Resistance of rapeseed (*Brassica napus* L.) to aluminium apparent in nutrient solution but not in soil

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Abstract

Canola is sensitive to acidic soils, and therefore apparently to aluminium (Al). Selection for resistance to Al is thus an important canola breeding objective. The primary site of Al toxicity is the root apex which severely restricts root growth. Relative root weight (RRW= root weight relative to control), therefore, best reflects the level of Al resistance among plants. In one experiment, two canola and two wheat cultivars were evaluated for resistance to Al under 9 Al concentrations (0-160 ?M) in solution culture. The Al resistant wheat cv. Diamondbird and the Al sensitive wheat cv. Janz showed a typical Al-dose growth response while the canola cvs. Oscar and Rainbow were as resistant to Al as Diamondbird. In another experiment, 24 genotypes were evaluated in 100 ?M Al. Twenty three genotypes had a RRW above 50% and 7 genotypes above 75%; only the *B. juncea* genotype had a RRW below 50%. Although many rapeseed genotypes were highly resistant to Al in solution culture this resistance was not expressed in an acid soil. Plants grown in acid soil showed severe chlorosis, necrosis and shoot stunting. These results indicated that nutrient solution culture may be unsuitable for evaluating rapeseed germplasm for resistance to Al and hence resistance to acid soils. An alternative Al-resistance model of rapeseed that may explain the discrepancies observed between nutrient solution and acid soil evaluations is needed. (NSW DPI - Acid Soil Action)

Key Words

wheat, canola, *B. juncea*, aluminum, screening

Introduction

In acid soils (pH<4.3) Al toxicity is the primary toxin to root growth. Current Australian canola cultivars are sensitive to acid soils and thus selection for resistance to Al toxicity is still a major canola breeding objective. Nutrient solution assays are a widely used approach for evaluating crop germplasm for resistance to Al. Solution culture assays, however, may not be necessarily suitable to evaluate the many putative mechanisms for resistance to Al that are known to exist between plant species and/or among genotypes within plant species (Conyers et al, 2005). In recent years we have performed a series of experiments with nutrient solution to evaluate *B. napus* germplasm for resistance to Al. Furthermore, we have also evaluated a selection of *B. napus* genotypes in an acid soil with high exchangeable Al. We have used rapeseed genotypes reported to be Al resistant as evaluated by the haematoxylin root staining assay (Rife et al, 1999) and other Australian rapeseed and canola genotypes. Contrary to expectations we have consistently found that most of the *B. napus* material evaluated exhibited a high level of resistance to Al, but this resistance, however, was not expressed in acid soil. We report the partial results from two nutrient solution assays.

Methods

In one experiment, an Al dose growth response curve was developed for both canola and wheat genotypes. Plants of the canola cvs. Oscar and Rainbow and the wheat cvs. Diamondbird and Janz were grown in a full nutrient solution culture with and without Al in 4.5 L pots. The experimental design consisted of four genotypes, nine Al treatments (0 (control), 20, 40, 60, 80, 100, 120, 140 and 160 ?M Al), three replicates and four seedlings per pot. Plants were grown in nutrient solution without Al for 7 days, transferred to new solutions with the Al treatments and grown for an additional 10 days. In another experiment, 24 rapeseed genotypes (23 *B. napus* and 1 *B. juncea*) were evaluated for resistance to Al in a full nutrient solution culture. Some of these genotypes have been reported previously to be resistant to Al evaluated by the haematoxylin root staining assay (Rife et al, 1999). Seedlings were grown in a common nutrient solution without Al for 4 days, and then transferred to individual pots (4 seedlings per pot) which contained either the control treatments (0 Al) or 100 uM Al and grown for an additional 11 days. The pH of the nutrient solutions of both experiments were maintained at 4.3. A selection of the rapeseed genotypes expressing Al resistance in nutrient solution were also grown in unlimed (pH 4.25) and limed (pH 5.80) acid soil. This soil assay has been successfully used to evaluate a number of other crop plant germplasm. At harvest, plants were separated into roots and shoots, dried and weighed.

Results

The Al resistant Diamondbird and the Al sensitive Janz showed typical dose responses to Al stress (Fig. 1). The canola cvs. Oscar and Rainbow were as resistant to Al as the Al resistant wheat Diamondbird (Fig. 1).

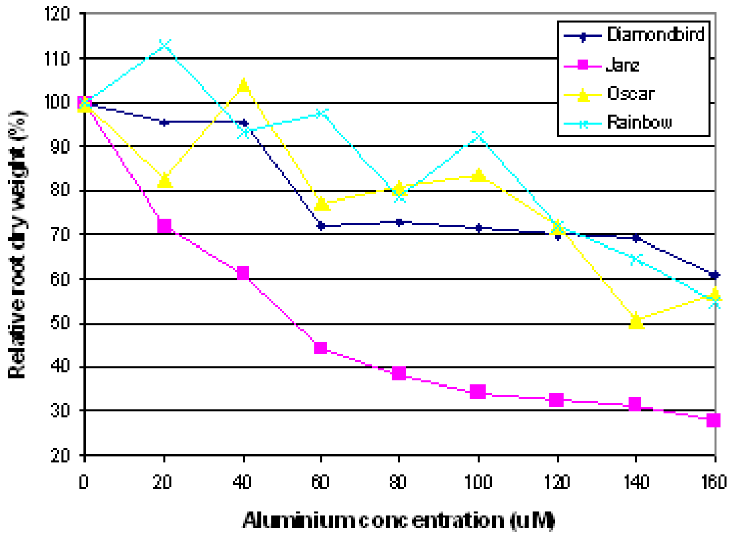
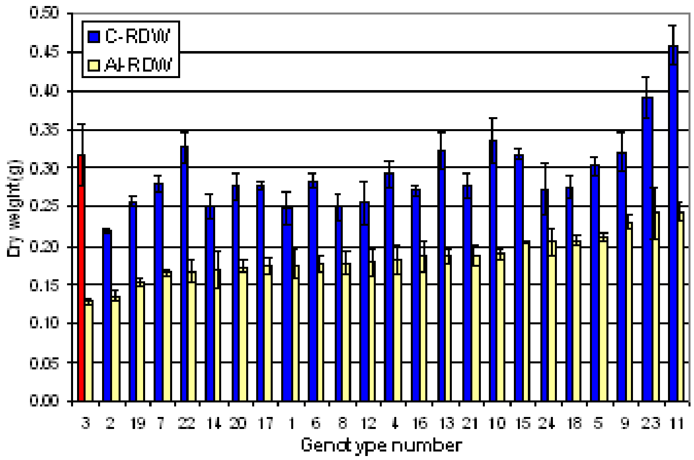


Figure 1. Relative root weight (RRW: root weight relative to control) of wheat cvs. Diamondbird and Janz and canola cvs. Oscar and Rainbow in response to increasing concentrations of Al.

Root dry weight (RDW) among rapeseed genotypes range from 0.22 to 0.46 g under control conditions and between 0.13 and 0.24 g under the Al stress (Fig. 2). Of the 24 genotypes evaluated, 23 genotypes had a (RRW: root weight relative to control) above 50% and 7 genotypes above 75%; while the *B. juncea* genotype had a RRW of 40% (calculations not shown). Although many rapeseed genotypes appeared to be resistant to Al in solution culture this resistance was not expressed in an acidic soil. Rapeseed plants grown in the acid soil showed chlorosis, necrosis and stunting and the experiment was thus terminated prematurely.



No	Genotype (Origin)	No	Genotype (Origin)
1	A 19890 (Pol)	13	Mokpo 2 (Kor)
2	98-5 (WWAI)	14	Mokpo 21 (Kor)
3	B. juncea (Aus)	15	Mokpo 22 (Kor)
4	Chon nam (Kor)	16	Mokpo 5 (Kor)
5	DH Line (UofA)	17	N001-28-246-5-4 (Kor)
6	Gisora (Ger)	18	Norin #1 (Jap)
7	Kosa (Ger)	19	Norin #3 (Jap)
8	Kuju 19 (Kor)	20	Norin 14 (Jap)
9	Kuju 51 (Kor)	21	Svalof gullen (Kor)
10	Lifura (Kor)	22	Oscar (Aus)
11	Linus (Kor)	23	Dunkeld (Aus)
12	Lisora (Ger)	24	Rainbow (Aus)

Figure 2. Root dry weight (RDW) of 23 *B. napus* and 1 *B. juncea* genotypes under control (C-RDW) and 100 *?M* Al (Al-RDW) in a nutrient solution assay

Conclusion

These results indicated that nutrient solution culture may be unsuitable for evaluating rapeseed germplasm for resistance to Al and hence resistance to acid soils. We are in the process of assessing an alternative Al resistance model for rapeseed that may explain the discrepancies observed between nutrient solution and acid soil evaluations.

References

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