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Effect of different Nitrogen levels and Bio-fertilizers on yield and economics of feed barley

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Abstract

The field experiment was carried out during the *Rabi* season of 2015-16 and 2016-17 at CCS Haryana Agricultural University, Hisar. It was laid out in split plot design replicated thrice with three nitrogen levels (50, 75 and 100 percent of RDN) in main plots and five different biofertilizers alone or in combination (control, *Azotobacter*, *Azotobacter* + PSB, PSB and *Biomixie Azotobacter* + PSB + *Azospirillum*) in sub plots. Based on the research investigation, it was found that increasing levels of nitrogen and biofertilizers had significant effect on yield and yield attributing characters. The grain yield was affected significantly as the level of nitrogen increased from 50 to 100 percent. Highest grain yield and biological yield of 52.29 qha^{-1} and 124.50 qha^{-1} were recorded with the application of 100% RDN, which were significantly higher over lower doses of nitrogen. The maximum number of effective tillers m^{-2} (413), grains per ear head (50.91) and 1000-grains weight (43.84 g) were also found maximum at 100% RDN. Maximum Net returns (45732) and B:C ratio (2.40) were achieved when 100% RDN was applied. Among different bio-fertilizers, *Biomix* recorded significantly higher yield attributes (effective tillers m-2, number of grains per spike and test weight). Grain and biological yield of 51.32 q ha^{-1} and 120.01 q ha^{-1}, respectively were recorded under *Biomix*, which were at par with Azotobacter + PSB treatment. Highest net returns of 41897 and B:C ratio of 2.28 were obtained with the application of *Biomix* in barley crop.

Keywords: Barley, Bio-fertilizers, Nitrogen levels, Grain yield and Economics

1. Introduction

Barley (*Hordeum vulgare*) is the world's 4th most essential cereal crop after wheat, rice and maize with a share of about 7% of the global cereals production and 15% of coarse grains consumption. Barley is grown throughout the temperate, tropical and subtropical regions of the world and can be successfully grown in adverse climatic conditions of drought, salinity and alkalinity due to its wide adaptability. In India it is mainly grown as a rainfed crop in problematic, marginal and resource poor soils except some malt barley under contract farming. It is a *rabi* cereal grain crop, which usually used as a food for human beings and feed for animals. For malting, both the two-row and six-row cultivars are used. Barley is superior to wheat as both grains and straw are highly digestible due to the absence of gluten. In the world, barley crop covers an area of 49.29 m ha with production 147.16 m t and productivity of 2990 kg ha^{-1}, respectively during 2016-17 (Anonymous, 2018). In India, barley is mainly grown in Rajasthan, Uttar Pradesh, Punjab and Haryana besides the minor quantities at other places with the area of 0.59 million hectares, 1.5 million tons production and 2550 kg/ha productivity in the year 2015-16 (Anonymous, 2016). With an area of 48.0 thousand hectare, production 167.0 thousand tones and average productivity 3480 kg/ha in Haryana, barley

is grown mainly in the South-Western zone (Anonymous, 2014-15). India supports about 512 million livestock population and there is tremendous pressure on timely availability of feed and fodder for the livestock (Singh *et al.*, 2016). India faces a net deficit of 61.1% green fodder, 21.9% dry crop residues and 64% feed (Kumar *et al.*, 2012). Since long, only chemical fertilizers are in use tremendously to raise crops which are quite expensive, so the small and marginal farmers are unable to afford chemical fertilizers in required quantity. Moreover, consistent and sole use of inorganic fertilizers has arisen as innumerable problems for example micronutrient deficiency, nutrient imbalance in case of plant and soil system, pest attack, environmental degeneration and degradation of soil health. Now, it is indeed to promote the integrated use of organic manure, bio-fertilizers with chemical fertilizers to minimize the dependence on inorganic fertilizers alone. Bio-fertilizer usually contains microorganisms having specific function such as *Azospirillum* to fix N_2 and Phosphate solubilizing bacteria to solubilize unavailable Phosphorous from the soil and fertilizer to be available to the plants (Saraswati & Sumarno, 2008). Inoculation of bacteria has synergistic and additive effects on plant growth besides reducing the cost of cultivation, reduced leaching of NO_3-N to ground water as well as reduced emission of N_2O greenhouse gas, the global warming effect of which is 300 times more than CO_2 (Kennedy *et al.*, 2004). The ability of these bacteria to contribute in crops yields is only partly a result of biological N_2 fixation. Due to prolonged cultivation of crops with recommended dose of inorganic fertilizers alone, the productivity of soils has gone down and time has come to figure out the judicious and well matched level of fertilizers with these inoculations in case of barley production. Keeping the above facts in view, present study was conducted to assess the effect of nitrogen levels and different bio-fertilizers alone or in combination on feed barley.

2. Material and methods

A field experiment was carried out during the *Rabi* season of 2015-16 and 2016-17 at Research Farm, Wheat & Barley Section, Dept. of Genetics & Plant breeding, CCS HAU, Hisar, Haryana (India) situated at 29°10' N latitude and 75° 46' E longitude at an elevation of 215.2 m above mean sea level. A composite sample of soil was collected from the experimental site before sowing and was analysed for various soil parameters. The soil was sandy loam in texture, having pH of 7.8, O.C. of 0.48 % (low), available P, 14 kg/ha (medium) and available K, 220 kg/ha (medium). The experiment was laid out in split plot design replicated thrice with three nitrogen levels (50, 75 and 100 percent of RDN) in main plots and five different alone or in combination (control, *Azotobacter*, *Azotobacter* + PSB, PSB and *Biomix*) in sub-plots. The recommended dose of nitrogen (RDN), P and K were 60, 30 and 20 kg /ha respectively. To carry out the experiment the land preparation operation *viz.* pre sowing irrigation, plowing and leveling were done. Half dose of nitrogen and full dose of phosphorous were applied as basal dose and another half dose of nitrogen was top-dressed at first irrigation. Feed barley variety BH 946 was sown at row spacing 22 cm manually on 11th November, 2015 during first year and on 13th November, 2016 during second year. Yield attributing parameters were recorded at the time of harvest. Five plants were selected randomly from each treatment to record the observations of yield attributing characters. The crop was harvested on 9th April, 2016 and 15th April, 2017 during first and second year, respectively.

The harvest index (HI) was calculated using the formula:

HI = (Economical yield / Biological yield)*100.

The cost of cultivation, net returns and B:C ratio were calculated using prevailing prices of inputs and output. The data were analyzed using appropriate analysis of variance (ANOVA). OPSTAT software was used to carry out statistical analysis.

3. Results and discussion

Data pertaining to grain yield of barley is presented in Table 1. A perusal of the data under nitrogen levels and different bio-fertilizers alone or in combination reveal that increasing levels of nitrogen resulted in significant increase in grain yield of barley. Highest grain yield was recorded with the application of 100% RDN (52.29 q/ha), which was significantly superior over the lower N levels. Similar trend was observed in case of biological yield, highest biological yield was recorded under 100% RDN (124.50 qha^{-1}), which was significantly superior over other treatments. Furthermore, grain yield of 100% RDN treatment was 6.87% and 26.51% higher over 75% RDN and 50% RDN, respectively. It might be due better yield attributing characters of barley which were also significantly higher with higher levels of fertilizer application. Behera and Rautaray (2010) also recorded maximum grain and straw yields under recommended fertilizer dose (100% NPK) than under 50% NPK. This increase in the yield of barley may be attributed to the increased plant height, leaf area index and higher dry matter partitioning with 100% RDN. Corroborative results for grain, straw and biological yield were also reported by Singh *et al.* (2013) , Javaheri *et al.*

(2014), Nega *et a*l. (2015) and Kumar *et al.* (2017). Harvest Index was also recorded maximum with the application of 100% RDN (42.0). Yield attributes *viz*., number of, effective tillers per m^{-2}, grains per earhead and test weight were favorably influenced by increasing nitrogen levels. Application of 100% RDN produced significantly more number of effective tillers per m^2 (413) than 50 % RDN. Number of grains per earhead and test weight were also found maximum under 100% RDN with the values of 50.91 and 43.84 g, respectively, which were significantly superior over the application of 50% RDN. Better yield attributes of barley due to application of higher nitrogen levels might be due to better growth parameters with the increasing level of nitrogen application. These findings of yield attributes substantiate the results reported by Chaturvedi and Chandel (2005), Chakrawarti and Kushwaha (2006), Singh *et al.* (2013) and Alghabari and Al-Solaimani (2015). Cost of cultivation of barley increased with the increasing levels of fertilizers. Highest net returns and benefit cost ratio was recorded with application of 100 % RDN (45732 and 2.40). Benefit cost ratio of barley increases significantly with increase in fertilizer levels from 50 to 100 % RDN (Table 2). The higher returns were obtained with increasing fertilizer levels are mainly due to higher yields recorded with higher nitrogen levels. These results are in accordance with those of Chakrawarti and Kushwaha (2006) who reported that the higher net profit was obtained with the application of 90 kg N ha^{-1} compared to 60, 30 kg N ha^{-1} and control treatments. A perusal of data presented in Table 1 revealed that, among different bio-fertilizers alone or in combination, seed inoculation with *Biomix* resulted in significantly

Table1. Effect of different nitrogen levels and bio-fertilizers on yield and yield attributes of barley (pooled data of 2015-16 and 2016-17)

Treatments	Effective tillers/m2	Grains/earhead	Test weight (g)	Grain yield (q/ha)	Biological yield (q/ha)	Harvest Index (%)
Nitrogen levels						
50% RDN	372	47.08	42.39	41.33	103.08	40.09
75% RDN	402	49.37	43.27	48.93	117.75	41.55
100% RDN	413	50.91	43.84	52.29	124.5	42
SEm±	3	0.16	0.22	0.48	1.22	-
CD (P=0.05)	13	0.64	0.89	1.93	4.91	-
Biofertilizers						
Control	382	47.21	42.29	45.53	110.94	41.04
Azotobacter	392	47.91	42.97	46.88	113.34	41.36
Azotobacter + PSB	404	50.83	43.51	48.9	117.49	41.62
PSB	394	48.32	43.13	47.01	113.78	41.32
BIOMIX	406	51.32	43.95	49.27	120.01	41.05
SEm±	4	0.51	0.23	0.54	0.97	-
CD (P=0.05)	11	1.51	0.68	1.57	2.85	-

Table 2. Effect of different nitrogen levels and bio-fertilizers on economics of barley (Pooled data of 2015-16 and 2016-17)

Treatments	Cost of cultivation (₹)	Net returns (₹)	B:C ratio
Nitrogen levels			
50% RDN	32403	30,581	1.94
75% RDN	32595	41,110	2.26
100% RDN	32761	45,732	2.4
Biofertilizers			
Control	32506	36346	2.12
Azotobacter	32606	38111	2.17
Azotobacter + PSB	32606	41013	2.26
PSB	32606	38337	2.18
Biomix	32606	41897	2.28

higher grain yield, which was at par with the *Azotobacter* + PSB treatment. Seed inoculation with *Biomix* resulted in grain yield of 49.27 qha^{-1} and biological yield of 120.01 qha^{-1}. Seed inoculation with Rhizobium, phosphorus solubilizing bacteria and organic amendment increased seed production of the crop (Panwar *et al*., 2006). Lowest value for grain and biological yield was recorded in control (45.53 and 110.94 qha^{-1}, respectively). However, the difference in grain yield and biological yield of barley in seed inoculation with *Azotobacter* and PSB alone were not significant with the control. Seed inoculation with *Biomix* resulted in 4.80, 5.09 and 8.21 % higher grain yield over PSB, *Azotobacter* and control treatment, respectively. Inoculation of barley with different combination of bio-fertilizers has synergic and additive effects on yield as they increase the fertilizer use efficiency as well as soil fertility by promoting soil microbial activities, narrow down C:N ratio, decline in bulk density and increase in water holding capacity at low moisture levels. Similar findings were also reported by, Nisha *et al.* (2007), Behera and Rautaray (2010), Yadav *et al.* (2011), Shirinzadeh *et al.*

(2013), Yadav *et al.* (2014) and Diman and Dubey (2017). Seed inoculation with *Biomix* recorded significantly higher value for effective tillers per m^2 i.e. 406, which was found significantly higher than the control and inoculation of bio-fertilizers alone but at par with the seed inoculation of *Azotobacter* and PSB in combination. Number of grains per earhead (51.32)and test weight (43.95 g) with *Biomix* inoculation were numerically at par with *Azotobacter* + PSB but significantly better over other treatments. The reason for increased yield attributes of barley might be due to release of growth hormones by various biofertilizers. Similar findings for yield attributes were reported by Singh and Prasad (2011), Thalooth *et al.* (2012), Shirinzadeh *et al.* (2013) and Diman and Dubey (2017). Among different combination of bio-fertilizers, seed inoculation with *Biomix* resulted in significantly higher net returns and benefit cost ratio which might be ascribed to the higher grain and biological yield recorded due to seed inoculation with *Biomix*. Seed inoculation with *Biomix* resulted in net returns of 41897 (Table 2). Least value for net returns was reported in untreatedtreatment (36346). Seed inoculation with Biomixresulted in highest benefit cost ratio (2.28). Higher B:C ratio in *Biomix* treatment is because of very less increase in cost of cultivation as compared to the control. Similar results were reported by Yadav *et al.* (2014).

Conclusion

On the basis of two year study during 2015-16 and 2016-17, it can be concluded that increasing nitrogen doses increased the yield attributes and yield of barley from 50% RDN to 100%. Application of 100% RDN also improves the B:C ratio. Inoculation of Biomixrecorded significantly higher yield attributes viz. effective tillers m-2, number of grains per spike and test weight. Grain and biological yield were recorded highest under Biomixtreatment. Higher net returns and B/C ratio were also obtained with the application of Biomix in barley crop.

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