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Property characteristics and sanitary quality of seeds used by soybean farmers in the municipality of Marcelândia-MT, in the agricultural year 2021-2022 - case study

Características da propriedade e qualidade sanitaria de sementes usadas por sojicultores no município de Marcelândia-MT, no ano agrícola 2021-2022 - estudo de caso

Características de propiedad y calidad sanitaria de semillas utilizadas por productores de soja en el municipio de Marcelândia-MT, en el año agrícola 2021-2022 - estudio de caso

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Abstract
Soybean is one of the most important crops for the Brazilian economy, as it is one of the most consumed oilseeds in the world. It is currently one of the fastest growing crops in Brazil, with an increase in the area produced and productivity. However, for this to occur, it is necessary for producers to acquire seeds of high physiological quality, free of pathogens, and with high germination and vigor, ensuring adequate stands in the field. Diseases are one of the main aggravating factors in the decrease in the quality of soybean seed lots. Thus, this work aims to collect soybean seeds cultivar BRASMAX BÔNUS IPRO - 8579 RSF to determine the sanitary quality of different batches of seeds, in addition to collecting information on the actions of producers in Marcelândia-MT. To carry out the sanitary analysis, the blotter test method was used, using filter paper in transparent acrylic boxes (gerbox). Sample 3498 was the one with the highest number of diseases among the lots analyzed with the presence of *Penicillium* sp., *Cercospora kikuchii*, *Fusarium* spp., Bacteria and *Colletotrichum truncatum*. Sanity analyzes showed that all seed lots had some type of pathogen.
Keywords: Pathogen; Germination; Diseases.

Resumo
A soja é a das culturas mais importantes para a economia brasileira, por ser uma das oleaginosas mais consumidas em todo o mundo. Atualmente é uma das culturas de maior expansão no Brasil, com aumento na área produzida e produtividade. Contudo para que isso ocorra é necessário que os produtores adquiram sementes de alta qualidade fisiológica, livre de patógenos, e com alta germinação e vigor, garantindo estandes adequados na lavoura. As doenças são um dos principais agravantes na diminuição da qualidade de lotes de semente de soja. Desta forma este trabalho tem como objetivo realizar coleta de sementes de soja cultivar BRASMAX BÔNUS IPRO - 8579 RSF para determinação da qualidade sanitária de diferentes lotes de sementes, além de levantar informações sobre as ações dos produtores de Marcelândia-MT. Para a realização da análise sanitária, foi empregado o método blotter test, utilizando-se papel-de-filtro em caixas de acrílico transparente (gerbox). A amostra 3498 foi a que apresentou a maior quantidade de doenças entre os lotes analisados com a presença de *Penicilium* sp., *Cercospora kikuchii*, *Fusarium* spp., Bactéria e *Colletotrichum truncatum*. As análises de sanidade mostraram que todos os lotes de sementes apresentaram algum tipo de patógeno.
Palavras-chave: Patógeno; Germinação; Doenças.

Resumen
La soja es uno de los cultivos más importantes para la economía brasileña, ya que es una de las oleaginosas más consumidas en el mundo. Actualmente es uno de los cultivos de más rápido crecimiento en Brasil, con aumento del área producida y de la productividad. Sin embargo, para que esto ocurra, es necesario que los productores adquieran semillas de alta calidad fisiológica, libres de patógenos, con alta germinación y vigor, asegurando soportes adecuados en campo. Las enfermedades son uno de los principales factores agravantes de la disminución de la calidad de los lotes de semillas de soja. Por lo tanto, este trabajo tiene como objetivo recolectar semillas de soja cultivar BRASMAX BÔNUS IPRO - 8579 RSF para determinar la calidad sanitaria de diferentes lotes de semillas, además de recolectar información sobre las acciones de los productores en Marcelândia-MT. Para realizar el análisis sanitario se utilizó el método de prueba de papel secante, utilizando papel filtro en cajas de acrílico transparente (gerbox). La muestra 3498 fue la de mayor número de enfermedades entre los lotes analizados con presencia de *Penicillium* sp., *Cercospora kikuchii*, *Fusarium* spp., Bacteria y *Colletotrichum truncatum*. Los análisis de sanidad mostraron que todos los lotes de semillas tenían algún tipo de patógeno.
Palabras clave: Patógeno; Germinación; Enfermedade.

1. Introduction

Soybean (*Glycine max* L.) is considered a crop of great economic importance, being it is the most consumed oilseed in the world. The crop has a prominent role in the Brazilian grain production scenario, occupying approximately 4.3% of the entire national territory, and in the cerrado, it concentrates 42% of its production, an area larger than Italy and similar to Vietnam, Congo and Malaysia (Exame Agro, 2021).

The trend is for the area cultivated by the crop to continue to grow and expand with each crop, promoting the occupation of areas on agricultural frontiers, in addition to maintaining cultivation in traditional areas.

In this sense, the importance of using high quality soybean seeds is evident, as this has relevance in production costs and can guide the income of the rural property, if it does not meet the productive expectations in the field.

Thus, the use of seeds of good physical, physiological, genetic, and sanitary quality should be recommended, avoiding damage to the crop stand, the need for reseeding, damages arising from disease attacks and ensuring satisfactory yield (Dartora et al., 2012). These factors account for the performance of seeds in the field, culminating in the establishment of the plant population required by the cultivar, a fundamental aspect that contributes to achieving high levels of productivity (Krzyzanowski, 2004).

The health of soybean seeds is essential, as it can negatively affect the physiological quality of the seeds, contributing to the reduction of their vigor and germination in the field. Soybeans in the field are infected by fungi, bacteria, viruses, and nematodes. Among these, the diseases caused by fungi stand out, not only due to the greater number, but also due to the damage caused to the yield and quality of the seeds (Henning, 2005; Krzyzanowski et al., 2008; Sediyama, 2009).

In addition, the environmental conditions (temperature, excessive humidity, solar radiation) in which seeds are stored before sowing can significantly influence the decline in their quality.

Based on this, it is essential to evaluate and test the seed lots produced to determine the physiological and sanitary quality. In this way, this work aims to collect data and concrete information about the sanitary quality of the seeds used by the producers in region north Mato Grosso state in the agricultural year 2021/22, as a means of contributing to the provision of knowledge about what really farmer is acquiring. In addition, the work will serve as a basis for further work on this topic.

In this sense, this work aimed to evaluate the sanitary quality of the seeds, in addition to collecting information on the actions of the producers in region north Mato Grosso state, regarding the acquisition, storage and pre-sowing practices, considering the maintenance of their physiological quality.

2. Methodology

The research was carried out in the municipality of Marcelândia, which belongs to the state of Mato Grosso, is located

approximately 712 km from the capital Cuiabá, at latitude 11º05'22" south and longitude 54º27'02" west, with an altitude of approximately 290 meters. The climate of the region is Am, conform Köppen climatic classification (Alvares et al., 2014).

The study was carried out from the collection of information in several rural properties in Marcelândia that work with soy production.

A selection was carried out among the properties surveyed, aiming to select those that presented a high degree of technification in the production process (soil correction, mechanization, fertilization, cultural treatments) in areas with cultivation greater than 100 hectares, within the municipality of Marcelândia-MT. It was also decided to standardize the same cultivar, in order to avoid that this variable could interfere in management practices and in the results of this survey.

After this selection, six rural properties with these characteristics were drawn. It is noteworthy that, on the property where the same cultivar was verified, but from different lots, both lots were sampled and these were taken for laboratory analysis, at the Soil and Plants Laboratory. In this way, nine samples of representative seeds of these properties were collected, carrying out the collection of soybean seeds of the BRASMAX BÔNUS IPRO - 8579 RSF cultivar, to determine the sanitary quality of different seed lots.

The soybean cultivar is marketed by the franchisor BRASMAX, and developed for soybean growing regions in the Brazilian cerrado with the INTACTA RR2 PRO technology. This cultivar belongs to the maturity group 7.9, with a plant height between 85 and 95 cm, its average cycle varies between 105 and 118 days and its growth habit is of the indeterminate type. The BMX BÔNUS IPRO soybean variety is recommended for cultivation with a population of 250 to 300 thousand plants per hectare, with an average weight of a thousand seeds of 190g, high demand in fertility for productive responses of grains (Centro Sul, 2022).

In this way, all randomly selected properties were visited for the collection of seed samples. Data collection was also carried out on the property, such as: size, cultivated area, distance from the urban center and production data. These were tabulated and the graphs made. None of the properties were identified, nor the participants, and the data collected were recorded in an aggregated way, without the possibility of individual identification.

Then, with the aid of the cereal sampler, at least ten sub-samples of the lots were randomly collected and later standardized and standardized, removing a representative composite sample, obtaining 300 grams of seeds that were immediately packed in kraft paper bags for later sending to the seed analysis laboratory to carry out a sanitary analysis of the samples.

In addition, a germination test was carried out on all the batches collected, to determine the germination power of each of the samples and, later, to gather information on the results of the sanitary analyzes carried out by the laboratory. This test was used 100 seeds, 25 on each sheet of paper with 4 repetitions totaling these final seeds.

To carry out the sanitary analysis, the blotter test method was used, using filter paper in transparent acrylic boxes (gerbox) – considered as experimental units, following the description of the Rules for Seed Analysis (Brasil, 2009). For each sample, 10 gerbox boxes with 25 seeds each were assembled, and these were evenly distributed on four sheets of filter paper previously autoclaved and moistened with distilled and autoclaved water. For the asepsis of the gerbox boxes, a 1.0% solution of sodium hypochlorite was used (commercial product “Q-Boa” – 20%). The experimental units were kept under incubation inside BOD (biological oxygen demand) germination chambers for a period of seven days, with a temperature of 20 ± 1 ºC under white fluorescent light in a photoperiod of 12 hours. After this period, the analysis of each experimental unit was carried out, verifying the presence, and identifying the pathogens and their incidence in each gerbox box, and the percentage of each microorganism was determined. The information was grouped by pathogen and its respective percentage within each seed sample.

The information obtained was tabulated, and graphs and tables were created in the Excel program of the Microsoft Office package. Open-ended questions were grouped when like the answers and discussed later.

3. Results and Discussion

Sanitary quality of seeds

Seed health is one of the most important factors when evaluating the quality of a batch of seeds intended for agricultural cultivation. This sanitary quality has a direct influence on the pattern and quality of the crop after its implementation.

The importance of seed health lies in the fact that approximately 90% of crops used for food, both human and animal, are propagated by seeds (Henning, 2005) and the inoculum present in them may result in an increase in diseases in the field. and their introduction into pathogen-free areas.

The sanity analyzes showed that all seed lots presented some type of pathogen, and of the 9 analyzed lots, 8 of them presented percentage of *Cercospora kikuchii*, presenting 10% in lot 3492 (Table 1).

Sample 3498 (Table 1) showed the highest number of pathogens among the lots analyzed with *Penicillium* sp. (10%), *Cercospora kikuchii* (2.5%), *Fusarium* spp. (2.0%), bacteria (1.0%), *Colletotrichum truncatum* (1.0%).

The incidence of *Cercospora kikuchii* showed a higher percentage of incidence compared to the other fungi recorded in this work. Samples 3492, 3493 and 3500 had an incidence average of 10.0; 7.5 and 6.5% respectively.

Seed health tests are used to quantify the phytosanitary quality of seed lots, and as a means of preventing the spread and development of diseases in the production field (Goulart, 2018).

Table 1. Sanity test of soybean seeds of the BRASMAX BÔNUS IPRO - 8579 RSF variety, crop 2021/2022.

Sample	Batch	Pathogen	Percent (%)
3492	001	*Cercospora kikuchii*	10,0
		Phomopsis sojae	1,5
3493	002	*Cercospora kikuchii*	7,5
3494	003	*Cercospora kikuchii*	4,0
		Fusarium spp.	1,0
3495	18	*Cercospora kikuchii*	1,0
		Bactéria	2,5
3496	181265229	*Cercospora kikuchii*	3,0
		Fusarium spp.	2,5
		Bactéria	1,0
3497	2521469873	*Cercospora kikuchii*	0,5
		Fusarium spp.	2,5
		Bacteria	1,0
		Colletotrichum truncatum	1,0
3498	615B06060M	*Cercospora kikuchii*	2,5
		Fusarium spp.	2,0
		Bacteria	1,0
		Colletotrichum truncatum	1,0
		Penicilium sp.	12,0
3499	70126	*Aspergillus* spp.	1,0
		Fusarium spp.	1,0
3500	1752567521	*Colletotrichum truncatum*	0,5
		Cercospora kikuchii	6,5
		Fusarium spp.	0,5
		Bacteria	2,5

Source: Authors.

In the soybean crop 2013/14, Chagas (2014) found a higher incidence of fungi of the species *Penicillium* sp. and *Fusarium semitectum* corroborating with the present study, being the same genera found.

The germination tests that were carried out proved that, even with the presence of pathogens, they did not interfere or cause a drop in the germination power of these seeds (Table 2).

All lots that were evaluated showed high germination power, and the lots reached germination superior to 95%. This can happen because they are seeds that are stored for a short period of time. As they are new seeds, the amount of pathogens present in the seeds did not negatively influence germination.

Table 2. Soybean seed germination test of the BRASMAX BÔNUS IPRO - 8579 RSF variety, crop 2021/2022.

Sample	Batch	Germination (%)
3498	615B06060M	96,00
3495	18	97,50
3500	1752567521	96,50
3499	70126	99,00
3496	181265229	99,25
3497	2521469873	98,50
3492	001	99,25
3493	002	98,50
3494	003	99,00

Source: Authors.

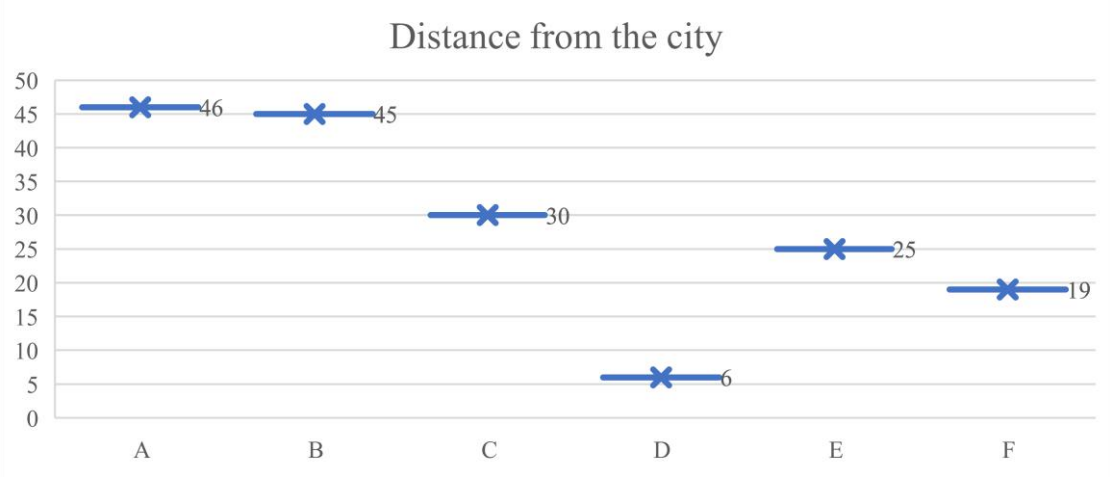
Analysis of the production process

Of the properties visited, it was found that their distance from the urban center of Marcelândia-MT varied between 6 km (closest) and 46 km (furthest). This distance shows that the surroundings of the urban center of the municipality have already been occupied with agricultural crops (Figure 1).

This proximity can lead to situations that favor access by actors directly related to the production process, such as input suppliers, grain purchase companies, machinery, and the employees themselves, who can more easily access the city and thus have access to possibility of interacting more intensively with the conurbation.

However, in the question related to the quality and health of soybean seeds, one must consider the need for their chemical treatment with fungicides, insecticides and nematicides, of high toxicological class. Thus, this practice involves the risk of contamination and pollution of the environment and the operator and must be carried out as a priority in order to avoid these risks. Reports of contamination of water courses, springs and people are common in the rural environment.

Figure 1. Distance (in kilometers) from the main property in relation to the urban center of Marcelândia – MT.



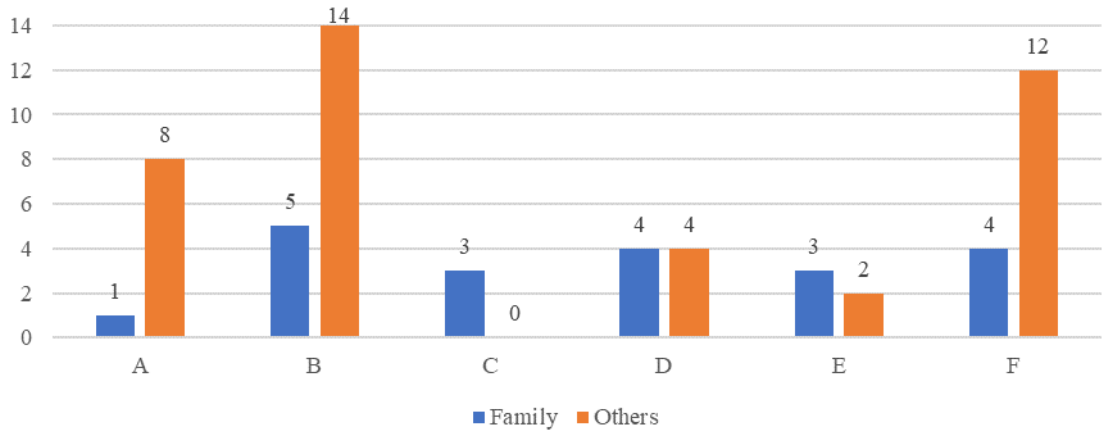
Source: Authors.

As for the number of people who work directly with the agricultural production of these properties, it was found that

the amount is quite variable and always increases depending on the greater territorial extension of the agricultural company (Figure 2). These data demonstrate the need for a larger body of employees in larger companies, even considering that modern rural companies are highly technician and mechanized. However, they still need collaborators, and it has been reported in several agricultural regions that this demand has been growing and with an accumulated deficit with each harvest, since these jobs require highly qualified labor in terms of knowledge and experience for the handling and operation of agricultural machinery.

Figure 3 also indicates the presence of hierarchically related people with blood ties to the owner, who are likely to be relatives at the first and second-degree levels. This information demonstrates that, even though there has historically been a rural exodus in recent decades and, together with this movement, a relative abandonment on the part of the consanguineous to the activity of the patron of the family, this did not occur among the rural properties selected for this study; or, if it occurred, there is still the presence of family members who develop activities directly related to the agricultural production of the property.

Figure 2. Number of people who work directly with the agricultural production activity on the rural property

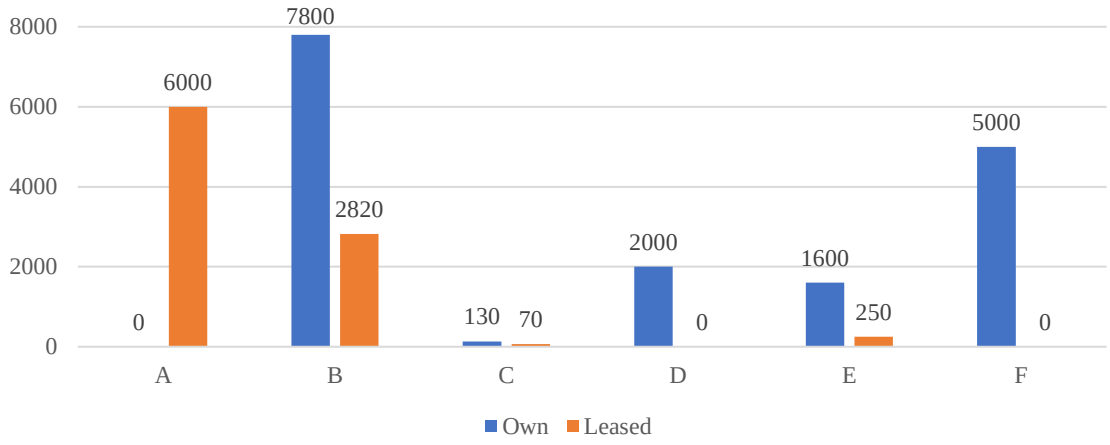


Source: Authors.

Of the properties involved in the research, it was found that most of them had most of the cultivated areas under the control of the family itself, and therefore were not leased or rented for agricultural purposes (Figure 3).

Some studies show that, in certain regions of Brazil, the leasing of land is very common, aiming to expand the area of cultivation beyond the limits of the property. However, in this case study in Marcelândia, it was found that this reality is still not happening.

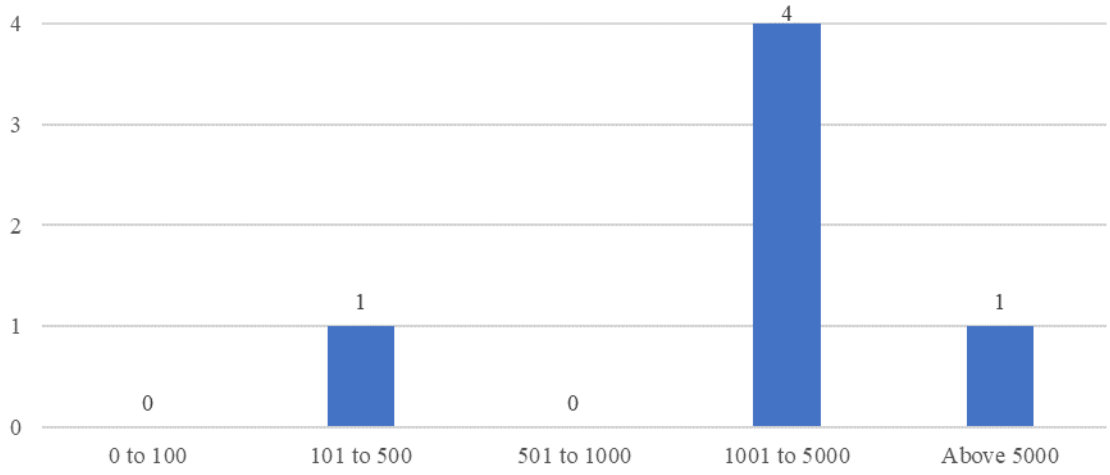
Figure 3. Total area of properties for this case study. Marcelândia – MT.



Source: Authors.

Regarding the size of the total area destined for cultivation, it was found that 66% of the properties surveyed grow soybeans and corn in areas with extensions between 1001 and 5000 hectares (Figure 4). This dimension is considered medium to large because the fiscal module in Marcelândia is 90 hectares (Vertice MT, 2022) and, according to the National Institute of Colonization and Agrarian Reform (Incra, 2022), it is considered medium-sized property when it varies between 4 and 15 fiscal modules and large when it exceeds 15 fiscal modules.

Figure 4. Area intended for agricultural cultivation.



Source: Authors.

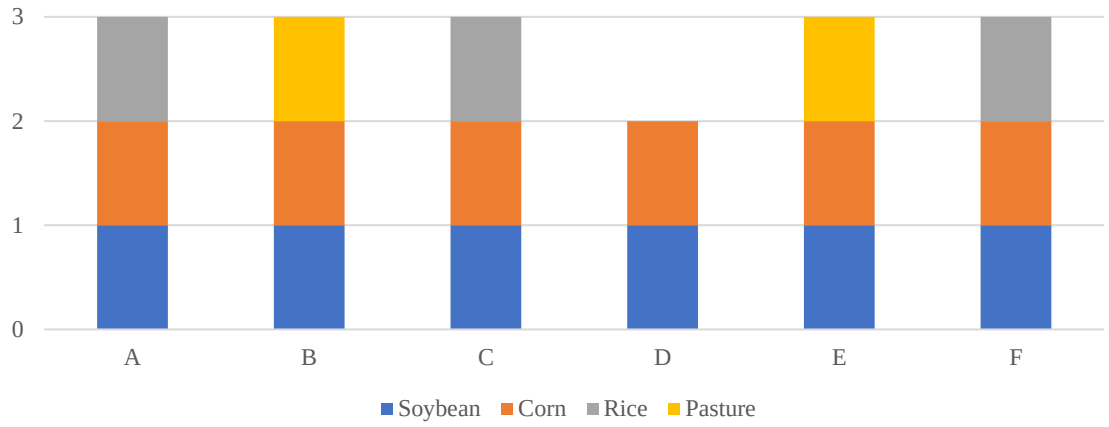
These data reinforce the trend of soybean cultivation, the most important Brazilian agricultural commodity, and its essence for the occupation of extensive areas of land. This practice is observed throughout the state of Mato Grosso, due to the added value and high cost of producing the oilseed, which makes its cultivation on small rural properties difficult.

Figure 5 complements this statement, indicating that essentially the areas, in addition to soybean cultivation, are in succession with corn cultivation, in the period known as “safrinha”, or “second crop”. In addition to these two crops, on the properties studied, the cultivation of upland rice (or upland rice) and the raising of cattle on pasture (livestock) are practiced.

Historically, the region of Marcelândia-MT, has the practice of extensive cattle raising proceeded from logging.

Agriculture is also an important economic element in the region, with cultivation in areas of approximately 50 thousand hectares, especially occupied by soy, corn and rice (PMM, 2022; Wikipedia, 2022).

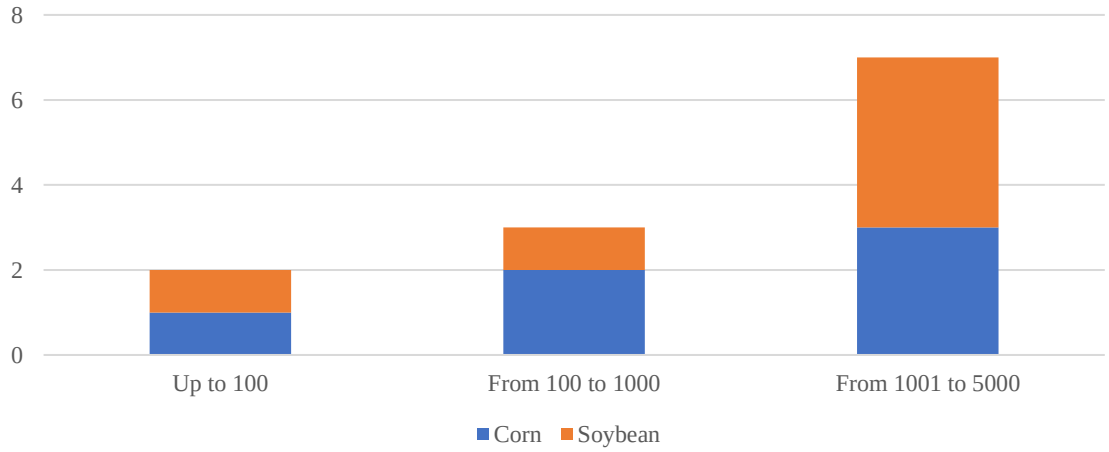
Figure 5. Main activities developed on rural properties.



Source: Authors.

Of the properties surveyed, 4 of these cultivate more than 1000 hectares of soybeans and 3 also do so for the cultivation of corn in the "safrinha" (Figure 6). The others cultivate in smaller extensions of land, both cultures.

Figure 6. Amount of the property intended for the cultivation of each crop.



Source: Authors.

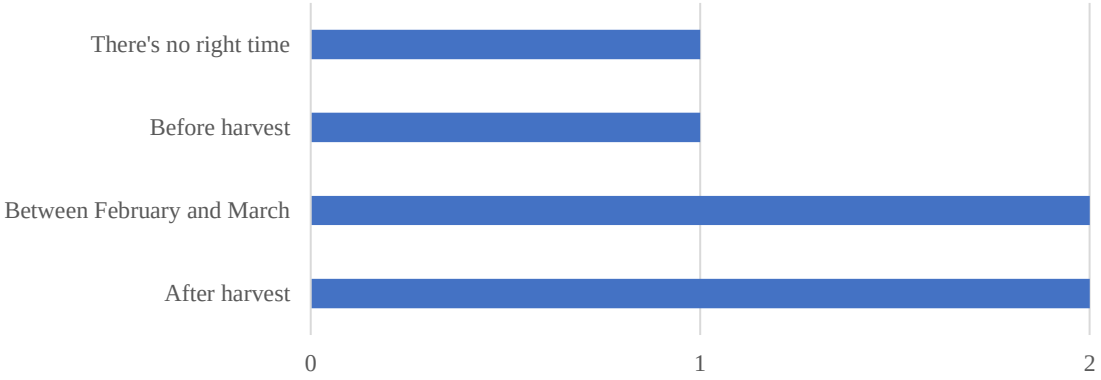
Within this context, it is possible to affirm that monoculture prevails in all properties, with only the succession between an oilseed crop and grass. This practice favors the infestation of pests, diseases and weeds, due to the reduction in biological diversity. Among these managements, the seed treatment is also highlighted, which, at the beginning of the development of the crop in the field, gives it initial protection and, depending on the product used, can allow the development of a healthy plant for up to 20 days.

The succession of soybeans with corn also allows breaking the cycle of diseases and pests, since they are different species and most diseases and pests find it difficult to infest them in succession, reducing their population. However, there are reports of pests that have already adapted to this succession, such as the green-bellied bug (*Dichelops melacanthus*) (Ávila et al.,

2020) and *Helicoverpa armigera* (Embrapa, 2022), among many others. Similarly, for some time now, growers have also encountered difficulties with rapidly growing weeds and, due to the substantial volume of viable seeds produced, have caused problems in both crops.

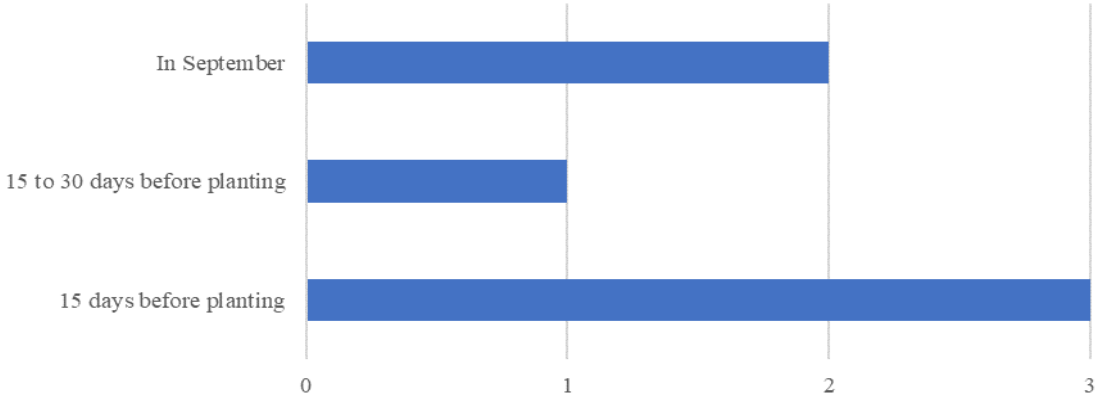
Regarding the harvest planning, it was found that the properties acquire soybean seeds in a period ranging from moments before the harvest of the previous harvest, until moments after this harvest (Figure 7). These data indicate the concern in anticipating the acquisition of this important input. However, this purchase is made with a later delivery date.

Figure 7. Seed acquisition time to start harvest planning.



Source: Authors.

Figure 8. Time when the producer receives the seeds, acquired in previous contracts.



Source: Authors.

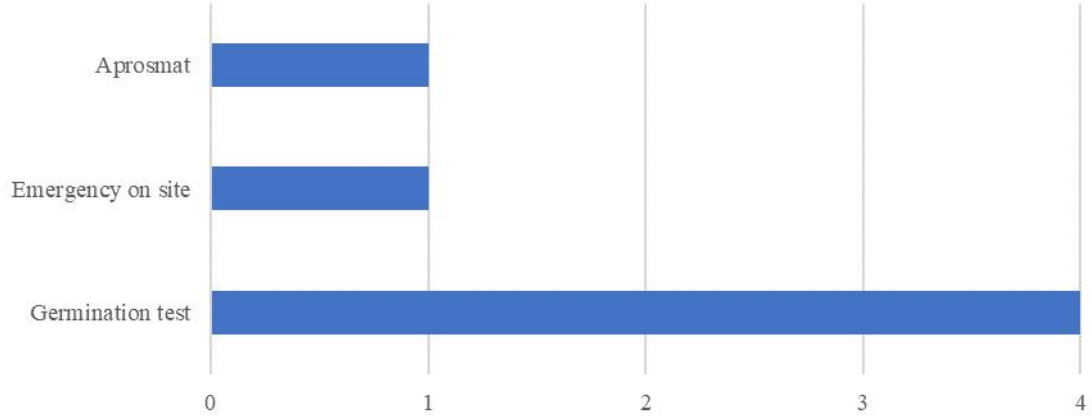
The delivery of seeds, after the execution of the purchase contract, according to the data presented in Figure 8, indicate that all properties receive the seeds of the next crop in moments that precede the beginning of sowing, which usually starts in early October, aiming to meet the cultivation window that runs from September 16 to December 31 (Indea, 2021). According to the normative instruction of this state inspection body, this "culture window" aims at the need for phytosanitary prevention and control of Asian rust; and considers the edaphoclimatic conditions of the State of Mato Grosso and the competitive power of the agricultural model of Mato Grosso.

After receiving the seeds, the rural properties store them in big-bags, which are containers made of high mechanical resistance braided polypropylene fabric, being manufactured in large dimensions to store, handle and transport dry, granulated and even liquid products. These containers are manufactured to support maximum loads of up to two tons, but, in general, for

the transport of seeds and fertilizers, they are limited to a capacity of 1,000 kilograms. Some companies that produce and supply these containers to seed companies, manufacture the big-bags and carry out treatment against UV rays, allowing them to be electrical insulators, in addition to enabling their recycling after use. Packages of this dimension are widely used in agricultural crops of grains and oilseeds due to the ease and optimization of time for transport, handling, loading and unloading, both for seeds and fertilizers (Bagbrasil, 2022).

Upon receipt, most producers carry out simple germination tests at the rural company itself (Figure 9). In general, this test is based on taking a small sample of seeds from the packages. These seeds are sown in small containers or even close to the company's headquarters. In general, it is sought to verify if the seeds present germination and emergence, seeking to bring safety to sowing in the field.

Figure 9. Performing seed analysis before starting sowing in the field.



Source: Authors.

However, in general, none of the properties was equipped with an adequate structure to carry out the standard germination test and vigor tests, which would attest to the physiological quality of these seeds. Correct analyses, following the standard defined by the research and standardization entities and endorsed by the Ministry of Agriculture, Livestock and Supply (MAPA), were only verified on one property. This, associated with the entity that represents the segment of seed companies in the state of Mato Grosso (Aprosmat, 2022), sends seed samples to this entity, which later performs the germination and vigor tests in the standard of the Rules for Seed Analysis (Brasil, 2009).

These tests carried out on the properties, although they do not constitute analyzes supported by standardized techniques, have their veracity, since, in general, they can guide the producer, especially with regard to the germination capacity of that batch.

This first verification of seed germinability and initial development of seedlings may not be verified, if the lot has any problems or has gone through adversities that compromised their viability. If this has occurred, the producer will refrain from sowing this material, avoiding further inconvenience and damage.

4. Conclusion

The batches of seeds collected in rural properties in the city of Marcelandia, region north Mato Grosso state, present incidence of pathogens presented in the work, especially *Cercospora kikuchii*.

The incidence of pathogens in the lots did not affect the germination power of the seeds.

Some practices such as germination test, seed conditioning in correct places, carried out in the properties allow the maintenance of the seed viability until the moment of sowing.

Acknowledgments

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