Nitrate reductase activity in rice as related to weed competitiveness

Maurice Ouko, Folkard Asch, Mathias Becker

Post graduate study program – Agricultural sciences and Resource management in the Tropics and Subtropics – ARTS – Universität Bonn, Nussallee 1, 53113 Bonn – email: mauro_75@yahoo.com; Web: http://www.arts.uni-bonn.de

Introduction

Upland rice systems in Africa are threatened by weeds. Most weeds out-compete rice plants in the uptake and use of nutrients especially NO3 which is the abundant form of nitrogen available under aerobic soil conditions. NO3 uptake follows a 2 step pathway via the iso-enzymes nitrate reductase (NR) and nitrite reductase. The rate limiting factor in NO3 uptake is the activity of NR (NRA) which in turn depends on the form and concentration of nitrogen. The activity of NR is thus a measure of the ability of higher plants to take up and use nitrate. We hypothesize that rice having high and early NRA, assimilate nitrate better and thus compete more efficiently with weeds.

Objectives

- To investigate genotypic differences among rice genotypes
- To investigate the role of the form and concentration of nitrogen in NRA
- To investigate weed competitiveness among rice genotypes
- To relate weed competitiveness among rice types to NRA

Conclusions

- NRA in rice varies with seedling age, genotype, N-form and concentration of nitrogen supply.
- Rice types adapted to upland conditions are more efficient in assimilating nitrogen.
- Weed competitiveness of traditional rice types may be attributed to superior nitrate assimilation.

Results - Summary

NRA of selected rice cultivars and weedy plants at 14 days after germination (DAG). Plants were grown hydroponically using Yoshida nutrient solution.

<table>
<thead>
<tr>
<th>Cultivar</th>
<th>Species</th>
<th>Genetic group</th>
<th>Ecotype</th>
<th>NRA(µmol NO3/g.h)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CG14</td>
<td>O. glaberima</td>
<td>Traditional upland</td>
<td>14.34</td>
<td></td>
</tr>
<tr>
<td>WAB 56-104</td>
<td>O. sativa</td>
<td>Improved upland</td>
<td>12.74</td>
<td></td>
</tr>
<tr>
<td>WAB 181-18</td>
<td>O. sativa</td>
<td>Improved upland</td>
<td>14.89</td>
<td></td>
</tr>
<tr>
<td>Montebianco</td>
<td>O. sativa</td>
<td>Traditional upland</td>
<td>14.24</td>
<td></td>
</tr>
<tr>
<td>Sahel 108</td>
<td>O. sativa</td>
<td>Improved lowland</td>
<td>12.74</td>
<td></td>
</tr>
<tr>
<td>OK4</td>
<td>O. sativa</td>
<td>Traditional upland</td>
<td>14.02</td>
<td></td>
</tr>
<tr>
<td>Suakoko 8</td>
<td>O. sativa</td>
<td>Improved lowland</td>
<td>12.74</td>
<td></td>
</tr>
<tr>
<td>CK4</td>
<td>O. sativa</td>
<td>Traditional lowland</td>
<td>14.02</td>
<td></td>
</tr>
<tr>
<td>Sahel 108</td>
<td>O. sativa</td>
<td>Improved lowland</td>
<td>12.74</td>
<td></td>
</tr>
<tr>
<td>WAB 56-104</td>
<td>O. sativa</td>
<td>Improved upland</td>
<td>14.89</td>
<td></td>
</tr>
<tr>
<td>CG14</td>
<td>O. glaberima</td>
<td>Traditional upland</td>
<td>14.34</td>
<td></td>
</tr>
<tr>
<td>WAB 56-104</td>
<td>O. sativa</td>
<td>Improved upland</td>
<td>12.74</td>
<td></td>
</tr>
<tr>
<td>WAB 181-18</td>
<td>O. sativa</td>
<td>Improved upland</td>
<td>14.89</td>
<td></td>
</tr>
<tr>
<td>Montebianco</td>
<td>O. sativa</td>
<td>Traditional upland</td>
<td>14.24</td>
<td></td>
</tr>
<tr>
<td>Sahel 108</td>
<td>O. sativa</td>
<td>Improved lowland</td>
<td>12.74</td>
<td></td>
</tr>
<tr>
<td>OK4</td>
<td>O. sativa</td>
<td>Traditional upland</td>
<td>14.02</td>
<td></td>
</tr>
<tr>
<td>Suakoko 8</td>
<td>O. sativa</td>
<td>Improved lowland</td>
<td>12.74</td>
<td></td>
</tr>
<tr>
<td>CK4</td>
<td>O. sativa</td>
<td>Traditional lowland</td>
<td>14.02</td>
<td></td>
</tr>
</tbody>
</table>

Traditional rice genotypes have higher NRA than their improved counterparts.

- NRA in rice is subjective to the form and concentration of nitrogen and changes with seedling age.
- Under optimal NO3 conditions traditional rice types are more weed competitive than improved types.

Materials & Methods

- The experiment was carried out under hydroponic conditions using Yoshida nutrient culture.
- The nitrogen source was modified to provide either 40 ppm NH4 (0 ppm NO3), 20 ppm NO3, 30 ppm NH4+20 ppm NO3 or 40 ppm NO3.
- In vivo NRA of both weedy and rice plants were determined at 7, 14 and 21 days after germination.
- Selected rice cultivars were grown in association with weedy plants.
- At 17 DAG growth parameters (fresh weight, dry weight, leaf area, plant height) were measured. These were used to assess the competitiveness of the rice plants.

Deutscher Tropentag 2003, 8-10 Oktober, Göttingen