RICE AND BARNYARDGRASS ESTABLISHMENT AS FUNCTION OF WATER STRESS

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Keywords: *Oryza*; *Echinochloa*; intermittent irrigation.

INTRODUCTION

In the southern region of Brazil, flooded rice stands out among the main agricultural activities, and this region is responsible for most of the national rice production. The states of Rio Grande do Sul (RS) and Santa Catarina (SC) grow about 1.26 million hectares of rice every year, whose production is around 9.7 million tons, resulting in an average productivity of 7.6 t ha^{-1} (CONAB, 2017). Among the factors that limit crop productivity, weed infestation can be highlighted. These compete directly with rice plants for light, water and nutrients, limiting both grain yield and quality (SOSBAI, 2016).

In this region rice is predominantly cropped under continuous flood irrigation system (MOTERLE et al., 2013). In SC, rice is planted mainly in the water-seeded system, where the water layer is established 20 days before planting and maintained throughout the crop cycle. However, in RS the water layer is established only from the V_3-V_4 development stage. One of the main aims of flooding is to reduce weed establishment, as it inhibits the emergence of weed plants and may slow the development of those already emerged. However, there are some species that can tolerate and even be favored by this method of irrigation, as the barnyardgrass (*Echinochloa* spp.) (ANDRES et al., 2007).

The genus *Echinochloa* comprises the most troublesome grass weeds in rice cultivation, which is mainly associated with their adaptability to the culture ecosystem (ANDRES & MACHADO, 2004), vast distribution and high infestation levels. As these species are adapted to the hypoxic environment, they compete with rice plants throughout the life cycle, and the chemical control with herbicides is limited by morphophysiological similarities with the crop. The competition of these grasses with flooded rice directly reduces productivity (EBERHARDT et al., 1999) as a function of the plants population, where Andres & Menezes (1997) found that one *Echinochloa* plant per square meter reduces rice yields by 64 kg ha^{-1}.

In RS, rice is planted in dry soil and irrigation is set about 20 - 30 days after crop emergence. During this period, both crop and weed plants are subjected to water stress, depending mostly on the occurrence of precipitation for establishment. Thus, in the initial development of a rice field, plant adaptation to moderate water stress levels may determine crop / weeds competition dynamics. Similarly, when the intermittent water management is used in rice, there is risk of water stress to be imposed to both crop and weed plants (SILVA & PARFITT, 2005).

Thus, the effect of water stress on the development of rice and weed plants should be understood. The present work aimed to evaluate the effect of different water stress levels on the development of both rice and barnyardgrass.

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MATERIAL AND METHODS

The study was established in a greenhouse at Embrapa Clima Temperado - Terras Baixas Station, Capão do Leão (RS), Brazil, from June to September 2016, in a completely randomized experimental design, in factorial scheme 2 x 5, with four replications. Factor "A" comprised the plant species (rice cv. BRS-Querência, or the weed *E. crus-galli*), and factor "B" comprised the water stress levels applied to the plots, as follows: (T1) continuous flood (CF) with 5 cm water layer (no water deficit); (T2) 0 kPa (saturated soil), no stress, no water layer; (T3) 10 kPa; (T4) 40 kPa; (T5) 100 kPa.

Experimental units consisted of black plastic pots, each with capacity of 5 L, filled with 5 kg of soil. The soil used at the experiment was an Albaquaf soil collected in rice fields at the same Institution where the study was conducted. This soil was collected from agriculture-free natural areas near rice fields at Terras Baixas Experimental Station. In rice fields, pH is usually not corrected because the water layer is enough to correct the pH after flooding is established, but as most plots of the trial were not going to be submitted to flooding, we decided to correct soil pH in order to guarantee equal soil pH conditions for all units. Seven rice or barnyardgrass (*E. crus-galli*) seeds were planted into each experimental unit, according to the treatment, and after emergence the five most homogeneous plants were maintained.

For CF treatment (T1), water layer was established prior to planting. For the other treatments (without flooding), the water tension corresponding to each treatment was established, and after stabilization the seeds were planted. The pots were irrigated when needed according to the water retention curve for the soil, and the soil moisture readings. Water stress was monitored by using sets of Watermark electro-tensiometers (Irrometer Co.), with a single sensor installed horizontally in each experimental unit, at 2 cm soil depth.

Plant emergence was assessed every day, starting one day after sowing (DAS), by registering the number of seedlings per pot which were at least 1 cm of height. The length of all plants into the plot was measured with a ruler, from the soil surface to the tip of the longer leaf 30 DAS. Root length was also measured with a ruler, from the seed to the tip of the longest root. Thereafter, the fresh biomass was separated in shoots and roots, put into paper bags, and taken to oven for drying at 65 ºC for five days. After this period, shoot and root dry mass were weighted.

Emergence rate was studied by adjusting a quadratic regression by the Loess method (CLEVELAND & DEVLIN 1988) to the data, as function of days after planting and water stress level, being established the 95% confidence interval (CUMMING et al., 2004). For shoot and root length and dry mass, the same regression was applied as function of plant species and water stress level, also with 95% confidence interval. Data were analyzed into the "R" statistical environment (R CORE TEAM, 2017).

RESULTS AND DISCUSSION

The emergence curves (Figure 1) shown that the establishment of both species was minimal when seeds were subjected to CF, with only barnyardgrass being able to emerge under a continuous water layer, establishing about 8% ofthe populations. Low seedling emergence was also observed when the soil was kept about 0 kPa (saturated) of water tension, where both species were able to establish about 12% of the population 30 days after planting (DAP) (Figure 1). The best results for plant establishment were obtained when the soil was kept at 10 kPa, where both species reached around 77% emergence 30 DAP. However, the emergence peak for rice plants was 5 days before barnyardgrass. Plant establishment in the other water tensions, especially for barnyardgrass, was mild (Figure1).

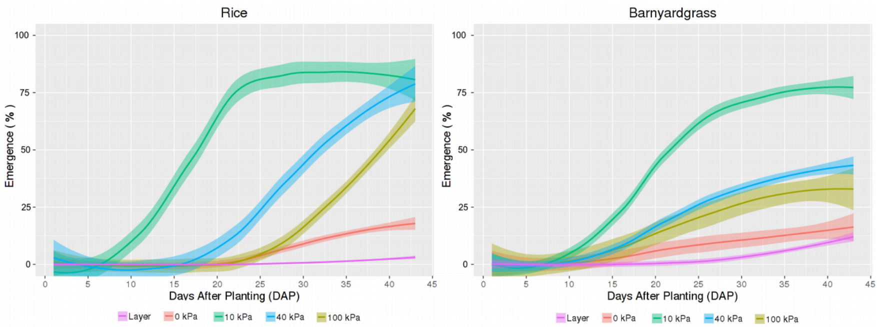

Figure 1. Emergence of rice and barnyardgrass (%), as function of days after sowing for each water tension. Confidence intervals at 5% are presented.

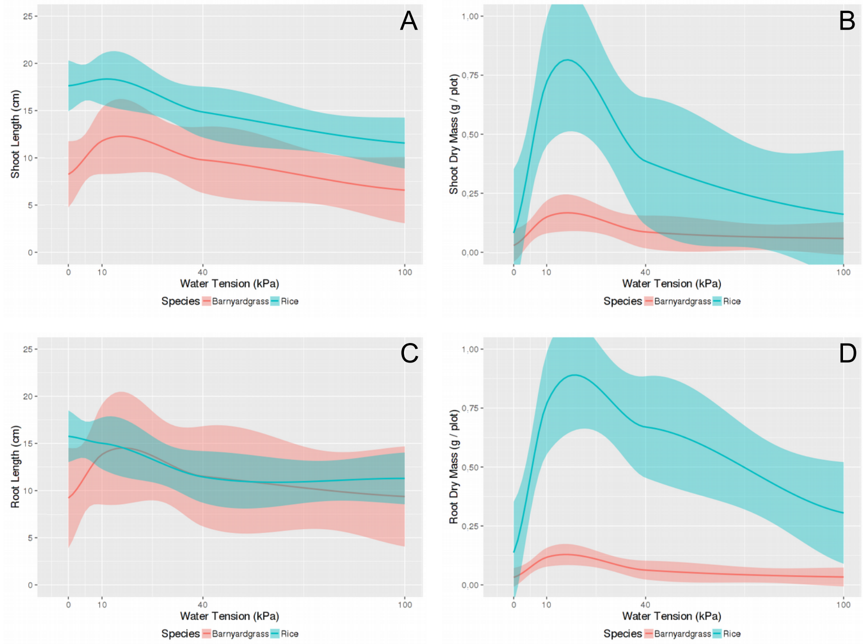

Figure 2. Shoot and root length (A and C, respectively) and dry mass (B and D, respectively), as function of water tension for each plant species. Confidence intervals at 5% are presented.

The shoot length (Figure 2A) of rice decreased almost linearly between water tensions of 10 and 100 kPa, where it ranged from 15 - 22 cm (10 kPa) to 10 - 15 cm (100 kPa). For the same water tensions, barnyardgrass varied from 8 - 16 cm to 4 - 11 cm, according to the respective confidence intervals at 5%. Under these conditions, rice is most prone to perform better in shoot length compared to barnyardgrass, being this confirmed for water tensions below 10 kPa. Surely this advantage for rice would exist only under equivalent plant densities. The root length of both species (Figure 2C), on the other side, were clearly equivalent as their confidence intervals overlaped, ranging from 12 - 17 cm (rice) and 8 - 18 cm (barnyardgrass) at 10 kPa, to 7 - 14 cm (rice) and 4 - 14 cm (barnyardgrass) at 100 kPa. Although differences – if existed, were discrete for shoot and root length. Shoot (Figure 2B) and root (Figure 2D) dry mass clearly differed, with rice always performing better compared to barnyardgrass between 0 and 40 kPa, where the confidence intervals did not overlap.

The results supply evidence that rice is most prone to overcome water stress conditions compared to barnyardgrass, when under equivalent plant density. However, barnyardgrass is usually present in much higher plant density than crop plants in fields traditionally cropped with rice. Thus, efficient control of barnyardgrass should be accomplished to avoid damage to rice crop by competition for environmental resources.

CONCLUSION

Under moderate water stress, rice tends to perform better that barnyardgrass in the initial stage of crop growth, when under equivalent plant density, but should be controlled for occurring in much higher plant density.

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