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Productivity and profitability of barley (*Hordeum balgare*) as affected by nitrogen levels and varieties under rainfed condition

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ABSTRACT

A field experiment was conducted during winter seasons of 2011-12 and 2012-13 at Research Farm, R.B.S. College, Bichpuri, Agra to study the effect of different levels of nitrogen and varieties on productivity and profitability of barley (Hordeum vulgare). The three levels of nitrogen and four varieties were tested in split plot design with three replications. Results revealed that the application of 60 *kg N ha^{-1} recorded significantly higher shoots (71.3 m^{-2}), shoot height (60.7 cm) and dry matter accumulation (78.3 g) over other treatments. Yield attributes viz. effective shoots, spike length, spikelets spike^{-1}, grains spike^{-1}, weight of grains spike^{-1} and 1000-grains weight increased with increase the level of nitrogen up to 60 kg N ha^{-1}. Significantly higher grain, straw and biological yield were produced with 60 kg N ha^{-1} over 20 and 40 kg N ha^{-1}. The highest gross returns, net returns and benefit:cost ratio were recorded with the application of 60 kg N ha^{-1}.The lower values of these economic parameters were recorded with 20 kg N ha^{-1}. Amongst the varieties, variety RD 2508 had significantly higher growth parameters as well as yield attributes followed by RD 2706. Variety RD 2508 also had significantly more grain, straw and biological yield of 7.2, 7.3 and 7.5% over RD 2624 respectively. The highest gross returns (Rs. 52,300) net returns (Rs. 28,900) and B:C ratio (2.24) were recorded with RD 2508 and minimum in variety RD 2624.*

Key Words: Barley, nitrogen, varieties, yield, economics

INTRODUCTION

Barley (*Hordeum vulgare*) is a cereal grain, member of family 'Poaceae', which serve as a major animal feed crop since biblical time. It ranks next only to wheat, rice and maize among cereals in its spread and is generally grown on marginal and sub-marginal lands with low inputs where the condition for wheat and other cereals are not favourable. It is mostly grown on light textured soils which have low nitrogen and organic matter with poor moisture retention capacity (Puniya *et al.*, 2015). Among the several nutrients, nitrogen is the most important nutrient responsible to a great extent for the higher yields of intensive agriculture. Recommended dose of fertilizers is a vitally important to supply plant nutrient soil of N and P deficient soils of India, particularly in the loamy sand soils of semiarid regions. Nitrogen is an essential constituent of plant proteins and chlorophyll and is present in many other compounds of greater physiological importance in plant metabolism such as nucleotides, phosphtides, enzymes, hormones, vitamin etc. (Balwan *et al.*, 2017). The new cultivars display improvements including disease resistance, plant architecture (stand ability), seed quality and yield, whilst there are also changes in flowering and maturity that could affect agronomic management. Consequently, different varieties with different genetic make-up mature at different rates but the difference in greater when sown early. In spite of cultivation of high yielding varieties, improved cultural practices and plant protection measures, fevourable weather is must for good harvests (Lal *et al.,* 2017). Hence, there is need to evaluate and standardize variety which can achieve high yield potential under optimum level of N in the rainfed condition.

METERIALS AND METHODS

A field experiment was conducted during *Rabi* seasons of 2011-12 and 2012-13 at Research Farm, R.B.S. College, Bichpuri, Agra, (27^0 2' North latitude, 77^0 9' East longitude and altitude of 163.4 m above mean sea level). The total rainfall was received of 58 mm during the crop growth period and most of which 34 mm was received in the month of February. The experimental soil was sandy loam in texture containing organic carbon 3.2 g kg^{-1}, available N 187.8, P 18.1 and K 189.7 kg ha^{-1} with pH 8.0. Twelve treatment combinations comprising three

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levels of nitrogen viz. N_{20}, N_{40} and N_{60} and four genotypes such as RD-2706, RD-2508, RD-2624 and RD-2660 were tested in split plot design and replicated thrice with levels of nitrogen in main plot and genotypes in sub-plots. The crop was sown in 2 and 4 November and harvested in 24 and 27 March during 2011-12 and 2012-13, respectively. The crop was fertilized with nitrogen (as per treatments) and phosphorus (30 kg P_2O_5 ha^{-1}) and potassium (20 kg K_2O ha^{-1}) in all the treatments. Urea, single superphosphate and muriate of potash were used as the source of N, P_2O_5 and K_2O, respectively. Entire quantities of nitrogen as per treatment, P_2O_5 and K_2O were applied at the time of sowing as basal dressing. The seed rate and row spacing were 100 kg ha^{-1} and 23 cm apart, respectively. The growth characters were recorded at harvest stage. The straw yield was computed by deducting the grain yield from the total biological yield. The economics was work out based on pooled yield data and considering price of input and output of the prevailing market rate. All the observations were analyzed statistically for their test of significance of the individual year and pooled analysis was done over the years using F-test (Gomez and Gomez, 1984). The significance of difference between treatments means compared with critical differences at 5% level of probability.

RESULTS AND DISCUSSION

Growth characters

The results revealed that barley crop responded well to nitrogen fertilization in terms of growth attributes. Number of shoots was the highest (71.3/m^2) with the application of 60 kg N ha^{-1}, which was significantly higher over 20 and 40 kg N ha^{-1}. Significant increase in shoot height was registered by increasing N rate from 20 to 40 (5.7%) and 40 to 60 kg ha^{-1} (3.5%). Maximum dry matter accumulation (78.3 g) was obtained with the application of 60 kg N ha^{-1} and it was significantly superior over other levels of nitrogen. This might be due to vital role of nitrogen in the plant. One of the main functions of nitrogen is the initiation of meristematic activity of plant. The cell division and enlargement are also accelerated by ample supply of nitrogen. Thus, the growth of plant by and large depends on nitrogen. The present findings are in consonance with those of Sikarwar *et al.* (2018).Variety RD 2508 had recorded significantly number of shoots, shoot height and dry matter accumulation, representing an increase of 4.3, 1.3 and 10.6% over RD 2624. Hence for realizing growth potential of a plant to the fullest extent, it's major growth stages should coincide with required sequence of climatic conditions. Thus the inherent capabilities of variety RD 2508 with enhanced vegetative growth with optimum duration available under prevailing climatic conditions might have helped the plants to efficiently utilize prevailing climatic conditions (Balwan *et al.*, 2018).

Table 1: Growth and yield attributes of wheat as affected by levels of nitrogen and varieties

Treatments	Shoots (m^{-2})	Shoot height (cm)	Dry matter accumu - lation (g)	Effective shoots m^{-1} row length	Spike length (cm)	Spikelets $spike^{-1}$	Grains $spike^{-1}$	Weight of grains $spike^{-1}$ (g)	1000 - grains weight (g)
Nitrogen (kg ha^{-1})									
N_{20}	65.2	53.8	71.4	61.2	5.7	11.1	33.1	1.9	30.6
N_{40}	68.9	57.4	75.5	67.1	6.2	12.8	33.9	2.1	31.3
N_{60}	71.3	60.7	78.3	72.3	6.4	13.7	34.6	2.7	31.7
SEm±	0.75	1.04	0.92	1.56	0.07	0.31	0.21	0.18	0.15
CD (P=0.05)	2.24	3.10	2.75	4.70	0.22	0.94	0.65	0.55	0.46
Varieties									
RD 2706	73.3	61.5	78.1	70.5	6.2	13.8	33.8	2.6	31.8
RD 2508	74.5	63.2	79.5	73.3	6.5	14.1	34.9	2.9	32.1
RD 2624	71.4	57.3	71.9	63.7	5.9	13.1	32.6	2.0	30.9
RD 2660	72.1	59.7	75.3	66.4	6.0	13.5	33.4	2.2	31.4
SEm±	0.35	0.53	0.45	0.91	0.06	0.09	0.33	0.09	0.11
CD (P=0.05)	1.05	1.60	1.34	2.73	0.18	0.28	1.00	0.26	0.34

Yield attributes

Yield attributes of barley crop increased significantly with increase in the level of nitrogen up to 60 kg N ha^{-1}. Application of 60 kg N ha^{-1} recorded significantly higher effective shoots m^{-1} row length, grains $spike^{-1}$ and weight of grain $spike^{-1}$ and also representing an increase of 18.1, 4.5 and 42.1% than 20 kg N ha^{-1}, respectively. However, the highest values of spike length, spikelets $spike^{-1}$ and 1000-grains weight were noted with the application of 60 kg N ha^{-1} but this level failed to its superiority over 40 kg N ha^{-1}. The ascending rate of nitrogen application up to 60 kg N ha^{-1} helped in improving plant growth as evident from higher dry-matter production which acted as source to provide greater amount of photosynthesis to the sink i.e. reproductive organs thus helping in significant increase in yield attributes. Significant improvement in yield attributes owing to N application was also reported by Puniya *et al.*, (2015) and Sikarwar *et al.*, (2018). Among the varieties tested, variety RD 2508 recorded significantly higher number of effective shoots m^{-1} row length, spike length, spikelets $spike^{-1}$, grains $spike^{-1}$ and weight of grain $spike^{-1}$ over other varieties and also represented an increase of 15.1, 10.2, 7.6, 7.1 and 4.5% over RD 2624, respectively. The highest 1000-grains weight was recorded with RD 2508 but this was statistically at par with RD 2706. The increased parameters might have attributed to higher manufacture of food and its subsequent partition toward sink. The availability and supply of nutrients to formation ultimately increased the number of grains $spike^{-1}$ and 1000-grains weight. Similar finding were observed by Singh *et al.*, (2013) and Balwan *et al.*, (2018).

Table 2: Yield and economics as affected by levels of nitrogen and varieties

Treatments	Grain yield (q ha^{-1})	Straw yield (q ha^{-1})	Biological yield (q ha^{-1})	Cost of cultivation (x10^3 ₹ ha^{-1})	Gross returns (x10^3 ₹ /ha)	Net returns (x10^3 ₹ /ha)	Benefit : Cost Ratio
Nitrogen (kg ha^{-1})							
N_{20}	30.80	45.89	76.69	23.7	49.2	25.5	2.08
N_{40}	32.10	48.15	80.25	24.0	51.4	27.4	2.14
N_{60}	32.70	49.05	81.75	24.3	52.3	28.1	2.16
SEm±	0.19	0.30	1.09	-	-	-	-
CD (P=0.05)	0.57	0.91	1.30	-		-	-
Varieties							
RD 2706	32.35	48.40	80.75	23.4	51.7	28.3	2.21
RD 2508	32.73	48.97	81.70	23.4	52.3	28.9	2.24
RD 2624	30.50	45.65	76.15	23.4	48.8	25.4	2.08
RD 2660	31.90	47.73	79.63	23.4	51.0	27.6	2.18
SEm±	0.11	0.09	0.16	-	-	-	-
CD (P=0.05)	0.32	0.28	0.49	-	-	-	-

Yield

The barley yield also increased significantly with every increment of nitrogen up to 60 kg N ha^{-1}. As grain yield is primarily a function of cumulative of yield attributing characters, the higher values of these attributes can be assigned as the most probable reason for significantly higher grain yield. Straw yield was also recorded higher with increasing rates of N application. It might be due to improved biomass per plant at successive stages and increase in various morphological parameters like shoot height, number of tillers etc. Significant improvement in yield owing to N application was also reported by Puniya *et al.*, (2015), Jadon *et al.*, (2015) and Jaga *et al.* (2017). The maximum biological yield was produced with the application of 60 kg N ha^{-1}, which was significantly superior over 20 and 40 kg N ha^{-1}. However, graded increase (20-40 and 40-60 kg ha^{-1}) in N application were associated with 4.6 and 1.9% increase in biological yield. Higher grain production was obtained with RD 2508 which was significantly superior to other genotypes. The next best genotype was RD 2706 and this genotype also proved its superiority over RD 2624 and RD 2660 in respect of grain production. Variety RD 2508 produced the maximum straw (48.9 q ha^{-1}) and

biological yield (81.7 q ha^{-1}) followed by RD 2706. Variety RD 2508 also had significantly more grain, straw and biological yield of 7.2, 7.3 and 7.5% over RD 2624 respectively. The difference in yields between barley varieties may be due to variation in their production capacity of grain and biological yield. Similar results were also reported by Jadon *et al.* (2015) and Verman *et al.* (2015).

Economics

The gross return, net return as well as benefit:cost ratio increased significantly with increase in the level of nitrogen up to 60 kg N ha^{-1}. The highest gross return (Rs. 52,300) net return (Rs. 28,100) and B:C ratio (2.16) were recorded with the application 60 kg N ha^{-1} and represented an increase of 6.3, 10.2 and 3.8% over 20 kg N ha^{-1}. The highest gross return under highest doses might be owing more grain and straw yield which led to proportionally highest gross return. Economic analysis showed that variety 2508 recorded the higher gross and net returns as well as benefit: cost ratio followed by RD 2706. Variety RD 2608 reduced the gross return, net return and benefit: cost ratio by 6.7, 12.1 and 7.1%, respectively than RD 2624. The significantly lowest benefit: cost ratio was observed mainly due to its genetically lower yield potential (Singh, 2017 and Sikarwar *et al.*, 2018). Thus, it can be concluded that variety RD 2508 performed better with respect of yield attributes, grain and straw yields, net returns and benefit: cost ratio of barley with 60 kg N ha^{-1} under rainfed condition of Agra.

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