Nitrate reductase activity in rice as related to weed competitiveness

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Introduction

Upland rice systems in Africa are threatened by weeds. Most weeds out-compete rice plants in the uptake and use of nutrients especially NO_3 which is the abundant form of nitrogen available under aerobic soil conditions. NO_3 -uptake follows a 2 step pathway via the iso-enzymes nitrate reductase (NR) and nitrite reductase. The rate limiting factor in NO_3 -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.

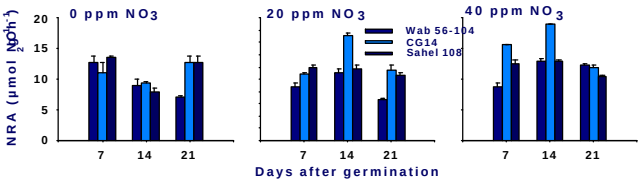
Results - Summary

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

Cultivar	Species	Genetic group	Ecotype	NRA(µmol NO_2/g/h)
CG14	*O. glaberrima*		Traditional upland	14.34
WAB 56-104	*O sativa*	japonica	Improved upland	9.07
WAB 181-18	*O sativa*	japonica	Improved upland	16.10
Morroberikan	*O sativa*	japonica	Traditional upland	14.69
Sahel 108	*O sativa*	indica	Improved lowland	11.74
CK4	*O sativa*	indica	Improved lowland	12.74
Suakoko8	*O sativa*	indica	Trad. lowland	14.02

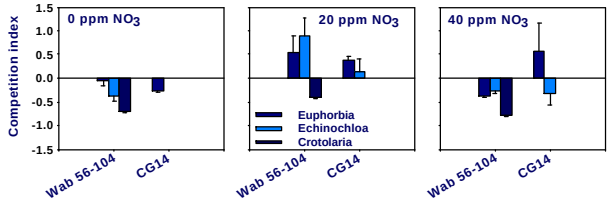
Common name	Species	Weed Type	Ecotype	NRA(µmol NO_2/g/h)
Maize	*Zea mays*	Narrow leafed	Upland weed	7.26
Barnyard grass	*Echinochloa crus pavonis*	Narrow leafed	Lowland weed	11.99
Japanese poinsetta	*Euphorbia heterophyla*	Broad leafed	Upland weed	7.43
Crotolaria	*Crotolaria*	Broad leafed	Upland weed	10.24

Traditional rice genotypes have higher NRA than their improved counterparts.



In vivo NRA of rice genotypes at 7, 14 and 21 days after germination. Plants were grown under varying concentrations of NO_3.

NRA in rice is subjective to the form and concentration of nitrogen and changes with seedling age

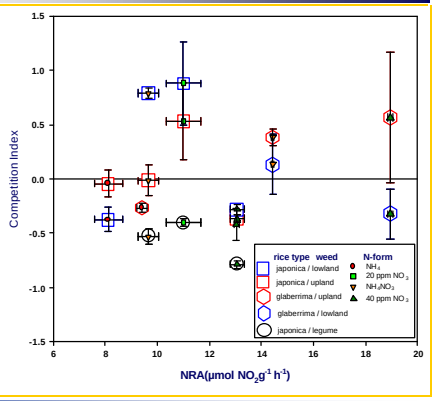


Rice genotypes grown on different levels of nitrate in competition with weeds and in mono-culture. Positive values indicate better rice growth under competition than in monoculture.

Under optimal NO_3 conditions traditional rice types are more weed competitive than improved types.

NRA of rice genotypes at 14 days after germination as related to weed competiveness

The relationship between NRA and competitiveness depends on N-form, N-level and weed type. Limited N nutrition increases NRA and competition index.



Materials & Methods

Pregerminated seeds ready for planting

Rice growing in experimental set-up

- The experiment was carried out under hydroponic conditions using Yoshida nutrient culture.
- The nitrogen source was modified to provide either 40 ppm NH_4 (0 ppm NO_3) , 20 ppm NO_3, 20 ppm NH_4 +20 ppm NO_3, or 40 ppm NO_3.
- 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.