Original Research Article

Influence of Bio fertilizers and Zinc on growth and yield of Lentil (*Lens culinaris* L.)

Abstract

A field experiment conducted was Crop Research Farm, Department of Agronomy, Sam Higginbottom University of Agriculture, Technology and Science, Prayagraj,(U.P), during the *rabi* season of 2021-22 with the objective to study the **"Influence of bio fertilizers and zinc on growth and yield of lentil *(Lens culinaris* L.)".**The soil in the experimental plot was sandy loam in texture, pH (7.2),low in organic carbon (0.82%),available N (274.48kg/ha), available P (26.80kg/ha) and available K (230.24kg/ha).The layout of the experiment was done in a Randomized block designs with nine treatments which has been replicated thrice. The bio fertilizers (rhizobium, phosphate solubilizing bacteria(psb) and vesicular arbuscular mycorrhiza(vam)) @ 25g/kg seeds and three levels of zinc (4,5,6 kg/ha).Growth and yield parameters namely plant height ,number.of nodules plant^{-1},dry weight, pods plant^{-1},number of seeds/pod ,test weight, seed yield ,Stover yield ,harvest index were collected from this experiment .The experiment results revealed that (treatment 3) Rhizobium at 25g/kg seeds + Zinc at 6kg/ha recorded Maximum plant height (35.24cm),dry weight (25.64),number of nodules (8.33/plant),pods/plant (160.32),seeds/pod (1.89),seed yield (1.79 t/ha),Stover yield (2.60 t/ha). Maximum gross return (91290.00 INR/ha), net returns (62405.65 INR/ha),and benefit cost (2.16)

Keywords : Economics ,Bio fertilizers Rhizobium, PSB,VAM, Zinc

Introduction

Lentil (*Lens culinaris or Lens esculenta*) is an edible legume. It is about 40 cm (16 inch) tall, and the seeds grow in pods, usually with two seeds in each. Lentil is a self-pollinated crop with very low percentage of natural out crossing .It belongs to the family Leguminosae, sub family papillionaceae.. Lentil is also known as a "poor mans" meat because of its rich protein content **(Bhatty,1984).**It contain about water 11%, protein 22 to 25%and carbohydrates 43.4-74.9g, fat 0.3-3.5g. It is also rich in iron, calcium, phosphorus and magnesium, niacin and high lysine and tryptophan content **(Erskine *et al.*2009)** .A significant amount of vitamin A and B is also provided by lentil **(Zafar *et al*. 2003).**

In India lentil ranked first in area and second in production with 39.79% and 22.79% of world area and production respectively. Canada rank first in production (41.16%) due to very high level of productivity(1633kg/ha) as compared to India (611kg/ha)

Bio fertilizers are gaining importance as they are eco-friendly, non-hazardous and non-toxic. The increasing demand for production of crops and food for such a vast population has led to an interest and necessity for the use of biofertilizers for the betterment of the crops and even for the health of soil.Rhizobium inoculation is essential for all the pulse crops to increase the yield of pulses. Rhizosphere, seed inoculation of legumes with an efficient rhizobial strain is necessary. It is a biofertilizers which increase symbiotic nitrogen fixation and ultimately it increase the yield. The presence of efficient and specific strains of rhizobium in the rhizosphere is one of the most important requirement for proper establishment an growth of grain legume plant **(Gyaneshwar *et al*. 2002).**

Microorganisms belongs to Phosphate solubilizing bacteria (PSB) can produce bioactive molecules and organic acids as inoculants in soil increase the phosphorous uptake by the plants and also improve the crop yield.These organisms also helpful to contribute phytate activity in plants that can produce phosphorous in plant by mineralization. **(A.K Bera *et al*.2013)**. The ability of phosphate solubilizing bacteria to convert insoluble form into soluble one. It increase crops yield particularly of pulse crop.

The word mycorrhiza is given to a mutualistic association between a fungus (Myco) and the roots (rhizo of the plants). Vesicular arbuscular mycorrhiza improve plant nutrition,mycorrihizal colonization of roots occurs in all agro ecosystem.The hyphae of fungus are able to take up nutrients such as phosphorous, zinc, copper and transport to host plant, thereby improving plant nutrition.Vam fungi improved nodulation in both lentil and black gram. Vesicular arbuscular mycorrhiza produce moisture requirement and increase the drought resistance of the crops.The fungus uses the carbon provided by the plant for its physiological function,growth and development. They improve soil structure, enhance plant health and vigor and minimize stress caused by pathogenic fungi, weed& pollution from heavy metals**.(Chen *et al*.2005).**

Zinc regulates auxin concentration in plants and helps in the synthesis of protein, chlorophyll etc**.(Singh *et al.*2003).** zinc plays a greater role during reproductive phase especially during fertilization .Remarkably pollen grain contains zinc in very high quantity. At the time of fertilization most of zinc is diverted to seed only **(Jenik and Barton 2005, Pandey and Gautam 2009).** Zinc deficiency occurs plant growth and development by reduce enzyme activity, disturbing ribosomal stabilization, and decreasing the rate of protein. It induces reducing flowers ovule infertility, low seed set and yield reduction.

MATERIALS AND METHODS

The experiment was carried out during *Rabi* season of 2021 at the CRF (Crop Research Farm) SHIATS, Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh. The crop Research Farm is situated at 25.750 N latitude, 87.190 E longitude and at an altitude of 98m above mean sea level. This area is situated on the right side of the river Yamuna and by the opposite side of Prayagraj City. After

completing presowing irrigation the field was ploughed and after levelling up.KLS-0903(Krishi) Lentil variety was sown 40-45kg/ha.seed inoculated by Rhizobium, Phosphate solubilizing bacteria (PSB),Vesicular arbuscular mycorrhiza (VAM). All nutrients were NPK applied in the form of Urea, Single super phosphate(SSP)and Murate of potash(MOP). Entire dose of P and K was applied basal for respective plots, half dose of N (as urea) was applied as basal, one-fourth at 30 days after sowing and remaining one-fourth at the time of flowering. Zinc levels are (4,5,6 kg/ha) was applied as soil application along with NPK fertilizers before sowing.In order to minimize weed competition hoeing cum weeding was done 20days after sowing. To main uniform plant stand at an intra-row spacing of 20cm extra plant were thinned out. weeding and hoeing was done with khurfi 30&45 days after sowing to facilitate aeration and removing the weeds.Neem oil 2% was sprayed to control insect pest particularly aphids. The lentil crop was harvested treatment wise at harvesting maturity stage. Growth parameters viz.plant height, dry matter accumulation were recorded manually on five randomly selected representative plants from each plot of each replication separately and after harvesting,seeds were separated from each net plot and were dried under sun for seven days. Later threshed,cleaned and seed yield,stover yield from each net plot was recorded and expressed in tonnes per hectare. The benefit cost ratio was worked out after price value of seed with straw and total cost included in crop cultivation

RESULT AND DISCUSSION

Growth attributes

It is noticed table 1. the influence of biofertilizers and Zinc on growth and yield of lentil the result revealed that maximum plant height (35.24cm), number of nodules/plant (25.64),Plant dry weight(8.33/plant) increased significantly with application of Rhizobium 25g/kg seeds + 6kg/ha $ZnSo_4$(treatment 3) as compared to other treatments statistically at par to Rhizobium 25g/kg seeds + 5kg/ha $ZnSo_4$(treatment 2).Rhizobium inoculation significantly increased seed yield by 35%.it may be due to increase in the availability of soil nitrogen to the plants for increased growth and development as rhizobium present in root nodules fixes atmospheric nitrogen. Zinc can help in the nodulation activity due to enzymatic activity and nitrogen fixation which ultimately increase nodulation. Higher dry matter accumulation depends upon the photosynthesis and respiration rate, which finally increases the plant growth with respect to increased plant height, number of nodules etc. The favourable effect of plant growth regulator and zinc might influence the metabolism of the plant, effect on photosynthetic pigments and activity of enzymes which in turn helps to increase in the vegetative growth.An enhanced growth and higher dry matter accumulation due to application of zinc. Zinc produce the growth hormones and precusor of auxins i.e. tryptophan.The results on higher crop growth was also reported by **Debnath *et al.* (2018) ,Narinder singh *et al.* (2016)**

Yield attribute

It is observed in table 2, the influence of Biofertilizers and Zinc on growth and yield of lentil the result revealed that higher number of pods/plant (160.32),number of seeds/ pod(1.89) ,seed yield(1.76t/ha), stover yield(2.60t/ha) was observed with application of Rhizobium 25g/kg seeds +6kg/ha

$ZnSo_4$(treatment 3) compared to other treatments statistically at par to PSB 25g/kg seeds + 6 kg/ha $ZnSo_4$(treatment 6) effect of rhizobium may be due to better availability of nitrogen to plants it will play an important role in increasing the crop production.Rhizobium produce growth hormones which stimulates root morphology. increasing in the number of such microorganisms accelerates the microbial process to augment to the extent availability of nutrient in the form which easily assimilated by the plant. Zinc has a greater role in the production of auxin and indole acetic acid, which helps in increased plant growth which resulted in more pods per plant .another reason is that zinc helps in more number of branches due to formation of stamens and pollens.zinc play role in photosynthesis, enzymes activation,fertilization and transolaction of assimilates towards the seeds will increase.The addition of rhizobium and zinc they increase might be due to better crop growth and development .The results of the present investigation are in close conformity with the findings of **Amit Kumar Tiwari *et al.* (2018)and Upadhyay R.G.,*et al.* (2016)**

Economics

It is noticed in table 3, the influence of Biofertilizers and Zinc on growth and yield of lentil the result revealed that higher cost of cultivation, gross return and net return increased with Rhizobium and Zinc. Application of Rhizobium at 25g/kg seeds +6kg/ha $ZnSo_4$(treatment 3) recorded highest gross return (91290.00 INR/ha), net returns (62405.65 INR/ha) and B:C ratio (2.16) This was attributed to increase in grain and straw yield as comparatively less cost than additional income under these treaments. Similarly results were also reported by **Rasool, S., & Singh, J. (2016).**

Table 1. Influence of Biofertilizers and zinc on growth parameters of Lentil

Treatments	Plant height (cm)	No.of nodules/plant	Plant dry weight (g/plant)	Crop growth rate ($g/m^2/day$)	Relative growth rate (g/g/day)
1. Rhizobium 25g/kg seeds + 4 Kg/ha $ZnSO_4$	34.82	7.663	25.36	9.93	0.0140
2 Rhizobium 25g/kg seeds + 5 Kg/ha $ZnSO_4$	35.15	8.00	25.55	9.96	0.0140
3.Rhizobium 25g/kg seeds + 6 Kg/ha $ZnSO_4$	35.24	8.333	25.64	10.00	0.0140
4. PSB 25g/kg seeds + 4 Kg/ha $ZnSO_4$	32.78	6.67	24.12	9.63	0.0143
5. PSB 25g/kg seeds + 5 Kg/ha $ZnSO_4$	33.02	7.00	24.26	9.73	0.0140
6. PSB 25g/kg seeds + 6 Kg/ha $ZnSO_4$	33.28	7.333	24.48	9.63	0.0143
7. VAM 25g/kg seeds + 4Kg/ha $ZnSO_4$	30.88	6.00	22.92	10.03	0.0153
8. VAM 25g/kg seeds + 5Kg/ha $ZnSO_4$	31.20	6.33	23.16	10.13	0.0150
9. VAM 25g/kg seeds + 6Kg/ha $ZnSO_4$	31.46	6.663	23.34	10.20	0.0150
F test	S	S	S	S	S
SEm (±)	0.03	0.30	0.03	0.08	0.001
CD (5%)	0.09	0.89	0.09	0.25	0.00

Table 2 Influence of Biofertilizers and Zinc on yield parameters of lentil

Treatments	No.of pods/plant	No.of Seeds/pod	Test weight (g)	Seed yield (t/ha)	Stover yield (t/ha)	Harvest index (%)
1. Rhizobium 25g/kg seeds + 4 Kg/ha $ZnSo_4$	155.84	1.49	18.84	1.58	2.32	40.51
2 Rhizobium 25g/kg seeds + 5 Kg/ha $ZnSo_4$	157.76	1.71	18.82	1.68	2.46	40.58
3.Rhizobium 25g/kg seeds + 6 Kg/ha $ZnSo_4$	160.32	1.89	18.82	1.79	2.60	40.77
4. PSB 25g/kg seeds + 4 Kg/ha $ZnSo_4$	155.62	1.39	18.86	1.55	2.28	40.47
5. PSB 25g/kg seeds + 5 Kg/ha $ZnSo_4$	157.42	1.66	18.84	1.65	2.43	40.44
6. PSB 25g/kg seeds + 6 Kg/ha $ZnSo_4$	160.20	1.85	18.84	1.76	2.56	40.74
7. VAM 25g/kg seeds + 4Kg/ha $ZnSo_4$	155.34	1.28	18.93	1.51	2.24	40.26
8. VAM 25g/kg seeds + 5Kg/ha $ZnSo_4$	156.64	1.56	18.88	1.62	2.41	40.20
9. VAM 25g/kg seeds + 6Kg/ha $ZnSo_4$	159.44	1.82	18.82	1.71	2.51	40.52
F test	S	S	NS	S	S	NS
SEm (±)	0.04	0.02	0.03	0.02	0.02	1.08
CD (5%)	0.12	0.07	-	0.06	0.06	-

Table 3. Influence of Biofertilizers and zinc on Economics of lentil

S. No	Treatments	Cost of cultivation (INR/ha)	Gross return (INR/ha)	Net return (INR/ha)	B:C ratio
1	Rhizobium 25g/kg seeds + 4 Kg/ha $ZnSO_4$	28610.35	80580.00	51969.65	1.82
2	Rhizobium 25g/kg seeds + 5 Kg/ha $ZnSO_4$	28747.35	85680.00	56932.65	1.98
3	Rhizobium 25g/kg seeds + 6 Kg/ha $ZnSO_4$	28884.35	91290.00	62405.65	2.16
4	PSB 25g/kg seeds + 4 Kg/ha $ZnSO_4$	28538.35	79050.00	50511.65	1.77
5	PSB 25g/kg seeds + 5 Kg/ha $ZnSO_4$	28675.35	84150.00	55474.65	1.93
6	PSB 25g/kg seeds + 6 Kg/ha $ZnSO_4$	28812.35	89760.00	60947.65	2.12
7	VAM 25g/kg seeds + 4Kg/ha $ZnSO_4$	28502.35	77010.00	48507.65	1.70
8	VAM 25g/kg seeds + 5Kg/ha $ZnSO_4$	28639.35	82620.00	53980.65	1.88
9	VAM 25g/kg seeds + 6 Kg/ha $ZnSO_4$	28776.35	87210.00	58433.65	2.03

Conclusion

From the present study it can be concluded that for better crop growth and productivity of lentil, the seeds must be inoculated with rhizobium at 25g/kg seeds and crop must be fertilized with 6kg/ha $ZnSo_4$ recorded highest growth and yield parameter,which may be more preferable for farmers since it is economically more profitable and hence,can be recommended to the farmers.

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