

YIELD SIMULATION FOR MAIZE PRODUCTION MAXIMIZATION IN THE STATE OF GOIÁS, BRAZIL, BY USING THE CERES-MAIZE MODEL

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ABSTRACT: The aim of this study was to determine the best cultivar and sowing date to be used for maize in the state of Goiás, to maximize the maize grain yield. It was used the Cropping System Model (CSM)-CERES-Maize, part of the DSSAT (Decision Support System for Agrotechnology Transfer) for yield simulation of two cultivars (DAS CO32 and DKB 333B) for seven sowing dates (01/11, 10/11, 20/11, 01/12, 10/12, 20/12 and 30/12), for eight locations in the state of Goiás. The meteorological data were obtained from SECTEC/SIMEHGO weather stations, for periods ranging from 5 to 27 years. The decision criteria used were the yield variability between the sowing dates, comparison of exceedance probability for yield and percentage of yield reduction due to water deficiency. The results showed that the highest simulated yield for the state of Goiás was obtained for DAS CO32 cultivar, for the sowing date of 10/12. This sowing date also showed the lowest percentage of yield reduction.

KEYWORDS: CORN, CROP MODEL, DECISION SUPPORT.

RESUMO: O objetivo do presente trabalho foi determinar a melhor cultivar a ser empregada e a melhor época de semeadura para a cultura do milho no Estado de Goiás, de modo a maximizar a produtividade agrícola dessa cultura. Para tanto, empregou-se o modelo CERES-Maize do sistema DSSAT para a simulação da produtividade de dois cultivares (DAS CO32 e DKB 333B) em sete datas de semeadura (01/11, 10/11, 20/11, 01/12, 10/12, 20/12 e 30/12), para oito localidades do Estado de Goiás. Os dados meteorológicos relativos a essas localidades foram obtidos junto ao banco de dados SECTEC/SIMEHGO, para períodos que variaram de 5 a 27 anos. Foi analisada a variabilidade da produtividade entre as datas de semeadura, comparação da probabilidade de excedente para a produtividade (probabilidade de o rendimento médio ser atingido e ultrapassado) e a taxa de redução da produtividade devido ao déficit hídrico. Os resultados indicaram que a cultivar DAS CO32 obteve a maior produtividade para o Estado de Goiás, realizando a semeadura em 10/12, quando também houve a menor taxa de redução da produtividade.

PALAVRAS-CHAVE: MILHO, MODELAGEM, TOMADA DE DECISÃO.

INTRODUCTION: Maize is of major importance to agriculture of the state of Goiás, Brazil. In each new season, the growers are required to make tactical decision about which cultivar to sow and when to do that in order to maximize grain yield and quality. Such decision making should be done based on technical information about the best sowing date and cultivar for each region. With this information, growers would be able to evaluate the risks involved with their decision (BRAGA et al., 2008). For maize crop, the selection of the best sowing date is related to the selection of the cultivar (ASSAD et al. 2003; BRUNINI et al., 2001). Generally, all the reported studies for determining the best sowing date for a given location made use of field experiments that have been done periodically with a limited number of years and

replications. However, sowing date responses depend on the weather variability, which can vary among years and locations (SASEENDRAN et al., 2005). In this context, crop simulation models, when properly calibrated and validated, become excellent tools for studies involving the quantification of the effects of agricultural management, genetics, soil and climate on yield and crop phenology (MATHEWS et al., 2002). The CERES-Maize model (JONES and KINIRY, 1986) has been extensively used for decision support for yield and planting date prediction (SASEENDRAN et al., 2005, SOLER et al., 2007), crop management (THORP et al., 2006), and selection of cultivars (JONES et al., 2003). Based on that, the objectives of this study were to determine the best sowing date and maize cultivar in order to maximize maize yield in the state of Goiás, Brazil.

METHODOLOGY: This study simulated maize growth, development and yield with the CERES-Maize model Version 4.5 (HOOGENBOOM et al., 2010). This model is a process-level that uses a daily time-step simulation. Growth and rates of change within the soil-plant-atmosphere system are calculated and integrated at daily time intervals (GUNGULA et al., 2003). The model was calibrated and validated for two maize cultivars (DAS CO32 - short cycle and DKB 333B - normal cycle) by SOLER et al. (2007). CERES-Maize model was applied for eight locations of the state of Goiás, Brazil. For each location, a different number of years of daily climate data (precipitation, solar radiation and maximum and minimum temperature), obtained from SECTEC/SIMEHGO weather stations, were used (Table 1). The low number of years of daily climate data for some sites was due to fails in the data series available, with several years without data. The simulated sowing dates for summer season were done every 10 days, starting on November 1st and ending in December 30th, totaling seven sowing dates. To evaluate the differences among the sowing dates for each cultivar, the following criteria were used: yield variability among sowing dates; comparison of the probability of exceedance for yield; and percentage of yield reduction due to water deficiency. Probability of exceedance is defined as:

$$E(x) = 1-F(x), F(x) = P(X \leq x) \quad (1)$$

where: $E(x)$ is the probability of exceedance (%); $F(x)$ is the function of accumulative distribution (%); and $P(X \leq x)$ is the probability that variable X is less or equal to x (HEINEMANN and STONE, 2008).

Table 1. Locations used in this study: Site; geographical coordinates (degrees); altitude (m); and number of years of the data series.

Site	Latitude (S)	Longitude (W)	Altitude	No. of years
Anápolis	-16.33	-48.97	1136	6
Ceres	-15.33	-49.60	739	8
Cristalina	-16.77	-47.68	1189	5
Jandaia	-17.05	-50.20	637	5
Jataí	-17.88	-51.78	696	6
Minaçu	-13.40	-48.05	343	6
Sto A. de Goiás	-16.50	-49.30	741	27
Vicentinópolis	-17.70	-49.78	648	6

RESULTS AND DISCUSSION: The highest simulated average yield observed for both cultivars was 5550 kg/ha for DAS CO32. For the two cultivars, the yield variability for the seven sowing dates is showed in Figure 1a and 1b. For both cultivars, there was no significant difference in yield between locations for each sowing date. For the DAS CO32 cultivar, the best average yield for the Goiás State was observed for the sowing in 10/12. This sowing date also showed the highest yield value for the probability of exceedance of 50%, 5567 kg/ha (Figure 2a). The lowest yield reduction value was 2.45% also observed for the sowing in 10/12 (Figure 3). The lowest average yield was observed for the sowing in 01/11 (Figure 1a). This sowing date also showed the highest yield reduction value, 4.84% (Figure 3). For the DKB 333B cultivar, the best average yield was observed for 10/12 (Figure 1b). This sowing date also showed the highest yield value for the probability of exceedance of 50%, 5367 kg/ha (Figure 2b). The lowest yield reduction value was 2.46%, observed for sowing in 10/12 (Figure 3). The lowest average yield was observed for sowing in 20/11 (Figure 1b). The sowing date 30/12 showed the highest yield reduction value, 5.46% (Figure 3).

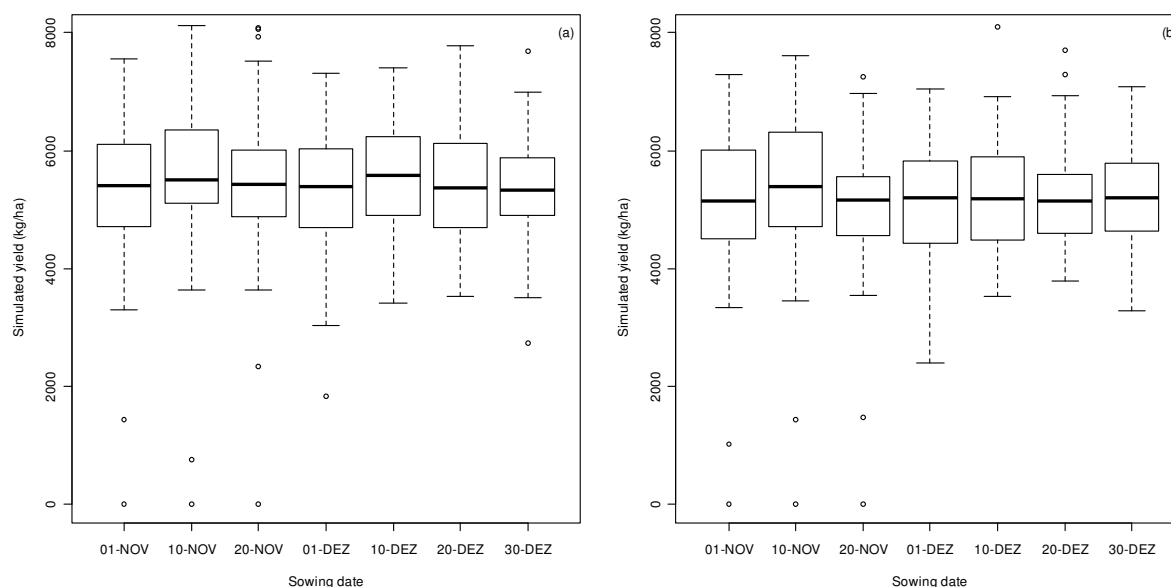


Figure 1. Average yield and its variation when simulated for seven sowing dates in the state of Goiás, Brazil: a) cultivar DAS CO32 and b) cultivar DKB 333B.

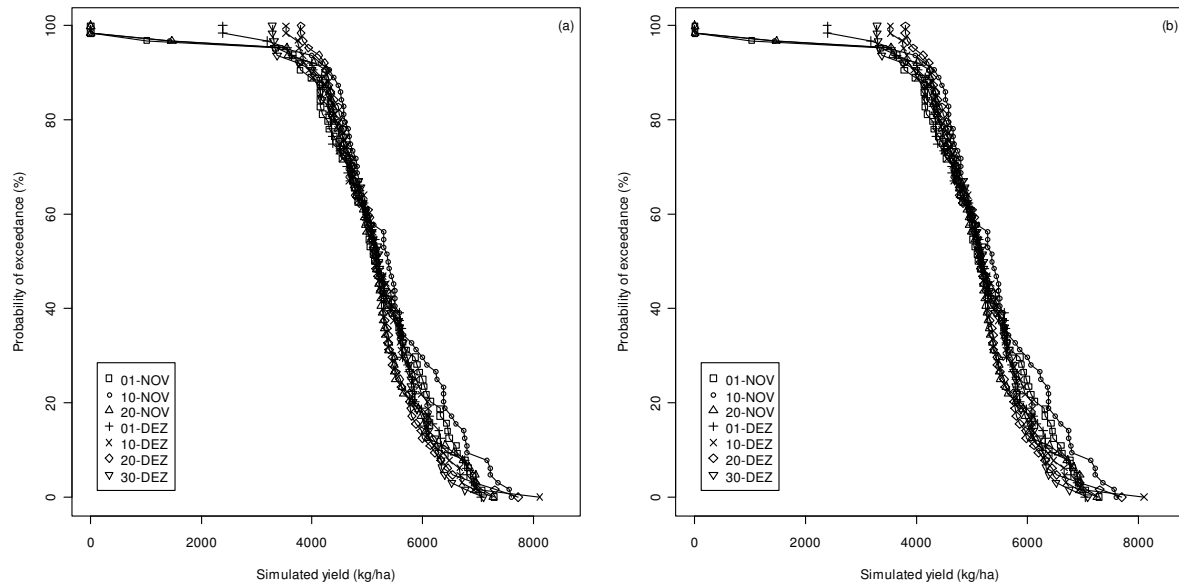


Figure 2. Probability of exceedance for simulated maize yield of (b), in the state of Goiás, Brazil.

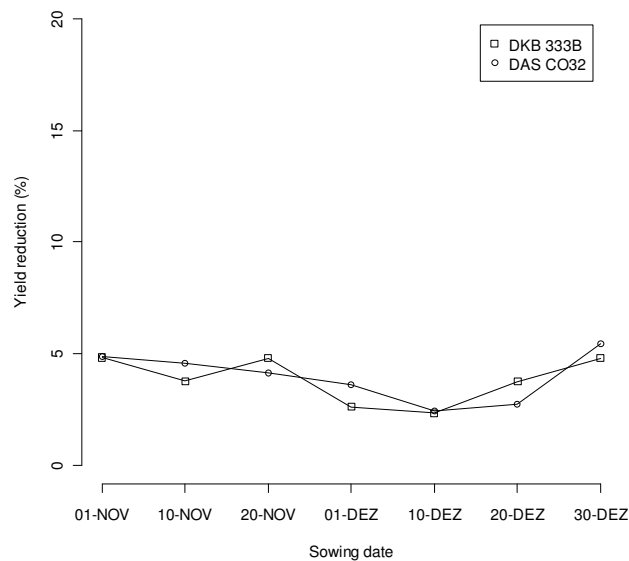


Figure 3. Maize yield reduction (%) for cultivar DAS CO32 and cultivar DKB 333B in each sowing date, in the state of Goiás, Brazil.

CONCLUSION: The results showed that in general the DAS CO32 cultivar presented the highest average yield for the state of Goiás and that 10/12 was the best sowing date for yield maximization. This sowing date also showed the lowest yield reduction value for both cultivars.

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