Edição especial – VI Workshop de Inovações Tecnológicas na Agricultura - WINOTEC

ISSN 2359-6562 (ONLINE) 2359-6562 (CD-ROM)

ZONEAMENTO DA CULTURA DO AMENDOIM NO CEARÁ SOB CENÁRIOS DE MUDANÇAS CLIMÁTICAS

IGOR OLIVEIRA DA SILVA[1], JOAQUIM BRANCO DE OLIVEIRA[2], PEDRO FELIPE SOARES LIMA[3], MARIA FERNANDA DA SILVA VIEIRA[4], ANDERSON CÂNDIDO VIEIRA[5]

[1]Engenheiro Agrícola, IFCE - Campus Iguatu, Rodovia Iguatu / Várzea Alegre km 05, s/n, Cajazeiras, 63500-000, Iguatu, Ceará, Brasil, Orcid: 0009-0000-1181-215X, E-mail: igoroliveiras2203@gmail.com
[2]Professor Doutor, IFCE - Campus Crato, CE-292, km 15 / Gisélia Pinheiro / CEP: 63115-500, Crato, Ceará, Brasil, Orcid: 0000-0002-2348-6643, E-mail: joaquimbranco@ifce.edu.br
[3]Engenheiro Agrícola, IFCE - Campus Iguatu, Rodovia Iguatu / Várzea Alegre km 05, s/n, Cajazeiras, 63500-000, Iguatu, Ceará, Brasil, Orcid: 0009-0009-9335-2569, E-mail: pedrocary123@gmail.com
[4]Graduando em Engenharia Agrícola, IFCE - Campus Iguatu, Rodovia Iguatu / Várzea Alegre km 05, s/n, Cajazeiras, 63500-000, Iguatu, Ceará, Brasil, Orcid: 0009-0003-2112-9604, E-mail: mfernandasv16@gmail.com
[5]Graduando em Engenharia Agrícola, IFCE - Campus Iguatu, Rodovia Iguatu / Várzea Alegre km 05, s/n, Cajazeiras, 63500-000, Iguatu, Ceará, Brasil, Orcid: 0009-0002-7594-7365, E-mail: candidovieiraanderson@gmail.com

RESUMO: O amendoim tem seu centro de origem na América do Sul, com o gênero possuindo cerca de 80 espécies descritas e se trata de uma cultura que já era cultivada pelas populações indígenas muito antes da chegada dos europeus no final do século 15. Objetivou-se nesse trabalho, realizar o zoneamento da cultura do amendoim em dois cenários de mudanças climáticas, sendo um mais otimista e outro pessimista em períodos limites até 2040, 2070 e 2100. Foram implantados pontos pluviométricos em todo o estado para a obtenção dos dados necessários para realização do estudo, juntamente com a construção de mapas de zoneamentos com diferentes cenários de temperatura e de chuva. Conclui-se que os cenários "B1 2070" e "A2 2070" podem ser considerados ideais para a produção da cultura do amendoim para o estado do Ceará, e as faixas de restrição presentes nesses cenários poderiam ser resolvidos com irrigação. Já os cenários extremos, "B1 2100" e "A2 2100", possuem restrições em quase todo o estado, e com isso, necessitaria de altos investimentos em irrigação para seu cultivo.

Palavras-chaves: Arachis hypogaea, Evapotranspiração, Temperatura.

PEANUT CROP ZONING IN CEARÁ UNDER CLIMATE CHANGE SCENARIOS

ABSTRACT: Peanuts originate in South America and include approximately 80 described species within the genus. This crop was cultivated by indigenous populations long before the arrival of Europeans in the late 15th century. The objective of this study was to characterize peanut crops under two climate change scenarios, one more optimistic and the other pessimistic, with timeframes extending to 2040, 2070, and 2100. Rain gauges were installed throughout the state to obtain the necessary data for the study, along with the construction of zoning maps with different temperature and rainfall scenarios. The conclusion is that scenarios "B1 2070" and "A2 2070" are considered ideal for peanut production in the state of Ceará, and the constraints present in these scenarios could be resolved with irrigation. The extreme scenarios "B1 2100" and "A2 2100" have restrictions across almost the entire state and therefore would require high investments in irrigation for cultivation.

Keywords: Arachis hypogaea, Evapotranspiration, Temperature.

Recebido em 03/12/2024 e aprovado para publicação em 12/12/2024
DOI: http://dx.doi.org/10.17224/EnergAgric.2024v39p207-212

1 INTRODUCTION

The peanut (Arachis hypogaea L.) is a dicotyledonous, herbaceous, annual plant belonging to the Fabaceae family and is considered the most important cultivated species. In Brazil, the most commercially important botanical types are Valencia and Virginia, whereas the Spanish group has less economic significance (Peixoto et al., 2008). Owing to its agricultural importance, determining suitable areas for its cultivation through zoning is strategic for reducing risks and guiding management practices.

According to Zhao and Yang (2018), agricultural zoning provides an important tool for activities that depend directly or indirectly on the environment, as it enables the identification of areas with agricultural potential for crop establishment, minimizing risks caused by adverse conditions. The techniques developed for the development of agroclimatic zoning are used for the spatial organization of the agricultural production process within the dynamics of the geomorphological landscape in natural ecosystems (Li; Ren, 2019).

When anthropogenic actions are implemented, the possible consequences under the control of a plant production system can be observed, and the zoning system can assist in decision-making regarding agricultural public policies within the national territorial area (Liu et al., 2020).

Soil and climate mapping of a region allows for the identification of the most favorable conditions for crop cultivation, considering the need to fully meet climatic requirements throughout the production cycle (Pereira et al., 2002). Among the limiting factors of this process are those that prevent soil water storage, resulting in recurring water deficits in agricultural activities (Silva & Beltrão, 2000). Therefore, knowledge of regional environmental conditions is an essential requirement for agricultural zoning, enabling the identification of the most suitable locations for crop development.

In this context, for Monteiro (2009) and Assad (2009), zoning determines the agricultural suitability or risk of regions within a country, state, or municipality, enabling the development of better agricultural policies, access to financing, and increased production. Thus, it becomes possible to define the suitability for cultivation of a given species of agricultural interest in each region, considering agroclimatic and soil requirements, as well as microeconomic and macroeconomic aspects.

Thus, the objective of this work was to carry out zoning of peanut crops in two climate change scenarios, one more optimistic and the other pessimistic, in limit periods up to 2040, 2070 and 2100.

2 MATERIALS AND METHODS

The study was conducted in the state of Ceará, which is located in northeastern Brazil between latitudes 2.5° and 8° south and longitudes 37° and 42° west. According to the Koppen climate classification, the study area has two climates, BSh and Aw, with a predominance of the BSh (semiarid) climate in 80% of the area. The air temperature was estimated according to equation 1 suggested by Oliveira, Arraes, and Viana (2013):

$$T_i = A_0 + A_1 \cdot h + A_2 \cdot h^2 + A_3 \cdot \lambda + A_4 \cdot \lambda^2 + A_5 \cdot \varphi + A_6 \cdot \varphi^2 + A_7 \cdot h \cdot \varphi + A_8 \cdot h \cdot \lambda + A_9 \cdot \varphi \cdot \lambda \quad (1)$$

where Ti represents the estimated monthly (i = 1, 2..., 12) and annual (i=13) average normal temperatures (oC); λ represents the station longitude (INMET) in degrees and tenths (negative values); φ represents the station latitude in degrees and tenths (negative values); h represents the digital elevation model; and An represents the coefficients of the regression equation.

The rainfall values used in the water balance were obtained from historical data from the National Water Agency, the Northeast Development Superintendence, and the Ceará Meteorological Foundation. Water balance calculations were performed using temperature and rainfall values, which were perturbed according to the scenarios to be evaluated (Table 1) for Ceará and neighboring states, which were used as boundary conditions.

Table 1. Rainfall and temperature scenarios evaluated for the state of Ceará.

SCENARIOS	PERIOD	TEMPERATURE	RAIN
Normal	1961-1990	Normal	Normal
B1 2040	By 2040	+0.5 °C	-10%
B1 2070	2041 - 2070	+1.5 °C	-25%
B1 2100	2071 - 2100	+3.5 °C	-40%
A2 2040	By 2040	+1.0 °C	-25%
A2 2070	2041 - 2070	+2.5 °C	-35%
A2 2100	2070 - 2100	+4.5 °C	-50%

Source: PBMCs (2013)

Spatializations of air temperature and water deficiency were generated, which were crossed and classified according to crop zoning criteria (Table 2) .

Table 2. Suitability classes for peanut cultivation.

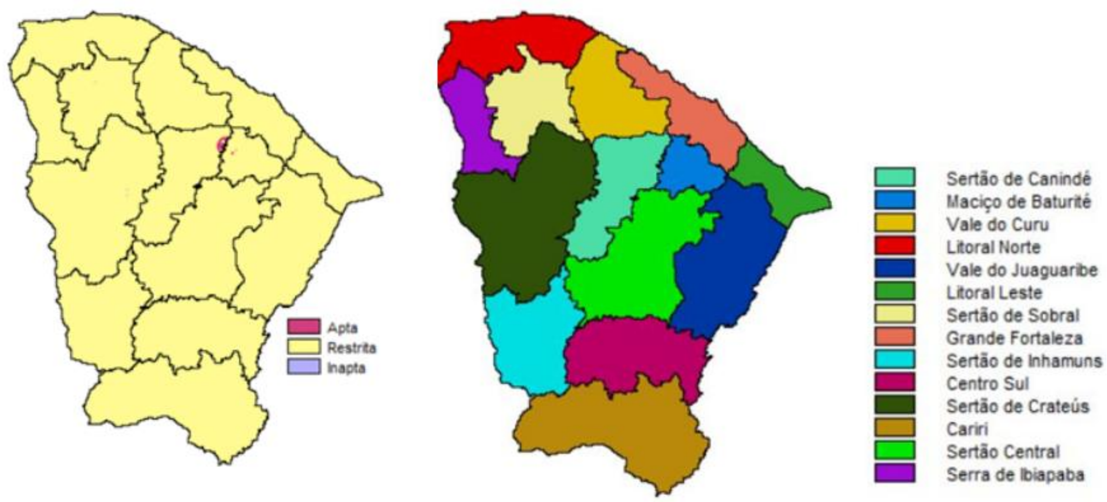
Fitness	Temperature	Water deficiency
Suitable	25 < Tm < 30	0 < DEF < 150
Restricted	18<Tm<25 and 30<Tm<33	DEF > 150
Unfit	Tm < 18 and Tm > 33	DEF=0

Source: Brazil (2011)

3 RESULTS AND DISCUSSION

The state of Ceará is divided into 13 subregions, where there are variations in temperature and rainfall. In the current scenario, peanut cultivation is restricted throughout the state of Ceará, as shown in Figure 1.

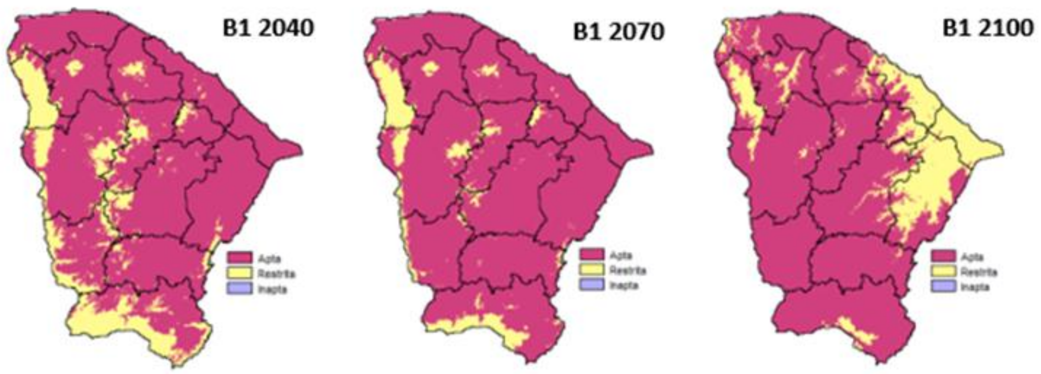
Figure 1. Standard scenario for peanut cultivation and subregions of the state of Ceará.



On the basis of Figure 2, scenario "B1" is considered the most optimistic scenario given the estimated climate changes, as it is less affected by climate change than scenario "A2."

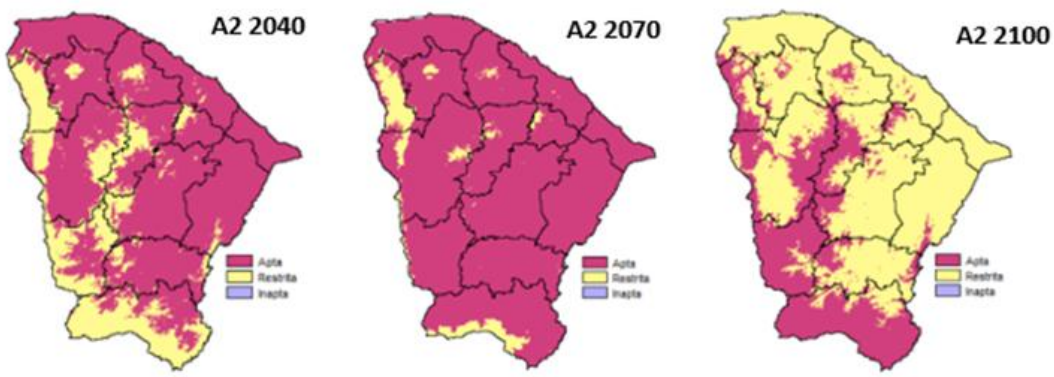
For peanut cultivation, the "B1 2070" scenario makes 90% of the state suitable for peanut production, with restrictions in only a small portion of the Serra de Ibiapaba, the sertão of Crateús, and Cariri regions, and negligible areas in small parts of the state. In the "B1 2040" and "B1 2100" scenarios, the restricted areas extend over larger portions; in the "B1 2040" scenario, the restricted areas are slightly larger than those in the "B1 2070" scenario. In the "B1 2100" scenario, the restricted areas extend over larger portions in other parts of the state, such as the Jaguaribe Valley region, the eastern coast, and part of Greater Fortaleza. The "B1 2070" scenario, given climate change, is the most suitable scenario for peanut cultivation.

Figure 2. Climatic suitability of peanuts in Ceará for scenarios B1 2040, B1 2700 and B1 2100.



The "A2 2040" scenario has plots similar to those of the "B1 2040" scenario but with slightly larger plots regarding restrictions. Similarly, the "A2 2070" scenario is the most suitable scenario for climate change, as is the "B2 2070" scenario. The "A2 2100" scenario presents 70% restrictions, as climate change in this scenario is abrupt for this crop, as shown in Figure 3.

Figure 3. Climatic suitability of peanuts in Ceará for scenarios A2 2040, A2 2700 and A2 2100 regarding restrictions.



Similar results were obtained by Cecílio et al. (2003) reported that, with respect to peanut cultivation, there is a large area restricted by water shortages in the north and a small area restricted by thermal shortages in the south. There are no areas unsuitable for peanut cultivation, precisely because peanuts are extremely tolerant to water deficit but extremely intolerant to excess water.

The increase in air temperature directly increases evapotranspiration, causing greater water deficits and reducing the intervals of lower climate risk in producing regions, further restricting the areas favorable to the insertion of the crop in the state (Campos; Silva; Silva, 2009). All of these increases in temperature and decreases in rainfall are completely detrimental, as they make crops unsuitable throughout almost the entire territory.

Silva et al. (2019) evaluated the spatial effect on corn production in the Sergipe hinterland and reported that the effect of Agricultural Climate Risk Zoning (ZARC), an agricultural policy variable that acts as a proxy for technology, had a relevant effect on corn productivity.

4 CONCLUSIONS

It is concluded that scenarios B1 2070 and A2 2070 can be considered ideal for peanut production in the state of Ceará, and the restrictions present in these scenarios could be resolved with irrigation. The extreme scenarios, "B1 2100 and A2 2100," have restrictions across almost the entire state, thus requiring significant investments in irrigation.

The B1 and A2 scenarios for 2070 may be more favorable for peanut cultivation than the same scenarios in 2040, even with higher temperatures and lower precipitation, because these conditions may more closely match peanuts' ideal climate requirements. Peanuts are heat tolerant and adapt well to drier climates, provided that they have sufficient water availability during critical phases, such as flowering and pod filling. Therefore, the 2070 climate conditions may offer a closer-to-ideal balance for peanut cultivation, even under a climate change scenario.

5 REFERENCES

ASSAD, ED Methodologies for climate risk zoning in Brazil. In: BRAZILIAN CONGRESS OF AGROMETEOROLOGY, 11, Latin American Meeting of Agrometeorology, 2, 1999, Florianópolis. **Proceedings** [...] Florianópolis: SBA, 1999. p.79-85.

CECÍLIO, RV; MELO JÚNIOR, JCF; PEZZOPANE, JEM; XAVIER, AC Agroclimatic zoning associated with the cultivation potential of coffee, sugarcane and peanuts in the upper and middle São Francisco subbasins in Minas Gerais. In: BRAZILIAN SYMPOSIUM ON REMOTE SENSING, 11th, 2003, Belo Horizonte. **Proceedings** [...] Belo Horizonte: SBSR, 2003. p. 2003.

CAMPOS, JHBC; SILVA, MT; SILVA, VPR Impact of global warming on cowpea cultivation in the State of Paraíba. **Brazilian Journal of Agricultural and Environmental Engineering** , Campina Grande , v. 14, n. 4, p. 396-404, 2010.

SILVA, MB; BELTRÃO, NEM Population levels and sowing configurations in peanut cultivation, under rainfed conditions in the Agreste da Borborema mesoregion of Paraíba State. **Journal of Oilseeds and Fibers** , Campina Grande, v. 4, n. 1, p. 23-34, 2000.

SILVA, DS; MOURA, FR; SILVA, MAS; SILVA, AAG Evaluation of the spatial effect on corn production in the Sergipe hinterland. **Brazilian Journal of Development ,** São José dos Pinhais, v. 5, n. 10, p. 20677-20701, 2019.

LI, P.; REN, L. Evaluating the effects of limited irrigation on crop water productivity and reducing deep groundwater exploitation in the North China Plain using an agro-hydrological model: I. Parameter sensitivity analysis , calibration and model validation . **Journal of Hydrology** , Amsterdam, vol. 574, p. 497-516, 2019.

LIU, Y.; LIU, L.; Zhu, A.; LAO, C.; HU, G.; HU, Y. Scenario farmland protection zoning based on production potential : A case study in China. **Land Use Policy** , Amsterdam, v. 95, article 104581, 2020.

BRAZIL. Ministry of Agriculture and Livestock. **Agricultural climate risk zoning** . Brasília, DF: MAPA, 2011.

MONTEIRO, JE Agrometeorology of crops: the meteorological factor in agricultural production. Brasília, DF: **INMET** , 2009. 530 p.

OLIVEIRA, JB; ARRAES, FDD; VIANA, PC Methodology for the spatialization of a reference evapotranspiration from SRTM data. **Agronomic Science** , Fortaleza , v. 44, n. 3, p. 445-454, 2013.

PEREIRA, AR; ANGELOCCI, L.R.; SENTELHAS, P. C. Agrometeorology: fundamentals and practical applications. Guaíba: **Agropecuária**, 2002.

PEIXOTO, CP; GONÇALVES, JA; PEIXOTO, MFSP; CARMO, DO Agronomic characteristics and peanut productivity at different spacings and sowing times in Recôncavo Baiano. **Bragantia** , Campinas, v. 67, n. 3, p. 563-568, 2008.

PBMC. **Executive Summary** : The Scientific Basis of Climate Change. Contribution of Working Group 1 to the First National Assessment Report of the Brazilian Panel on Climate Change. Brasília, DF: PBMC:UFRJ, 2013.

ZHAO, J.; YANG, X. Distribution of high - yield and high- yield - stability zones for maize yield potential in the main growing regions in China. **Agricultural and Forest Meteorology** , Amsterdam , v. 248, p. 511-517, 2018.