Response of malt barley (*Hordeum vulgare* L.) to levels and scheduling of nitrogen application on yield attributes, yield and economics under normal and late sown conditions

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Abstract: The field experiment was conducted to find out the effect of nitrogen levels and its split application on yield attributes, yield and economics of malt barley (*Hordeum vulgare* L.) under normal and late sown conditions during winter seasons of 2005-06 and 2006-07. The results showed that significantly higher effective tillers / m row, spike length, grains / spike, test weight, grain, straw and biological yield, harvest index and net returns of malt barley were observed under normal sown condition compared to late sown condition. Further, application of increasing levels of nitrogen from 60 to 90 kg ha⁻¹ significantly enhanced effective tillers / m row, spike length, grains / spike, test weight, grain, straw and biological yield, harvest index and net returns of malt barley. Scheduling of nitrogen at 1/3 as basal + 1/3 at Iˢᵗ irrigation + 1/3 at IIⁿᵈ irrigation brought a substantial improvement in above yield attributing characters and yields, harvest index and net returns of malt barley.

Key Words: Effective tillers, Spike length, Grains per spike, Grain and straw yield, Nitrogen levels, Growing environments, Scheduling of nitrogen application, Malt barley


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INTRODUCTION

Barley is one of the important cereal crops. Use of barley (*Hordeum vulgare* L.) in malt industry is most significant out of its all uses where it is being used in making beer, different type of alcohol. Many crop management factors affect the yield of this crop. For higher production of malt barley, the influence of weather elements particularly the temperature on crop growth and development and their by own crop productivity is well established so, planting time may affect the productivity of malt barley (Zhang *et al.*, 2002). Nitrogen is considered as most important element in production of cereals. Barley crop has also been found to respond significantly to varying levels to nitrogen fertilizations. However, there has been limited field research on the scheduling of N fertilizer that suit as both grain yield for malting barley. Time of application of nitrogen is known to exert considerable influence on the yield of crop. Nitrogen efficiency especially in light soils can be increased and losses reduced by regulating it through the scheduling of nitrogen application so as to match with its uptake by the growing plants. Too much splitting of N may increase the yield of malt barley. Keeping these points in view, a field experiment was conducted to find out the effect of nitrogen levels and its scheduling under different growing environments in arid and sandy soils of North-Western Rajasthan.

MATERIAL AND METHODS

The experiment was conducted at College of...
Agriculture, Bikaner during winter seasons of 2005-06 and 2006-07. The soil of the experimental field was loamy sand and low in organic matter. The treatments comprised of two levels of growing environments (normal and late sown) and two nitrogen levels (60 and 90 kg ha⁻¹) as main plot treatments and five levels of scheduling of nitrogen application (Full basal, 3/4 at basal + 1/4 at Ist irrigation, 2/3 at basal + 1/3 at Ist irrigation, 1/2 at basal + 1/2 at Ist irrigation and 1/3 at basal + 1/3 at Ist irrigation + 1/3 at IInd irrigation) as sub plot treatments and were laid out in Split Plot Design with four replications. The data collected were analyzed statistically by using Fisher’s analysis of variance (Fisher, 1950) technique and individual treatment means were separated by using least significant difference (LSD) test at 5 per cent probability level. The nitrogen as per treatments was applied through urea after adjusting the nitrogen supplied through DAP (applied for 40 kg P₂O₅ ha⁻¹) and potassium (30 kg K₂O ha⁻¹) also supplied through MOP. The calculated quantity of urea for different treatments was applied as basal and remaining nitrogen were given at Ist and IInd irrigation as per treatments. The malt barley variety RD-2503 was sown on 12th November (normal sown) and 2nd December (late sown) during 2005, and 20th November (normal sown) and 5th December (late sown) during 2006, maintaining 22.5 cm row to row spacing. A seed sample was taken from the produce of each of the net plot harvested and 1000-seeds were counted and weighed as test weight in grams. The harvested material from net area of each plot was thoroughly sun dried. After drying, the produce of individual net plot was weighed with the help of spring balance and recorded as biological yield in kg plot⁻¹. Later, biological yield per plot was converted to q ha⁻¹. The grain yield of each net plot (inclusive of tagged plants) was recorded in kg plot⁻¹ after cleaning the threshed produce and was converted as q ha⁻¹.

**RESULTS AND DISCUSSION**

The results of the present study have been presented and discussed under the following headings:

**Effect of growing environments:**

The data further revealed that effect of normal sowing significantly increased the number of effective tillers, spike length, number of grains per spike and test weight of malt barley over late sowing on pooled basis. This may due to the fact that under normal sown conditions, the reproductive phase experienced optimum temperature conditions while under late sown conditions, steep rise in temperature at this stage reduced the duration of reproductive phase as well as growth of grains expressed in terms of seed index and number of grains per spike. As a consequence of favorable climatic conditions, improvement in yield attributing characters was also observed by Gupta et al. (2001).

A perusal of pooled data embodied in Table 1 revealed that significantly higher grain, straw and biological yields and harvest index of malt barley was observed under normal sown condition compared to late sown condition. The significant increase in grain yield under normal sown conditions seems to be on account of significant increase in yield attributes. It is also established fact that the prevalence of higher temperature shortens period from ear initiation anthesis thus reducing supply of photosynthates relative to the rate of

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Effective tillers (m/row)</th>
<th>Spike length (cm)</th>
<th>Grains / spike</th>
<th>Test weight (g)</th>
<th>Grain yield (q/ha)</th>
<th>Straw yield (q/ha)</th>
<th>Biological yield (q/ha)</th>
<th>Harvest index (%)</th>
<th>Net returns (Rs/ha)</th>
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<tbody>
<tr>
<td><strong>Growing environments</strong></td>
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<tr>
<td>Normal sown</td>
<td>59.28</td>
<td>5.26</td>
<td>31.82</td>
<td>43.63</td>
<td>28.55</td>
<td>33.60</td>
<td>62.19</td>
<td>45.78</td>
<td>17711</td>
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<tr>
<td>Late sown</td>
<td>52.93</td>
<td>4.80</td>
<td>29.27</td>
<td>42.40</td>
<td>26.32</td>
<td>31.32</td>
<td>57.64</td>
<td>45.59</td>
<td>15702</td>
</tr>
<tr>
<td>C.D. (P=0.05)</td>
<td>2.35</td>
<td>0.15</td>
<td>0.91</td>
<td>0.75</td>
<td>0.09</td>
<td>0.09</td>
<td>1.81</td>
<td>0.14</td>
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<tr>
<td>60 kg/ha</td>
<td>51.99</td>
<td>4.66</td>
<td>28.25</td>
<td>42.37</td>
<td>25.31</td>
<td>30.36</td>
<td>55.73</td>
<td>45.40</td>
<td>14946</td>
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<tr>
<td>90 kg/ha</td>
<td>60.22</td>
<td>5.39</td>
<td>32.83</td>
<td>43.66</td>
<td>29.55</td>
<td>34.55</td>
<td>64.10</td>
<td>45.98</td>
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<tr>
<td>C.D. (P=0.05)</td>
<td>2.35</td>
<td>0.15</td>
<td>0.91</td>
<td>0.75</td>
<td>0.09</td>
<td>0.09</td>
<td>1.81</td>
<td>0.14</td>
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<td><strong>Scheduling of nitrogen application</strong></td>
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<tr>
<td>Full basal</td>
<td>46.20</td>
<td>4.00</td>
<td>24.18</td>
<td>42.69</td>
<td>21.76</td>
<td>26.76</td>
<td>48.52</td>
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<tr>
<td>3/4 Basal + 1/4 at Ist irrigation</td>
<td>51.70</td>
<td>4.64</td>
<td>28.16</td>
<td>42.81</td>
<td>25.26</td>
<td>30.26</td>
<td>55.52</td>
<td>45.43</td>
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<tr>
<td>2/3 Basal + 1/3 at Ist irrigation</td>
<td>56.82</td>
<td>5.21</td>
<td>31.62</td>
<td>42.96</td>
<td>28.25</td>
<td>33.44</td>
<td>61.88</td>
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<tr>
<td>1/2 Basal + 1/2 at Ist irrigation</td>
<td>60.55</td>
<td>5.48</td>
<td>33.43</td>
<td>43.16</td>
<td>30.09</td>
<td>35.09</td>
<td>65.18</td>
<td>46.10</td>
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<tr>
<td>1/3 Basal + 1/3 at Ist irrigation + 1/3 at IIst irrigation</td>
<td>65.26</td>
<td>5.80</td>
<td>35.32</td>
<td>43.46</td>
<td>31.80</td>
<td>36.73</td>
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<tr>
<td>C.D. (P=0.05)</td>
<td>2.90</td>
<td>0.20</td>
<td>1.19</td>
<td>NS</td>
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<td>0.12</td>
<td>2.43</td>
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</tbody>
</table>

NS=Non-significant

Effect of scheduling of nitrogen application:

Table 1 further, revealed that nitrogen application in three equal splits viz., 1/3 at basal + 1/3 at I\textsuperscript{st} irrigation + 1/3 at II\textsuperscript{nd} irrigation recorded significantly higher number of effective tillers, spike length, number of grains per spike except plant height and test weight of malt barley on pooled basis over two splits viz., 1/2 at basal + 1/2 at I\textsuperscript{st} irrigation, 2/3 at basal + 1/3 at I\textsuperscript{st} irrigation, 3/4 at basal + 1/4 at I\textsuperscript{st} irrigation and full basal. Full basal application of N had minimum and significantly lower number of effective tillers, spike length and number of grains per spike on pooled data. Test weight of malt barley was not influenced by the different scheduling of N application. Increase in yield attributing character of malt barley due to split application of nitrogen might be due to the prevented losses of nitrogen through leaching and volatilization as compared to application in single dose and two split applications as a result the barley crop was benefited through adequate supply of nitrogen at different growth stages, which have helped in increasing yield attributes (Singh and Singh, 2005). Application of nitrogen as full basal, lower availability of nitrogen resulting into nitrogen deficiency at growth and development stage and hence a weak growth and development. Similar trend in results with regard to yield attributing characters by crop were also reported by Roy and Singh (2006).

Data in Table 1 further indicate that highest grain, straw and biological yields and harvest index of malt barley was obtained under split application of nitrogen as 1/3 at basal + 1/3 at I\textsuperscript{st} irrigation + 1/3 at II\textsuperscript{nd} irrigation which was found significantly higher over 1/2 at basal + 1/2 at I\textsuperscript{st} irrigation, 2/3 at basal + 1/3 at I\textsuperscript{st} irrigation, 3/4 at basal + 1/4 at I\textsuperscript{st} irrigation and full basal on pooled basis. Further, two equal N splits viz., 1/2 at basal + 1/2 at I\textsuperscript{st} irrigation was significantly superior over 2/3 at basal + 1/3 at I\textsuperscript{st} irrigation, 3/4 at basal + 1/4 at I\textsuperscript{st} irrigation. Full basal application of N had minimum grain and straw yield and harvest index during both the years. The increase in grain and straw yield might be due to continued and timely availability of nitrogen under three splits of nitrogen to malt barley. The assured availability of essential nutrient nitrogen and metabolites which in turn increased photosynthetic efficiency and accumulation of photosynthates, synchronized to demand for growth and development.

\begin{table}
\centering
\begin{tabular}{|c|c|c|c|c|}
\hline
Scheduling of nitrogen application & Normal sown & Late sown & Mean \\
\hline
  & 60 kg N ha\textsuperscript{-1} & 90 kg N ha\textsuperscript{-1} & 60 kg N ha\textsuperscript{-1} & 90 kg N ha\textsuperscript{-1} & Mean \\
\hline
Full basal & 18.87 & 21.51 & 21.72 & 24.95 & 21.76 \\
3/4 Basal + 1/4 at I\textsuperscript{st} irrigation & 24.92 & 26.30 & 22.77 & 27.05 & 25.26 \\
2/3 Basal + 1/3 at I\textsuperscript{st} irrigation & 27.62 & 32.44 & 24.73 & 28.23 & 28.25 \\
1/2 Basal + 1/2 at I\textsuperscript{st} irrigation & 28.86 & 35.49 & 26.62 & 29.39 & 30.09 \\
1/3 Basal + 1/3 at I\textsuperscript{st} irrigation + 1/3 at II\textsuperscript{nd} irrigation & 29.44 & 40.01 & 27.60 & 30.15 & 31.80 \\
Mean & 25.94 & 31.15 & 24.69 & 27.95 & 27.43 \\
S.E ± & C.D. (P = 0.05) & & & & \\
A-means at Same level of S&N & 1.23 & 2.45 & & & \\
S&N-means at Same level of A & 1.31 & 2.67 & & & \\
\hline
\end{tabular}
\caption{Interaction effect of growing environments, nitrogen levels and scheduling of nitrogen application on grain yield (q ha\textsuperscript{-1}) of malt barley (pooled data)}
\end{table}
development of each yield components. Gupta et al. (2001) and Patel et al. (2004) also reported that split application of nitrogen increases the nitrogen use efficiency considerably by supplying nitrogen at the critical stages when the crop nitrogen requirement is more. These results are in agreement with the experimental findings of Roy and Singh (2006) in malt barley.

Nitrogen application in three equal splits viz., 1/3 at basal + 1/3 at I
d irrigation + 1/3 at II
irrigation also recorded significantly higher net returns over two splits viz. 1/2 at basal + 1/2 at I
irrigation, 2/3 at basal + 1/3 at I
irrigation, 3/4 at basal + 1/4 at I
irrigation and full basal on pooled data.

Interaction effect:
There was also significant interaction effects between sowing dates, nitrogen levels and its scheduling on pooled basis, which indicated that the maximum and significantly higher grain yield of malt barley was recorded with 90 kg N ha

-1 applied in three equal splits under normal sown condition, but the effect of three splits of 90 kg N ha

-1 was not observed under late sown conditions compared to two equal splits of 90 kg N. Similarly, when 60 kg N ha

-1 was applied in three splits under both the sowing conditions, no significant effect was observed when compared with two equal splits (Table 2).

Conclusion:
Keeping in view the objectives framed for undertaking the study and the results obtained after experimental period, under mentioned conclusions may be drawn. Application of nitrogen @ 90 kg N ha

-1 in three splits as 1/3 at basal + 1/3 at I
irrigation + 1/3 at II
irrigation with normal sown proved to be the best practice for yield attributing characters, yields and net returns of malt barley.

REFERENCES


