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SUNFLOWER TOLERANCE TO ALUMINUM

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ABSTRACT

- Sunflower is very sensitive to soil acidity and, in general, cannot tolerate Al saturation greater than 5%. Under these conditions, root growth is drastically affected reducing the ability of plants to explore larger soil volume, which consequently may block water and nutrient absorption. The aim of this study was to evaluate the tolerance of sunflower genotypes to four aluminum concentrations.
- An experiment was carried out at the Seed Laboratory of Embrapa Soja. Seeds of ten sunflower genotypes (Pioneer 6510, CF 101, Embrapa 122, BRS 323, BRS 322, V 70004, SYN 045, BRS G 32, HLA 211 CL and Catissol) were put directly on germination paper moistened with four doses of aluminum (0, 0.4, 0.8 and 1.2 mg dm^{-3} Al), using $Al_2(SO_4)_3.18H_2O$. Ten seeds were used for each treatment, with three replications. Rolls were placed in a growth chamber, in the dark and at a temperature of 25 ° C. Dry weight of roots was evaluated at seven days after.
- Dry weight of roots of sunflower genotypes was significantly affected by levels of aluminum in solution.
- Genotypes BRS 322, BRS 323 and BRS G 32 produced higher dry weight of roots, which was statistically superior to genotypes Catissol, Embrapa 122, SYN 045 and HLA 211 CL.
- The method is able to separate sunflower genotypes by development of roots under different concentrations of aluminum.

Key words: *Helianthus annuus* – Al – soil acidity – root development

INTRODUCTION

Sunflower has a tap root system with a large number of secondary roots that can reach up to two meters deep in adult plants grown in soil without chemical and/or physical impediments (Jones, 1984; Cox and Jolliffe, 1986). However, one of the major constraints for sunflower crop in Brazil is its sensitivity to soil acidity, and consequently, to high contents of Al commonly found in Brazilian soils (Vitorello et al., 2005).

Sunflower is very sensitive to soil acidity and, in general, cannot tolerate Al saturation greater than 5%. Al is absorbed by the roots, causing phytotoxicity, primarily damaging the normal functioning of the roots, inhibiting their growth by blocking the mechanisms of water and nutrients absorption and transport (Rossiello and Netto, 2006). This leads to a decreased volume of soil explored by these plants, which become more sensitive to drought and lodging, reducing nutrient absorption and preventing the crop to express its yield potential (Castro and Oliveira, 2005).

Surface application of lime is the main practice used to raise soil pH and reduce the available concentration of Al. Soil correction occurs primarily in the superficial layers due to low mobility of its components and is less effective in correcting the acidity of deep layers (Hartwig et al., 2007). One possibility is the application of plaster for reduction of exchangeable Al in the subsurface, but it can be uneconomic due to high costs (Rossiello and Netto, 2006).

One way to solve this problem is to incorporate tolerance to Al in sunflower through breeding. Therefore, new methods for selecting tolerant genotypes should be quick, inexpensive, with easy execution, and with the efficiency of traditional methods.

The objective of this study was to develop a method for early selection of tolerant sunflower genotypes to aluminum and to evaluate the tolerance of sunflower genotypes to different Al concentrations.

MATERIAL AND METHODS

The experiment was carried out in a growth chamber of the Seed Laboratory at Embrapa Soja, Londrina - PR, in August 2011, using seeds of ten sunflower genotypes: Pioneer 6510, CF 101, Embrapa 122, BRS323, BRS 322, V 70004, SYN 045, BRS G 32, HLA 211 CL and Catissol.

Seed germination was performed directly on germination paper roll, with four concentrations of aluminum. To fabricate the roll, we used three sheets of paper: two supporting the seeds and a third covering them. Seeds were placed 3.0 cm apart from each other. The paper was moistened with 2.5 times the weight of dry substrate, with concentrations of 0, 0.4, 0.8 and 1.2 mg dm-3 of Al using $Al_2(SO_4)_3\ 18H_2O$.

All seeds were placed in the same way on paper to facilitate the growth of seedlings. Each roll of paper with the seeds was tied with strip rubber, wrapped in plastic bag and placed in a growth chamber, in the dark and at a temperature of 25°C. Ten seeds were used for each treatment, with three replications.

After seven days, rolls were opened and dry weight of roots was evaluated. Results were submitted to analysis of variance and means were compared by Tukey´s multiple range test at 5% probability.

RESULTS AND DISCUSSION

The production of dry weight of roots as a function of aluminum content varied significantly ($p < 0.05$) among ten genotypes, showing different responses to increased doses of Al. Genotypes BRS 322, BRS 323 and BRS G 32 produced greater dry weight of roots, statistically higher than genotypes Catissol, Embrapa 122, SYN 045 and HLA CL 211 (Figure 1).

Figure 2 shows the restrictive effect of increasing doses of aluminum in the development of sunflower roots and the differences in dry weight among genotype controls (0 dose of Al), showing a characteristic that may improve the establishment of plants in areas without chemical impediment or water deficit risk.

We observed different reactions of sunflower genotypes with increased doses of aluminum (Table 1). Sunflower BRS 322, which showed the highest root growth in the absence of aluminum and the highest dry weight of roots, had 22.0% of reduction in roots when Al was increased from 0.0 to 0.4 mg dm^{-3} and still produced a great amount of roots even when Al was increased up to 0.8 or 1.2 mg dm^{-3}, indicating a great ability for aluminum tolerance. On the other hand, for genotype CF 101, the decrease in root growth (-1.4%) was very small in the first dose of aluminum, but the largest depressing effect on the development of roots (40.9%) was observed when Al was increased from 0.8 to 1.2 mg dm^{-3}.

Besides the difference in the reduction percentage in the presence of aluminum, differences were observed among genotypes in the initial development of the roots in the absence of aluminum. As an example, the initial dry weight for the genotype BRS 322 was 12.4 mg, and it was 6.7 mg for SYN 045, indicating that the latter is a material with lower ability to form roots, even in soil without chemical restrictions.

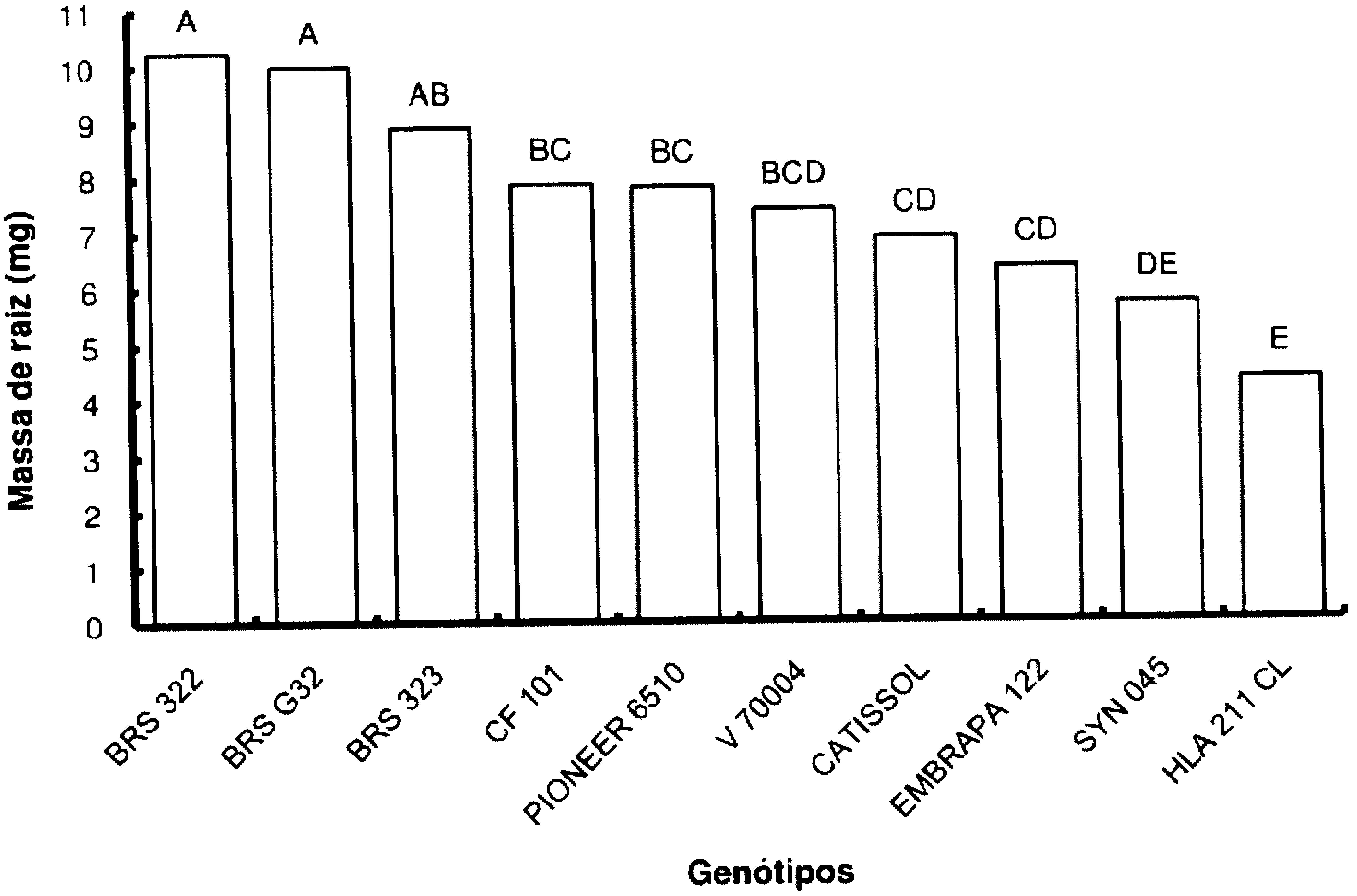

Figure 1. Dry weight of sunflower roots in response to aluminum. Means with the same letters do not differ by Tukey´s multiple range test at 5% probability.

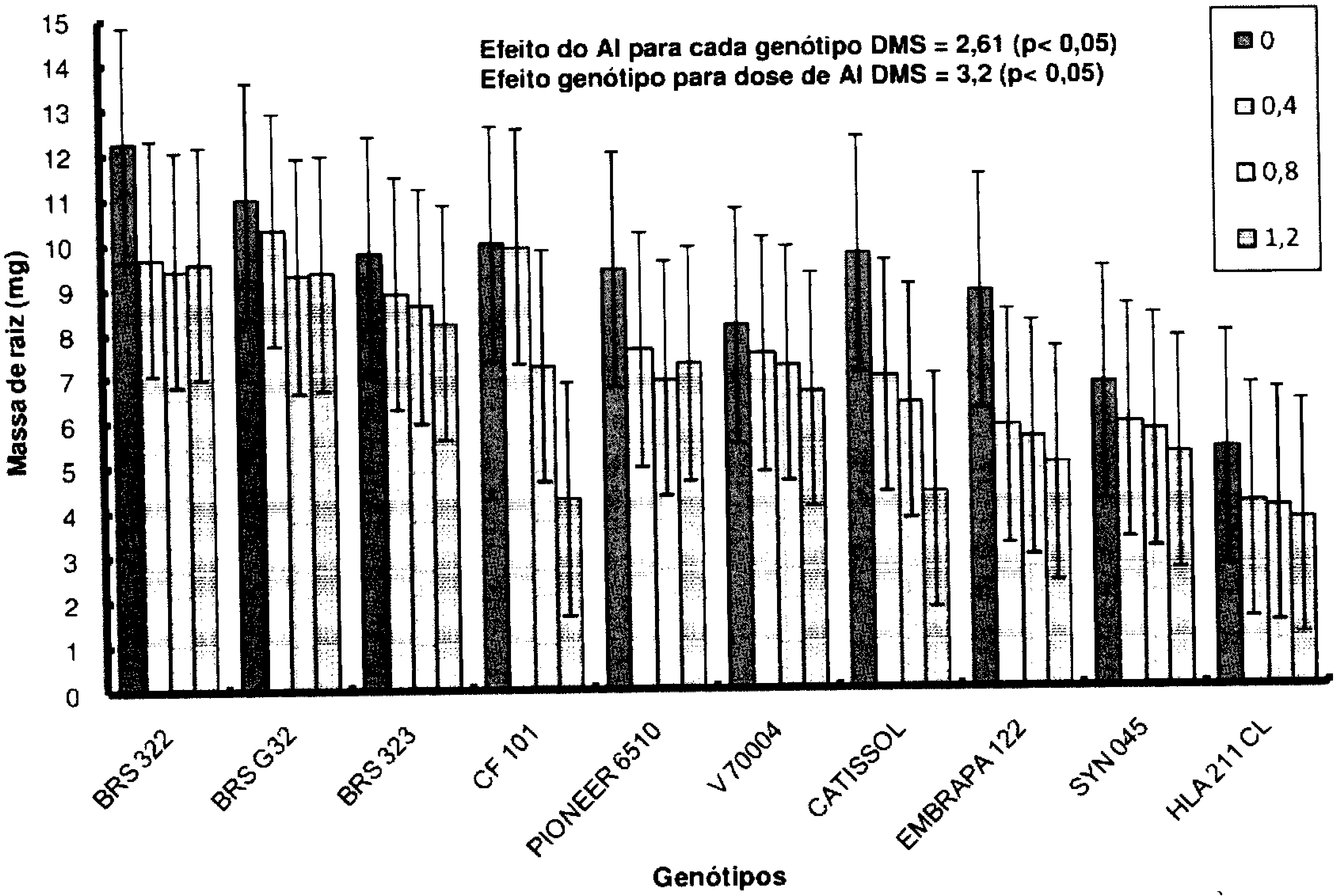

Figure 2. Dry weight of sunflower roots as a function of increasing doses of aluminum (mg dm^{-3}).

Table 1. Root biomass (means of three doses compared to zero Al) and reduction of sunflower roots (percentage) as a function of increasing doses of aluminum.

Genotypes	**Root biomass**		**Variation in doses of Al (mg dm^{-3})**			**Total**
	Mean	**0.0 Al**	**0.0 - 0.4**	**0.4 - 0.8**	**0.8 - 1.2**	
	------- **mg** --------		------------------------- **reduction (%)** -------------------------			
BRS 322	10.3 a	12.4	22.0	3.0	0.0	22.8
BRS G32	10.0 a	11.0	6.4	9.4	0.0	14.9
BRS 323	8.8 ab	9.7	8.4	3.2	4.3	15.2
CF 101	7.9 bc	10.0	1.4	25.6	40.9	56.7
PIONEER 6510	7.8 bc	9.4	18.7	8.2	0.0	21.8
V 70004	7.4 bc	8.0	6.3	2.2	8.4	16.1
CATISSOL	6.9 cd	9.8	28.4	7.9	31.7	55.0
EMBRAPA 122	6.3 cd	8.9	34.0	6.1	9.1	43.7
SYN 045	6.0 dc	6.7	10.0	2.8	8.6	20.0
HLA 211 CL	4.4 e	5.3	21.3	1.8	9.1	29.7

CONCLUSIONS

The method is able to separate sunflower genotypes based on the development of roots in different concentrations of aluminum and can be used in breeding programs for screening genotypes that are more tolerant to aluminum or being suitable for soils with different acidity management.

ACKNOWLEGMENTS

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