PHOTOSYNTHETIC CAPACITY OF WEEDY RICE AND RICE UNDER DIFFERENT WATER CONDITIONS

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INTRODUCTION

Rice is one of the most important cereals produced in the world. It is cultivated mainly in paddy fields using a continuous flood. In Brazil, Rio Grande do Sul (RS) and Santa Catarina (SC) States are the main producers, being responsible for approximately 80% of the national production, where the average productivity is 6,837 and 7,139 kg ha^{-1}, respectively (CONAB, 2017).

Paddy rice cropping fields in southern Brazil are generally highly productive, although yield averages are still lower than those achieved in areas that adopt high-tech practices such as experimental fields. One of the main reasons for yield reduction in this crop is related to unsatisfactory weed control (GALON et al., 2007; AGOSTINETTO et al., 2008). Their importance has been increasing due to the adoption of minimum till and the low efficacy of non-selective herbicides against them.

Among the main weeds in paddy rice in RS, weedy rice is the most important, limiting crop productivity due to its competitive ability and is present in all regions of the state (AGOSTINETTO et al., 2001). Currently, with the introduction of Clearfield® technology, the main control method used is with herbicides belonging to the chemical group of imidazolinonas. These herbicides inhibit the Acetolactate Synthase enzyme (ALS) and are highly efficient, practical and of fast action. However, the application of these herbicides at doses not recommended, with prolonged residuals and/or the absence of mechanisms of action rotation over time in the same area caused selection pressure (VARGAS, 2017) and favored the appearance of resistant biotypes to imidazolinones. Thus, several biotypes of rice-weeds have already been found to be resistant to ALS-inhibiting herbicides in Brazil (HEAP, 2017).

Taking into account the problems associated to weedy rice in the rice fields, it is necessary to deepen our knowledge about this weed, understanding better the factors associated with the competitive capacity of weedy rice and the adaptive cost of herbicide-resistant biotypes. In this sense, a description of the different photosynthetic capacity among resistance and susceptible species can provide clues about their susceptibility to chemical control and adaptability under different environmental conditions. Thus, the objective of this study was to evaluate photosynthetic parameters of weedy rice and rice susceptible and resistant biotypes under different water regimes.

MATERIAL AND METHODS

The study was established in a greenhouse at Embrapa Clima Temperado - Terras Baixas Station, Capão do Leão (RS), Brazil, from March to April 2017, in a completely randomized experimental design, in factorial scheme 2 x 6, with three replications.

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Factor “A” comprised the water conditions: field capacity (FC); and water deficit (WD), corresponding to 60% less of the volume of water in the FC. Factor “B” comprised different biotypes of *Oryza sativa*, as follows: S33 and S140 (weedy rice susceptible to imidazolinones herbicides); R150 and R226 (weedy rice resistant to imidazolinones herbicides); BRS Pampa (rice susceptible to imidazolinones herbicides) and Embrapa CL (an early lineage rice resistant to imidazolinones herbicides).

The rice and weedy rice seeds were placed to germinate in germitest paper, which was moistened with distilled water, in the amount equivalent to 2,5 times the mass of the dry paper. The seeds were kept for seven day in germinator at 25-30 ºC. After that, when the seeds presented radicle, the seedlings were transplanted to rhizotrons filled with substrate, which constituted the experimental units. The experiment was conducted on rhizotrons to facilitate roots assessments (data not shown).

The rhizotrons were irrigated daily in order to maintain all the experimental units in FC. The irrigation was ceased in half of the rhizotrons 12 days after transplanting (DAT) the seedling, characterizing WD treatment. The study was conducted until 21 DAT, when the evaluations were performed. The variables evaluated were: initial fluorescence, maximum fluorescence, electron transport rate and effective quantum yield of PSII with PAM-2500 chlorophyll fluorometer.

The data were analyzed for normality, by the Shapiro-Wilk test and the homoscedasticity, by the Hartley test, and later submitted to analysis of variance ($p \leq 0.05$); When significant, means were compared by the Student-Newman-Keuls test at 5% probability.

RESULTS AND DISCUSSION

The initial fluorescence did not differ between Embrapa CL and BRS Pampa, presenting similar behavior for both water regimes. The biotypes of weedy rice resistant to imidazolinones showed significant differences in each treatment, where R226 had values 30% higher under FC than in WD. However, the R150 biotype had an opposite behavior showing higher values under WD. Susceptible biotypes (S33 and S140) did not show differences under FC but when in WD the S33 had reduced initial fluorescence than S140 (Figure 1a).

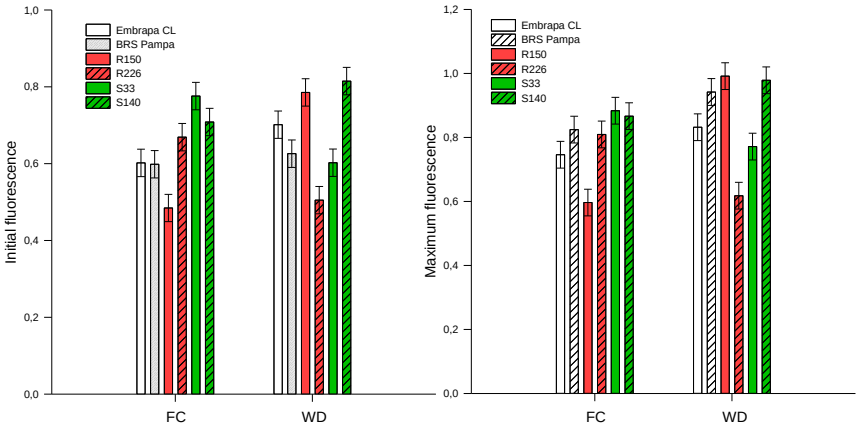

Figure 1. Initial fluorescence (a) and maximum fluorescence (b) of weedy rice and rice under two water conditions: Field capacity (FC) and water deficit (WD). The means were compared by the Student-Newman-Keuls test at 5% probability.

The values of initial fluorescence increased to Embrapa CL, R150 and S150 in plants under WD. These results are in accordance with the ones reported by Puteh et al. (2013), where rice cultivars (MR219 and MR232) and two biotypes of weedy rice (Bertam and Ketara) has an increased initial fluorescence under water deficit.

The crop and weedy rice biotypes susceptible to the herbicides did not show significant differences in the maximum fluorescence, under FC. However, the resistant biotypes different among them, where R226 showed a maximum fluorescence 25 % higher than R150. In WD, differences were observed among all three groups of plants (weedy rice susceptible or resistant to imidazolinones herbicides and crop cultivars), where BRS Pampa, R150 e S140 showed higher values than Embrapa CL, R226 e S33, respectively (Figure1b).

Resistant biotypes of weedy rice did not show differences in the electron transport rate under FC and WD. The BRS Pampa when compared to Embrapa CL, showed values 30 and 50% higher under FC and WD, respectively. The susceptible biotypes showed significant differences in the electron transport rate, where S140 had values 20% higher under FC compared to WD. However, S33 had an opposite behavior, increasing the electron transport rate in about 70% under WD when compared to FC (Figure 2a).

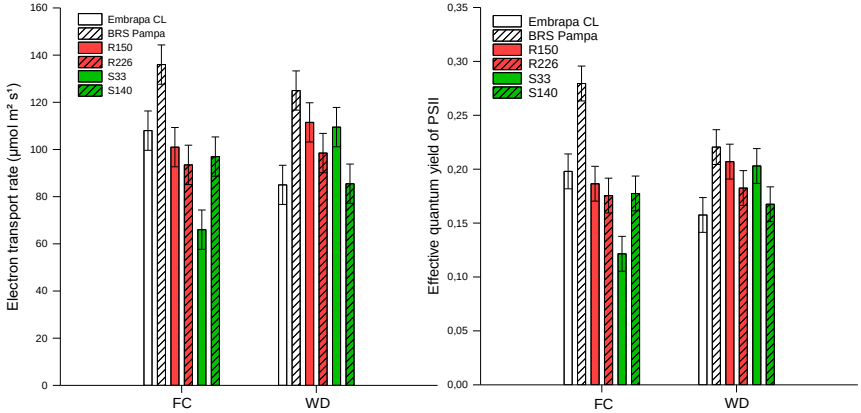

Figure 2. Electron transport rate (a) and effective quantum yield of PSII (b) of weedy rice and rice crop under two water conditions: Field capacity (FC) and water deficit (WD). The means were compared by the Student-Newman-Keuls test at 5% probability.

The effective quantum yield of PSII was higher for BRS Pampa in comparison to Embrapa CL, which differed significantly between the two water regimes. The susceptible biotypes showed differences among all treatments, where S140 had higher values under FC than in WD. S33 had an opposite behavior increasing in about 80% the effective quantum yield of PSII in WD. Differences where not observed between resistant biotypes under FC and WD (Figure 2b).

Similar results for the effective quantum yield of PSII were observed by Puteh et al. (2013), where the authors observed a reduction in the values for the crop cultivars under water deficit. On the other hand, the biotypes of weedy rice were not affected by water regimes. Stresses induced in plants by external factors can alter several mechanisms, such as the activity of the rubisco enzyme, the effective and maximum quantum yield of PSII, and the real efficiency of the PSII (YIN et al 2010). Moreover, the results observed for all parameters evaluated between the susceptible and resistant biotypes can occur due to the fitness cost associated with the herbicide resistant

CONCLUSION

The photosynthetic capacity is affected by water conditions which is dependent on the biotype or cultivar. However, in general, weedy rice strains were comparatively more tolerant under water stress condition than cultivated rice varieties.

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