Nitrate effects on pre-emergence growth of maize

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Introduction

Additional nitrate (NO_3^-) at concentrations likely to occur in agricultural soils can cause increased rate of mobilisation of seed reserves in temperate cereals (Andrews *et al.*, 1991a,b, 1994). This effect appears to be dependent on substantial uptake of NO_3^- and thus is unlikely to occur with plants which take up little NO_3^- at the seedling stage. Maize (*Zea mays* L.) is an important cereal of subtropical/tropical origin. Individual seed weight is much greater for maize than for temperate cereals. Previous work indicates that for maize, NO_3^- uptake is low during the first 2 to 3 weeks of growth when the endosperm is actively supplying reduced N to the seedling (Oaks, 1983). The present study examines NO_3^- effects on growth of maize prior to emergence from the substrate.

Methods

Seed of maize (accession no. PX9199) was obtained from Corson Seed International, Gisborne, New Zealand. Mean seed weight (MSW) was 385 mg. Seed used in the experiment was MSW ± 5%. Seed was sown at 60 mm depth in 100 mm diameter, 200 mm tall pots (3 per pot) containing a vermiculite/perlite (1:1) mixture soaked with basal nutrient solution (Andrews *et al.*, 1989) containing 0, 1 or 10 mol m^{-3} potassium nitrate. Potassium concentration in the 0 and 1 mol m^{-3} NO_3^- treatments was made equal to that at 10 mol m^{-3} NO_3^- by the addition of potassium sulphate. Plants were grown in the dark in a controlled environment chamber at 15 ± 1°C. All pots were flushed with the appropriate nutrient solution every 2 or 3 d. All plants were harvested 17 d after sowing and shoot length and shoot and root fresh weight (FW) were determined. Shoots, roots and seeds were then dried for 96 h at 70°C and weighed. There were twelve replicates per treatment, each replicate comprising one pot of three plants. Analysis of variance was carried out on all data. The experiment was repeated twice. Effects discussed have an F ratio with a probability of $P<0.01$ and were obtained in the repeat experiments.

Results and Discussion

Shoot length and root FW and dry weight (DW) were not affected by NO_3^- but shoot FW and DW were greater at 10 than at 0 or 1 mol m^{-3} NO_3^- (Table 1). The percentage increase was greater for FW than for DW due to an increase in shoot water content. Increased shoot water content with additional NO_3^- occurs with temperate cereals also and indicates greater levels of osmoticum in cells (Andrews *et al.*, 1991a,b, 1994). Although addition of 10 mol m^{-3} NO_3^- caused an increase in shoot plus root DW, it did not affect residual seed DW. However, as shoot plus root DW was such a small proportion of the original seed DW this is to be expected. The consistent

Table 1. Effect of different concentrations of applied nitrate (NO_3^-) on shoot length and fresh weight (FW) and dry weight (DW) of the component parts of maize prior to emergence from the substrate. Seed was sown at 60 mm depth.

Applied NO_3^- (mol m^{-3})	Shoot length (mm)	Root FW (g)	Root DW (g)	Shoot FW (g)	Shoot DW (g)	Cotyledon DW (g)
0	55.2	0.207	0.015	0.323	0.024	0.285
1	60.2	0.212	0.015	0.325	0.023	0.284
10	59.3	0.211	0.015	0.390	0.028	0.284
s.e.m.	2.9	0.014	0.001	0.015	0.001	0.002

finding (three experiments) of increased shoot plus root DW with additional NO_3^- indicates that for maize as for temperate cereals, NO_3^- causes increased rate of mobilisation of seed reserves. Previous work indicates that NO_3^- uptake by maize is low at the seedling stage (Oaks, 1983). However, preliminary tissue analysis (Merckoquant test strips) indicated that NO_3^- accumulation was as great in maize seedlings as for wheat seedlings. Thus, NO_3^- stimulated mobilisation of seed reserves with maize could be dependent on substantial NO_3^- uptake.

References

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