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Vale do Ipanema: Potential and benefits of indian mustard culture by the beekeeping

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ABSTRACT

As agriculture is widely linked edaphoclimatic characteristics of a place. In this study, digital terrain modeling (DTM) was performed to precipitation parameters, altitude and temperature Micro region Vale do Ipanema. And then these data were analyzed and compared with the requirements of the brown mustard, in order to verify adaptability indian mustard cultivation and its relation to beekeeping. The districts analyzed were Águas Belas, Buíque, Itaíba, Pedra, Tupanatinga and Venturosa. It was possible to conclude that the micro-region has the ability to develop the cultivation of indian mustard, it is a versatile product with great financial returns, which can help with beekeeping in the region, since it is directly linked to beekeeping, bee is the main pollinator of the crop. The crop of indian mustard, can contribute to the increase bee production and the quality of life in the place.

Keywords: adaptability, *Brassica juncea* (L.) Czern, pollination, honeybee

INTRODUCTION

Cruciferae family, now known as Brassicaceae, is considered an important botanical family, cover several species of vegetables of great economic value, such as brown mustard (*Brassica juncea* (L.) Czern) which is also popularly known as mustard-de- leaf, oriental mustard, smooth mustard, Indian mustard, brown mustard or Chinese mustard (ALMEIDA, 2003; BATTISTI et al, 2013; Grubben and

DENTON., 2004; Oram et al, 1999; REIS and BOITEUX, 2008; USDA, 2016;).

The *Brassica juncea* is a herbaceous plant, annual, erect and vigorous, large leaves, elongated with serrated margins. The flowers are yellow, large and hermaphrodites, ie they have both sexes in the same flower (AGROBIO Périgord, 2013; APHORTEP, 2009). The flowers of brown mustard, have a biological self-incompatibility mechanism

between the pollen and the egg from the same flower, because of this reason, require cross-pollination, so that there is production of fruits and seeds (AGROBIO Périgord, 2013; APHORTESP 2009).

In the world more than 60% of the crop species are pollinated by animals with the bees which is a major component by allowing a large variety of plants (Hladun et al, 2012; ROLLINA et al, 2013). Chestnut mustard flowers have food resources that are important to their pollinating insects, also standing out for its economic impotância (SILVA & PAREJA, 2012). For this feature, the brown mustard is considered a bee plant, in which the bees (*Apis mellifera*) use it as a source of pollen and nectar (ALMEIDA, 2003). The flowers, once dried, form fruits, siliques (type of pod), containing the seeds (APHORTESP, 2009). Chestnut mustard leaves can be consumed in various ways, such as stews, soups, raw in salads, sandwiches, cakes, preserves, among others. It is rich in vegetable fiber, calcium, iron, phosphorus and vitamin A and B complex (APHORTESP, 2009; EMBRAPA, 2016; Grubben and DENTON, 2004; ONTARIO, 2012). Further, the seeds may provide mustard oil, which after being crushed serve for the production of mustard paste (flavoring) (Grubben and DENTON, 2004; ONTARIO, 2012).

According to FAO data (2012) the world's largest producer of mustard in 2012 were Nepal (145,173 t), Canada (118,600 t), Myanmar (90000 t), Russia (41,506 t), Ukraine (30980 t), Czech Republic (15,466 t), United States (13,580 t) and France (13,500 t). According ALVES et al. (1988) in Brazil, condiment production through seeds, depends on imports, most of the seeds imported from Europe. During the years 1980-1983 the imports fluctuated, and this was no less than 100t / year.

Climatic factors such as the seasons, temperature, precipitation, solar radiation and relative humidity, influence the quality of the production and development of brown mustard. She is coming from temperate regions, but is capable of developing into Tropical and Subtropical Regions, and see being improved, for more hot and dry regions (Alves et al., 1988; BATTISTI et al, 2013).

The mustard cultivars, better adapted to semiarid conditions than other plants of the family such as canola and hence the thermal excesses. However, the cultivation of brown mustard is sensitive to extended photoperiod, but is famous for tolerating annual rainfall 500-4000 mm, and adapt well to all types of soils, but have better results in sandy soil, well drained, rich in organic matter and pH between 5.5 and 6.8 can reach up to 7.5 because a lower pH favors the occurrence of diseases such as "clubroot". In addition, tolerating annual temperatures between 6 and 37, present as ideal temperature range 15 to 24°C. Thus, brown mustard is convenient both in tropical soils low altitudes than at relatively cool climate conditions. At high temperatures the brown mustard, bloom early and your income is lower, which may cause undesirable or spicy pungent flavors in the leaves, but even so its production is still viable (BATTISTI et al, 2013; Grubben and DENTON, 2004; ONTARIO, 2012). According to the UFGRS of (2002), brown mustard is able to produce between 1,200 and 1,500 kg / hectare. According to the UFGRS of (2002), brown mustard is able to produce between 1,200 and 1,500 kg / hectare. For the production of seeds, brown mustard is tolerant to adverse conditions such as water stress, low pH or high, salinities and insect damage (Grubben and DENTON, 2004).

Studying these related parameters is a good alternative to check for new agricultural frontiers of mustard greens in the region. The Brazilian Agreste is an intermediate region Zona da Mata and the Hinterland Zone, which is characterized by presenting zonally, similarity the two regions. In the closest to the hinterland areas, the climate is hot and dry, with the rainy season from February to June, while in the areas closest to Forest Zone, the rainy season extends from March to July. In Pernambuco Agreste represents about 24.7 % of the state (LIMA, 2007; ARAÚJO FILHO et al., 2000; IBGE, 2010; MENDES et al., 2014). Inserted in this context, the micro Valley Ipanema, is located in Pernambuco, more precisely in the Agreste, owns a land area of approximately 5,274 square kilometers (Verslype, et al., 2015).

The objective is through this study, the creation of MDT for precipitation parameters, temperature and topographic Microregion Valley Ipanema through Surfer 12, to see which municipalities fit for the cultivation of mustard, which can be used as support for honey production, as well as condiment production, salads, among others, which in turn may promote the economic and social development of the region studied, because it is a crop of great economic importance in many countries.

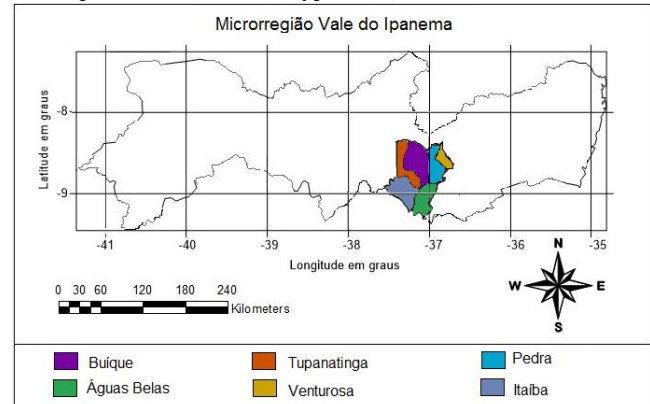
MATERIALS AND METHODS

The study was conducted from January to March 2016 in Laboratory Environment Group, Surveying and Sustainable Agriculture - GETAP, located in the Department of Rural Technology - DTR, the Federal Rural University of Pernambuco - UFRPE.

The study area was the micro-region of Ipanema Valley and its municipalities, located in northeastern Brazil, the central coordinates

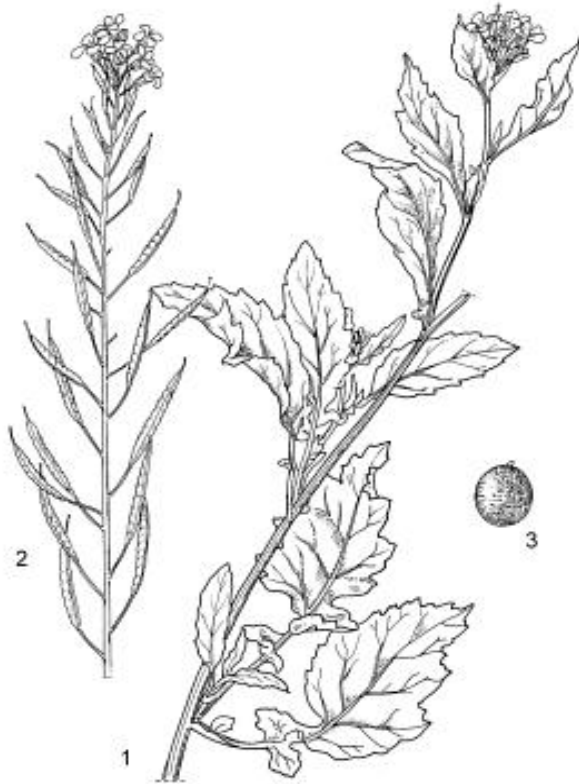
708028.00 me (N) 9020969.20 m (E), zone 24, datum WGS84, as can be seen in (Figure 1). Digital images were used Globe 2015, Google Earth Pro 7.1.4.1529 to obtain the limits of micro-region and its municipalities. Which were subsequently scanned by Digital Modeling of Land (MDT) through 12 Surfer program.

Figure 1 – Representation of Microregion Valley Ipanema and its municipalities. Source (Verslype et al., 2016).



To address the analysis, soil and climatic characteristics of the municipalities of the micro region of Ipanema Valley were compared with the requirements of the culture of brown mustard, in order to verify the potential and the benefits of growing insertion of mustard greens in the region. For this, we analyzed the requirements of the brown mustard culture. Which according Grubben and DENTON (2004), Brown mustard (Figure 2) fits well annual rainfall 500-4000 mm and annual temperatures ranging between 6 and 37 °C. However, prefer milder temperatures ranging between 15 and 25 °C (EMBRAPA, 2011) and rely on cross-pollinated for seed production (AGROBIO PÉRIGORD, 2013; FREE, 1993). And we were also analyzed precipitation and temperature parameters in the months from January to December in 30 years of the municipalities of the micro region. And then these data were scanned in MDT and discussed.

Figure 2 – Brown mustard (*Brassica juncea* (L.) Czern) 1- branch with flowers 2 - branches with flowers and fruit and 3 - seed. Source (Grubben , C.J.H. & DENTON , 2004).



RESULTS AND DISCUSSION

1. Characterization of the study area

The Microregion Valley Ipanema is formed by the waters of municipalities Fine , Buíque , Itaíba Stone Tupanatinga and Venturosa (Verslype et al . , 2015) . Is inserted in Agreste Pernambucano , which is a transitional area between the forest zone and the Pernambucano Hinterland , has a maximum extent of 24 000 km2 .

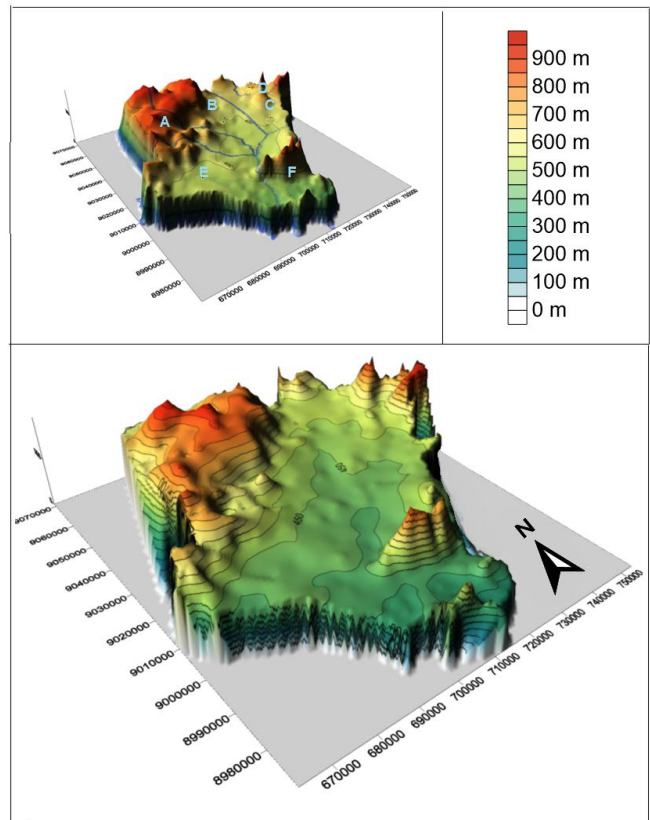
1.2. Altimetry

The Agreste Pernambucano , is located almost entirely on the Borborema Plateau , formed by massive and high hills , with altitudes ranging between 650-1000 meters. As also on the geo-environmental units Sertanejas Depressions, Sedimentary Basins, Reworked Surfaces, Region of

Massive and low hills (CONDEPE , 2006; CPRM , 2005; MDA , 2006).

Due to the characteristic topography of the region , the average altitude of the micro-region municipalities vary between 800 and 376 m (CPRM , 2005; DCA , 2015) . Still according to data from CPRM (2005) , DCA (2015) and RODAL (1998) the Buíque municipality has the highest average elevation of the micro-region with 800 m , followed by the municipalities of Tupanatinga 709 m , Stone 660 m, Venturosa 530 m, Itaíba 470 m city that holds the lower altitude is Águas Belas with 376 m . In (Figure 3) was represented in the MDT altimetry of the municipalities of Microregion Valley Ipanema.

Figure 3 – Altimetry from Ipanema Valley micro-region was represented by MDT . In the - Tupanatinga , b - Buíque , c - Stone d - Venturosa , and - Itaíba and f - Águas Belas . Source (Verslype et al . , 2016)



1.3. Photoperiod

The state of Pernambuco, is located at low latitudes , where there is a significant variation in

photoperiod remains around 12 h , almost throughout the year , ranging from 11 h 56 min to 12 h 65 min (MEDEIROS, 2009).

1.4. Climate

Because of the characteristic Mesoregion relief Agreste Pernambucano in Ipanema Valley Microregion climate is tropical rainy, the type's' hot and humid, with autumn and winter rains, according to Köppen. Featuring dry summer and rainy season that begins in January / February ending in September, and may advance to the month of October (CONDEPE, 2006; CPRM, 2005; Verslype et al, 2015). The average annual temperature of the micro-region of Ipanema Valley (Figure 4), ranges from 24.5 to 21,6°C. As the municipality of micro-region with the highest average annual temperature Águas Belas with 24.5°C, followed by the municipalities of Itaíba 24.1°C, Venturosa 23,7°C, 22.5°C Stone Tupanatinga 22,3°C and 21,6°C with Buíque (Verslype et al, 2015; Verslype & Caldas, 2016).

According to DCA data (2015) and IBGE (2010) the municipalities of Microregion expose a minimum annual temperature ranging between 18 and 22 ° C. In which the municipality of Buíque has the lowest temperature of the region with 18 ° C, followed by the municipalities of Tupanatinga 18.5°C, 18.6°C Stone Itaíba with 19.7 ° C, Águas Belas with 20°C and 22°C with Venturosa. While the maximum annual temperature of municipalities ranged between 26 and 32.2°C. It is the Water Fine municipality which has the highest temperature in the region that is 32.2°C, followed by the municipalities of Itaíba with 32,1°C, Buíque with 30.3°C, 30.1°C Tupanatinga, 30.1°C Stone and Venturosa with 26.0°C. In (Figure 5) was

represented MDT in the maximum temperature and minimum annual.

Figure 4 – Average annual temperature of the municipalities of Microregion Ipanema Valley represented by MDT . Source (Verslype et al . , 2016).

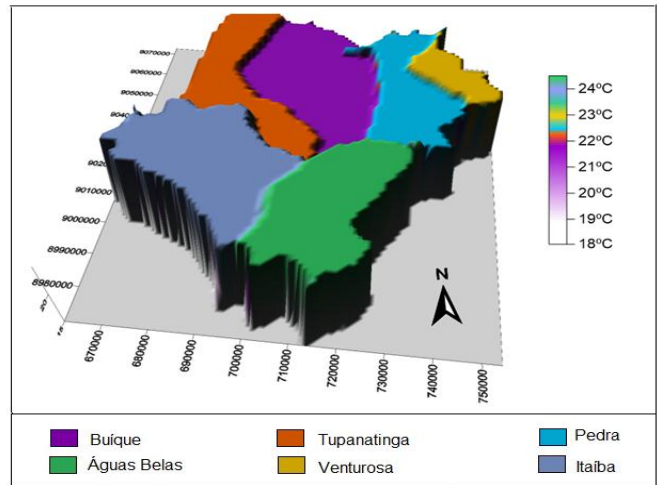
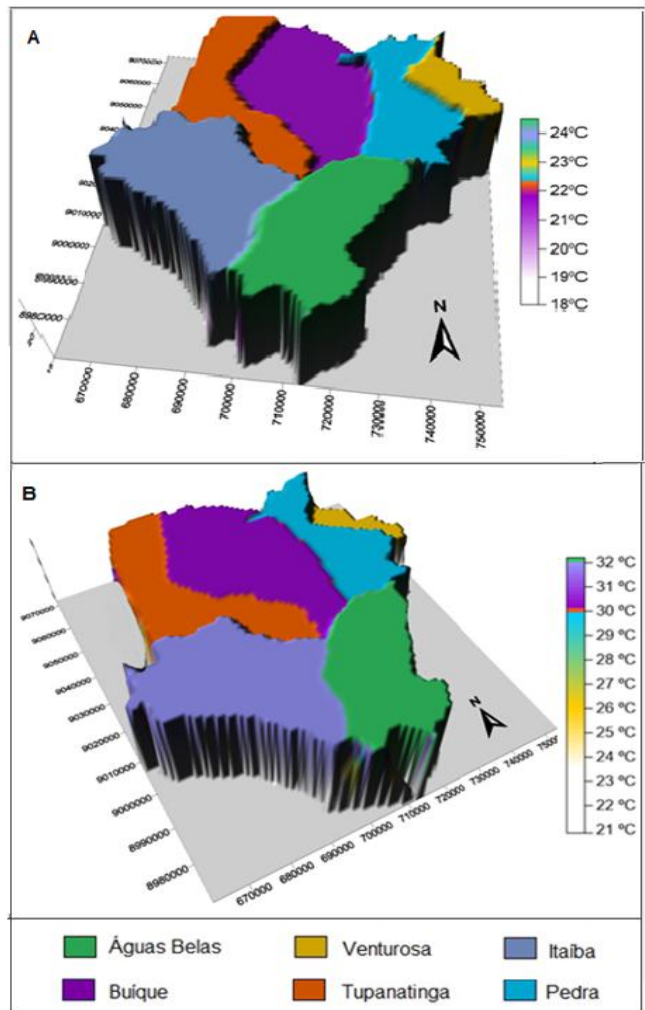


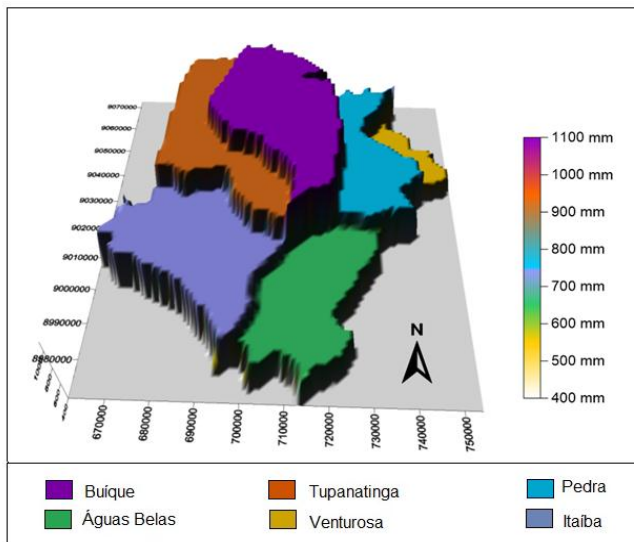
Figure 5 – A - Minimum annual temperature and B - Maximum annual temperature of the municipalities of Microregion Ipanema Valley represented by MDT Source (Verslype et al. , 2016).



In addition to elevated temperatures, the micro-region presents a number of days of rainfall during the year ranging between 70 and 130 days. Reaching the time of maximum rainfall between the months of February, March and April in the western part of the area, and by May, June and July in the northern part and the western part of the same (CPRM, 2005; Verslype et al., 2015).

Microregion in the city that exposes the highest average annual precipitation index is Buíque with 1100.1 mm, followed by Tupanatinga municipalities with 928.9 mm, Stone 756.1 mm, 742.4 mm Itaíba, Águas Belas with 652.8 mm and the municipality with the lowest index rush Microregion is Venturosa with 549 annual mm (Verslype et al., 2015). In (Figure 6) can be displayed representing the average rainfall of the micro-region, the digital terrain modeling.

Figure 6 – Average annual rainfall in the municipalities of Microregion Ipanema Valley represented by MDT. Source (Verslype et al., 2016).



As the brown mustard has a biological mechanism self-incompatibility between pollen and ovule of the same flower, it requires the presence of an insect for pollination, which is essential for

producing good seed crop (AGROBIO PÉRIGORD, 2013; FREE, 1993).

For its flowers are much visited by bees (SANTOS, 1956). It is considered an important bee plant because its flowers possess important food resources that bees (*Apis mellifera*) need as the vital source of nectar and pollen (ALMEIDA, 2003; Choudhary & Sharma, 2008; SILVA and PAREJA, 2012). According SOUFFLET 2014, there was 10 times more bees on the brown mustard, than on the white mustard. In addition, 86% of bees observed on brown mustard were pollinating, against only 20% who were on the white mustard. According to EMBRAPA (2003) pollination can increase production between 5 and 500%, it is estimated that annually pollination generate a global benefit over one hundred billion dollars. Inserted in this context, the brown mustard might be a good alternative to beekeeping activities in the region, since according to IBGE data (2014) the Águas Belas municipality had an output of 200 kg of bee honey as Buíque had a production 250 kg in the year 2014. As honey production is directly linked to bee flora, the produced volume, color and flavor of honey depends on the botanical species from which the bees extract the nectar (Caldas et al., 2015). The honey mustard greens has a whitish color with a mild flavor, but when fresh, can have taste and strong aroma, leaving a slight burning sensation in the mouth (KIRK & HOWES, 2012).

2. Potential for the cultivation of Brassica juncea in the micro-region of the municipalities of Ipanema Valley

Comparison of climatic requirements of mustard greens with the climatic characteristics of the micro-region of Ipanema Valley, it was observed that the cultivation of Brassica juncea has the potential to be

implemented in all municipalities of the micro region.

For in relation to temperature it is one of the main limiting factors, which according Grubben and DENTON (2004) to cultivate accepts temperatures ranging between 6 and 37 ° C. The average annual temperature Microregion Valley Ipanema, ranged from 24.5 to 21,6°C is suiting the preferences of the culture, even when faced with the maximum and minimum temperatures in the region ranging between 18 and 32,2°C, still found within the temperature range accepted by the culture.

Another limiting factor for cultivation, are water resources, but the average annual rainfall indices of micro-region ranging between 500 and 1,100 mm, are within the culture requirements (Graph 2). And when confronted photoperiod in the region, which is one of the mustard sensibilities, did not show to be a problem because the photoperiod does not vary much, not having very long periods.

In addition to being dependent on pollination entomophilous with bee and its main pollinator, the culture is directly linked to beekeeping. This relationship may increase or maintain beekeeping in the region, and even encourage other municipalities in the micro-region to develop beekeeping, since the culture depends on pollination.

The incentive to brown mustard cultivation in the region can decrease low-income problems and promote the economic development of the region, since it is a culture of great economic and social importance in many countries, due to its versatility of products and by-products, as the plant can be marketed in the form of salad with their seeds it is possible to produce mustard oil and even to the production of seasoning.

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