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Problems of chemical control in agriculture: a perspective of agriculture

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Abstract
Agriculture is important in the food production sector and, to meet all the food demand of the population, the agricultural sector has modernized, using chemical control in agriculture to control pests, diseases and weeds. The objective of this work was to carry out a literature review on the problems of chemical control in agriculture from an agricultural perspective, in order to demonstrate how chemical control affects the agricultural sector. The present study was developed based on the review of literature and relevant research based on data from the years between 2015 to 2021, using articles and data in Portuguese on academic google, using chemical control problems and the perspective of agriculture with agrochemicals as keywords. To ensure the production of crops, crop management must be carried out correctly, and the control of pests, diseases and weeds that affect crops, for this, one of the methods used today is chemical control. With the use of chemical control, it made it possible for agriculture to achieve large productions with the benefits provided by its use in the control of pests, diseases and weeds, but it brought with it some problems in its use, whether in the social, environmental and social spheres. Due to the problems caused by the large use of agrochemicals and the search for sustainable rural development, other alternative methods are adopted in agriculture, such as biological and cultural control, which has brought many benefits, one of which is the reduction of the use of chemical control. In agriculture, reducing costs and helping to maintain the sustainability of the entire agricultural production sector. In this way, the inadequate use of chemical control has brought and brings problems, such as contamination and intoxication in the environment and to human beings, in addition to problems related to resistance to pests, diseases and weeds, making their control more expensive, requiring the adoption of other methods. control methods, such as cultural control and biological control, which have in themselves more sustainable characteristics, thus reducing the use of agrochemicals in agriculture and reducing the problems caused by their use.
Keywords: agrochemicals; alternative control; productivity; sustainable.

Problemas do controle químico na agricultura: uma perspectiva da agricultura

Resumo
A agricultura é importante no setor de produção de alimentos e, para atender a toda a demanda de alimentos da população, o setor agrícola se modernizou, utilizando do controle químico na agricultura para o controle de pragas, doenças e plantas daninhas. O objetivo do trabalho foi realizar uma revisão de literatura sobre os problemas do controle químico na agricultura por uma perspectiva da agricultura, visando demonstrar como o controle químico afeta o setor agrícola. O presente estudo foi desenvolvido com base na revisão de literatura e pesquisas relevantes com base nos dados dos anos entre 2015 a 2021, utilizando-se de artigos e dados em português no google acadêmico, usando problemas do controle químico e perspectiva do da agricultura com agroquímicos como palavras-chave. Para garantir a produção das lavouras, o manejo da lavoura deve ser realizado de forma correta, e o controle de pragas, doenças e ervas daninhas que afetam as lavouras, para isso, um dos métodos utilizados hoje é o controle químico. Com o uso do controle químico, possibilitou que a agricultura alcançasse grandes produções com os benefícios proporcionados pelo seu uso no controle de pragas, doenças e infestantes, porém trouxe consigo alguns problemas no seu uso, seja no âmbito social, ambiental e no social. Devido aos problemas causados pelo grande uso de agroquímicos e a busca pelo desenvolvimento rural sustentável, outros métodos alternativos, são adotados na agricultura, como o controle biológico e cultural, que trouxe muitos

benefícios, um deles é a redução do uso de controle químico. Na agricultura, reduzindo custos e ajudando a manter a sustentabilidade de todo o setor de produção agrícola. Desse modo, o uso inadequado do controle químico trouxe e traz problemas, como contaminações e intoxicações no ambiente e ao ser humano, além de problemas relacionados a resistência de pragas, doenças e plantas daninhas tornando mais oneroso seu controle, sendo necessário a adoção de outros métodos de controle, como o controle cultural e o controle biológico, que possuem em si, características mais sustentáveis, reduzindo dessa forma, o uso dos agroquímicos na agricultura e reduzindo os problemas causados por sua utilização.
Palavras-chave: agroquímicos; controle alternativo; produtividade; sustentável.

1. Introduction

Agriculture is essential for human beings to survive, being an important sector for survival, but many problems were generated with the misuse of agriculture, and one of the problems that have been discussed by many researchers is the irrational use of chemicals in agriculture.

Agriculture is essential for human survival, being an important sector for survival, but many problems have been generated with the misuse of agriculture, and one of the problems that has been discussed by many researchers is the irrational use of chemicals in agriculture.

In the view of agriculture in relation to the use of chemical products, the use of pesticides arose from the need for food production, as the increase in population is a reality, so, as evolution progresses, their use in agriculture has increased, due to the need to capital and the population's demand for food (OLIVEIRA; SILVA, 2020).

The demand for food has become increasing due to development conditions, causing great concern in all sectors, especially food, changing the population scenario and forcing technological development to provide food for the growing population.

According to the Food and Agriculture Organization - FAO (2017) and the United Nations - UN (2017), if the growth rate of the world population remains constant, the global population will be 9.8 billion in 2050, 29% a year. more than the current population (7.6 billion inhabitants). To provide food for the population increase, it is estimated that food production by 70%. This population scenario will result in food insecurity in which one in nine people in the world (or about 805 million people) will not have enough food and a healthy and active life, demonstrating the effects caused by high population growth in relation to food production and distribution (FAO, 2015).

In the search to overcome this food insecurity and meet the food demand of the population, it is necessary to use technologies and techniques that favor the increase of agricultural production. For this, it is necessary to use various means to help increase crop production and often think much more about crop productivity (FAO, 2015; OLIVEIRA; JAIME, 2016; SAATH; FACHINELLO, 2018).

The technologies used for the development of agriculture include the application of various technologies such as no-till system, sustainable development, crop management and many other techniques, and one of the techniques that is still widely used is the chemical control of pests and pathogens in agriculture (DIAS, 2018; FREITAG *et al*., 2019).

In order to produce and maintain agricultural sustainability through the use of chemicals in the field of crop management, it is necessary to seek sustainable agricultural production and solutions to combat diseases, pests and weeds that cause damage and reduce crop production (SANTOS *et al*., 2018; BERNARDO *et al*., 2019).

Following the path of sustainability, production systems are governed by the guidelines of sustainable rural development, which is a production process that involves the social, economic and environmental sectors, with a focus on economic, social development and environmental sustainability (FREITAG *et al*., 2019; SOUZA *et al*., 2020).

According to Padilha *et al*. (2018) and Folmer *et al*. (2019), sustainable rural development is characterized by the ability of the agroecosystem to maintain its income over time, with stability of the productive capacity of the agroecosystem, preservation of the diversity of fauna and flora and the ability of the

agroecosystem to sustain itself. Thus, aiming at sustainable agricultural production, and providing good factors of production in agriculture, based on sustainable rural development, seeking to increase production, it is necessary to improve the use of chemical products in agriculture, which will favor greater profitability.

According to Barbosa *et al*. (2018), pesticides, pesticides and pesticides are some of the terms used for a group of chemicals used in agriculture to control pests, diseases and weeds, preventing them from causing damage to crops.

The control of pests, diseases and weeds becomes necessary due to their greater presence in crops. In addition, higher yielding crop varieties may be susceptible to soil stresses, exotic pests and pathogens, and agrochemical-resistant organisms (UENO; COSTA, 2016; DIAS, 2018; OLIVEIRA *et al*., 2018; BELLÉ; FONTANA, 2018).

Thus, the agricultural sector must be managed with a view to increasing crop yields with minimal damage caused by pests, diseases and weeds, better use of chemical products and following sustainable rural development, to enable food supply and ensure the survival of future generations, with less damage to the environment and agriculture.

Thus, as one of the most efficient methods for the control of pests, diseases and weeds is the use of chemical products, but their use has brought several problems to the environmental sector, including agriculture, it is necessary to use it correctly in the sector agricultural.

The use of agrochemicals in agriculture for the management of the crop cycle is the most used method for the control of pests, diseases and weeds, due to its various aspects of use and its benefits in agriculture (OLIVEIRA *et al*., 2018; BELLÉ; FONTANA, 2018). However, chemical control can and does bring with it toxic effects on other living organisms and the environment, due to its inappropriate use and its composition, in which each product causes a risk, and it is necessary to use consciously and use other control methods when necessary. possible (COSTA *et al*., 2018; KETZER *et al*., 2020).

To avoid the use of chemical control, the integration of control methods is essential, thus reducing or replacing the use of chemical control in agriculture, preventing the problems caused by the improper and excessive use of agrochemicals in the environment and to man (COSTA *et al*., 2018; DONATO *et al*., 2021).

In this way, other control methods gain space in agriculture, for having a more sustainable characteristic and for promoting the reduction of the use of agrochemicals. Some of the controls are cultural and biological control, helping to reduce the problems of chemicals in agriculture (MARVULLI *et al*., 2019; CARVALHO; SILVA, 2020).

The objective of this work was to carry out a literature review on the problems of chemical control in agriculture from an agricultural perspective, in order to demonstrate how chemical control affects the agricultural sector.

2. Material and methods

The present study was developed based on a review of literature and relevant research based on data from the years between 2015 to 2021, using mostly journal articles and mainly more recent publications, focusing on those published between 2017 and 2021. The other data were used to better compose the work, bringing indices and research, covering the years 2015 to 2021.

For the present work, for the search, we used academic google and google, searching for data sources in Portuguese and using chemical control problems and agriculture perspective with agrochemicals as keywords.

3. Results and discussion

To compose the work, different sources and articles were used, seeking to describe the problems of chemical control in agriculture, focusing on the agricultural perspective. As research results, the broad themes obtained were divided into chemical control in agriculture, benefits of chemical control, problems caused by the use of agrochemicals and solutions in the use of chemical control.

In each theme, he explains data on the perspective of agriculture, which together make up the work, explaining in an assertive way about the research data.

Chemical control in agriculture

Brazil is one of the largest agricultural producers in the world and the second largest exporter of agricultural products. For this, Brazilian agriculture has undergone several transformations in products, techniques, practices, management, technologies and use of

chemicals such as fertilizers and pesticides (LOPES *et al*., 2019; SARABIA *et al*., 2019).

In addition, Brazil is the largest consumer of pesticides next to China (1.8 million tons/year) in the world. The consumption of pesticides in Brazil is similar to the US, with a consumption rate of approximately 0.4 million tons/year (REMBISCHEVSKI; CALDAS, 2018).

Although this appears to be high, Brazil uses fewer chemicals in agriculture than other countries when compared in cultivated land area, as discussed below. The wide use of agrochemicals in Brazil is a result of the adoption of the Green Revolution Policy, increased incidence of pests in crops, introduction of transgenics, subsidized agricultural credits and tax exemptions for agrochemicals (PIGNATI *et al*., 2017; LEÃO *et al*., 2018).

When considering the amount of biocides used per unit of arable area, Brazil ranks 28th in the world, with 4.57 kg/ha in 2015, behind many countries such as Italy, Belgium and the Netherlands (7–9 kg/ha), South Korea, Japan and China (11–13 kg/ha), as well as Colombia (14.7 kg/ha) and Chile (25.07 kg/ha). It is worth noting that the arable area in Brazil corresponds to about 18% of the country's territory, of which only 7.6% are currently agricultural (REMBISCHEVSKI; CALDAS, 2018). Thus, Brazilian agriculture itself uses few agrochemicals when compared to other countries, as it is highly technified, using a smaller portion of arable land, so the amount of product applied is much smaller due to its territorial extension in the country.

Although the consumption of agrochemicals in Brazil is increasing due to the development of resistance of pathogens caused by the use of these chemicals, it is worth noting the increased use of chemicals in agriculture.

The results of the consumption of pesticides are obtained through the census, which converges in trend with the data on the volume of sales of agrochemicals. According to the Brazilian Institute for the Environment and Renewable Natural Resources - IBAMA (2016), the volume of pesticides sold in Brazil increased more than 2.5 times between 2006 and 2017, from 204.1 thousand tons to 541.8 thousand tons. This demonstrates a significant increase in the use of these chemicals in the agricultural sector.

According to the Brazilian Institute of Geography and Statistics - IBGE (2015), Brazil increased its planted area by 26% (from 62.6 million ha to 79 million ha) in this period, between 2005 and 2014. of chemical products during 2005-2014 is also due to this increase in planted area. The use of pesticides in crops doubled from 3.2 kg of pesticides/ha in 2005 to 6.7 kg/ha in 2014. This increase is greater when compared to the use of kg/ha in agriculture.

The increase in the use of pesticides in agriculture has affected several sectors, and their use is still necessary to protect crops from damage. With the use of pesticides it is possible to produce enough food to meet the demand of the population. This demonstrates the importance of using pesticides in agriculture for crop management.

According to Barbosa *et al*. (2018) and Sarabia *et al*. (2019), these chemicals are used in agriculture for the management of pests, diseases and weeds and are marketed to contribute to small agricultural production processes, acting as agents of biological, chemical and physical processes.

They are responsible for controlling pests, diseases and weeds, which are agents that cause damage to crops and, in severe cases, even loss of production, demonstrating the need to use chemical control (UENO; COSTA, 2016; DIAS, 2018; OLIVEIRA *et al*., 2018; BELLÉ; FONTANA, 2018).

Thus, for agriculture, the use of chemical control is a reality, and its use is very important to guarantee the survival of the human population, and to enable greater crop yields, due to the reduction of damage, and thus, increase production and the supply. the demand for food.

Benefits of chemical control

The benefits of using chemical control in agriculture are: less labor, which is increasingly expensive and with little quantity and quality of work required; greater efficiency even in rainy seasons compared to other methods; allows for minimal cultivation and planting of crops; allows for broadcast planting or changing the spacing when necessary (SAUSEN *et al*., 2020).

In addition, biocides can control pests, diseases and weeds at different stages of their development and the control achieved is faster compared to other control measures, being the best option for faster and more effective management (PONTES *et al*., 2017; BARBOSA *et al*., 2018; LOPES *et al*., 2019; LINS JUNIOR *et al*., 2020).

Chemical control can be adopted as a form of prevention if used properly in the field, enabling increased productivity by reducing damage caused by pests, diseases and weeds (OLIVEIRA; BRIGHENTI, 2018; OLIVEIRA; SILVA, 2020; BARBOSA *et al.,* 2018).

All these benefits are very important for agriculture, as they help in the management of the harvest, in the quality and quantity of production, in the production model, in the production system and in the entire production chain due to the control carried out. They are also important for the development of the culture and for the production due to the control that occurs in the culture, in addition, the possibility of increasing the productivity of the crops due to chemical control is seen as something good and necessary to meet the demand of the population.

Due to the high demand for food, and to face food insecurity, the use of chemical control is very important in agriculture, due to the many benefits presented. In addition, minimal use of agrochemicals along with other control methods for effective pest, disease and weed management reduces the cost and problems arising from the incorrect use of chemicals in agriculture.

Problems caused by the use of agrochemicals

Although important in agriculture, the use of agrochemicals, and especially their inappropriate use, has brought many problems in environmental and social aspects, causing many harmful effects to the development of society.

Pesticides are one of the most representative groups of contaminants in the environment due to their intensive use in agriculture, bringing negative consequences, among which the contamination of surface waters stands out, making it possible to trigger a series of problems to human health and impacts on ecosystems (BOTELHO *et al*., 2020; BECKER *et al*., 2020).

Therefore, it is important to highlight the problems generated by its inappropriate use, justifying and exploring how chemical control can affect agriculture and also demonstrating how it can affect the whole production system itself.

According to Oliveira *et al*. (2020), the use of chemical products in agriculture caused several problems, such as loss of soil fertility, exclusion from family farming, reduction of labor, water pollution, erosion process, among others. This has resulted in abandoned fields, unfarmable sites, eroded soils, few people in the fields, difficulties in finding people to work in the fields, scarce and inadequate labor for field work, pollution of rivers and environments. All these problems make it difficult to manage and maintain agriculture and field management, affecting the production chain.

According to Oliveira and Brighenti (2018) and Santos and Silva (2018), the use of agrochemicals resulted in the development of resistance in weeds, pests and pathogens, by eliminating natural enemies and generating a selection pressure, which is difficult to control and, making disease and pest management more expensive. By using chemicals inappropriately and affecting the production system, interrupting the cycle of natural enemies and biotypes, it generates selective pressure, selecting biotypes. This selection directly affects the environment, as it leads to the resistance of these biotypes, and by eliminating their natural enemies and causing the selection of this biotype, the control of pests, diseases and weeds becomes more expensive.

According to Dettmer *et al*. (2019), chemical management in agriculture made it unstable and generated economic, social and environmental problems at all levels of agricultural production. This has resulted in changes in input prices, production costs, increased product costs, pollution, soil degradation, environmental destruction, misuse of natural resources, among other problems.

In the environmental sector, chemical control caused contamination of soils and water sources due to the release and accumulation of pesticide residues and metals in soils and water bodies. This resulted in the destruction of the biodiversity of microorganisms and insects beneficial to crops that are susceptible to the molecules applied, and created an imbalance in the fauna and flora of the environment (VINCHIRA-VILLARRAGA; MORENO-SARMIENTO, 2019; LINS JUNIOR *et al*., 2020).

Other problems associated with the use of agrochemicals is the contamination of food and water by residues, which remain in the food chain, passing through animals for human consumption or directly through the ingestion of a contaminated product. Problems occur in humans through application and inhalation of products during handling, in addition to surface contamination in humans, causing a number of possible diseases (LEÃO *et al*., 2018; SOUSA *et al*., 2018; VINCHIRA-VILLARRAGA; MORENO-

SARMIENTO, 2019; OLIVEIRA; SILVA, 2020; LINS JUNIOR *et al*., 2020).

This contamination generated many cases of intoxication and disease development, sometimes causing death or loss of body function depending on the level of inappropriate contact with the products (LEÃO *et al*., 2018; SOUSA *et al*., 2018; OLIVEIRA; SILVA, 2020).

In this way, decision-making in its use is essential to prevent problems from occurring and lead to the disruption of society, leading to impacts on all existing sectors, whether in the modification of the biological, chemical and physical properties of the environment, directly relating to or indirectly, through the quality of environmental resources, social and economic activities, health, safety and the welfare of society (BOTELHO *et al*., 2020; BECKER *et al*., 2020).

Following what was discussed by the aforementioned authors, it is noted that the use of chemicals in agriculture can bring many problems, requiring replacement by other methods, but mainly with a new view of cultivation, as seen in the work of Botelho *et al*. (2020) on pesticides in agriculture explaining the agents of environmental damage and the search for sustainable agriculture, in the works of Oliveira and Brighenti (2018) and Santos e Silva (2018) discussing the resistance of weeds, pests and pathogens, in the works de Dettmer et al. (2019) affecting society as a whole, and in Vinchira-Villarraga and Moreno-Sarmiento (2019) and Lins Junior *et al*. (2020), demonstrating the environmental problems caused by the use of chemical control.

Thus, it is noted that the use of chemical control must be carried out in a controlled and appropriate way, so that it does not harm the environment, society and agriculture, which is necessary for food production. Thus, as its use is important, it should be used when necessary, and as it has many benefits, its use in agriculture is still essential for the control of pests, diseases and weeds.

Solutions in the use of chemical control

Many methods and practices can be used to minimize the use of chemicals in agriculture. One of them is the proper use of chemicals, being adopted in necessary cases, when other control methods are not as effective (COSTA *et al*., 2018; OLIVEIRA; BRIGHENTI, 2018).

One of the solutions is the integration of cultural, biological, mechanical and physical control methods that can reduce and sometimes replace the use of chemical control in agriculture, avoiding the problems caused to the environment and to man (COSTA *et al*., 2018; DONATO *et al*., 2021).

Of the alternative methods, the most used in agriculture is cultural and biological control, which has been one of those responsible for minimizing the use of chemicals in agriculture, helping the agricultural sector and enabling sustainable production.

Cultural control consists of good agricultural practices, manipulating the pre-planting and plant development conditions, favoring the growth and development of the crop, in relation to the pathogen, agricultural pest and the weed (MARVULLI; COSTA; GARCIA, 2019; PERUCH, 2019; PERUCH; COLARICCIO; BATISTA, 2018; OLIVEIRA; BRIGHENTI, 2018).

Agricultural pest, disease and weed control practices include the use of bait plants, fertilization, well-managed irrigation, plowing, destruction of infested plant parts, weeding, use of locally adapted varieties, crop rotation, harrowing, destruction of residual crops, pruning, planting density, proper planting time, use of mulch, spacing between rows, among others (MARVULLI; COSTA; GARCIA, 2019; OLIVEIRA; BRIGHENTI, 2018; CARVALHO; SILVA, 2020).

All these practices affect control in some way, such as good irrigation, avoiding excess (excessive moisture for the development of diseases) and lack (water stress leaving the plant susceptible to attack by pests and diseases), destruction of residual crops and pruning to prevent pathogen survival and provide a suitable environment for its development, planting density to suppress weed growth.

According to Fernandes (2019), biological control consists of regulating the number of plants and animals through natural enemies, which are basically agents of biotic mortality. All species of plants and animals have a biotic mortality agent due to their ecological nature, thus, throughout their biological development, the regulation of the biotic system itself, composed of microbial agents and plant extracts, occurs.

The use of biological control is seen as something sustainable, as it is used to control a certain biotype, without altering the fauna and

flora, in addition to favoring the recovery of areas by not degrading the environment.

Microbial agents and plant extracts are forms of biological control, which have several qualities such as: ease of application, lower cost, transformation or recovery of contaminated soils, does not leave residues in the environment and provides sustainable management of pests and diseases (NOGUEIRA *et al*., 2020; COPPO *et al*., 2017; FISCHER *et al*., 2018).

In biological control, for example, the use of Trichogramma pretiosum Riley to control tomato moth and the use of bioinsecticides based on the entomopathogenic bacterium Bacillus thuringiensis stands out, being an alternative to reduce the use of chemical control and provide greater sustainability (FERREIRA *et al*., 2017; ZANUNCIO JUNIOR *et al*., 2018; LINS JUNIOR, 2019).

For control agents of plant origin, use of plant extracts derived from plants, such as Azadirachta indica A. Juss (Neem), Chenopodium ambrosioides (Mastruz), which have toxicological effects for a certain range of insects (ALVES *et al*., 2017; SILVA *et al*., 2017; DANTAS *et al*., 2019).

The use of biological control with the use of fungi, bacteria, viruses and insects to control weeds falls within the perspective of biological control, and is usually known as bioherbicide, for fungi as biofungicide and for pests bioinsecticide, being disseminated and used by agriculture as discussed in the work by Costa *et al*. (2018) on the use of control methods and talking about the use of bioherbicide, in ketzer's work on biofungicide and in the work of Ferreira et al. (2017), Zanuncio Junior *et al*. (2018) and Lins Junior (2019) on the use of bioinsecticide or even on the possibility of its use.

The use of both extract and microbiological agents are interesting in biological control. Extracts prepared from plants show good results in the control of pests and some diseases. Microbiological agents are well regarded in the control of pests and diseases that are otherwise difficult to control.

The implementation of these solutions is still on the way to agriculture, and many works already bring solutions to chemical control, as in the work by Donato *et al*. (2021) on biological control as an alternative for ant control, in the work by Becker *et al*. (2020) in the use of technological innovations to reduce the amount of agrochemicals, in the work by Ketzer on the use of extracts as an alternative fungicide, and in the work by Costa *et al*. (2018) on weed control methods in organic systems, all of these demonstrating solutions in the use of chemical control, and demonstrating for an agricultural vision.

Thinking about the sustainable model, but aiming at high productivity of crops, with a focus on agriculture, adopting methods that help control pests, diseases and weeds, will help reduce the use of agrochemicals in crops, avoiding environmental, social and food problems, favoring sustainable development with greater productivity in agriculture.

3. Final considerations

Agriculture is very important for food production and due to the increase in food demand, methods that favor its production, whether chemical control or other methods, must be used with due care. For agriculture, chemical control is essential in the control of pests, diseases and weeds, bringing many benefits in its use, reducing the damage caused and guaranteeing the productivity of crops.

However, inadequate use has brought and brings problems, such as contamination and intoxication in the environment and to humans, as well as problems related to resistance to pests, diseases and weeds, making their control more expensive, requiring the adoption of other control methods, such as cultural control and biological control, which have more sustainable characteristics, thus reducing the use of agrochemicals in agriculture and reducing the problems caused by their use.

Thus, it is important to highlight the need for chemical control, but also the problems caused, being essential to replace or reduce chemicals to avoid the damage caused and provide a more sustainable agriculture.

References

ALVES, A.C.L.; MILK, F.S.; NASCIMENTO, I.N.; OLIVEIRA, G.M.; BATISTA, J.L. Insecticidal activity of vegetable oils on pasture termites under laboratory conditions. *In*: INTERNATIONAL CONGRESS OF AGRARIAN SCIENCES, 2., 2017, Natal. **Annals [....].** Recife: Instituto Internacional Despertando Vocações, 2017, p. 1-5. Available at: https://www.researchgate.net/profile/Antonio-Leite-Alves/publication/326546171_ATIVIDADE_INSETICIDA_DE_OLEOS_VEGETAIS_SOBRE_CUPINS_DE_PASTAGEM_EM_CONDICOES_DE_LABORATORIO/

links/5c61fa19299BEFICIIDA-INSETICIDA-INSETICIDA-INSOPASTAGEM14 CONDITIONS-OF-LABORATORY.pdf. Accessed on: 28 jul. 2021.

BARBOSA, H.T.G.; NASCIMENTO, X.P.R.; FREITAS-SILVA, O.; SOARES, A.G.; COSTA, J.B.N. Organophosphate Compounds and Their Role in Agriculture. **Virtual Journal of Chemistry**, Niterói, v.10, n.1, p.172-193, 2018. https://doi.org/10.21577/1984-6835.20180015

BECKER, R.S.; ALONÇO, A.S.; FRANCETTO, T.R.; RODRIGUES, H.E.; BACK, R.; MENDONÇA, M.T. Technological innovations in agricultural machines for weed control. **Tecno-lógica**, Santa Cruz do Sul, v.15, n.2, p.98-108, 2020. Available at: https://online.unisc.br/seer/index.php/tecnologica/article/view/15546/9627. Accessed on: 8 jun. 2022.

BELLÉ, R.B.; FONTANA, D.C. Soil pathogens: main vascular and root diseases and forms of control. Encyclopedia **Biosphere**, Goiânia, v.15, n.28, p.779-803, 2018. https://doi.org/10.18677/EnciBio_2018B65

BERNARDO, J.T.; AGUILERA, J.G.; SILVA, R.B.; MEDEIROS, R.E.; VIAN, R.; NIELLA, G.R.; ULHHOA, C.J. Trichoderma on-farm isolation: a tool in soil disease control for farmers in Brazil. **Scientific Electronic Journal of UERGS**, Porto Alegre, vol.5, no.3, p.263-270, 2019. https://doi.org/10.21674/2448-0479.53.263-270

BOTELHO, M.G.L.; PIMENTEL, B.S.; FURTADO, L.G.; LIMA, M.C.S.; CARNEIRO, C.R.O. BATISTA, V.A.; MARINHO, J.L.M.; MONTEITO, A.L.P.R.; SILVA, T.P.; PONTES, A.N.; COSTA, M.S.S. Pesticides in agriculture: agents of environmental damage and the search for sustainable agriculture. **Research, Society and Development**, Vargem Grande Paulista, v.9, n.8, e396985806, 2020. https://doi.org/10.33448/rsd-v9i8.5806

CARVALHO, W.P.; SILVA, E.S. Alternative pest and disease control by horticulturists in the urban area of Boa Vista-RR. **Revista Ambiente: Gestão e Desenvolvimento**, Boa Vista, v.13, n.1, p.36-46, 2020. Available at: https://periodicos.uerr.edu.br/index.php/ambiente/article/view/646/466. Accessed on: 11 feb. 2021. https://doi.org/10.24979/646

COPPO, J.C.; MIORANZA, T.M.; COLTRO-RONCATO, S.; STARGALIN, J.R.; KUHN, O.J.; SCWAN- ESTRADA, K.R.F. Health and germination of soybean seeds treated with plant and fungus extracts. **Journal of Agro-environmental Sciences**, Alta Floresta, v.15, n.2, p.92-99, 2017. https://doi.org/10.5327/Z1677-606220171472

COSTA, C.A.; GUINEA, R.; BELT, H.E.; COSTA, D.T.; COSTA, T.; RELATIVE, C.; PARENTS, C.; GOMES, M.; AGUIAR, A.A.R.M. Family farming and crop protection: traditional approaches and proximity to organic farming practices. **Journal of Agricultural Sciences**, Lisbon, v.41, p.164-173, 2018a. Available at: https://revistas.rcaap.pt/rca/article/view/17086/13922. Accessed on: 15 feb. 2021.

COSTA, N.M.; RODRIGUES-COSTA, A.C.P.; COELHO, É.M.P.; FERREIRA, S.D.; BARBOSA, J.A. Weed control methods in organic systems: a brief review. Revista Brasileira de Herbicidas, Londrina, v.17, n.1, p.25-44, 2018b. https://doi.org/10.7824/rbh.v17i1.522

DANTAS, P.C.; ARAÚJO, R.G.V.; ABREU, L.A.; ARAÚJO JÚNIOR, J.V.; BATISTA, A.S.; SABINO, A.R.; CUNHA, J.L.X.L.; DUARTE, A.G. Toxicity of plant extracts on citrus coccidophilus (brèthes, 1905) (coleoptera: coccinellidae). **Brasilian Journal of Development**, Curitiba, v.5, n.3, p.2060-2067, 2019. Available at: https://www.brazilianjournals.com/index.php/BRJD/article/download/1217/1082. Accessed on: 4 apr. 2021.

DETTMER, C.A.; ABREU, U.G.P.; GUILHERME, D.O.; DETTMER, T.L.; MOL, D.; SANTOS, M.H.R. Agriculture and innovation: a study on the feasibility of using "rock dust" in agricultural production systems. *In*: INTERNATIONAL MEETING OF MANAGEMENT, DEVELOPMENT AND INNOVATION, 3., 2019, Naviraí. **Annals [....]**. Navirai: UFMS, 2019, p. 1-10. Available at: https://www.alice.cnptia.embrapa.br/alice/bitstream/doc/1119197/1/Agriculturainovacao2019.pdf. Accessed on: 11 feb. 2021.

DIAS, J. Alternative pest and disease control. **Review Magazine**, Santo Antônio de Jesus, v.3, p.1-2, 2018. Available at: https://www3.ufrb.edu.br/seer/index.php/revise/article/view/1676/944. Accessed on: 18 feb. 2021.

DONATO, A.; NUNES, F.A.; MENEZES, B.F.; VARGAS, A.B. Control of leaf-cutting ants with penicillium spp. from decomposing oranges: application at different frequencies evaluated by farmers. **Revista Extensão em Foco**, Palotina, n. 24, p.230-250, 2021. Available at: https://revistas.ufpr.br/extensao/article/view/77179/pdf. Accessed on: 18 jun. 2022.

FAO. **The state of food security in the world 2014**. Rome: Food and Agriculture Organization of the United Nations, 2015. Available at http://www.fao.org/publications/sofi/en/. Accessed on: 17 feb. 2021.

FAO. **Brazil representative presents food demand scenario**. 2017. Available at: http://www.fao.org/brasil/noticias/detail-events/en/c/901168/. Accessed on: 16 feb. 2021.

FERNANDES, A.C.S.A. Agroecological thinking as a break in the paradigms of conventional agriculture. **Terra Mundus Magazine**, Ciudad Autónoma de Buenos Aires, v.6, n.1, p.1-12, 2019. Available at: http://dspace.uces.edu.ar:8180/xmlui/bitstream/handle/123456789/5378/O%20pensamento_Simees_Alencar_Fernandes.pdf?sequence=1. Accessed on: 12 feb. 2021.

FERREIRA, T.C.; NASCIMENTO, D.M.; SILVA, E. The of alternative methods for pest control in seeds. **Journal of Agricultural Sciences**, Lisbon, v.60, n.1, p.112-119, 2017. https://doi.org/10.4322/rca.2217

FISCHER, I.H.; MORAES, M.F.; PALHARINI, M.C.A.; FILETI, M.S.; CRUZ, J.C.S.; FIRMINO, A.C. Effect of conventional and alternative products on postharvest disease control in avocados. **Brazilian Journal of Fruit Culture**, Jaboticabal, v.40, n.1, p.1-10, 2018. Available at: https://www.scielo.br/pdf/rbf/v40n1/0100-2945-rbf-40-1-e-408.pdf. Accessed on: 5 feb. 2021.

FOLMER, I.; MEURER, A.C.; MACHADO, G.E.; FONTOURA, M.S.; FERREIRA, A.M. Rural education and sustainable rural development: Arroio Grande Santa Maria District Field School/RS. **Diversitas Journal**, Santana do Ipanema, v.4, n.1, p.190-202, 2019. https://doi.org/10.17648/diversitas-journal-v4i1.730

FREITAG, C.; KLESENER, H.M.; PLEIN, C. Contributions of solidary cooperativism to family farming and sustainable rural development. **Orbis Latina Magazine**, Foz do Iguaçu, v.9, n.1, p.95-109, 2019. Available at: https://revistas.unila.edu.br/orbis/article/view/1526/1417. Accessed on: 12 feb. 2021.

IBAMA. **Pesticide marketing reports**. Ibama, 2016. Available at: https://www.ibama.gov.br/agrotoxicos/relatorios-de-comercializacao-de-agrotoxicos#historicodecomercializacao. Accessed on: 14 feb. 2021.

IBGE. Sustainable development indicators: studies and research. Rio de Janeiro: IBGE, 2015. (Geographical information, n. 9). Available at: https://biblioteca.ibge.gov.br/visualizacao/livros/liv94254.pdf. Accessed on: 16 feb. 2021.

KETZER, F.; BEMVENUTI, A.; VEIVERBERG, S.; DÓRR, M.G.; SCHMIDT, M.A. Use of Tabernaemontana catharinensis extract as an alternative fungicide for natural agriculture. **Brazilian Journal of Development**, Curitiba, v.6, n.7, p.45050-45059, 2020. https://doi.org/10.34117/bjdv6n7-213

LEÃO, R.S.; MARQUES, R.C.; BURALLI, R.J.; SILVA, D.S.; GUIMARÃES, J.R.D. Public health assessment by exposure to agrochemicals: an experience with family farming in northwestern Rio de Janeiro. **Sustainability Magazine in Debate, Brasília**, v.9, n.1, p.81-94, 2018. Available at: https://www.researchgate.net/profile/RejaneMarques/publication/324902630_Avaliacao_de_saude_publica_por_exposicao_a_agroquimicos_uma_experiencia_com_a_agricultura_familiar_no_noroeste_do_publica-ab64-agro2-agricultura_agricultura-family_no_noroeste_do_publica-ab64-agro2-852's experience-with-family-agriculture-in-northwest-of-Rio-de-Janeiro.pdf. Accessed on: 17 feb. 2021.

LINS JUNIOR, J.C.; SANTOS, J.P.; WANSER, A.F.; VALMORBIDA, J. Cost of insect pest control in open field and greenhouse tomato production systems in Caçador, Santa Catarina. **Ignis Magazine**, Hunter, v.9, n.1, p.113-122, 2020. Available at: https://45.238.172.12/index.php/ignis/article/view/2349/1177. Accessed on: 9 feb. 2021.

LOPES, F.G.; MOREIRA, J.N.; SILVA, M.G.; BRUNET, P.D.M.; NASCIMENTO, D.M. Diagnosis of pesticide use in PISG and PIVAS, PB. Journal of Agroecology in the Semiarid, Sousa, vol.3, no.1, p.21-31, 2019. https://doi.org/10.35512/ras.v3i1.2747

MARVULLI, M.V.N.; COSTA, G.S.; GARCIA, E. A. Alternative control methods for phytosanitary defense in organic rural properties. *In*: NATIONAL SYMPOSIUM OF AGRIBUSINESS TECHNOLOGY, 11., 2019, Ourinhos. **Annals [....].** Ourinhos: Faculty of Technology of Ourinhos, 2019, p.305-311. Available at: https://www.fatecourinhos.edu.br/anais_sintagro/index.php/anais_sintagro/article/view/27/37. Accessed on: 11 feb. 2021.

NOGUEIRA, M.M.; ABUD, L.L.S.; STIVAL, M.M. Survey of pests and diseases in vegetables grown in the UNIVAR school garden. Interdisciplinary **Electronic Magazine**, Barra do Garças, v.12, p.57-63, 2020. Available at: http://revista.sear.com.br/rei/article/view/109/147. Accessed on: 11 feb. 2021.

OLIVEIRA, E.L.; PAULINO, G.S.; PAULO, R.K.L.; CARVALHO, A.N.; MAGALHÃES, A.S.; CUNHA, C.S. Monitoring and identification of pest insects in the passion fruit crop (Passiflora spp.) for the implementation of integrated pest management. *In*: LATIN AMERICAN AGROECOLOGY CONGRESS, BRAZILIAN AGROECOLOGY CONGRESS, AGROECOLOGY SEMINAR OF THE FEDERAL DISTRICT E ENTORNO, 6, 10, 5., 2017, Brasília. **Annals [....].** Brasília: Cadernos de Agroecology, 2018, p. 8-12. Available at: http://cadernos.aba-agroecologia.org.br/index.php/cadernos/article/view/1264/1466. Accessed on: 18 feb. 2021.

OLIVEIRA, F.H.; SILVA, V.R. Use of pesticides or agroecological control of agricultural pests and diseases? A reflection from the municipality of Alvorada do Gurguéia-PI. **Brazilian Journal of Agroecology and Sustainability Magazine**, Garanhuns, v.1, n.2, p.1-20, 2020. Available at: http://www.ead.codai.ufrpe.br/index.php/BJAS/article/view/2925/482483283. Accessed on: 8 feb. 2021.

OLIVEIRA, L. dos S.; PEREIRA, A.I.S.; LOPES SOBRINHO, O.P.; CRAVEIRO, S.A.; XAVIER, R. dos S.; PEREIRA, A. da G.S. Agroecological practices in vegetable gardens adopted by family farmers in the agricultural field in Codó, Maranhão. Magazine Research, Society and Development, Vargem Grande Paulista, vol.9, no.6, p.1-18, 2020. Available at: <https://dialnet.unirioja.es/descarga/articulo/7435455.pdf>. Accessed on: 16 Feb. 2021. https://doi.org/10.33448/rsd-v9i6.3340

OLIVEIRA, M.F.; BRIGHENTI, A.M. **Weed control**: Physical, mechanical, cultural, biological and allelopathic methods. 1. ed. Brasília: Embrapa, 2018. 176p. Available at: https://ainfo.cnptia.embrapa.br/digital/bitstream/item/193269/1/Controle-plantas-daninhas.pdf. Accessed on: 12 feb. 2021.

OLIVEIRA, N.R.F.; JAIME, P.C. The meeting between sustainable rural development and health promotion in the Food Guide for the Brazilian Population. **Health and Society Magazine**, São Paulo, v.25, n.4, p.1108-1121, 2016. Available at: https://www.scielosp.org/article/sausoc/2016.v25n4/1108-1121/. Accessed on: 20 feb. 2021.

PADILHA, N.; CORBARI, F.; ZANCO, A.M.; CANQUERINO, Y.K.; ALVES, A.F. PNAE's contribution to sustainable rural development in the municipality of Pitanga – PR. Brasilian. Journal of Development, Curitiba, v.4, n.7, p.4351-4365, 2018. Available at: https://www.brazilianjournals.com/index.php/BRJD/article/view/414/458. Accessed on: 19 feb. 2021.

PERUCH, L.A.M.; COLARICCIO, A.; BATISTA, D.C. Control of passion fruit diseases: current situation and perspectives. **Agricultural and Livestock in Santa Catarina**, Florianópolis, v.31, n.1, p.37-40, 2018. Available at: https://publicacoes.epagri.sc.gov.br/RAC/article/view/243/208. Accessed on: 19 feb. 2021.

PIGNATI, W.A.; LIMA, F.A.N.S.; LARA, S.S.; CORREA, M.L.M.; BARBOSA, J.R.; LEÃO, L.H.C.; PIGMATTI, M.G. Spatial distribution of pesticide use in Brazil: a tool for Health Surveillance. **Revista Ciência e Saúde Coletiva**, Rio de Janeiro, v.22, n.10, p.3281-3293, 2017. https://doi.org/10.1590/1413-812320172210.17742017

PONTES, N.C.; NASCIMENTO, A.R.; GOLYNSKI, A.; MOITA, A.W.; MAFFIA, L.A.; OLIVEIRA, J.R.;

QUEZADO-DUVAL, A.M. Application volume and chemical control efficiency of bacterial spot in industrial tomato. **Revista Horticultura Brasileira**, Brasília, v.35, n.3, p.371-376, 2017. https://doi.org/10.1590/s0102-053620170309

REMBISCHEVSK, P.; CALDAS, E.D. Agrochemicals for pest control in Brazil: critical analysis of the use of the term agrotóxico as a tool for risk communication. **Revista Vigilância Sanitária em Debate**, Rio de Janeiro, v.6, n.4, p.2-12, 2018. https://doi.org/10.22239/2317-269x.01195

SAATH, K.C.O.; FACHINELLO, A.L. Growth in world food demand and land factor restrictions in Brazil. **Journal of Rural Economics and Sociology**, Brasília, v.56, n.2, p.195-212, 2018. https://doi.org/10.1590/1234-56781806-94790560201

SANTOS, R.N.; SILVA, G. V. Insect pest monitoring for control decision making in soybean crop. **Terra e Cultura Magazine: Teaching and Research Notebooks**, Londrina, v.34, n.esp., p.294-309, 2018. Available at: http://periodicos.unifil.br/index.php/Revistateste/article/view/526/477. Accessed on: 19 feb. 2021.

SANTOS, W.R.; SILVA, N.D.; BARBOSA, A.A.; RAMOS, P.R.; CORDÃO SOBRINHO, J.P.; SILVA, E.S. Agricultural production and management problems in the Independent Settlement Project I in the city of Confresa-MT. *In*: LATIN AMERICAN AGROECOLOGY CONGRESS, BRAZILIAN AGROECOLOGY CONGRESS, AGROECOLOGY SEMINAR OF THE FEDERAL DISTRICT E ENTORNO, 6, 10, 5., 2017, Brasília. **Annals [....].** Brasília: Cadernos de Agroecology, 2018, p. 6-11. Available at: http://cadernos.abaagroecologia.org.br/index.php/cadernos/article/view/622/786. Accessed on: 14 feb. 2021.

SARABIA, D.T.; SANTOS, M.S.M.; MUELLER, L.P.; BATISTOTE, M.; SCORZA JÚNIOR, R.P. The panorama of the use of pesticides in Brazil. Environmental Education in Action Magazine, Novo Hamburgo, v.18, n.68, 2019. Available at: https://www.revistaea.org/artigo.php?idartigo=3704. Accessed on: 13 feb. 2021.

SAUSEN, D.; MARQUES, L.P.; BEZERRA, L.O.; SILVA, E.S.; CANDIDO, D. Biotechnology applied to weed management. **Brasilian Journal of Development**, Curitiba, v.6, n.5, p.23150-23169, 2020. https://doi.org/10.34117/bjdv6n5-027

SILVA, E.C.; VIEIRA, D.D.; LEONEL, L.V. Comparison of the insecticidal activity of Chenopodiumambrosoides and Azadirachta indica in the control of Sitophilus zeamais. **Revista Cultura Agronômica**, Ilha Solteira, v.26, n.4, p.554-559, 2017. https://doi.org/10.32929/2446-8355.2017v26n4p554-559

SOUSA, G.D.; MARQUES, D.J.S.; SERRA, R.B.G.; SOUSA, A.C.; FIGUEIREDO, G.J.A. An environmental perception of turbid water community farmers about the use of pesticides in the Gramame River watershed region, João Pessoa (PB). **Brazilian Journal of Environmental Education**, São Paulo, v.13, n.2, p.32-339, 2018. https://doi.org/10.34024/revbea.2018.v13.2474

SOUZA, L.L.; MENDES, F.A.T.; BORGES, N.S.; COSTA, J.M..; FERREIRA, E.Y.C.S.; ALEIXO, L.L.S.; SILVA, E.V.S. The debate around sustainability: sustainable rural development – Literature review. **Brasilian Journal of Development**, Curitiba, v.6, n.12, p.96305-96322, 2020. Available at: https://www.brazilianjournals.com/index.php/BRJD/article/view/21300/17008. Accessed on: 16 feb. 2021.

UENO, B.; COSTA, H. Diseases caused by fungi and bacteria. *In*: ANTUNES, L.E.C.; REISSER JUNIOR, C.; SCHWENGBER, J.E. (Org.). Strawberry cultivation. Brasília: Embrapa, 2016. p. 413-480. Available at: https://biblioteca.incaper.es.gov.br/digital/bitstream/123456789/3014/1/BRT-morangueiro-hcosta.pdf. Accessed on: 18 feb. 2021.

VINCHIRA-VILLARRAGA, D.M.; MORENO-SARMIENTO, N. Biological control: Camino a la modern agriculture. **Colombian Journal of Biotechnology**, Bogotá, v.21, n.1, p.2-5, 2019. https://doi.org/10.15446/rev.colomb.biote.v21n1.80860

ZANUNCIO JUNIOR, J.S.; LAZZARINI, A.L.; OLIVEIRA, A.A.; RODRIGUES, L.A.; SOUZA, I.I.M.; ANDRIKOPOULOS, F.B.; FORNAZIER, M.J.; COSTA, A.F. Agroecological pest management: alternatives for sustainable agriculture. **Intelletto**

Scientific Magazine, Venda Nova do Imigrante, v.3, n.3, p.18-34, 2018. Available at: https://biblioteca.incaper.es.gov.br/digital/bitstream/123456789/3582/1/Manejo-agroecologico-de-pragas-v3-n3-2018.pdf. Accessed on: 28 jul. 2021.