Trends in Horticulture (2021) Volume 4 Issue 1
doi:10.24294/th.v4i1.1798

ORIGINAL RESEARCH ARTICLE

Edaphoclimatic zoning of the melon crop

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ABSTRACT

The melon culture is one of the Brazilian horticultural crops, due to its productive potential and socio-economic role. It is recommended for the State of Goiás and the Federal District for it is easy to plant and having need of zoning of climatic conditions and thus, being able to perform their sowing. The present work used the Sarazon program to perform the water balance of the melon crop, for the 2nd, 4th and 6th five-day sowing dates in August, September and October and in relation to the water reserves in the soil of 50 mm and 75 mm. The data were spatialized using the SPRING 4.3 program. It was observed that the producers are performing in practice what can be demonstrated in theory that the period October 16–20 is the most indicated for sowing in soils of 50 mm of water reserve and October 6–10 the beginning of sowing in soil of 75 mm of water reserve for the cultivation of melon and have adequate profitability.

Keywords: Cucumis Melo; Water Reserve; Vegetables; Water Requirement Satisfaction Index

ARTICLE INFO

Received: 8 February 2021
Accepted: 26 March 2021
Available online: 15 April 2021

1. Introduction

Melon is a vegetable (oleraceous) that occupies a place of evidence in the economic market, cultivated worldwide for adapting to different soils and climates and presents importance in the volume of fruits exported by Brazil[1,2]. Melon is a species of the curcubitaceae family, genus *Cucumis* species *Cucumis melo* L. It is native to the valleys of Iran and northwestern India[3,4]. Horticulture is considered a prominent activity in Brazilian agriculture, having as one of the favorable characteristics in its production the short cycle that allows several harvests in the same year[3,5].

Brazil, with the opening of the external market has been acquiring expressive importance[6], is among the ten melon producers in the world being considered the third producer of melon in South America, behind only Argentina and Chile. In 2012, the planted area was 22,810 hectares, totaling a production of 575,386 tons[7].

In Brazil, the state of Rio Grande do Norte is the largest producer and exporter of melon, with the Agropolo Mossoró Vale do Açu standing out for planted area[8]. In Mato Grosso in 2010 an area of 62 hectares was planted, which produced 436 tons[9] and in 2012, 101 hectares were cultivated, totaling a production of 1,193 tons[7].

According to Silva[10], the use of the water balance to define planting/sowing times can contribute to the reduction of climatic risks, avoiding periods of water deficit in the critical phases of the crop. With the aid of computer programs, faster and more precise results can be obtained, allowing the evaluation of biomass production and grain yield.

The rainfall regime of the State of Goiás and the Federal District is distributed in two distinct phases: the dry and the rainy period[11–13]. The rainy period goes from October to March, corresponding to 80 to 90% of all rainfall[13]. The northern and northeastern regions of the state have an annual precipitation of 1,200 mm to 1400 mm, increasing in gradient in the east-west direction of the state, presenting a range of 2400 mm to 2,600 mm annually in the region of Piracanjuba[14].

Regarding the climatic requirements, the melon is a plant that requires high temperatures for its development, both during the day and at night throughout the cycle, being harmed when temperatures and relative humidity are low[3]. These climatic variables are important indicators for choosing the best time for planting[2] and areas for its production. The optimal annual precipitation is between 1,400 and 2,300 mm, although it tolerates much higher precipitation, as long as soil drainage is satisfactory. In regions where precipitation is less than 1,000 mm per year irrigation should be used[15].

The objective of the present work was to elaborate the edaphoclimatic zoning for the melon crop, aiming to define potential cultivable areas, best planting season, relative productivity as a function of the Water Requirement Satisfaction Index ISNA. Nine simulations of water balance were performed on different planting dates: 2nd, 4th and 6th five-month periods of August, September and October (6 to 10, 16 to 20 and 26 to 30), the soil variable was considered because it is important for the realization of appropriate zoning.

2. Methodology

The edaphoclimatic zoning for the melon crop was performed using the Sarazon® water balance and Spring® 4.3 programs. According to the methodology used by Andrade Júnior *et al.*[16]; Brunini *et al.*[17]; Cunha *et al.*[18]; Maluf *et al.*[19]; Maluf *et al.*[20]; Moraes and Oliveira[21]; Moraes *et al.*[22]; Moraes *et al.*[23]; Moraes *et al.*[24]; Moraes *et al.*[25]; Oliveira *et al.*[26]; Oliveira *et al.*[27]; Oliveira *et al.*[28]; Oliveira *et al.*[29]; Oliveira *et al.*[30]; Oliveira[31]; Sans *et al.*[32]; Silva and Assad[33] where the parameters evaluated were the ISNA and two soil water reserves for the water balance. This water balance, generator of the ISNA indices, of 80% probability of occurrence, allowed the generation of thematic maps of water balance, which were georeferenced for the State of Goiás and the Federal District, as specified below.

2.1 Water balance

To perform the water balance, the daily rainfall data series from 161 rainfall stations with 15 years of observations, provided by the former National Department of Waters and Electric Energy (NDAEE), were used. The stations used are from the State of Goiás and the Federal District. The water balance calculation will be done for pentadial periods, using the Sarazon® program. The nine planting simulations were 2nd; 4th and 6th pentadials of the months of August, September and October.

The actual evapotranspiration (ETr) is estimated by the third degree equation, proposed by Eagleman[34], which describes the evolution of actual evapotranspiration (ETr) as a function of potential crop evapotranspiration (ETpc) and soil moisture (UR). In water balance simulations, the soil variable has to be considered. The soil types considered are a function of water storage capacity and are as follows:

Type 1: soils with medium water storage capacity (50 mm);

Type 2: soils with high water storage capacity (75 mm).

2.2 Generation of thematic maps of agroclimatic risk

In the execution of this work 18 databases were generated and these databases were the source for the generation of 18 thematic maps and among these 18 thematic maps 06 thematic maps were defined which best qualify the choice of the best planting dates for the melon crop.

Each planting date is a database (being three for the month of August, three for September and three for October) being two types of soil the information for each date is doubled, that is, nine possible dates for planting times two types of soil totals 18 databases. However, at the end of this work we will have as fruit three dates that best represent the choice for each soil and we will end up with three maps for each soil.

The ETr/ETp ratio expresses the amount of water that the plant consumes (ETr) and that desirable to ensure its maximum productivity (ETp). The ETr/ETpc ratio is known as ISNA (water requirement satisfaction index) which expresses the percentage of water available to plants.

The ISNA values for melon were obtained, being generated from these data the database, using Sarazon® considering the different planting dates. Once the ETr/ETpc relations were determined for the melon, a frequency analysis was performed with a rainfall occurrence probability of 80%, as recommended by Bernardo *et al*.[35] For the realization of edaphoclimatic zoning three classes of climatic aptitude were delimited as recommended by Silva[10]:

- For ISNA $\geq$ 0.60, the crop is exposed to a low climate risk;
- For values 0.60 > ISNA > 0.50, the crop is exposed to medium climate risk;
- For ISNA $\leq$ 0.50, the crop is exposed to a high climate risk.

With the ISNA values, a database was created with the respective geographic coordinates and ISNA values, with the use of the SPRING program (GIS), the thematic maps of climate risks were generated, finalizing the execution of the 2016/2018 project:

- Typing of ASCII files (ISNA);
- Importing the ASCII file;
- Generating the point grid;
- Fractionation of climate risk classes;
- Delimitation for Goiás and the Federal District;
- Correlation with the soil maps;
- Association of classes to polygons;
- Vector editing;
- Confection of the thematic maps;
- Printing the maps.

Three thematic maps of climate risk were made for each water storage capacity in the soil (50 and 75 mm) for the melon crop after adjusting the interpolation values, defining the climate suitability classes and choosing the ones that best represent the calculated data.

3. Results achieved

The melon culture can generate to the family farmers a considerable source of added income, when properly conducted and under favorable environmental conditions, which are related to temperature, relative humidity and light, these being important indicators for the choice of the best planting season[2].

According to Pinto *et al*.[36], the period of greatest water demand extends from the development of the branches until the beginning of fruiting, pointing out that during the maturation phase, excess water can harm the quality of the fruits. Several works, particularly in Brazil, propose varied methods and criteria to evaluate the agricultural aptitude of various plants and relate climatic parameters with agricultural productivity on a regional scale.

According to Teramoto[37], every agricultural crop is influenced by a large number of environmental factors, some of which cannot be managed, such as climate, while others, such as soil and water availability, can be managed to allow the crop to perform better. In this sense, the search for high yields at low production costs implies knowing in detail the environment in which the crop is implemented, in order to rationalize the relationships between the different production factors.

In recent years, with the need to improve productivity, while maintaining the quality of crops, an extremely useful working tool has emerged, the edapho-climatic zoning, which allows the mapping of soil characteristics, relief, fertility, climate and rainfall. The melon culture adapts to different types of soils, with good porosity, that allow a better development of the root system, better infiltration of water and easier drainage[38].

Thus, edaphoclimatic zoning constitutes an organizational tool for agricultural planning, based on a survey of the factors that define the agricultural aptitude based mainly on the attributes of the soils, topography, slopes and climate found in different areas of the regions studied. When one has delimited the soil and climate conditions of a region, one can define climatically homogeneous regions and thus establish the crop to be planted in the researched area.

The edaphoclimatic zoning is faster and easier when using Geographic Information Systems (GIS), which allow cross-referencing data that help to define and delimit areas suitable for cultivation, with the use of simple procedures, such as water balance, slopes, soil types and others. Nine thematic maps were generated for each soil type and from these we chose six that best define the climatic suitability for melon cultivation.

In areas of soil with a water storage capacity of 50 mm, the whole month of August is unsuitable for melon planting in the State of Goias. From September 16th–20th, according to **Figure 1**, large areas are at high climate risk and the other areas of the state and the Federal District are at medium climate risk for melon planting.

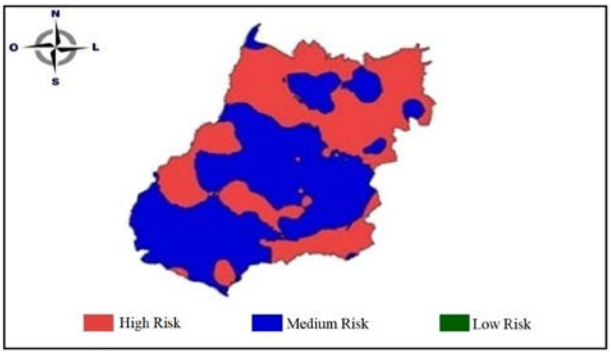

Figure 1. Climate risk for melon crop for planting between September 16–20 for a soil water reserve of 50 mm.
Source: Authors, 2018.

In the period October 16–20, according to **Figure 2**, a large part of the state presents medium climate risk, a good part presents low climate risk and in two areas the climate risk is high, thus allowing planting in almost the entire state. After the period of October 26–30, according to **Figure 3**, we can plant in the entire State of Goiás and in the Federal District.

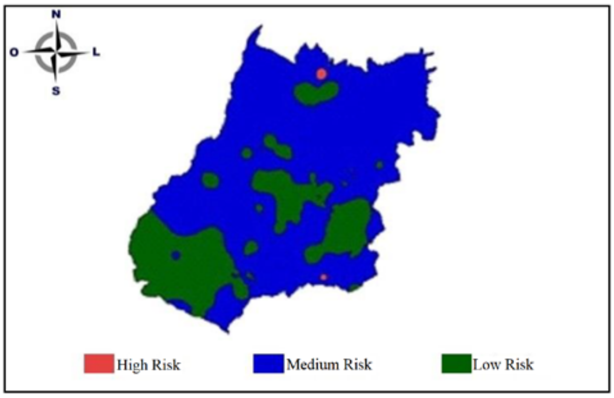

Figure 2. Climate risk for melon crop for planting between October 16–20 for a soil water reserve of 50 mm.
Source: Authors, 2018.

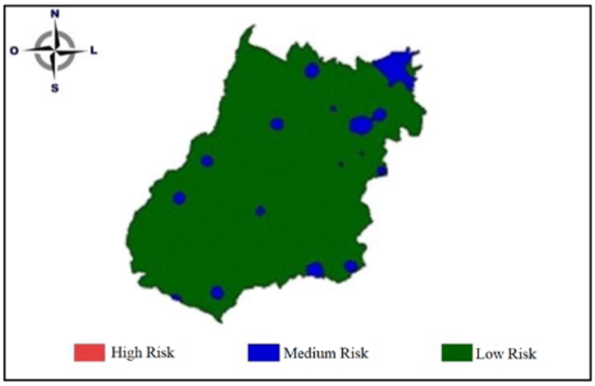

Figure 3. Climate risk for melon crop for planting between October 26–30 for a soil water reserve of 50 mm.
Source: Authors, 2018.

Figure 4 shows the planting for the melon crop from September 16–20. Thirteen areas are at high risk for melon planting and cannot be used; the other areas are medium and one is at low risk for melon planting.

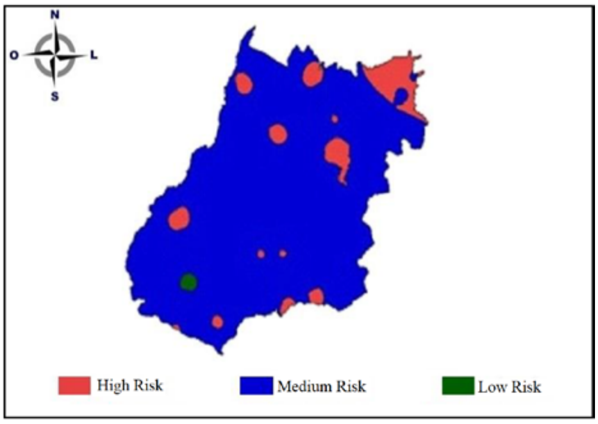

Figure 4. Climate hazard for melon crop for planting between September 16–20 for a soil water reserve of 75 mm
Source: Authors, 2018.

For the period October 6–10for the entire state of Goiás only two points have high climate risk to the planting of melon and most have medium climate risk and the rest with low climate risk for the planting of melon, as shown in **Figure 5**. As for the period from October 16–20 we have almost the entire state in low-risk climate to the implementation of the crop, as shown in **Figure 6**.

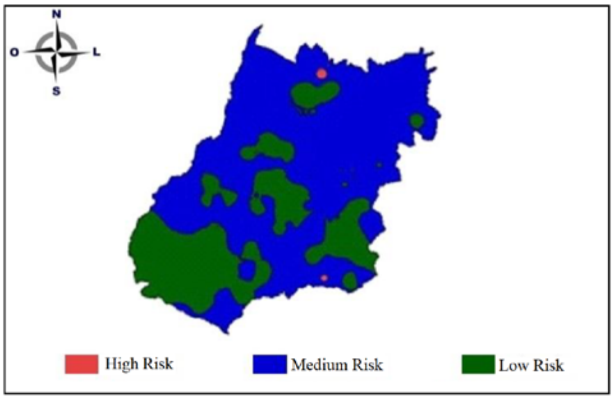

Figure 5. Climate risk for melon crop for planting between October 6–10 for 75 mm soil water reserve.
Source: Authors, 2018.

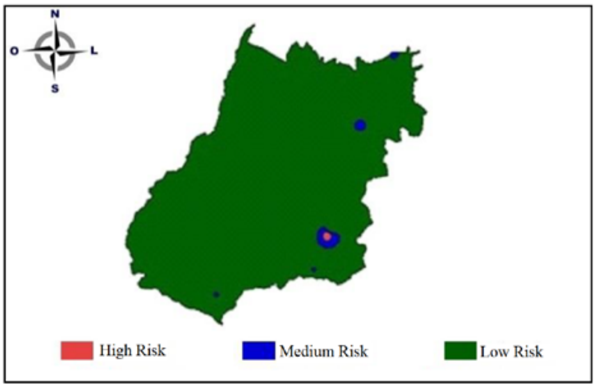

Figure 6. Climate hazard for melon crop for planting between October 16–20 for a soil water reserve of 75 mm.
Source: Authors, 2018.

4. Conclusion

The use of the Geographic Information System with the calculation of the water balance were the necessary and fundamental tools to finalize the referred work, this way the financial gain is expressive and incalculable. The planting of the melon culture performed in soil with a water reserve of 50 mm is harmed in the months of August and September, being favored in the month of October. When the soil has a water reserve of 75 mm, planting is favored in the months of September and October. The climatic risk for planting low melon in the month of October decreases in function of the water reserve in the soil.

Conflict of interest

The authors declare that they have no conflict of interest.

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