

Adubarroz: a brazilian experience for fertilization and liming recommendation of irrigated rice via computational system

Adubarroz: uma experiência brasileira em recomendações de adubação e calagem para o arroz irrigado via sistema computacional

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ABSTRACT

Recommendations for fertilizing irrigated rice in southern Brazil have been constantly evolving over years. In this process, the influence of factors such as the development cycle of varieties and sowing period increased. Thus, computational tools that take these and others important aspects into account can potentiate the fertilization response of rice. This study describes the computer program "ADUBARROZ". The software provides recommendations of fertilizer rates and liming requirements of irrigated rice, based on information entered by the user. The system takes various factors that regulate the crop response to fertilization into account. A final report is established with the graphical representation of input management over time.

Key words: software, fertilizer, *Oryza sativa*, lime, crop yield.

RESUMO

As recomendações de adubação para a cultura do arroz irrigado no Rio Grande do Sul vêm passando por constante evolução ao longo dos anos. Com isso, fatores como o ciclo de desenvolvimento das variedades e a época de semeadura podem ter influência sobre o potencial de resposta à adubação. Nesse sentido, ferramentas computacionais que consideram esses e outros aspectos importantes podem potencializar a resposta do arroz à adubação. Objetivou-se com este trabalho descrever o programa computacional "Adubarroz". Esse software fornece a recomendação de adubação e calagem para o arroz, a partir das informações fornecidas pelo usuário. O sistema considera diversos fatores que regulam a resposta à adubação, gerando um relatório final com expressão gráfica do manejo dos insumos no tempo.

Palavras-chave: software, fertilizante, *Oryza sativa*, calcário, rendimento de grãos.

The productivity of irrigated rice (*Oryza sativa*) in Rio Grande do Sul, southern Brazil, has increased remarkably in recent years. This evolution is mainly due to the improved management practices used by farmers. In this context, official recommendations for fertilization of irrigated rice are being updated according to the evolution of the production potential of varieties. Then, with the advance of the genetic potential of cultivars and soil and crop management, the recommendations had to be revised, now including different expectations of fertilization response (SOSBAI, 2014). The current criterion takes into account the level of adequacy to all yield-related factors of rice, raising the level of yield expectation proportionately to the suitability.

Updated recommendations of rice fertilization are available and can be accessed freely by farmers. However, the interpretation of soil analyses, although apparently simple, requires practice and attention. In this sense, auxiliary tools can make work much safer and more dynamic. Based on this, a computer system was developed to help the recommendations of soil fertilization and liming of rice in the State of Rio Grande do Sul, Brazil. This manuscript aims to present this program and its main advances to fertilization management of irrigated rice.

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The program called ADUBARROZ was developed with CodeGear™ Delphi® for Win32®, using native components of the language in the presentation of a standard Windows interface, aside from the component package TRichView to generate final reports. The tool determines N, P, K and S rates and limestone required for rice based on information provided by the user in a sequence of simple screens.

The system is initiated by an introductory screen showing the title of the program, the authors and access buttons to four introductory screens or direct access to the initial work screen (1st step in Figure 1). In the screen “Properties of the plot/field”, soil properties underlying the recommendation are requested (2nd step in Figure 1) and provide information for the system to calculate the expected response, according to the soil characteristics, associated with aspects that interfere with the

fertilization response of rice (MENEZES et al., 2012). Information on clay content, pH, SMP index, P, K, OM, Ca, Mg and cation exchange capacity at pH 7.0 (CEC_{pH 7.0}) are mandatory.

In the ADUBARROZ sequence, a series of screens is designed to determine whether the expected response to fertilization will be very high, high, medium or low, according to criteria established by SOSBAI (2014). In the program, the user must first choose the variety to be used (3rd step in Figure 1). On the same screen, the sowing period must be informed (4th step in Figure 1). Once the genotype is determined, its maximum potential response to fertilization is presented, in relation to the sowing time.

If the user chooses a sowing period that does not coincide with the maximum yield potential of the selected variety, ADUBARROZ will show a warning, suggesting a corrected date or

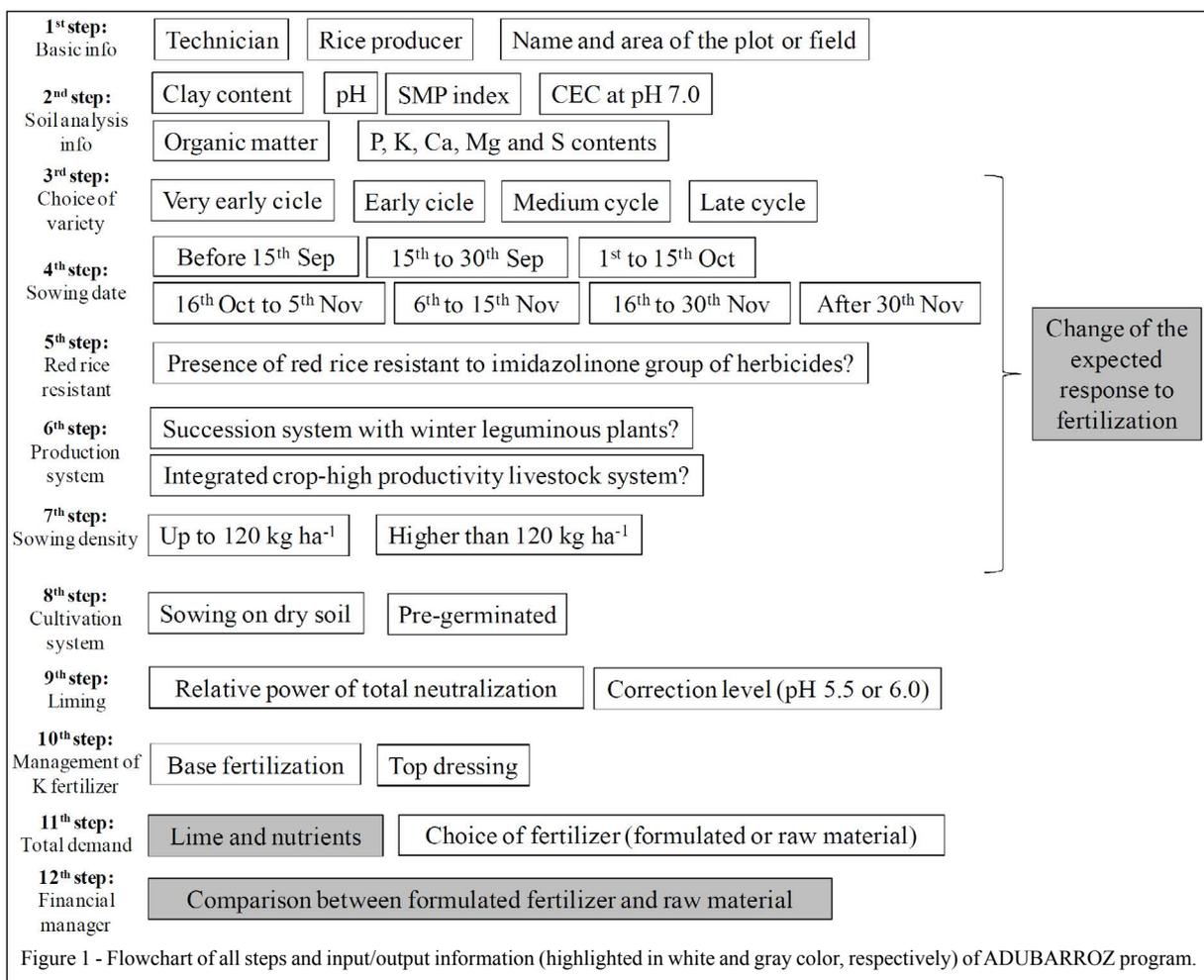


Figure 1 - Flowchart of all steps and input/output information (highlighted in white and gray color, respectively) of ADUBARROZ program.

its maintenance. If the user chooses to maintain an inadequate sowing date (MENEZES et al., 2012), the program automatically reduce the expected crop response to fertilization.

A major aspect of determining the fertilization response of rice is the infestation of the area with red rice, the most harmful weed for rice yield in southern Brazil (MARCHESAN et al., 2004). So, the program user must inform whether there is an infestation of resistant red rice in the field for which the recommendation is being formulated (5th step in Figure 1). If the user selects the positive option for the presence of red rice, automatically the expectation for the crop response to fertilization will be diminished by one level, except when it is already "Low" because of the previously provided information.

Another factor that affects the expected response to fertilization is the history of the area, with regard to the possibility of inclusion in an integrated crop-livestock system (ICLS) and/or the cultivation of leguminous species for top dressing preceding rice (6th step in Figure 1). If this insertion is confirmed, the system automatically reduces the expected response to a certain level, except when it is already "Low", based on previously supplied information.

The next step of ADUBARROZ indicates how densely the rice should be sown (7th step in Figure 1), since an adequate plant population is one of the main factors defining yield. If the sowing density chosen is greater than 120kg ha⁻¹, the expected response to fertilization is reduced by one level.

The cultivation system has no influence on the recommendations of N, P, K and S for irrigated rice in the Brazilian Southern (SOSBAI, 2014), but affects the time when fertilizers should be applied. In this sense, the program user must inform the cultivation system to develop the recommendation by the ADUBARROZ (8th step in Figure 1). The cultivation system also determines criteria of liming in the area (SOSBAI, 2014) (9th step in Figure 1).

The next step defines the possibility of splitting K fertilization (10th step in Figure 1). In soils with clay content below 15% and CEC_{pH 7.0} below 5.0cmol_c dm⁻³, the program automatically recommends split applications, because of the possibility of nutrient loss by leaching.

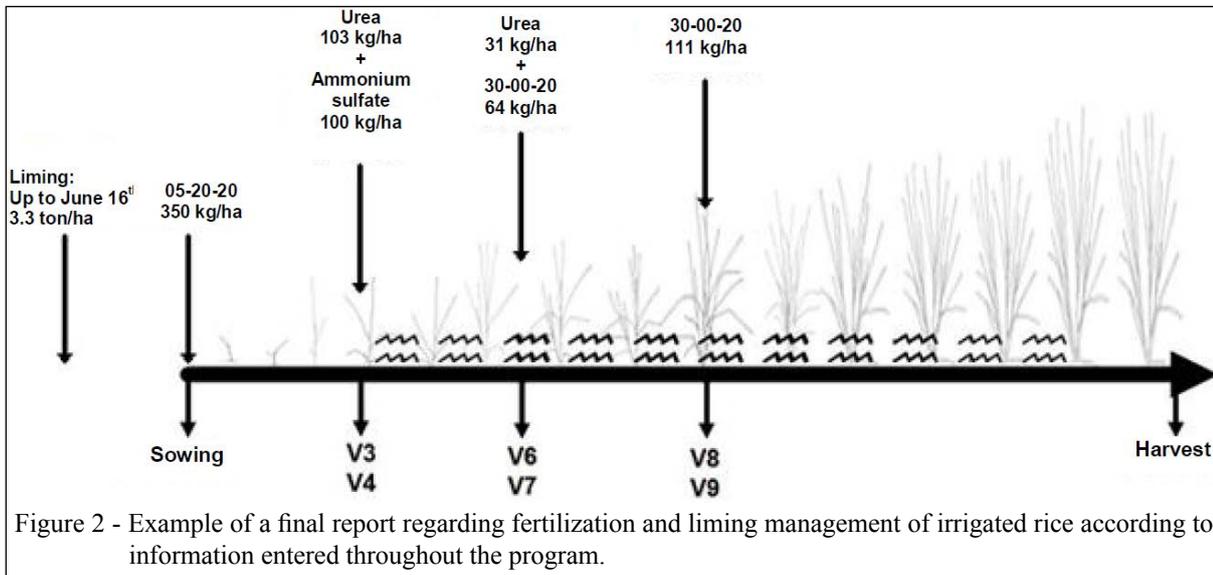
In the following program steps, ADUBARROZ presents a screen with nutrient demands for the plot/field, which was calculated based on the pre-entered information (11th step in Figure 1, as output information). If the soil is

S-deficient (content below 10mg dm⁻³), the program automatically recommends adding S. Later, the source of base fertilizers is requested (11th step in Figure 1, as input information), which determines the following screen of the program. If formulated fertilizer is chosen, the N, P₂O₅, K₂O and SO₄²⁻ contents must be informed. However, if the user decides to use raw material, potassium chloride (KCl) is suggested as standard. It is mandatory to inform the P source.

After all previous stages, ADUBARROZ shows a screen with a cost management option (12th and last step in Figure 1). If the user accepts this option, the possibility of fertilization based on "Formulate" or "Raw Material" fertilizer is defined in the follow-up screen. The decision can be made comparing costs with base fertilization consisting of raw materials. Once the costs of inputs have been entered, ADUBARROZ calculates the cost per hectare and the total cost per plot/field, from the amount of each input determined by the system, according to the nutrient demand. In case of an imbalanced ratio of formulate fertilizer/demand, a warning will recommend the choice of another more balanced formula.

In the Final Report, as part of the fertilization and liming recommendation, the management of input application in time is presented graphically (Figure 2). Limestone is applied on a date preceding the informed sowing data by three months. Base fertilization is indicated at the same time as sowing when on dry soil, or as top dressing in stages V₃-V₄, in the pre-germinated system. Top dressing is fractionated according to the maturation of the variety, and is split in two applications for cultivars with a very early or early cycle (66% of N in V₃-V₄ and 34% of N in V₈-V₉, fractions which were already discounted from the N possibly applied at sowing) and into three applications for medium or late cycle varieties (50% of N in V₃-V₄; 25% of N in V₆-V₇ and 25% of N in V₈-V₉, fractions which were already discounted from the N possibly applied at sowing).

Success in the recommendations of fertilization indicated by this computer system is based, apart from soil analysis, on the level of adequacy of all factors that influence rice productivity. These recommendations are an auxiliary tool to be used cautiously, always considering knowledge of crop specificities and other production factors, aside from the farmer's socioeconomic status.



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