Cultivar competition of soybeans in degraded pasture in the municipality of Piraquê-TO in the 2020/2021 harvest

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ABSTRACT

Soybean is a crop of great economic importance for Brazil, being the main crop of Brazilian agribusiness. In this sense, it is necessary to know the characteristics of soybean cultivars being of extreme importance, especially when grown in a new agricultural frontier. For this reason, the objective of this work was to know the performance of ten soybean cultivars in the northern region of the state of Tocantins, being a new agricultural frontier where the climatic and soil conditions differ from the traditional producing regions. The experiment was conducted at Bonanza Farm (Piraquê-TO), in a completely randomized block design (DBC), with nine treatments, represented by soybean cultivars and four blocks in the 2020/21 production cycle.

Keywords: Soybean cultivars, Adaptability, North of Tocantins, Weather Conditions, Increased productivity.

1 INTRODUCTION

Soybean is a species rich in protein whose scientific name is *Glycine Max*, presenting the probable center of origin in China, belonging to the family of Fabaceae (EMBRAPA, 2011). According to Muller (1981), soybean is an annual, herbaceous, autogamous, erect legume that presents a variety of morphological characteristics. According to Sediyama et al., (1985) soybean has a diffuse root system, that is, a system that consists of an undeveloped main axial root and secondary roots.

For Embrapa (2018) it is a complete food in energetic and protein content, being of great importance in reducing malnutrition worldwide. It is considered the best protein of the vegetable kingdom presenting an average content that varies from 36% to 40%, and can reach 45% in special cultivars, thus having the ability to replace the nutritional content of animal protein by containing all the essential amino acids.

Liener (1994) states that soybeans are composed of 20% oil, 5% ash, 40% protein and 35% carbohydrates. Callou (2015) also adds that soybean has polyunsaturated fatty acids, fiber (soluble and insoluble) and proteins with high biological content, also presenting the presence of polyphenols.

The high nutritional contents of soy make it the most used in animal nutrition both for its protein richness and for its balance in the balance of amino acids, which makes it exceptional and the most adequate vegetable protein supplementation available. (KYNETEC, 2013)

In Brazil according to Inoue (2019) the cultivation of soybeans was only introduced in the late nineteenth century, in Bahia in the year 1882, but a more abundant advance occurred from the year 1914, in Rio Grande do Sul and only in the year 1941, it began to be considered a large-scale production.

Also according to the author, in the year 1960, the Ministry of Agriculture in order to maximize productivity in the country, made several investments where they aimed at the potential use of the Cerrado, however, the infeasibility of expansion in the cultivated areas made evident the migration of soybean cultivation to the Midwest region, and from the year 2010, due to the various social and economic changes aimed at the expansion of this agriculture, new potential regions stood out, known as MATOPIBA, which corresponds to the states of Maranhão, Tocantins, Piauí and Bahia.

The MATOPIBA Region corresponds to the new agricultural frontier in Brazil that is characterized by the restricted inclusion of the northeastern cerrados, since its climatic conditions are unfavorable to production requiring investment in science to expand its productive potential (IPEA, 2017).

Among the states that make up the economic mesoregion of MATOPIBA, Tocantins was the last to start soybean cultivation, however, today it is considered the second largest producer in the region followed by Bahia. For Tocantins the discovery of soybean cultivation is very important, because it currently leads the state's agribusiness with 83% of exports and cattle ranching activities, even soybean cultivation correspond to only 10% with agricultural exports. It is estimated that if the states continue to grow at the same pace, within a decade, Tocantins could become the first largest soybean producer in the region (EMBRAPA, 2019).

In this context, the knowledge of soybean cultivation in edaphoclimatic conditions in the State of Tocantins is still incipient.

Thus, the theme is justified due to the need to demonstrate through research, the adaptability of some cultivars in the North of Tocantins, through the analysis of data collection encompassing from the evaluation of the climate, soil analysis, the appropriate choice of soybean cultivar and harvesting practices serving as an aid to the producer to be able to have greater ownership in choosing the most appropriate cultivars for more productive future crops.

Therefore, the objective of this work is to evaluate the productive performance of nine soybean cultivars at Bonanza Farm, Piraquê Municipality, Northern region of Tocantins, in the 2020/2021 harvest, in order to demonstrate to producers/readers a more detailed analysis of the cultivars and their adaptation in the region.

2 LITERATURE REVIEW

2.1 SOYBEAN EXPANSION IN BRAZIL

In 2018 Brazil was considered the second largest producer of soybeans in the world, with about 34 million hectares planted, occupying most of the crops, because its profitability, stability, and affordable commercialization, make it stand out among the other grains behind only the United States in productivity scale, also making soybean become one of the most important legumes both for the country's economy and for the global economy, from the purpose of grains, to their derivatives (FERREIRA, 2011; Sediyama, 2005; CONAB, 2018).

According to Conab (2019) Brazil is currently the largest exporter of soybeans in the world, which is the main crop in terms of increasing area and production capacity corresponding to 48% of 240.65 million tons of grains produced in 2019, where according to the Secretariat of Foreign Trade (Secex) and the Ministry of Economy (ME) Brazilian soybean exports in 2018 corresponded to 40.64 billion of dollars equivalent to 16.98% of national exports, making soybeans the most important product in the Brazilian trade balance of the year.

The United States Department of Agriculture (2019) reported that in the 2018/2019 harvest, Brazil produced approximately 117 million tons of soybeans, which compared to the 2019/2020 harvest had a growth of 6 million tons, which corresponds to 5.13%. With this, the estimate is that Brazil will become the largest producer of soybeans in the world, and should have an expansion of planted area of approximately 2.21%, with 35.15 million hectares in the 2018/2019 harvest and 36.90 million hectares in the 2019/2020 harvest. Already related to productivity, the average in five years is that in the 2019/2020 harvest it was 3,330 kg/ha and in the 2018/2019 harvest the value was 3,240 kg/ha.

For Conab (2019), in the 2018/2019 harvest, Brazil presented a 3.5% drop in soybean production compared to the 2017/2018 harvest. This drop was due to the drought of December 2018 and January 2019, with production of 115.07 million tons in the 2018/2019 harvest and 119.28 million tons in the 2017/2018 harvest.

For a better expansion, better use and higher productivity, it is necessary that there is knowledge of all the technological advances, nutritional requirements, water and genetic improvement of the cultivars and their adaptability to various environmental conditions, in order to observe their behavior in the face of these variations and thus have greater and better results. (FERRARI, 2008)

2.2 CLIMATIC CHARACTERISTICS AND SOIL CONDITIONS IN THE REGION

For the analysis of the performance of the cultivars, the first challenge is in the proper diagnosis. For this reason, an evaluation of the climatic conditions and soil conditions is made through a laboratory analysis where soil samples from the Farm are collected and sent to Nova Mutum-MT, to then make decisions on how to make the necessary corrections of this soil.

This analysis is one of the ways to evaluate the fertility of the soil to be explored, which allows a better liming and fertilization. The collection of samples is taken from the arable layer of the land that undergoes constant variation due to corrections that involve the addition of concealers and fertilizers from other crops. Where it was possible to observe through the analysis carried out that the soil of the Farm, it is a mixed soil, with percentage of sand and silt much higher than that of clay that reaches a maximum of 25% and presents many spots, as well as practically all the soil of the state of Tocantins.

As for the climatic characteristics of the Farm is observed in the region, that the rain usually begins in mid-October, but only stabilizes at the end of November, suffering a small drought in early December, which is the famous summer, having the highest percentage of rain in the months of January, February and March, and according to data collected through the rain gauge on the farm where the calculated reaches the index of variation of annual rainfall between 1900 and 2400mm.

For Fao (2012) climate change can alter crop production significantly and Fagundes et al., (2010) explains the reasons by stating:

> [...] because it will likely be accompanied by an increase in air temperature due to the increase in the concentration of carbon dioxide (CO2), directly influencing the development, growth and yield of agriculture.

2.3 SOIL CORRECTION

After knowing the soil conditions and the climate of the region, the diagnosis is made, and then strategies are outlined for better soil preparation. This strategy occurs through the need of the soil in the search for correction or maintenance for greater productivity of the cultivars.

Based on the results obtained in the analysis of climatic and soil conditions, there was a need to correct the acidity and make the fertilization for the best preparation of the experimental lands that are divided into equal plots, with the same soil and management characteristics, subdivided into blocks of the same size, separating three blocks for each cultivar.

Initially the first hand of grading was done with the aid of agricultural machinery, then the correction is made with the appropriate limestone in the necessary quantity, an agricultural input used to correct the acidity of the soil, neutralizing the Ph, also providing macronutrients necessary in order to neutralize the phytotoxic effects of aluminum and manganese, increasing the proportion of nutrients to the plants and potentiating the effects of fertilizers, Since in addition to acidity other problems can be found and verified in the analysis, such as calcium deficiency, magnesium and excess aluminum. (BOTUVERÁ CALCARIO, 2020)

In the case of the soil of the Farm where the study is being carried out, two types of limestone will be used to correct the surface acidity: dolomitic, which is a limestone with a higher concentration of calcium oxide (CaO) and magnesium (MgO), and calcitic that has a higher concentration of calcium oxide (CaO) and low concentration of magnesium oxide (MgO). 2.5 tons of dolomitic limestone and 3 tons of limestone per ha will be used. (SOUSA, 1996)

After liming, the second hand of grading is done to incorporate this limestone into the soil, and only then is the soil leveling and subsurface correction done with plaster to the section, with the aid of the calcareadeira, in the amount of 480 kg per ha. Gypsum in turn is used in order to decrease the saturation of aluminum in the soil in deeper layers, because the sulfate present in it takes calcium to the depth below 40 cm, and consequently the plant has a larger and deeper root development going beyond the surface layer, which helps in increasing the absorption of water and nutrients, improving the productivity index. It should be noted that gypsum does not have the function of neutralizing the acidity of the soil, it is used as a source of sulfur, calcium and as a nutrient. (SOUSA, 1996)

As soon as the application of the gypsum is done, the first application of desiccant crop protection will be made, with Glyphosate in a proportion of 2.5 liters per ha, aiming at the total cleaning of invasive plants.

At the time of planting with the planter will be applied in the furrow of each row, the fertilizer, where 200 kg of fertilizer will be used ref.11-52-00 per ha.

After all the preparation and adaptation of the soil for cultivation, the sowing is done, and the management begins, which involves from the daily observation of possible problems, to the application of agricultural pesticides, as a form of prevention for possible diseases and pests.

2.4 CHARACTERISTICS AND PROPER MANAGEMENT OF SOYBEAN

In addition to the aspects observed for the choice of cultivars, it is taken into account the characteristics pointed out by Carvalho (2010), where due to mechanized harvesting the cultivars must present favorable height to it, which can vary between the cultivars, since the duration of the cycle of each one varies and is related to the environmental conditions and its flowering season.

As for management:

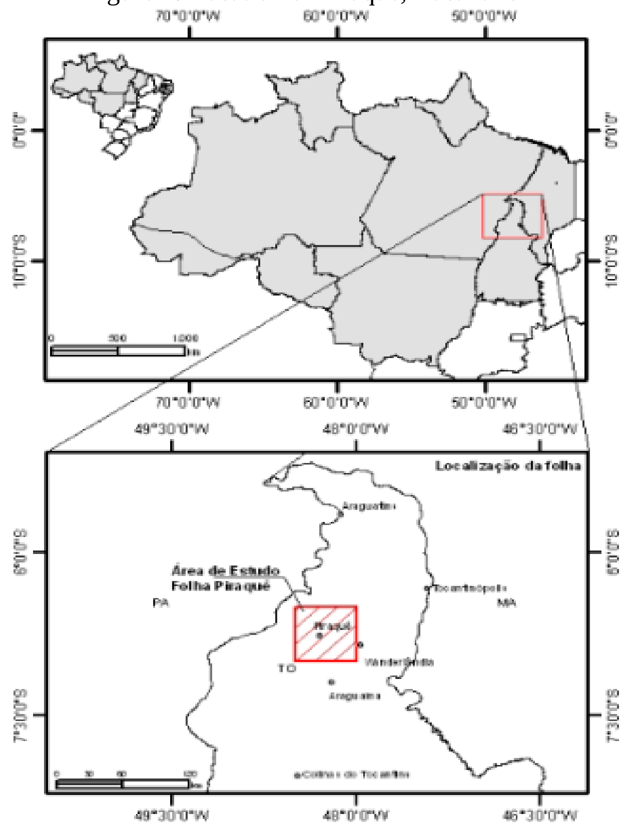
> Some management practices should be considered beyond the choice of a good cultivar, such as sowing at the recommended time for the region of production, the use of appropriate spacing and densities for these cultivars, the monitoring and control of weeds, pests and diseases and the reduction of possible grain losses that occur at harvest (Ritchie, 1994).

In order to monitor, the daily monitoring of the planting will be done, where possible ones will be observed invasive plants that can steal nutrients from the soil and also possible pests and diseases that can damage and endanger every crop.

3 MATERIALS AND METHODS

The study is being conducted in an experimental area of Bonanza Farm, Piraquê Municipality in the North of the state of Tocantins, (Figure 1), in the 2020/21 agricultural harvests. The koppen classification for this region is Aw (tropical climate with dry season) 06° 46' 25" S and 48° 17' 49" W and average altitude of 180 meters.

Figure 1: Location of Piraquê, Tocantins



Source: Dias and Maia (2009)

The experiment was set up on January 6, 2021 in a completely randomized design (BDC), with nine treatments, represented by the soybean cultivars TGM 2383 IPRO, ST845 IPRO, SYN 1687 IPRO, M8349 IPRO, ST 824 IPRO, NK8770 IPRO, M 8644, JURUENA and BMX DESAFIO RR, with each cultivar distributed in three blocks measuring 20x50 (1000m²), around 0.01 hectare each, denominated as A, B and C. The cultivars used have different phenological cycles, from the earliest to the later.

As for the cultivars, a treatment is made in the seeds before sowing, using 100 ml of Acorda (rooting), 40 ml of Singular (fipronil), 150 ml of Vitavax (fungicide) and 0.25 grams of Graphite per ha, in order to a rapid germination, greater fixation of the plant to the soil, providing greater stability and acting preventively against possible diseases.

Regarding planting, the spacing between plants respected the technical recommendations according to each cultivar. The spacing between rows was used 50 cm and the planting depth was approximately 3 to 6 cm.

Data represented in the following table:

Table 1: Distribution and Cycles of Cultivars

Plot	**Cultivate**	**Sowing**	**Cycle**	**Dist.**	**Dt. Planting**	**Germination**
1	TGM 2383 IPRO	TALISMAN	113	15 S/M	06/01/21	12p/m
2	ST 845 IPRO	TALISMAN	115	15 S/M	06/01/21	7p/m
3	SON 1687 IPRO	TALISMAN	125	15 S/M	06/01/21	12p/m
4	M 8349 IPRO	TALISMAN	113	15 S/M	06/01/21	12p/m
5	ST 824 IPRO	SOYTECH	107	15 S/M	06/01/21	11p/m
6	NK 8770 IPRO	SYNGENTA	113	15 S/M	06/01/21	8p/m
7	M 8644	TALISMAN	120	11 S/M	06/01/21	10p/m
8	JURUENA	NIDERA	120	9 S/M	06/01/21	7p/m
9	BMX CHALLENGE RR	ADRIANA	105	22 S/M	06/01/21	15p/m

(Source: Own author)

For the fertilization, which occurs during planting, 200 kg per ha of the MAP 11-52-00 formulation were used, where the soil analysis was taken into account, with corrective purposes to reach the recommended levels for soybean cultivation.

During the process of crop development, management techniques are made that include the application of pesticides and other techniques aimed at good performance, without taking into account the interference of external factors that can influence the result of the study, not following a pattern, but acting according to the need of the crop.

For this experiment, after germination and average plant growth, two applications of 200 kg of KCL 00-00-60 per ha were made, thrown at an agricultural fertilizer distributor, to help obtain stronger and more resistant plants.

In the pre-planting period, applications of pesticides such as Insecticide, Post-emergent Herbicide and Selective Herbicide were made through the ground sprayer in order to eliminate weeds, possible pests and insects.

Then, during the post-planting, Insecticides, Fungicides, Foliar and Mineral Fertilizer and post-emergent and selective herbicide were applied according to the need of the plant, seeking to stabilize the control of invasive plants, pests and fungi. During this period, Inoculant was also used in order to achieve greater nitrogen fixation in the plant for greater resistance and uniformity. Finally, the desiccant was used to standardize the planting, in various periods and quantities as observed in the following table:

Table 2: Amount of Pesticides Used

Date	**Product**	**Description**	**Dosage**
17/12/2020	Cypermethrin	Insecticide	0.193 L/ha
17/12/2020	Reducam NPK Sili 4	Fertilizer Folear	0.033 L/ha
17/12/2020	Clorim	Post-Emergent Herbicide	0.092 L/ha
17/12/2020	DMA 806 BR	Selective herbicide	0.991 L/ha
17/12/2020	Glyphotal	Post-Emergent Herbicide	3,742 L/ha
22/01/2021	Reducam NPK Sili 4	Fertilizer	0.046 L/ha
22/01/2021	Cypermethrin	Insecticide	0.229 L/ha
22/01/2021	Glyphotal	Post-Emergent Herbicide	3,053 L/ha
27/01/2021	Revigo Master	Mineral Fertilizer	2,000 L/ha
03/02/2021	Nodusoja	Inoculante	35.931 ds
04/02/2021	Redutam NPK Emergency 5	Fertilizer	0.029 L/ha
04/05/2021	Sperto	Systemic insecticide	0.467 kg/ha
04/02/2021	Aproach First	Fungicide	0.302 L/ha
12/02/2021	Cypermethrin	Insecticide	0.200 L/ha
12/02/2021	Trivor	Systemic insecticide	0.264 L/ha
12/02/2021	Redutam NPK Sili 5	Fertilizer	0.040 L/ha
12/02/2021	Expert	Insecticide	0.800 kg/ha
12/02/2021	Aproach Prima	Fungicide	0.400 L/ha
23/02/2021	Privilege	Contact insecticide	0.330 L/ha
23/02/2021	Redutam NPK Sili 5	Fertilizer	0.041 L/ha

23/02/2021	Expert	Insecticide	0.963 kg/ha
23/02/2021	Unizeb Gold SC	Fungicide	1,857 kg/ha
23/02/2021	Tridium	Fungicide	2,751 kg/ha
25/02/2021	Redutam NPK Sili 4	Fertilizer	0.021 L/ha
25/02/2021	Glyphotal	Post-Emergent Herbicide	0.196 L/ha
01/03/2021	DMA 806 BR	Selective herbicide	0.012 L/ha
27/03/2021	Absolute	Fugicida	0.259 L/ha
27/03/2021	Tridium	Fungicide	0.519 L/ha
27/03/2021	Reducam NPK Sili 4	Fertilizer	0.052 L/ha
27/03/2021	Glyphotal	Post-Emergent Herbicide	2,939 L/ha
27/03/2021	Expert	Insecticide	1,815 L/ha
08/04/2021	Expert	Insecticide	1,600 L/ha

(Source: Own author)

4 RESULTS AND DISCUSSIONS

4.1 RESULTS ACHIEVED

There was a significant difference at the level of $P<0.05$ for the treatment effect for the variables yield, number of branches (Nramos), number of pods (Nvages) and number of grains per plant (Ngplanta).

Table 3: Yield (kg/h-¹), height (cm), number of branches (nramos), number of pods per plant (nvages), number of grains per pod (ngvagens) and number of grains per plant (ngplanta) in nine soybean cultivars in soybean in opening areas of the municipality of Piraquê-TO

Cultivars	Produt. (kg/h^{-1})*	Height (cm)*	Nramos *	Nvagens *	Ngvagens	Ngplanta*
TMG 2383 IPRO	1200b	54,76c	74d	88c	3	103b
ST 845 IPRO	1956th	82,13a	86b	102b	3	108b
SON 1687 IPRO	1233b	55,66c	62E	74E	3	82E
M 8349 IPRO	1306b	58,30c	73d	87c	3	98c
ST 824 IPRO	726c	48.16d	52f	61f	3	74f
NK 8770 IPRO	466d	39,46e	49f	57f	3	72f
M 8644	1460b	61,93c	70d	82d	3	89d
JURUENA	1346b	58,20c	78c	92c	3	105b

BMX CHALLENGE RR	1786th	73,83b	92a	109a	3	120th

(Source: Own author)

Regarding yield, the cultivars ST 845 IPRO and BMX DESAFIO RR presented higher yields, obtaining 1956 kg.h-1 and 1786 kg.h-1, respectively. On the other hand, the cultivar NK 8770 IPRO presented the lowest productive performance, with 466 kg $^{ha-1}$. These results are lower than those observed by RAMOS et al (2019), who obtained 3756 kg ha-1 cultivar BMX DESAFIO RR in Rondonópolis-MT, where the average temperature is 26.8 °C and the average annual rainfall is 1127 mm. In addition, these values are lower than the average productivity of Tocantins (3,135 kg.h-1) in the 2017/18 harvests. However, it is worth noting that the cultivation was carried out in an area that was previously a degraded pasture area.

As for height, the cultivar ST 845 IPRO presented the largest size, with 82.13 cm and the smallest was NK 8770 IPRO, with 39.46. These values are similar to those obtained by DONÁ et al., (2019), who evaluated 20 soybean cultivars in Palmital-SP and the height ranged from 79 to 44 cm.

There was a great variation in the number of branches (Nramos) and number of pods per plant (Ngplanta). The cultivar BMX DESAFIO RR has the highest number of branches (92) and the highest number of pods per plant (109), while the smallest were NK 8770 IPRO (49) and ST 824 IPRO (52) for the number of branches and NK 8770 IPRO (61) and ST 824 IPRO (57) for number of pods per plant. According to Martins et al. (1999) the intraspecific competition of soybean plants by environmental factors, especially light, determines the greater or lesser number of branches, that is, in higher plant densities, due to the excessive number of plants in the line, there is less availability of photoassimilates for the vegetative growth of plants in the form of branches. Variations in the number of pods per plant as a function of plant density were also observed by Tourino et al. (2002).

There was no significant difference ($p<0.05$) for the number of grains per pod and the average number was 3 Ngvagens.

For the number of grains per plant, the cultivar that presented the highest average was BMX DESAFIO RR, with 120 and the lowest were presented by NK 8770 IPRO (72) and ST 824 IPRO (74). These values are higher than those obtained by Oliveira et al., (2017), who observed 60 to 47 pods per plant in soybean cultivation in Ipameri-GO. Dalchiavon and Carvalho (2012) verified that the number of pods per plant was the production component that had the highest correlation with soybean productivity. This correlation was also verified in our research.

5 CONCLUSION

According to the research carried out, the cultivar BMX DESAFIO RR presented the best agronomic performance in the municipality of Piraquê-TO. On the other hand, the cultivar NK 8770 IPRO presented the worst performance.

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