IMPACT OF CLIMATE CHANGE ON WATER STRESS IN BEAN CROPS CULTIVATED DURING THE WET SEASON

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The common bean (Phaseolus vulgaris L.) is the most cultivated and consumed legume in Brazil and plays an especially significant role in the Brazilian diet. Reductions in agricultural productivity associated with climate change and an absence of adaptation are expected in the future, which will result in severe consequences for Brazil's food security. In South America, there is a projected reduction in productivity for the common bean mainly due to the increase in temperatures and drought. Thus, the bean breeding program will play an important role in adapting common beans to climate change. Here, we evaluate the historical and future probabilities (2030) of occurrence, intensity, and impact of seasonal variations in water deficiency, which are the most important limiting factors for common beans in the state of Goiás, where the Cerrado biome predominates (Figure 1). 26 climatic stations located in the state of Goiás were assessed, with daily data on rainfall, maximum and minimum temperatures, and global solar radiation for the period from 1980 to 2013, which will be our baseline, and three soil classes - Latosol, Argisol and Cambisol, which represent 64, 19 and 6% of the agricultural area in the state of Goiás. As future climate data, 12 global climate models (GCM) were used, presenting daily data for the variables of maximum and minimum temperature, precipitation and global solar radiation for four RCPs (scenarios of representative concentration trajectories: 2.6; 4.5; 6.0 and 8.5). Two methods of correcting bias in GCM data were applied in this study, the delta method that applies the correction to the mean and the CF method that applies the correction to the variance and mean. The development, growth and productivity of common beans were simulated using the CSM-CROPGRO model for two cultivars, Pérola and BRS Radiante. The simulations were carried out considering seven sowing dates for the wet season (November 1st to December 30th), two cultivars (Pérola and BRS Radiante), three soil classes and baseline climatic data (1980 to 2013) and future climatic data (2020 to 2045 - 96 scenarios and four RCPs).

Target audience: researchers and teachers.

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RESULTS

Beans in the state of Goiás are cultivated during three periods of the year: wet season, dry season, and winter. This study focused on the wet season, with sowing between November and December. During the wet season, two environmental groups - highly favorable environment (HFE) and favorable environment (FE) - covering 62% of the bean cultivated area in the state of Goiás were observed. For each group, two drought profiles were obtained (without drought deficiency, reproductive deficiency) considering all sowing dates and cultivars. The results suggest that, in comparison with the historical period (1980– 2005), climate change will make water deficiency more frequent, but less severe, across the region due to the positive interaction between beans and the increase in atmospheric CO_2. The probability of drought occurrence increased from 16% (baseline) to 43% (2030, RCP 8.5). The results are consistent with RCPs, although the benefits of rigorous mitigation (RCP 2.6) are evident. In addition, we highlight the importance of sowing in early November and using short cycle cultivars, thanks to the possibility of escape minimizing the impacts of droughts which also demonstrated higher yields (cv. Radiante - early flowering and early maturity for most situations of drought) in both environments. In this study, the short cycle cultivar (cv. Radiante) generally outperformed the other cultivar in terms of stability and productivity. The shorter cycle characteristic of cv. Radiante minimized the impacts of droughts, illustrating how this feature can be a powerful tool in conditions of climate change. We conclude that adaptation to drought due to climate change is necessary for Embrapa's improvement program.

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NEXT STEPS AND RECOMMENDATIONS

The next stage of this study aims to put into practice the strategies suggested in Embrapa Arroz e Feijão's bean breeding program.

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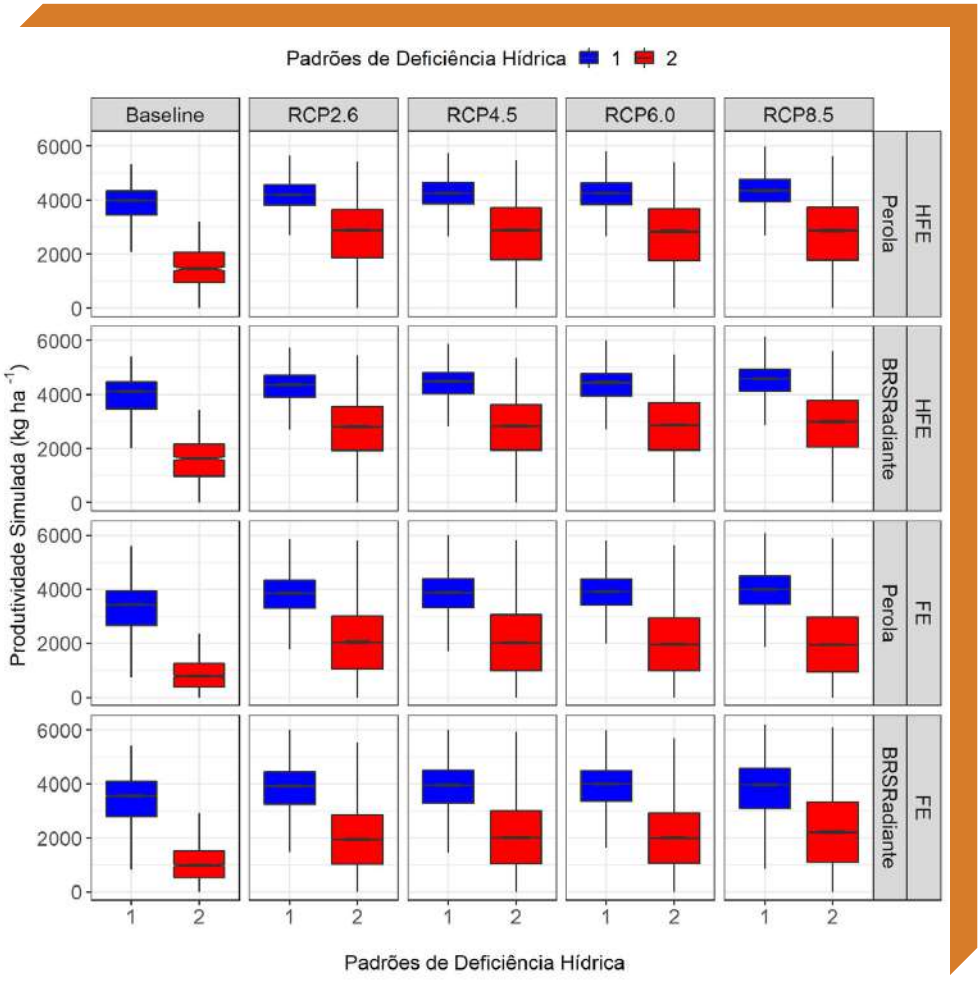
Figure 1: Variation of simulated current (baseline) and future (RCPs 2.6, 4.5, 6.0 and 8.5) common bean yield for the wet season, for the Pérola and Radiante cultivars



Caption: HFE and FE are environmental groupings, with HFE being highly favorable and FE favorable, respectively. The drought profile 1 is without deficiency and 2, water deficiency in the reproductive phase. The thick horizontal line represents the median.

Source: Authors.