presence of legumes crops in field (Ahmadpour, 2017) [1].

Plant growth promoting Rhizobacteria (PGPR) shows a dynamic role in the sustainable agriculture industry. The mechanisms of PGPR embrace adaptable hormonal and nutritional balance, persuading resistance against plant pathogens, and solubilizing nutrients for easy uptake by plants. In addition, PGPR show synergistic and antagonistic interactions with microorganisms within the rhizosphere and beyond in bulk soil, which discursively boosts plant growth rate. There are many bacteria species that act as PGPR.

Pseudomonas fluorescens is an aerobic, gram-negative, ubiquitous organism present in agricultural soils and well altered to grow in the rhizosphere. This rhizobacterium holds many characters to act as Bio Control agent and to promote the plant growth ability. In the plant rhizosphere, It produces a wide spectrum of bioactive metabolites, that is, antibiotics, siderophores, volatiles, and growth-promoting substances which contends aggressively with other microorganisms and adapts to environmental stresses. In addition, pseudomonads are responsible for the natural suppressive of some soil stomached pathogens (Khanna, 2006) [14].

Materials and Methods

The present examination was carried out during *Rabi* 2020 at Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj, UP, which is located at 25.28ºN latitude, 81.54ºE longitude and 98 m altitude above the mean sea level. K-73 variety used for sowing lentil. The experiment laid out in Randomized Block Design which consisting of Ten treatments with T1: CONTROL, T2:75% Vermicompost + Rhizobium, T3: 75% Vermicompost + PGPR, T4:75**%**Vermicompost + Rhizobium + PGPR, T5:100% Vermicompost + Rhizobium, T6:100% Vermicompost + PGPR, T7: 100% Vermicompost + Rhizobium ++ PGPR, T8:125% Vermicompost + Rizobium, T9: 125% Vermicompost + PGPR, T10:125% Vermicompost + Rizobium + PGPR. The experimental site was uniform in topography and sandy loam in texture, nearly neutral in soil reaction (P^H 7.1), low in Organic carbon (0.38%), medium available N (225 kg ha^{-1}), higher available P (19.50 kg ha^{-1}) and medium available K (213.7 kg ha^{-1}). In the period from germination to harvest several plant growth parameters were recorded at systematic intervals along with it after harvest several yield parameters were recorded those parameters are growth parameters, plant height, branches per plant and plant dry weight are recorded. The yield parameters like Pods per plant, seeds per Pod, grain yield, test weight (1000 seeds), Stover yield and harvest index were recorded and statistically analyzed using analysis of variance (ANOVA) as applicable to Randomized Block Design (Gomez K.A. and Gomez A.A. 1984).

Results and Discussions

Effect of Levels of Vermi-compost and Bio-fertilizers ON Plant Height on Lentil

At Harvest the Uppermost plant height (35.7 cm) was chronicled by T_{10}(Vermicompost@125% + Rhizobium + PGPR) .Where T_7 (Vermicompost @ 100%+Rhizobium + PGPR) and T_4 (Vermicompost 75% +Rhizobium+PGPR) had recorded (35.4 cm and 35.4 cm) which was statistically at par with T_{10}(Vermicompost@125% + Rhizobium + PGPR).

The increase in plant growth was credited to the increase accessibility of nutrients with application of organic fertilizer, unceasing supply of nutrients due to the action of biofertilizers and release of nutrients from organic fertilizer plays fundamental role in several physiological and biochemical processes, *viz*., root development, photosynthesis, energy transfer reaction and symbiotic biological N-fixation process.

Effect of Vermi-compost and Bio-fertilizers on Branches/Plant of organic Lentil

At 75 days the Highest number of Branches/Plant (5) was chronicled by T_{10}(Vermicompost@125% + Rhizobium + PGPR) .Where T_7 (Vermicompost @ 100%+Rhizobium + PGPR) and T_4 (Vermicompost 75% + Rhizobium +PGPR) had recorded (5.6 and 5.6) which was statistically at par with T_{10}(Vermicompost@125% + Rhizobium + PGPR).

The Highest Number of Branches / plant was attributed to the mutual effect of vermicompost and biofertilizers. Vermicompost improved the physical property of soil and activities of *Rhizobium* culture, and PGPR temper root development and growth through the construction of phytohormones, secondary metabolites and enzymes. The inhibitory effect of apical bud upon lateral bud results in the production of Highest number of branches due to the application of levels of vermicompost and Bio fertilizers.

Effect of Vermi-compost and bio-fertilizers on dry matter accumulation of organic lentil

At 75 days the Highest plant dry weight (5.7 g) was chronicled by T_{10}(Vermicompost@125% + Rhizobium + PGPR). Where T_7 (Vermicompost @ 100%+Rhizobium + PGPR) and T_4 (Vermicompost 75% +Rhizobium + PGPR) had recorded (5.6 and 5.6 g) which was statistically at par with T_{10}(Vermicompost@125% + Rhizobium + PGPR).

As regards the combined submission of applied nutrients *viz*., vermicompost and biofertilizers results in more production of effective leaves, that is more photosynthetic surface and efficiency activity that resulted in augmented production of photosynthates and more increased assimilatory apparatus under the combined or integrated nutrient supply system.

Effect of Vermi-compost and bio-fertilizers on no. of nodules /plant, no. of pods/plant, no. of seeds/pod in organic lentil

Number of Pods /Plant

Number of Pods/Plant were found significant. The highest number of pods/plants was chronicled (58.7) by T_{10}(Vermicompost@125% + Rhizobium + PGPR) .Where T_7 (Vermicompost @ 100%+Rhizobium + PGPR) and T_4 (Vermicompost 75% + Rhizobium +PGPR) recorded (57.3 and 57.1) which was significantly at par with T_{10}(Vermicompost@125% + Rhizobium + PGPR).

Number of Seeds/Plant

Number of Seeds/Pod were found significant .The highest number of seeds/plant was chronicled (1.7) by T_{10}(Vermicompost@125% + Rhizobium + PGPR) .Where T_7 (Vermicompost @ 100%+Rhizobium + PGPR) and T_9 (Vermicompost @125% + PGPR) recorded (1.6 and 1.4) which was significantly at par with T_{10}(Vermicompost@125% + Rhizobium + PGPR).

Test Weight

Test Weight were found Significant .The highest test weight was chronicled (19.2) by T_{10}(Vermicompost@125% + Rhizobium + PGPR) where T_1 (Vermicompost@75%+Rhizobium), T5 (Vermicompost @100%+Rhizobium),T_7 (Vermicompost @100% +Rhizobium +PGPR) T_8 (Vermicompost @ 125% + Rhizobium), T_9 (Vermicompost@ 125%+Rhizobium + PGPR) was recorded (17.7, 17.6, 18.1, 17.5, and 17.2) Which was statistically at par with T_{10}(Vermicompost@125% + Rhizobium + PGPR).

No. of Nodules/ Plant

At 75 days the Highest number of Nodules/Plant (23.0) was chronicled by T_{10}(Vermicompost@125% + Rhizobium + PGPR). Where T_7 (Vermicompost @ 100%+Rhizobium + PGPR) and T_4 (Vermicompost 75% + Rhizobium +PGPR) had recorded (22.0 and 21.3) which was statistically at par with T_{10} (Vermicompost@125% + Rhizobium + PGPR).

Integrated nutrient management in legumes is of great importance as it inspires the root nodulation, growth and productivity per unit. Inaddition to soil health on the sustainable basis, Root-nodulation study indicated that the combined application of Vermicompost + *Rhizobium* culture

+ PGPR, Rhizobium–legume associations are of great ecological and agronomic importance

Effect of Vermicompost and Biofertilizers on yield and yield attributes in Organic Lentil.

Data in Table 2 tabulated the yield and yield attributes of Organic Lentil and there was increasing in seed yield (2520.3 t/ha) and Stover yield (5959.3 t/ha) which are chronicled maximum with the application of T_{10} Vemicompost@125%+Rhizobium +PGPR which was significantly higher. Where T_7 (Vermicompost + Rhizobium +PGPR) was recorded (1619.7 & 2049.3 t/ha) which was statistically at par with T_{10}(Vermicompost@125% + Rhizobium + PGPR. Although in the Harvest index maximum chronicled with the application of Vemicompost @ 125%+Rhizobium +PGPR

This may be due to the stimulatory effect in cell division, cell elongation and background of cell structure and also higher dose may be accountable for increased leaf area and chlorophyll content causing higher photosynthesis and assimilation, metabolic activities responsible for overall reproductive phase and ultimately amended the seed yield.

Table 1: Effect of vermicompost and biofertilizers on growth attributes of organic lentil

Treatments	Plant height (cm)						No. of Branches/plant			Dry Matter Accumulation			
	15 DAS	30 DAS	40 DAS	60 DAS	At harvest	30 DAS	45 DAS	60 DAS	At harvest	30 DAS	45 DAS	60 DAS	At harvest
1.CONTROL	5.1	9.0	11.8	16.3	30.6	0.8	1.8	3.2	3.4	1.0	1.7	2.8	4.6
2.Vermi@75%+Rhizobium	5.3	9.4	12.3	16.8	32.3	0.9	2.4	3.2	4.0	1.0	1.8	3.3	4.8
3.Vermi @75%+PGPR	5.4	9.6	12.3	17.0	32.7	1.0	2.5	3.4	4.1	1.0	2.4	3.2	5.1
4.Vermi@75%+Rhizobium+PGPR	5.9	9.7	12.7	19.4	35.4	1.3	3.1	3.8	5.6	1.2	3.1	3.6	5.6
5.Vermi @100%+Rhizobium	5.5	9.7	12.5	18.2	33.5	0.9	2.9	3.5	4.3	1.1	3.0	3.4	5.2
6.Vermi@100%+PGPR	5.6	9.7	12.6	18.5	33.2	1.0	2.7	3.3	4.1	1.1	2.7	3.5	5.3
7.Vermi@100%+Rhizobium+PGPR	6.3	10.1	13.0	19.7	35.4	1.8	3.7	4.2	5.6	1.3	3.3	3.8	5.6
8.Vermi@125% +Rhizobium	5.9	9.9	12.8	18.5	34.1	1.0	3.1	3.2	3.9	1.1	2.7	3.4	5.4
9.Vermi @125% +PGPR	6.0	9.8	12.8	19.0	33.9	1.0	3.1	3.3	3.9	1.1	2.8	3.5	5.3
10.Vermi@125%+Rhizobium+PGPR	6.5	10.4	13.1	20.0	35.7	1.9	3.9	4.5	5.8	1.4	3.4	3.9	5.7
F test	S	S	S	S	S	S	S	S	S	S	S	S	S
S. em (+)	0.07	0.07	0.07	0.10	0.12	0.07	0.08	0.11	0.07	0.03	0.14	0.13	0.05
CD (5%)	0.23	0.22	0.23	0.31	0.36	0.23	0.25	0.32	0.23	0.11	0.41	0.38	0.15

Table 2: Effect of Vermicompost and Biofertilizers on yield attributes of Organic Lentil

Treatments	Siliquae/plant	Seeds/Siliquae	Test weight (g)
1.CONTROL	1.1	52.8	17.7
2.Vermi@75%+Rhizobium	1.2	53.9	16.6
3.Vermi @75%+PGPR	1.3	55.1	15.5
4.Vermi@75%+Rhizobium+PGPR	1.5	57.1	16.9
5.Vermi @100%+Rhizobium	1.3	55.2	17.6
6.Vermi@100%+PGPR	1.3	53.8	16.7
7.Vermi@100%+Rhizobium+PGPR	1.6	57.3	18.1
8.Vermi@125% +Rhizobium	1.2	53.8	17.5
9.Vermi @125% +PGPR	1.4	55.1	17.2
10.Vermi@125%+Rhizobium+PGPR	1.7	58.7	19.2
F- test	S	S	S
S. EM (±)	0.12	0.86	0.76
C. D. (P = 0.05)	0.35	2.48	2.20

Table 3: Effect of Sulphur levels and Spacing on yield and yield Attributes fo Oragnic Lentil

Treatments	Seed yield (t/ha)	Stover yield (t/ha)	Harvest index (%)
1.CONTROL	550.0	5482.7	33.4
2.Vermi@75%+Rhizobium	1596.3	5223.0	34.2
3.Vermi @75%+PGPR	1615.0	5558.7	37.5
4.Vermi@75%+Rhizobium+PGPR	1969.7	5706.7	35.7
5.Vermi @100%+Rhizobium	1866.0	5541.7	37.6
6.Vermi@100%+PGPR	1893.3	5247.0	34.9
7.Vermi@100%+Rhizobium+PGPR	2049.0	4672.7	29.5
8.Vermi@125% +Rhizobium	1965.3	5486.0	35.9
9.Vermi @125% +PGPR	1749.3	5534.0	37.7
10.Vermi@125%+Rhizobium+PGPR	2520.3	5959.3	38.4
F- test	S	S	S
S. EM (±)	22.7	33.73	0.73
C. D. (P = 0.05)	65.7	97.43	2.13

Conclusion

It is concluded from the above discussion that application of Vermicompost @125 (6.5 t/ha)+ Biofertilizers (Rhizobium+ PGPR) @ 20g/Seed treated plots in Lentil was originated to be the best, that recorded significantly higher crop growth rate, seed yield. It also drew the maximum Gross return, Net

return, and benefit cost ratio as associated to other treatment combinations.

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