

## Effect of Levels and Time of Nitrogen Application on Grain and Malt Quality Characteristics of Barley Varieties

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### Abstract

A field experiment was conducted on the loamy sand soil during *rabi* season of 2008-2009 to study the effect of four nitrogen levels (0, 30, 60 and 90 kg N/ha) and three times of nitrogen application (whole at sowing, 2/3<sup>rd</sup> at sowing + 1/3<sup>rd</sup> after first irrigation and 1/3<sup>rd</sup> at sowing + 2/3<sup>rd</sup> after first irrigation) on grain yield, grain and malt quality characteristics of two barley varieties (VJM 201 and DWR UB52). For grain purpose it was observed that the variety DWR UB52 was proved better as it yielded 41.9 q/ha which was about 5.8% more than VJM 201, whereas for malt purpose both varieties were found to be equally suitable. Highest nitrogen level of 90 kg/ha resulted in significantly higher grain yield (50.2 q/ha) as well as grain and malt quality parameters like grain hardness, husk content, protein content, diastatic power and  $\alpha$ -amylase activity than those recorded at recommended dose of nitrogen i.e. 60 kg/ha and than 30 kg N/ha and control. The grain yield and quality parameters were not influenced by application of nitrogen as basal dose or when it was applied in splits.

**Key words :** Barley varieties, Nitrogen levels, Time of nitrogen application, Grain yield, Malt quality.

In Punjab, rice-wheat cropping system is being practiced on about 75% of the total cropped area. This system has resulted in depletion of ground water table, deteriorated the soil health, increased the pest and disease problem and has created ecological imbalance. For diversification of this system barley (*Hordeum vulgare* L.) can be a good replacement in the *rabi* season. Worldwide, barley is used as both food and feed, but its most economically important use is for malting and brewing. Malt is the most important product of barley and its quality depends on the traits like test weight, grain plumpness, husk content, grain protein content,  $\alpha$ -amylase activity and diastatic power. Amongst all these protein content of grain is key characteristic for malting quality, as high protein content generally impairs quality by altering malt modification, extract yield, filtration during brewing, clarity of beer and foam stability, prolongs steeping time, causes erratic germination and increases malting losses. The quality malt is used by breweries to make beer, alcohol, whisky, malt syrups, malted milk and vinegar. Nitrogen being the main constituent of amino acids is also known to be precursor of proteins, and protein is considered as an important

parameter for malting quality. Insufficient nitrogen can reduce the quality below acceptable levels, while excess nitrogen usually enhances undesirable high protein levels (1). Time of nitrogen application is another important cultural practice for realizing potential yield of the crop or varieties. Application of full dose of nitrogen at sowing may not be able to meet the nutritional requirement of the crop up to maturity and it may result in sub-optimal increase in grain yield and low nitrogen content. While, the split application of nitrogen may result in increase in protein content of the grain which is a desirable quality parameter. Therefore, the present investigation was conducted to evaluate the effect of levels and time of nitrogen application on grain and malt characteristics of two barley varieties.

### Methods

A field experiment was conducted during *rabi* season 2008-2009 at Student's Research Farm, Department of Agronomy, Punjab Agricultural University, Ludhiana on loamy sand soil, medium in available nitrogen, phosphorus and potassium. The ex-

**Table 1.** Effect of various treatments on grain yield, grain and malt quality parameters.

Treatments	Grain yield (q/ha)	Grain hardness (kgs)	Hectoliter weight (kg/hl)	Kernel plumpness (weight basis (%))	Husk content (%)	Protein (%)
<b>Varieties</b>						
VJM 201	39.6	12.7	62.4	84.9	10.6	9.8
DWRUB52	41.9	12.9	63.3	85.6	10.3	9.9
CD ( $P=0.05$ )	1.6	NS	0.2	0.5	0.1	NS
<b>Nitrogen Levels (kg/ha)</b>						
0 (Control)	30.3	12.3	65.1	86.7	10.0	9.4
30	37.4	12.5	64.0	85.8	10.3	9.5
60	45.2	13.0	62.1	84.7	10.6	9.5
90	50.2	13.5	60.2	83.9	11.0	10.5
CD ( $P=0.05$ )	2.3	0.4	0.3	0.7	0.2	0.3
<b>Time of Nitrogen Application</b>						
Whole at sowing (recommended)	40.2	12.8	62.9	85.5	10.2	9.8
2/3 <sup>rd</sup> at sowing + 1/3 <sup>rd</sup> after first irrigation	41.6	12.9	62.8	85.3	10.4	9.8
1/3 <sup>rd</sup> at sowing + 2/3 <sup>rd</sup> after first irrigation	40.5	12.9	62.6	84.9	10.7	9.9
CD ( $P=0.05$ )	NS	NS	NS	NS	0.1	NS

**Table 1.** Continued.

Treatments	Starch (%)	$\alpha$ -amylase activity (SKB units/g)	Diastatic power ( $^{\circ}$ L)	Malt recovery (%)	Malt yield (kg/ha)
<b>Varieties</b>					
VJM 201	61.1	33.5	106	85.7	3393.7
DWRUB52	59.9	33.9	105	84.1	3523.8
CD ( $P=0.05$ )	0.2	NS	NS	0.6	—
<b>Nitrogen Levels (kg/ha)</b>					
0 (Control)	62.3	30.4	102	86.8	2630.1
30	61.5	32.0	104	85.8	3208.9
60	59.9	35.3	107	84.1	3801.3
90	58.4	37.2	110	82.7	4151.5
CD ( $P=0.05$ )	0.3	0.7	0.5	0.8	—
<b>Time of Nitrogen Application</b>					
Whole at sowing (recommended)	61.0	33.8	106	84.7	3404.9
2/3 <sup>rd</sup> at sowing + 1/3 <sup>rd</sup> after first irrigation	60.5	33.6	106	85.0	3536.0
1/3 <sup>rd</sup> at sowing + 2/3 <sup>rd</sup> after first irrigation	60.1	33.7	106	84.9	3438.9
CD ( $P=0.05$ )	0.2	NS	NS	NS	—

periment was laid out in split-design with three replications keeping combination of two varieties (VJM

201 and DWR UB52) and four nitrogen levels (0, 30, 60 and 90 kg N/ha) in main plots and three times of

nitrogen application (whole at sowing, 2/3<sup>rd</sup> at sowing + 1/3<sup>rd</sup> after first irrigation and 1/3<sup>rd</sup> at sowing + 2/3<sup>rd</sup> after first irrigation) in sub-plots. All recommended practices were followed except N, which was applied as per treatments.

Representative samples were tested for various grain and malt quality characteristics. Grain hardness was measured using the hardness tester supplied by Kiya Seisa Kosho Ltd., Japan. Hectoliter weight by using the test weight apparatus designed by DWR Karnal and the results are expressed as (kg/hl). Kernel plumpness as per methods described by (2) using a sieve having  $0.24 \times 1.9$  cm slotted openings. Husk content was determined as per the procedure given by (3). Protein and starch content were analysed using whole grain analyzer infratech-1241 supplied by FOSS analytical AB, Sweden. Malting of the barley (200 g) was carried out as per the method suggested by (4). Malt quality parameters i.e diastatic power and  $\alpha$ -amylase activity were determined following standard (5, 6). Malt recovery and malt yield was calculated by the following formula :

$$\text{Malt recovery (\%)} = \frac{\text{Malt weight}}{\text{Sample weight}} \times 100$$

Malt yield (kg/ha) was computed by multiplying the grain yield (kg/ha) with the malt recovery (%).

## Results and Discussion

### *Effect of Varieties*

Differences among both varieties were observed for different quality traits (Table 1). Variety DWR UB52 had significantly higher hectoliter weight and kernel plumpness (63.3 kg/hl and 85.6%, respectively) than variety VJM 201 but the later variety had significantly higher husk content and starch content (10.6 and 61.1%, respectively) than the former. Grain hardness and protein content was statistically similar in both the varieties. DWR UB52 had more test weight which implies that its grains were denser, uniform in size and of the desired shape which decreased the inter-grain spaces, therefore higher hectoliter weight. The plump kernels of DWR UB52 might have resulted in reduced husk to endosperm ratio, thereby reducing husk content. Differences among varieties for malt quality parameters viz.  $\alpha$ -amylase activity and

diastatic power were found to be non-significant. As variety VJM 201, gave higher malt recovery of 85.7% which was significantly higher than DWR UB52 (84.1%) and thus resulted in higher malt yield that was recorded with DWR UB52 (3,523.8 kg/ha). Higher malt yield of DWR UB52 was due to higher grain yield (41.9 q/ha) of variety DWR UB52 as compared to 39.6 q/ha of variety VJM 201.

### *Effect of Nitrogen Levels*

Maximum grain yield of 50.2 q/ha was recorded with highest dose of 90 kg N/ha and it was significantly higher than 60 kg N/ha (45.2 q/ha), 30 kg N/ha (37.49/ha) and control (30.3 q/ha). These results were in conformity with earlier findings (7), as observed higher grain yield at 80 kg N/ha as compared to application of lower doses of nitrogen. The grain quality parameters viz. grain hardness, husk content and protein content were increased whereas hectoliter weight, kernel plumpness and starch content were decreased significantly with each incremental dose of 30 kg N/ha i.e. from 0 to 90 kg/ha (Table 1).

Grain hardness significantly increased from 12.3 to 13.5 kgs when nitrogen level increased from 0 to 90 kg/ha. Significantly higher grain hardness with the application of 90 kg N/ha might be due to that the increased nitrogen levels increased the availability of nitrogen which resulted in significant increase in protein content in grain leading to a stronger bondage between the stored protein and declining starch pocket formation within the proteins. The maximum hectoliter weight (65.1 kg/hl) was obtained with control and the minimum (60.2 kg/hl) was recorded with the application of 90 kg N/ha. Reduction in hectoliter weight with increase in nitrogen levels might be attributed to the increased number of grains per ear which resulted in smaller size of grains that cannot pack efficiently, thus results in low test weight. Progressive and significant reduction in kernel plumpness with increase in the dose of nitrogen application might be due to increased grain protein content, which might have increased the compactness of grains, thereby reducing kernel plumpness. The maximum protein content (10.5%) was obtained with 90 kg N/ha which was significantly higher than 60 (9.9%) and 30 kg N/ha (9.5%) and control (9.4%). Significant increase in the grain protein content with the increase

in nitrogen could be attributed to more nitrogen uptake by the plant and more translocation of nitrogen to the grain. Nitrogen being the precursor of protein increased the grain protein content accordingly. The possible reason for decreased starch content with increase in nitrogen can be related to protein content as protein and starch content of the grain are inversely proportional to each other i.e. with increase in protein content, starch content decreased and vice versa.

Malt quality parameters viz.  $\alpha$ -amylase activity and diastatic power were significantly increased with increase in levels of nitrogen. The higher  $\alpha$ -amylase activity and diastatic power of malt (37.2 SKB Units/g and 110° L), respectively was recorded with the application of 90 kg N/ha which might be due to higher grain protein content. As these parameters are the indicators of enzymatic activity, enzymes being protein increases with increase in protein content. The findings are in accordance with (8) that increasing nitrogen rates significantly increased the diastatic power and  $\alpha$ -amylase activity. Malt recovery however decreased significantly with increase in levels of nitrogen. But the malt yield was maximum (4151.5 kg/ha) at 90 kg N/ha than 60 and 30 kg N/ha and control.

#### *Effect of Time of Nitrogen Application*

Nitrogen application at different growth stages failed to have any significant effect on grain yield of the crop. Significant increase in starch content was observed with the treatment which received full dose

of nitrogen at sowing (61.0%) and was significantly better than other two treatments i.e. where nitrogen was applied in splits. While the maximum husk content (10.7%) was observed under treatment that received 1/3<sup>rd</sup> nitrogen at sowing and 2/3<sup>rd</sup> after first irrigation. The differences for grain hardness, hectoliter weight, kernel plumpness and protein content were found to be non-significant among different nitrogen application time.

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