POTASSIUM MANAGEMENT AND ITS INFLUENCE ON GRAIN AND SEED QUALITY OF IRRIGATED RICE

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INTRODUCTION

Potassium (K) is the nutrient with high demand for rice cultivation (SOUZA et al., 2015). It can increase rice production because it influences the starch formation, sugar transfer, chlorophyll development, grain formation and weight grain, and root system development. Overall, K acts positively on rice productivity components (ZARATIN et al., 2004).

Unfortunately, information about K management during rice cycle and its influence on grain quality and on physiological seed characteristics are still scarce in the scientific literature. Indeed, this information is important because the price paid to the producer depends on grain physical quality grains after processing. Furthermore, the percentage of whole grains is one of the most important parameters for the determination of commercial price (SOSBAI, 2018). Based on this context, this work presents the effects of different stages of K application on rice grain yield, physical (whole grain and chalk kernel) and seed physiological quality (vigor and germination).

MATERIAL AND METHODS

A field experiment was performed on 2016/2017 and 2017/2018 rice grown seasons at the "Instituto Rio Grandense do Arroz (IRGA)" located at Cachoeira do Sul state of Rio Grande do Sul, Brazil. Five treatments were tested; control without K application (T1), 100% of K dose applied at sowing (T2), 50% of K dose applied at sowing and the remaining 50% applied at the V3 stage, according to Counce et al. (2000) scale, (T3), 50% of K dose applied at sowing and the remaining 50% applied at V6 stage (T4), and 50% of potassium dose applied at sowing and the remaining 50% applied at V8 stage (T5). K was spread on the soil and the total K (formula 00-00-60) dose used on each treatment was 135 kg/ha.

The experiment consisted of a randomized complete block design, with four replicates. Each experimental assay was composed of 18 rice lines of 5 m length and spaced 0.17 m. The area totalized 15.3 m^2 and all treatments, such as weed, pests and diseases control followed the technical recommendations for flooded rice in South of Brazil (SOSBAI, 2018).

An area of 4.75 m^2 for each plot was manually harvested and the grain yield was calculated. A portion of 100 g of rice and husks was selected, which was submitted to a model rice tester. Whole rice percentage in each sample was determined. For the peeled samples (5 g), the average

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chalk kernel index was determined according to an international scale from zero to five (CIAT), where zero means a totally spotless grain and five means a grain wholly taken by chalk kernel.

The seed quality was quantified by the percentage of germination using Biochemical Oxygen Demand (BOD) camera incubation. Four replicates of 100 seeds from each treatment and seedling evaluations were performed at 7 and 14 days after sowing (DAS), according to the criteria established by the Brazilian Rules for Seed Testing (MAPA, 2009). At 7 DAS, the germinated plants were considered "vigor" and those germinated at 14 DAS were considered a percentage of the total germination.

Statistical analysis was performed using the Scott-Knott test at a 5% probability of error. The variable germination percentage (at 7 and 14 DAS) was transformed by the $\mathrm{yt} = \sqrt{y+1}$.

RESULTS AND DISCUSSION

Rice response to the different stages of K management varied according to the growing season (Figure 1). In the 2016/2017 season, the evaluated quality parameters were influenced by the stages of potassium application. The only exception was the grain yield, which was not affected. Whole grain parameter had an increase of 1.3% when K was applied near to the reproductive stage (V8). Zaranti et al. (2004) and Dann and Stevens (2017) reported that the beneficial K effects on physical quality of rice grains, mainly due to its influence on grain filling. In this work, it is possible to increase up to 2% of whole grains in relation to the control without application. In the second harvest (2017/2018), this parameter was not influenced by K.

In the treatment with application of 50% of potassium closer to the reproductive stage, the lowest chalk kernel index was found, from 2.09 when 50% fertilization was performed in V3 (T3) to 1.74 when it was performed at V8 stage (T5) or 1.69 without K application (T1). The negative influence of potassium on this index is mainly evidenced when all fertilization is done before flooding the area. In the second crop season, this parameter even being four times smaller than in the first year. Although chalk kernel is influenced by genetic factors, this behavior most likely occurs because it is also influenced by management and meteorological factors. The last one is one that has a big influence. The temperature increasing when grain is being filled induces a non-compacted arrangement between the starch granules and protein in the cells. Consequently, air spaces diffract and diffuse the light, making visual appearance as an opaque grain (SANTOS, 2012).

The results of this work corroborate with the findings reported by Wang et al. (2004). These authors recommended potassium application closer to panicle formation because plants are able to increase the absorption and the proportion of potassium in the stage of elongation until flowering. It favors a higher number of full grains, decreases gypsum index, and increases grain quality. Despite the negative influence of K on grain quality, the application of 50% at sowing and 50% up to V3 stage was the management with a higher influence on seed vigor (Figure 1). In such sense, crop management should be modified, depending on the purpose of the crop to be produced.

Despite the benefits on grain physical quality and on seed physiological quality, grain yield was not affected by the management of K fertilization in both growing seasons (Figure 1). This behavior can be attributed to the spatial variation of K in the soil. According to Leite et al., (2017) this is an element with a high influence of soil mineralogy where flooded rice is cultivated. It can reach a spatial variation of 87.5% in the same area of cultivation. The absence of correlation between available potassium available in the soil and grain yield has been attributed to factors such as the entry of potassium by irrigation water, the release of potassium from minerals (non-exchangeable or structural), and to its increased diffusion. Therefore, the different forms of potassium present in the soil and in the soil solution can be a source of this nutrient to plants in the short-term. Consequently, it could explain the differences or non-differences of the responses according to rice fertilization, especially grain yield (SILVA et al., 2015; BUI et al., 2019).

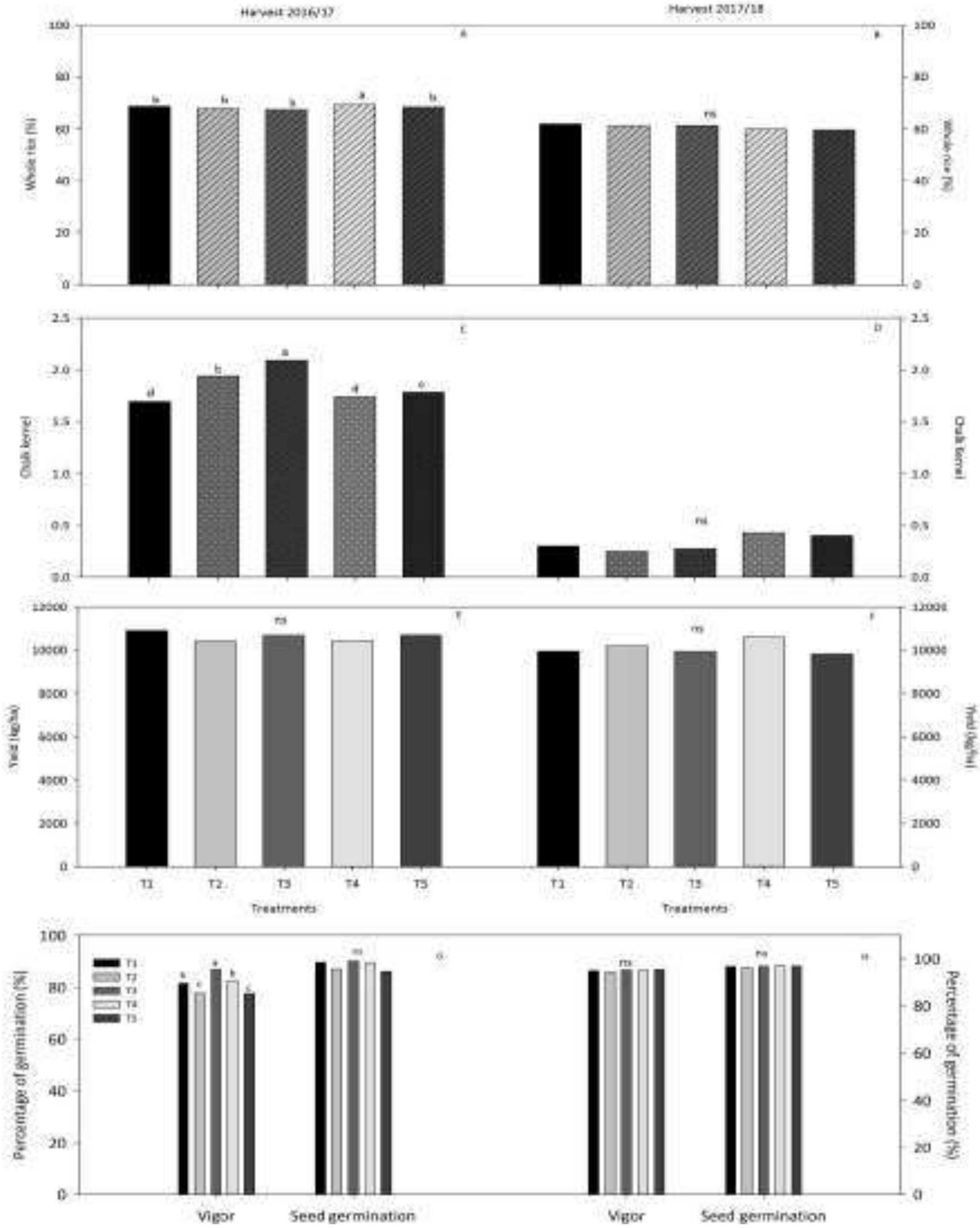

Figure 1. Effect of stage of K management on whole rice (%) (A and B), chalk kernel (C and D), rice yield (kg/ha) (D and E), and percentage of germination and vigor (G and H), in two growing seasons. (T1): control without K application; (T2): 100% of K dose applied at sowing; (T3): 50% of K sowing + 50% V3 stage; (T4): 50% at sowing + 50% at V6 stage; (T5) 50% at sowing + 50% at V8 stage (T5).

CONCLUSION

1. Potassium management influences physical quality of rice grains.
2. When carried out near to the reproductive stage, it can increases the percentage of whole grains and decrease chalk kernel index.
3. When the objective is to produce seeds, all K fertilization should be done up to the V3 stage in order to increase seed vigor.

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