Original Research Article

Influence of Biofertilizers and Zinc on Yield and Economics of Barley (Hordeum vulgare L.)

ABSTRACT

The field experiment entitled "Influence of Biofertilizers and Zinc on Yield and Economics of Barley"was conducted during *Rabi* season, 2022 at Crop Research Farm in the Department of Agronomy, Naini Agriculture Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj Uttar Pradesh. The treatment consisted of Biofertilizers [*Azotobacter*, PSB and *Azotobacter* + PSB], Zn (20, 25 and 30 kg/ha) and control. The experiment was layout in Randomized Block Design (RBD) with 10 treatments and replicated thrice. The soil in the experimental area was sandy loam with pH (8.0), Organic Carbon (0.62%), Available N (225 kg/ha), Available P (38.2 kg/ha) and Available K (240.7 kg/ha). Application of *Azotobacter* + PSB and Zn 30 kg/ha produces higher grain yield (4.29 t/ha), straw yield (6.72 t/ha), Gross return (108675 INR/ha), Net return (78555 INR/ha) and B:C (2.61).

Keywords: Barley, Biofertilizers, Zinc, Yield, Economics

INTRODUCTION

After wheat, rice, and maize, barley (Hordeum vulgare L.) is the fourth most significant cereal in the world. Brewing industries use barley primarily for the production of malt. When opposed to wheat, barley grains and straw are more digestible because they don't contain gluten.When it comes to production and acreage among Rabi cereals in India, barley comes in second place to wheat. The northern plains of India, specifically the states of Uttar Pradesh, Haryana, and Rajasthan, are where barley is primarily farmed. With an average productivity of 29.88 q/ha, barley was grown on 609000 ha in India, producing 1818000 tonnes. With more than 52% of the nation's production and 46% of its total land, Rajasthan is India's largest state, followed by Uttar Pradesh. In Uttar Pradesh, barley was cultivated on 159.0 thousand ha area with 498.0 thousand tonnes of production at an average productivity of 31.32 q/ha**(IIWBR, 2020-21)**.

Azotobacter are abiotic, naturally occurring soil microorganisms that bind atmospheric nitrogen that is unavailable to plants and play a significant role in the nitrogen cycle in nature.Inoculation with *Azotobacter* has been found to reduce the requirement of chemical fertilizer up to 50 per cent **(Soleimanzadeh and Gooshchi, 2013)**. Azotobacter, the most widespread heterotrophic free-living bacterium, is crucial for crop production. In order for fertiliser to be available to plants, bio-fertilizer typically comprises microorganisms with specific functions, such as N2 fixation by Azospirillum and phosphorus solubilization by P solubilizing bacteria from the soil. **(Saraswati and Sumarno, 2008)**.

Sandy soils and soils high in calcium carbonate are linked to several zinc deficiency issues around the world. Zinc deficiencies occur all over the world on a variety of soil types, but semi-arid locations with calcareous soils, tropical regions with heavily worn soils, and soils with a sandy texture tend to be the most severely affected. **(Akay, 2011)**. Acidic, calcareous, and weathering soils can all exhibit zinc shortage. In calcareous soils, zinc insufficiency frequently coexists with iron deficit. The adsorption of aqueous zinc in these soils by clay and limestone particles is a contributing factor to zinc insufficiency. Zinc insufficiency in degraded soils is brought on by a lack of organic matter. **(Alam *et al*., 2010)**

2. MATERIALS AND METHODS

This experiment was laid out during the *Rabi* season of 2022 at Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj (U.P.). The crop research farm is situated at 25^0 39” 42” N latitude, 81^0 67” 56” E longitude and at an altitude of 98 m above mean sea level. The experiment was laid out in Randomized Block Design Which consisted of ten treatments with T_1 – *Azotobacter* + Zn 20 kg/ha, T_2 –*Azotobacter* + Zn 25 kg/ha, T_3 – *Azotobacter* + Zn 30 kg/ha, T_4 - PSB + Zn 20 kg/ha, T_5 - PSB + Zn 25 kg/ha, T_6 - PSB + Zn 30 kg/ha, T_7 - *Azotobacter* + PSB + Zn 20 kg/ha, T_8 - *Azotobacter* + PSB + Zn 25 kg/ha, T_9 - *Azotobacter* + PSB + Zn 30 kg/ha, T_{10} - Control (NPK 80-30-20 Kg/ha).Seeds are sown at a spacing of 23 cm × 5 cm to a seed rate of 100 kg/ha. The recommended dose of nitrogen (80 kg/ha), phosphorus (30 kg/ha) and potassium (20 kg/ha) in the form of Urea, DAP and MOP, respectively and Biofertilizer and zinc were applied as per the treatments. Data recorded on different aspects of the crop, *viz.*, growth, yield attributes were subjected to statistically analysis by analysis of variance method. (**Gomez and Gomez, 1976)** and economic data analysis mathematical method.

Result and Discussion

Grain Yield (t/ha):

At harvest, Treatment 9 [*Azotobacter* + PSB + Zinc 30 kg/ha], was recorded significantly maximum Seed yield (4.29 t/ha) which was superior over all other treatments. However, treatment 8 [*Azotobacter* + PSB + Zinc 25 kg/ha] (4.20 t/ha), treatment 7 [Azotobacter + PSB + Zn 20 kg/ha] (4.11 t/ha), treatment 6 [PSB + Zn 30 kg/ha] (4.06 t/ha), was found to be statistically at par with the treatment 9.

The significant and largest amount of seeds were produced when biofertilizers (20g/kg seed) were applied, which may have been due to increased application rates or the release of growth hormones by different biofertilizers. Diman and Dubey (2017).

Straw yield (t/ha):

At harvest, Treatment 9 [*Azotobacter* + PSB + Zinc 30 kg/ha], was recorded significantly maximum Straw yield (6.72t/ha) which was superior over all other treatments. However, treatment 8 [Azotobacter + PSB + Zn 25 kg/ha] (6.38 t/ha), treatment 7 [Azotobacter + PSB + Zn 20 kg/ha] (6.22 t/ha), treatment 6 [PSB + Zn 30 kg/ha] (6.06 t/ha), was found to be statistically at par with the treatment 9.

It is possible to attribute the beneficial effects of applied Zn on these features to its stimulatory action on the majority of plant physiological and metabolic processes. Zinc application to the soil has a positive impact on crop yields of grain and straw. (Dogra *et al.* 2014).

Cost of Production (INR/ha)

Cost of production (30120.00 INR) was found to be highest in treatment 9 [*Azotobacter* + PSB + Zinc 30 kg/ha] as compared to other treatments.

Gross return (INR/ha)

Gross return (108675.00) was found to be highest in treatment 9 [*Azotobacter* + PSB + Zinc 30 kg/ha] as compared to other treatments.

Net return (INR/ha)

Net return (78555.00) was found to be highest in treatment 9 [*Azotobacter* + PSB + Zinc 30 kg/ha] as compared to other treatments.

B: C Ratio

Benefit Cost Ratio (2.61) was found to be highest in treatment 9 [*Azotobacter* + PSB + Zinc30 kg/ha] as compared to other treatments.

CONCLUSION:

It is concluded that in barley with the seed inoculation with Azotobacter and PSB along with the application of Zn 30 kg/ha observed highest seed yield, straw yield, gross return, net return and benefit- cost ratio.

Table 1: Response of Biofertilizers and Zinc on Yield of Barley.

S.No.	Treatment combination	Grain Yield (t/ha)	Straw Yield (t/ha)	Harvest index (%)
1.	*Azotobacter* + Zn 20 kg/ha	3.77	4.99	43.01
2.	*Azotobacter* + Zn 25 kg/ha	3.87	5.64	40.69
3.	*Azotobacter* + Zn 30 kg/ha	3.90	5.74	40.48
4.	PSB+ Zn 20 kg/ha	3.77	5.82	39.33
5.	PSB+ Zn 25 kg/ha	4.09	5.92	40.87
6.	PSB+ Zn 30 kg/ha	4.06	6.06	40.09
7.	*Azotobacter* + PSB+ Zn 20 kg/ha	4.11	6.22	39.82
8.	*Azotobacter* + PSB+ Zn 25 kg/ha	4.20	6.38	39.69
9.	*Azotobacter* + PSB+ Zn 30 kg/ha	4.29	6.72	38.96
10.	Control (RDF)	3.58	4.78	42.80
	F-test	S	S	NS
	SEm(±)	0.12	0.21	1.43
	CD(p=0.05)	0.36	0.64	-

Table 2: Response of Biofertilizers and Zinc on Economics of Barley.

S. No.	Treatment combination	Cost of cultivation (INR/ha)	Gross return (INR/ha)	Net Return (INR/ha)	B:C
1.	*Azotobacter* + Zn 20 kg/ha	29620.00	90925.00	61305.00	2.07
2.	*Azotobacter* + Zn 25 kg/ha	29870.00	95925.00	66055.00	2.21
3.	*Azotobacter* + Zn 30 kg/ha	30120.00	96950.00	66830.00	2.22
4.	PSB + Zn 20 kg/ha	29620.00	95075.00	65455.00	2.21
5.	PSB + Zn 25 kg/ha	29870.00	101175.00	71305.00	2.39
6.	PSB + Zn 30 kg/ha	30120.00	101350.00	71230.00	2.36
7.	*Azotobacter* + PSB + Zn 20 kg/ha	29620.00	103025.00	73405.00	2.48
8.	*Azotobacter* + PSB + Zn 25 kg/ha	29870.00	105400.00	75530.00	2.53
9.	*Azotobacter* + PSB + Zn 30 kg/ha	30120.00	108675.00	78555.00	2.61
10.	Control (RDF)	28300.00	86550.00	58250.00	2.06

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