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EFFECT OF NITROGEN ON GROWTH, YIELD AND NUTRIENT UPTAKE BY MALT BARLEY GENOTYPES

K.P.S. JADON, DINDAYAL GUPTA[1], S.B. SINGH, LAKHPAT SINGH[1] AND PRATAP SINGH[2]

Department of Agronomy, Raja Balwant Singh College, Bichpuri, Agra, (U.P.)-283105
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ABSTRACT

A field experiment was conducted during rabi seasons of 2011-12 and 2012-13 at R.B.S. College Agricultural farm, Bichpuri (Agra) to evaluate the effect of nitrogen on growth, yield and nutrient uptake of malt barley genotypes. The experiment comprised of three levels of nitrogen and four genotypes was laid out in split plot design with three replications. The results revealed that the every increase in the level of nitrogen increased the all growth characters and yield attributes significantly up to 120 kg N ha^{-1} except 1000-grains weight. Application of 120 kg N ha^{-1} resulted significantly higher yields (grain, straw and protein) except biological yield and nitrogen uptake (grain and straw) and the percent increase in these traits under 120 kg N ha^{-1} over 60 kg N ha^{-1} were 12.2, 17.3, 29.1, 23.2, 30.5 and 79.8, respectively. Significantly higher values of growth parameters, yield attributes (except 1000-grains weight), yields and uptake of nitrogen were obtained with genotype DWRUB 52. On the basis of growth parameters, yield attributes, yields and uptake of nitrogen, the barley genotypes may be arranged as DWRUB 52 > RD 2668 >DWR 92 > K 551.

Key Words: Barley, genotypes, growth, nitrogen, nutrient uptake, protein, yields

INTRODUCTION

Barley (*Hordeum vulgare L.*) is one of the most valuable food crop that survives almost every weather conditions. It is the staple food and largely required for making breads and beer. However, almost 60% of the total barley produced in India is consumed as cattle feed. In addition, to direct human consumption, about 0.25 million tonnes of barley is used by the malting industries in the country for the production of beer, whisky and other products, *viz.* industrial alcohol and vinegar. Malt syrup is utilized in the preparation of candies, breakfast, beverages and medicines. By product of brewing and distilling industry known as 'brewers' and distiller grain is useful as cattle feed. Bold and plump seeded barley varieties are suitable for manufacture of pearl barley and powder products which form the diet of the sick and convalescent people. Pearl barley is used for barley water, which is diuretic and is given to persons suffering from kidney disorders (Trivedi, 2009). Nitrogen is considered to be the most important plant nutrient as it has a great stimulating influence on the development of the vegetative parts. All vital processes are associated with the presence of functionally reactive plasma in the protein of which nitrogen is a characteristic constituent. The efficiency of utilization of added nitrogen fertilizer is about 50-70 per cent, as applied N is subjected to various kinds of losses in the field, causing for low yield. The low nitrogen content of Indian soils further accentuates this problem. Hence, it requires optimum application of nitrogen fertilization for the crop of better yield and quality. In order to get maximum benefit from nitrogen use it should not only be applied in right quantity but also at right time according to the growth stages of the crop. Genotypes play a vital role in crop production. The choice of right genotype of barley helps to augment crop productivity by about 20-25%. Any genotype of barley before being recommended for general cultivation for particular region must be judged for its potential, tolerance against disease, in general, and in particular, responsiveness to added water and fertilizer and adaptability to different agro-climatic conditions. Thus, the value of stable and high yielding genotype has been universally recognized as an important factor for boosting crop production. Hence the present study was undertaken to find out the response of different malt barley genotypes to nitrogen in semi arid condition of Agra region.

MATERIALS AND METHODS

A field experiment was conducted during winter (*rabi*) seasons of 2011-12 and 2012-13 on Barley at R.B.S. College Agricultural Research Farm, Bichpuri, Agra (U.P.). The soil of the experimental field was sandy loam in texture, having pH 8.1, organic carbon 3.2 g ha^{-1}, low in available N (190 kg ha^{-1}), medium in available P_2O_5 (24 kg ha^{-1}) and high in K_2O (290 kg ha^{-1}). The treatments comprised three levels of nitrogen (60, 90 and 120 kg ha^{-1}) and four genotypes {DWR 92, DWRUB 52, RD 2668 and K 551} were tested in split-split plot design, keeping N levels in main plot and genotypes in sub plot with three replications. The crop was fertilized with N as per treatment and phosphorus (40 kg) and potash (30 kg) ha^{-1}. Urea, single super phosphate and muriate of

[1]*Corresponding author Email: dgupta072@gmail.com, Shri Megh Singh College, Abidgarh, Agra*
[2] *Sarvoday Mahavidhyalya, Choumuhan, Mathura*

potash were used as the source of N, P_2O_5 and K_2O, respectively. Half dose of N as per treatment and full dose of P_2O_5 and K_2O were applied at the time of sowing as basal blow the seed. The remaining half dose of N was top dressed as 40 days after sowing. Barley genotypes were sown on 30th Nov, in both th years using seed rate of 100 kg ha^{-1} and row spacing 18 cm apart. The growth characters were recorded at harvest stage, yield were recorded at maturity. The plant samples collected at harvest were analyzed for nitrogen (*Kjeldahl method*). Protein content was calculated by multiplying the nitrogen percentage with 6.25.

RESULTS AND DISCUSSION

Growth parameters

The data (Table 1) indicated that the the variations in all the growth parameters due to levels of nitrogen were significant. The number of plants per running metre tended to increase with increasing N rates and the highest value was noted with 120 kg N ha^{-1}. This was found significantly superior to other doses of nitrogen with the lowest value at 60 kg N ha^{-1}. Significantly taller plants were obtained with the application of 120 kg N ha^{-1}.The dry matter accumulation as well as flag leaf area were maximum at 120 kg N ha^{-1} and minimum with 60 kg N ha^{-1}. The increases in dry matter accumulation and flag leaf area with 120 kg N ha^{-1} were 10.7 and 4.7 and 12.4 and 6.1% over 60 and 90 kg N ha^{-1} respectively. The increasing levels of N increased days to 75% blooming and maturity while 60 kg N ha^{-1} recorded minimum days to 75% blooming and maturity. It is well emphasized that increased rate of nitrogen improved overall growth of the crop in term of dry matter production per plant by virtue of its impact on morphological and photosynthetic components along with accumulation of nutrient (Yadav *et al.* 2012, Singh *et al.* 2013). Results (Table 1) showed that the genotypes had exerted significant effect on all the growth parameters. Barley genotype DWRUB 52 had significantly higher crop stand m^{-2} followed by RD 2668 than DWR 92 and K 551. Highest plant height and dry matter accumulation were obtained with DWRUB 52, which were significantly superior over all other genotypes. The lowest plant height and dry matter accumulation were noticed with K 551. Genotype DWRUB 52 attained the highest flag leaf area which was significantly superior to other genotypes. The next best genotype was RD 2668 in this regard, while the lowest flag leaf area was attained with genotype K 551. Among different genotypes tested, DWRUB 52 took significantly more days to 75% blooming and maturity as compared to all other genotypes, while the minimum days were taken by K 551. Thus, there appeared to be very wide differences among these four barley genotypes with respect to growth characters. This may due to variation in the genetical variability among the genotypes against growth characters as well as due to changing in the agro climatic conditions. These results are in close conformity with the findings of Mukherjee (2012).

Yield attributes

Data (Table 1) revealed that N application had significant influence on yield attributes. Application of 120 kg N ha^{-1} recorded higher number of effective shoots m^{-1} row length (84.25) and spike length (6.95) and also significantly superior over its lower doses. The spikelets spike^{-1} and grains spike^{-1} increased significantly with every increase in the level of nitrogen up to 120 kg N ha^{-1}. The maximum weight of grains spike^{-1} was obtained with 120 kg N ha^{-1}. Increasing rate of nitrogen from 60 to 90 and 90 to 120 kg ha^{-1} brought 6.5 and 7.8% increase in weight of grains spike^{-1}, respectively. The lowest value was noted with 60 kg N ha^{-1}. The levels of nitrogen had no significant effect on 1000-grains weight. However, 1000-grains weight decreased with increase in the levels of nitrogen up to 90 N kg ha^{-1}. Adequate supply of N helps in the increased production of larger dark green leaves due to proper meristematic activities in the cell. Which help the maximum utilization of sunlight and other growth factor which ultimately resulted in production of more photosynthates and translocation from leaves to reproductive parts. Yadav *et al.* (2012) and Singh *et al.* (2013) reported similar results. The yield attributing characters significantly affected with barley genotypes. Genotype DWRUB 52 gave higher effective shoots m^{-1} row length, spike length, and spikelets spike^{-1} followed by RD 2668. Both these genotypes were significantly superior to other genotypes. The highest grains spike^{-1} and weight of grains spike^{-1} was also obtained with genotype DWRUB 52 and these values were found 7.26 and 59.68%, respectively more than genotype K 551. The results corroborate with those of Kumar *et al.* (2007). Barley genotypes did not affect the 1000-grains weight significantly. However, genotype DWRUB 52 recorded higher1000-grains weight of 26.38, 7.61 and 12.88 per cent than that of DWR 92, RD 2668 and K 551, respectively.

Yields

Data (Table 2) revealed that the yields (biological, grain and straw) of barley enhanced significantly with higher levels of nitrogen over its

Table 1: Growth and yield contributing characters of barley as affected by nitrogen and genotypes (mean of two years)

Treatment	Growth parameters						Yield attributes					
	Crop stand (m^{-2})	Plant height (cm)	Dry matter accum-ulation (g)	Flag leaf area (cm^2)	Days to 75% blooming	Days to maturity	Effective shoots m^{-1} row length	Spike length (cm)	No. of spike-lets /spike	No. of grains /spike	Weight of grains /spike (g)	1000-grains weight (g)
Nitrogen (Kg ha^{-1})												
60	76.83	79.20	82.88	28.55	62.4	103.9	72.3	5.84	11.68	25.13	2.28	50.39
90	83.13	83.75	87.79	29.19	64.2	107.0	78.7	6.37	12.78	25.60	2.43	46.80
120	89.04	87.68	93.15	30.46	66.2	108.3	84.2	6.95	13.93	26.25	2.62	47.41
SEm±	0.24	0.18	0.02	0.07	0.33	0.18	0.16	0.03	0.02	0.22	0.04	3.59
C.D. (P=0.05)	0.68	0.50	0.07	0.20	0.92	0.51	0.44	0.09	0.05	0.60	0.12	NS
Genotypes												
DWR 92	80.89	80.85	84.01	27.75	63.7	105.1	76.1	5.98	12.53	25.31	2.29	42.30
DWRUB 52(C)	89.67	91.14	98.28	31.75	66.2	108.6	84.6	7.56	13.80	26.58	2.97	53.46
RD 2668 (C)	85.67	86.02	88.88	30.81	64.7	107.7	80.9	6.54	13.12	25.97	1.66	49.68
K 551 (C)	75.78	76.15	80.58	27.30	62.4	104.2	72.0	5.46	11.73	24.78	1.86	47.36
SEm±	0.37	0.11	0.05	0.07	0.32	0.23	0.17	0.06	0.03	0.28	0.05	0.21
C.D. (P=0.05)	0.78	0.22	0.11	0.17	0.67	0.39	0.37	0.13	0.08	0.59	0.09	NS

lower dose. The bio-mass production increased significantly with 90 kg N ha^{-1} as compared to 60 kg N ha^{-1}. However, the highest bio-mass production was obtained with 120 kg N ha^{-1} but it was statistically at par with 90 kg N ha^{-1}. Every increase in the level of nitrogen increased the grain yield significantly up to 120 kg N ha^{-1}. The per cent increase in grain yield with 90 and 120 kg N ha^{-1} over 60 kg N ha^{-1} were 6.7 and 12.3, respectively. Application of 120 kg N ha^{-1} produced the maximum straw yield and proved significantly superior to other levels of nitrogen. The harvest index decreased with every increase in level of nitrogen. The significantly lower harvest index was noted with 120 kg N ha^{-1} as compared to other levels of nitrogen. Increased availability of N from soil media was also responsible for effective shoots m^{-1} row length, grains ear^{-1} and 1000-grains weight which were responsible for better expression of yield. Positive effect of nitrogen on yields was reported by Kumar *et al.* (2007) and Chauhan *et al.* (2014). The data (Table 2) indicated that biological, grain and straw yields were significantly affected by different genotypes. Maximum biological yield was produced with genotype DWRUB 52 followed by RD 2668. Both these genotypes were significantly superior to other genotypes. Higher grain production was obtained with genotype DWRUB 52 which was significantly superior to other genotypes. The next best genotype was RD 2668 and this genotype also proved its superiority over DWR 92 and K 551 in respect of grain production. Genotype DWRUB 52 produced the maximum straw yield (64.89 q ha^{-1}) followed by RD 2668. Genotype DWRUB 52 proved its superiority over other genotypes. The difference in yields between barley genotypes may be due to variation in their production capacity of grain and biological yield. Similar results were also reported by Kumar *et al.* (2007). The variations in harvest index due to different genotypes were found to be significant with decreasing order. On the basis of harvest index, the barley genotypes may be arranged as K 551 > DWR 92 > RD 2668 > DWRUB 52. The significantly lowest harvest index (42.09) was obtained with Genotype DWRUB 52.

Protein content and yield

The highest protein content in grain (74.1%) and straw (30.8%) was obtained with120 kg N ha^{-1}, which was significantly higher than 60 and 90 kg N ha^{-1} (Table 2). Application of 120 kg N ha^{-1} resulted in significant higher protein yield than 60 and 90 kg N ha^{-1}. The lowest protein yield was recorded with 60 kg N ha^{-1}. Positive effect of nitrogen on protein content has been reported by Toder Mal *et al.* (2014) and Chauhan *et al.* (2014). Genotype DWRUB 52 recorded significantly higher protein content in grain (11.7%) and straw (3.4%) followed by RD 2668 than DWR 92 and K 551. The lowest protein content in grain and straw was noticed with K 551. Maximum protein yield was produced with genotype DWRUB 52 followed by RD 2668 and both the genotypes proved their superiority over DWR 92 and K 551 in respect of protein yield.

Uptake of nitrogen

Nitrogen application had a significant influence on nitrogen uptake by barley (Table 2). With the successive increase in N levels from 60 to 120 kg N ha^{-1}, the uptake of nitrogen in grain and straw increased significantly. Application of 120 kg N ha^{-1} gave the higher nitrogen uptake through grain and straw which proved significantly

Table 2: Yield and nitrogen uptake as affected by different levels of nitrogen and genotypes (mean of two years

Treatments	Biological yield (q ha^{-1})	Grain yield (q ha^{-1})	Straw yield (q ha^{-1})	Harvest index (%)	Protein content (%)		Protein yield (kg ha^{-1})	N uptake (Kg ha^{-1})	
					Grain	Straw		Grain	Straw
Nitrogen (Kg ha^{-1})									
N_{60}	81.09	38.14	48.69	43.98	9.23	2.39	355.5	56.8	18.9
N_{90}	93.91	40.70	53.21	43.51	9.96	3.00	411.8	65.8	26.0
N_{120}	99.93	42.82	57.12	42.99	10.63	3.31	458.8	74.1	30.8
SEm±	2.26	0.51	0.77	0.003	0.06	0.03	5.71	0.82	0.30
C.D. (P=0.05)	6.27	1.40	2.15	0.007	0.16	0.09	15.84	2.28	0.82
Genotypes									
DWR 92	79.69	37.19	47.40	43.99	9.28	2.73	340.1	55.4	20.9
DWRUB 52(C)	111.88	46.99	64.89	42.09	11.70	3.37	552.0	88.3	35.5
RD 2668 (C)	100.39	43.13	57.02	42.97	11.30	2.95	447.7	71.4	27.2
K 551 (C)	77.61	34.90	42.71	44.98	8.46	2.54	294.9	47.2	17.5
SEm±	3.76	0.37	0.55	0.007	0.07	0.04	5.88	0.70	0.50
C.D. (P=0.05)	7.91	0.79	1.17	0.011	0.15	0.08	12.36	1.48	1.04

superior to lower levels of nitrogen. The per cent increases in nitrogen uptake through grain and straw under 90 and 120 kg N ha^{-1} over 60 kg N ha^{-1} were15.9 and 30.5 and 7.1 and 79.8, respectively. The uptake of nitrogen was lower with 60 kg N ha^{-1} due to lower grain and straw production leading to lesser uptake. These results corroborate with those reported by Pradhan *et al.* (2014) and Chauhan *et al.* (2014). The highest uptake of nitrogen by grain and straw was recorded with DWRUB 52, which was significantly higher than other genotypes. The lowest uptake of nitrogen by grain and straw was noticed by K 551. The difference in N uptake by various genotypes may be due to variation in their production capacity of grain and straw. Similar results were reported by Mukherjee (2012).

From the results, it may be concluded that the DWRUB 52 genotype with 120 kg N ha^{-1} showed the best performance in respect of growth, yield attributes, yields and uptake of nitrogen.

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