Early Ontogenetic Responses of Six Commercial Chloris Gayana Cultivars to Salinity

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EARLY ONTOGENETIC RESPONSES OF SIX COMMERCIAL CHLORIS GAYANA CULTIVARS TO SALINITY

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ABSTRACT
Some physiological aspects relevant to pasture establishment under saline conditions were evaluated in six cultivars of *Chloris gayana* . Two tetraploid cultivars: Boma and Callide, and four diploid ones: Bell, Katambora, Pioneer and a local accession of Pioneer, were analyzed. The effect of salinity on seedling emergence, the number of stolons per plant and frost tolerance were evaluated in the field, while effects on germination, early vegetative growth, regrowth after clipping, ion accumulation and stolon rooting were assessed in the greenhouse. Salinity had a negative effect on seedling emergence. Saline solutions delayed or altogether inhibited germination, but seeds retained viability in 100 and 200 mM NaCl solutions. Growth of all the cultivars was reduced at high salinities, more markedly in cv. Boma, where stolon production was also affected. This cultivar was the most susceptible to frost and had lower Na and higher K accumulation in leaf tissues.

KEYWORDS
Chloris gayana, Rhodes grass, salinity

INTRODUCTION
Approximately 129 million hectares are considered saline in South America (Szalbolcs, 1991). In the Argentinean Arid Chaco, pasture productivity is remarkably reduced in several million hectares climatically suitable for cattle raising but affected by salinity (Angueira, 1986). *Chloris gayana* is known for its salt tolerance and ability to withstand dry conditions, soil salinity and light frost (Bogdan, 1969), nevertheless it ranged intermediate in a salt-tolerance study involving five other forage crops: *Cynodon dactylon, Leptochloa fusca, Distichlis spicata, Paspalum vaginatum, Medicago sativa* (Pasternak *et al.,* 1993). As *Chloris gayana* is especially suitable for cultivation under the environmental conditions prevailing in the Argentinean dry Chaco, it is desirable to increase its salt tolerance to adapt it to the salt-affected soils of the area.

The purpose of this study was to assess in *Chloris gayana* at the early stages of growth, the existence of intraspecific variability for physiological traits associated with salt tolerance. Attention was centered on aspects which are relevant for pasture establishment, such as germination, seedling establishment and growth, Na balance management, stolon production and rooting.

MATERIAL AND METHODS
The following cultivars or ecotypes of *Chloris gayana* (Kunth) were included in this study: tetraploid cultivars Boma and Callide, and diploid cultivars Pioneer, Katambora, Bell, and a local accession of Pioneer, referred to as Pioneer Local. Field trials were sown in November (spring) in Santiago del Estero, in two plots: E1, with low soil extract conductivity (3.62 dS/m) and C4 where conductivity was 10-15 dS/m between 0-20 cm.. A random block design was used, where the main plot was salinity and secondary plots cultivars. Each cultivar was repeated five times within each salinity level. Plots were cut at fist level in April and June. Fresh and dry matter was measured, and phenological stage and frost damage were assessed. Stolons were counted in November.

For germination tests, seeds were imbibed for three days in sterile saline solutions of various concentrations (0, 100, 200 and 400 mM NaCl), put on filter paper moistened with the same solutions, and germination was checked for an additional period of 9 days. In order to determine whether ungerminated seeds in saline treatments retained viability after this period, they were transferred after 9 days to trays containing filter paper moistened in distilled water and germination was assessed after three additional days. There were 8 repetitions per cultivar and treatment, the experiment was repeated twice.

The effects of salinity on seedling growth, regrowth after clipping and Na and K accumulation were assessed in plants grown in hydroponics in the greenhouse. Salinity levels were 25 (controls), 100, 200, and 400 mM NaCl. Na and K were determined by flame photometry in samples from the youngest expanding leaves.

RESULTS AND DISCUSSION
Salinity decreased germination rates with a significant decline observed by 100 mM NaCl. All cultivars responded similarly. No seeds germinated at 400 mM NaCl. When ungerminated seeds were transferred from the saline solutions to water, germination percentages after three days approached control levels at 100 mM NaCl and were higher than 60% at 200 mM NaCl. Thus, seeds of all the cultivars tested retained viability in 100 and 200 mM NaCl solutions. Similar trends were observed in tomato by Kurth *et al.* (1986) who showed germination was not impaired by a 10-day exposure to 460 mM NaCl solution. Barley seeds retained viability after 4-day imbibition in a 1 M NaCl solution (Bliss *et al.,* 1986). These results suggest that the germination stage would not limit the establishment of pastures of these cultivars in saline soils, since surface salinity in the field would have to exceed 20 dS/m (equivalent to a 200 mM NaCl solution) to significantly inhibit germination, a value which is considered unusually high for arable lands (United States Laboratory Staff, 1954). Rain during the germination period would decrease surface salinity and germination percentages could easily approach levels observed in the absence of stress. However, seedling emergence in the field was significatly lower ($P< 0.05$) in the saline plot. Thus, events taking place beyond germination may be responsible for this result.

Seedling growth, measured as Leaf Relative Elongation Rate (LRER) was reduced by salinity in all cultivars, and cv. Boma was the most sensitive (Table 1). This coincides with field results, which show that salinity-associated productivity decreases were highest in this cultivar (Table 2), which also had the lowest number of stolons per plant in the saline plot, and was the most susceptible to frost. Boma is a tetraploid cultivar, and in previous comparisons between diploid and tetraploid cultivars, tetraploid cv. Sanford was found to be more salt-sensitive than the diploid cultivars to which it was compared (Taleisnik and Grunberg, 1993) .

Na and K concentration were determined in the youngest expanding leaf of plants grown at 200 mM NaCl. Na accumulation was obviously higher in salinized plants than in controls, but it was significantly ($P<0.01$) lower in cultivar Boma than in the rest. Under control conditions, no differences in K or Na accumulation were observed

among cultivars. Potassium concentration in leaves of salt-treated plants was lower than in controls in all cultivars except Boma. Consequently, the K/Na ratio was significantly higher in cv. Boma than in the rest (Table 1), both under control and salinized conditions, resulting both from low Na as well as high K accumulation. In rice (Gregorio and Senadhira, 1993) and in species within the Triticieae, tolerant germplasm had higher K/Na ratios, both on account of high K as well as low Na accumulation (Shah *et al.,* 1987, Dvorak *et al.,* 1994). The opposite trend, however, was found in *Chloris gayana,* where Boma, the least tolerant cultivar, exhibited the highest K/Na ratio and K concentration, in coincidence with results previously reported for the tetraploid cultivar Sanford (Taleisnik and Grunberg, 1993).

In summary, information from these studies indicates that *Chloris gayana* cv Boma is relatively less salt tolerant than the diploid cultivars surveyed. No differences in salt sensitivity were found among diploid cultivars in germination, early vegetative growth, ion accumulation and osmotic adjustment. Besides growth, the most conspicuous physiological differences between cv. Boma and the rest, in the response to salinity, were the relatively lower Na and higher K accumulation in leaf tissues.

Table 1
Effect of salinity on growth (Na molarity at which leaf elongation rate is reduced to 50%) , K/Na ratio and Na excretion ratio in seedlings of six cultivars of *Chloris gayana* grown in hydroponics.

Cultivar	50% LRER	K/Na ratio	Na excretion ratio
Pioneer Local	312	0.39	9.40
Pioneer	250	0.30	17.20
Katambora	250	0.38	10.20
Bell	237	0.44	19.50
Callide	275	0.45	11.50
Boma	100	0.85	2.30

Table 2
Effect of salinity on growth, stolons per plant and frost susceptibility (% of green leaves) in a field trial involving five cultivars of *Chloris gayana*. Numbers are percentages of the saline vs the control plot.

Cultivar	Growth	Stolons	Green leaves
Pioneer Local	52.40	89.02	38.52
Pionneer	97.22	139.68	57.86
Katambora	42.94	115.94	85.31
Boma	19.40	34.44	14.58
Callide	45.02	65.59	12.96

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