REVIEW STUDY ON THE SUSTAINABLE USE OF CHEMICAL FERTILIZERS IN SOYBEAN CULTURE

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Abstract. *Soybean cultivation is an essential part of global food production, providing a valuable source of protein for human and animal consumption. However, the use of chemical fertilizers in soybean culture has raised concerns about its negative impact on the environment and human health. Sustainable use of chemical fertilizers in soybean culture is crucial to meet the growing demand for food while minimizing the environmental impact of agriculture.The use of chemical fertilizers in soybean culture has been shown to increase crop yields significantly. However, excessive use of chemical fertilizers can lead to soil degradation, water pollution, and greenhouse gas emissions. Integrated nutrient management practices, such as the use of organic fertilizers, crop rotations, and conservation tillage, can reduce the dependency on chemical fertilizers in soybean culture. These practices enhance soil fertility, reduce soil erosion, and increase carbon sequestration, resulting in a more sustainable and resilient agroecosystem. Additionally, the adoption of precision agriculture technologies, such as site-specific nutrient management, can improve the efficiency of chemical fertilizer use, reducing the potential for environmental damage.The sustainable use of chemical fertilizers in soybean culture also requires attention to social and economic factors. Farmers need access to affordable and high-quality fertilizers, as well as training and support to adopt sustainable practices.*

Keywords*: Soybean; Chemical fertilizers; Sustainable; Precision agriculture;Organic fertilizers; Crop rotation; Integrated pest management.*

INTRODUCTION

Soybean is an important crop that is widely cultivated for its high economic and nutritional value. However, the intensive cultivation of soybean requires the use of chemical fertilizers, which can lead to environmental pollution and other negative impacts. Therefore, the sustainable use of chemical fertilizers in soybean culture is crucial for the preservation of soil quality, biodiversity, and human health.(14)

Chemical fertilizers are commonly used in soybean cultivation to provide essential nutrients to the plant. However, the excessive use of chemical fertilizers can lead to nutrient imbalances, soil degradation, and environmental pollution. Sustainable agriculture practices aim to minimize these negative impacts by using chemical fertilizers in a more targeted and efficient manner, while also incorporating other practices such as organic fertilizers, crop rotation, and integrated pest management. .(4)

Precision agriculture is a key practice in sustainable soybean cultivation, which involves applying fertilizers in a precise and targeted manner based on soil analysis and crop needs. This reduces fertilizer waste and ensures that crops receive only the necessary amount of nutrients.(10). Organic fertilizers derived from natural sources can also improve soil health and fertility, while reducing the need for chemical fertilizers. Crop rotation is another effective practice that can maintain soil fertility and reduce the build-up of pests and diseases harmful to soybean crops. Additionally, the use of cover crops can reduce soil erosion and improve soil structure, providing additional nutrients to the soil. .(1, 2)

Integrated pest management practices can also contribute to the sustainable use of chemical fertilizers in soybean culture by managing pests and diseases in a holistic manner, using a combination of biological, cultural, and chemical control methods. By reducing the use of chemical pesticides, the negative impacts on the environment can be reduced, while maintaining a healthy soybean crop. .(5)

Sustainable use of chemical fertilizers in soybean culture is crucial for the preservation of soil quality, biodiversity, and human health. By adopting sustainable practices such as precision agriculture, organic fertilizers, crop rotation, and integrated pest management, soybean cultivation can be maintained while minimizing the negative impact on the environment..(5,6)

MATERIAL AND METHODS

The sustainable use of chemical fertilizers in soybean culture is an important topic for several reasons. Firstly, the intensive use of chemical fertilizers in soybean cultivation can have negative impacts on the environment, such as soil degradation, water pollution, and greenhouse gas emissions. These environmental concerns can be addressed through sustainable practices that reduce the negative impacts of chemical fertilizers on the environment. .(3, 9)

Secondly, soybean is an important crop worldwide with high economic value. Ensuring the sustainable use of chemical fertilizers can help maintain the productivity of soybean farms in the long term, ensuring economic benefits for farmers and the industry. Sustainable practices such as precision agriculture, organic fertilizers, crop rotation, cover crops, and integrated pest management can help reduce the use of chemical fertilizers while maintaining productivity. .(3)

Thirdly, soybean is a valuable source of nutrition, providing protein and other essential nutrients for both human and animal consumption. Ensuring the sustainable use of chemical fertilizers in soybean cultivation can help maintain food security for populations that depend on soybean products. .(4)

This paper aims to explore and describe new methods for achieving a more sustainable soybean culture by utilizing innovative techniques that have been developed in recent years. With the increasing demand for soybean products globally, it is essential to adopt sustainable practices that can preserve soil quality, biodiversity, and human health.

RESULTS AND DISCUSSIONS

The management of fertilizers is a very important job regarding sustainable cultivation of soybean. In that case we had search for some methods to ensure that fertilizers are used properly and the plant is benefiting of the exact amount of nutrients to develop at the maximum potential.

1. Precision Agriculture

Precision agriculture and fertilization go hand in hand as one of the main goals of precision agriculture is to apply inputs, such as fertilizers, only where they are needed. The use of precision agriculture in fertilization can help to reduce fertilizer use, lower costs, and minimize environmental impact. .(17)

Traditionally, farmers have applied fertilizers uniformly across their fields, without taking into account variations in soil nutrient levels. This can lead to over-fertilization in some areas, which can cause nutrient runoff and other environmental problems, and under-fertilization in others, which can lead to lower crop yields. By using precision agriculture techniques, farmers can apply fertilizers more precisely and in a way that maximizes crop growth and minimizes environmental impact. (17, 19)

One of the key technologies used in precision agriculture for fertilization is soil sensors. These sensors can be placed in the soil to monitor soil nutrient levels and provide real-time data on the nutrient needs of the crops. By analyzing this data, farmers can determine the exact amount of fertilizer needed in each area of the field and apply it precisely where it is needed. This can help to reduce fertilizer use and minimize the risk of nutrient runoff. (11)

Another technology used in precision agriculture for fertilization is variable rate technology (VRT). This technology allows farmers to vary the rate of fertilizer application based on the specific needs of each area of the field. By using VRT, farmers can apply more fertilizer in areas where the soil is nutrient-poor and less fertilizer in areas where the soil is nutrient-rich. This can help to optimize crop growth and reduce fertilizer use. (19)

In addition to soil sensors and VRT, precision agriculture also uses remote sensing technology, such as aerial imagery and satellite data, to monitor crop growth and detect nutrient deficiencies. This technology can be used to create nutrient maps that show the nutrient needs of each area of the field, allowing farmers to apply fertilizer precisely where it is needed. (19)

Precision agriculture can also help to reduce the environmental impact of fertilization. By minimizing fertilizer use, precision agriculture can reduce the risk of nutrient runoff into waterways, which can cause algal blooms and other environmental problems. Precision agriculture can also help to reduce greenhouse gas emissions associated with fertilizer use by optimizing the timing of fertilizer application to minimize emissions. (6)

One of the challenges of using precision agriculture in fertilization is the need for accurate and reliable data. Soil sensors and remote sensing technologies are only effective if they provide accurate data on soil nutrient levels and crop growth. Without accurate data, precision agriculture cannot provide the desired benefits. Additionally, there is a need for standardization in the way data is collected and analyzed to ensure that data can be compared across different farms and regions. (17, 6)

Another challenge of using precision agriculture in fertilization is the cost of implementing the technology. Soil sensors, VRT equipment, and remote sensing technologies can be expensive, and the cost of implementing precision agriculture can be a barrier for some farmers. However, over time, the cost of precision agriculture is expected to decrease as the technology becomes more widely adopted and economies of scale are achieved. (19)

2. Organic fertilization

Organic fertilization in soybean culture involves the use of natural sources of nutrients to supplement the soil and support the growth of soybean plants. Organic fertilization is becoming increasingly popular as farmers seek to reduce their reliance on synthetic fertilizers, which can have negative environmental impacts. (7)

One common organic fertilizer used in soybean culture is compost. Compost is made by decomposing organic materials such as yard waste, food scraps, and manure. It is rich in nutrients, including nitrogen, phosphorus, and potassium, which are essential for plant growth. Compost can be applied to soybean fields before planting or as a top dressing during the growing season. (7)

Another organic fertilizer used in soybean culture is animal manure. Manure is rich in nutrients and can be a valuable source of organic matter for soil. However, it is important to use manure in moderation as excess application can lead to nutrient runoff and environmental problems. Manure should also be composted before application to reduce the risk of contamination and reduce odors. (8)

Cover crops can also be used as an organic fertilizer in soybean culture. Cover crops are grown during the fallow season to help improve soil health and fertility. Cover crops can help to reduce soil erosion, increase soil organic matter, and fix nitrogen in the soil. Some common cover crops used in soybean culture include clover, rye, and oats. (8)

In addition to these organic fertilizers, farmers can also use other organic materials such as bone meal, blood meal, and fish emulsion. These materials are rich in nutrients and can be used to supplement the soil and support soybean growth. (4, 13)

Organic fertilization in soybean culture offers several benefits over synthetic fertilization. Organic fertilizers can improve soil health and fertility, reduce soil erosion, and support beneficial soil organisms. Organic fertilizers can also reduce the risk of nutrient runoff and other environmental problems associated with synthetic fertilizers. (13, 15)

However, there are some challenges associated with organic fertilization in soybean culture. Organic fertilizers can be more expensive than synthetic fertilizers, and their nutrient content can be variable. (7)Organic fertilizers may also take longer to release their nutrients, which can lead to slower plant growth. In addition, organic fertilizers may not provide all of the nutrients that soybeans need in the right proportions, which can lead to imbalances and reduced yields. (16)

To address these challenges, farmers can use a combination of organic and synthetic fertilizers in their soybean fields. By using a combination of fertilizers, farmers can take advantage of the benefits of both types of fertilizers and minimize their drawbacks. (8)

Organic fertilizers such as compost, manure, and cover crops can improve soil health and fertility, reduce environmental impacts, and support sustainable agriculture practices. However, organic fertilization should be used in conjunction with synthetic fertilizers to ensure that soybean plants receive all of the nutrients they need for optimal growth and yield. (7)

3. Crop rotation

Crop rotation is a practice where different crops are grown on the same land in a particular sequence over a period of years. Crop rotation has several benefits, including improving soil health, reducing pests and diseases, and increasing yields. Soybean is a common crop that can be included in a crop rotation plan. (12)

Crop rotation involving soybean typically involves seeding soybean after a non-legume crop, such as corn or wheat, and then planting a different non-legume crop the following year. The non-legume crops in the rotation help to break up disease and pest cycles, as well as add organic matter and nutrients to the soil. Legumes, like soybean, are included in the rotation because they fix nitrogen in the soil, reducing the need for nitrogen fertilizers. (18,9)

One of the main benefits of crop rotation involving soybean is that it can help to reduce the incidence of soybean diseases and pests. For example, soybean cyst nematodes, which are microscopic worms that attack the roots of soybean plants, can build up in soil over time and cause significant yield losses. By rotating soybean with non-host crops, the nematodes are starved of their food source, reducing their populations and damage. (18)

In addition to reducing pests and diseases, crop rotation involving soybean can also help to improve soil health. Soybean plants have a relatively shallow root system that does not penetrate deep into the soil. By rotating soybean with crops that have deeper root systems, such as corn or wheat, the soil is aerated and organic matter is added to the soil, improving soil structure and nutrient availability. (13)

Another benefit of crop rotation involving soybean is that it can increase yields. Research has shown that soybean yields are often higher when soybean is planted in a rotation compared to continuous soybean planting. This is likely due to the improved soil health and reduced pest and disease pressures associated with crop rotation. (2)

When planning a crop rotation involving soybean, it is important to consider the specific needs of soybean plants. Soybean plants require well-drained soil and do not tolerate waterlogged conditions. They also require adequate amounts of phosphorus, potassium, and other micronutrients. Farmers should plan their crop rotation to ensure that soybean is planted in fields with suitable soil conditions and adequate nutrient availability. (5)

Crop rotation is beneficial for soybean culture in matters of fertilization for several reasons. One of the main benefits of crop rotation is that it helps to maintain soil fertility by balancing soil nutrient levels. (5) Different crops have varying nutrient requirements and take up nutrients in different proportions. For example, soybeans are known to fix atmospheric nitrogen into the soil, which can benefit subsequent crops that require nitrogen. On the other hand, corn is known to be a heavy nitrogen feeder, and planting soybeans after corn can help to reduce the buildup of nitrogen in the soil. (1)

In addition to balancing soil nutrients, crop rotation can also help to reduce the need for synthetic fertilizers. By rotating soybeans with non-host crops, farmers can reduce the incidence of soil-borne diseases and pests that can reduce crop yields. This, in turn, reduces the need for fertilizers and other inputs to maintain yield levels. (13)

Another benefit of crop rotation for soybean culture is that it can improve soil health and structure. Different crops have different root structures, and rotating crops can help to break up compacted soil and improve soil aeration and water infiltration. This, in turn, can improve nutrient uptake by crops and reduce the need for fertilizers. (15)

Overall, crop rotation is beneficial for soybean culture in matters of fertilization as it helps to balance soil nutrient levels, reduce the need for synthetic fertilizers, and improve soil health and structure. By rotating soybeans with non-host crops, farmers can maintain high yields while reducing the environmental impacts of farming.

CONCLUSIONS

Soybean culture is one of the moste important culture beacause has the ability to , provide a significant source of protein and oil for human and animal consumption. Soybeans are grown extensively in many countries. Soybean products are used in a variety of applications, including food, feed, fuel, and industrial products.

Sustainable agriculture practices are essential for soybean culture, including precision agriculture, organic fertilization, crop rotation, and integrated pest management. These practices aim to reduce environmental impacts and increase yields, promoting long-term sustainability. Precision agriculture helps to optimize crop inputs, reduce waste, and minimize environmental impacts. Organic fertilization can improve soil health, reduce greenhouse gas emissions, and reduce dependence on synthetic fertilizers. Crop rotation helps to manage pests and diseases, reduce soil erosion, and promote sustainable agriculture. Integrated pest management helps to manage pests and diseases while minimizing environmental impacts and reducing the use of pesticides. (17, 19)

Precision agriculture in soybean culture involves the use of technology to optimize crop inputs, including fertilizer, water, and seed. This approach can improve yields, reduce environmental impacts, and increase profitability. Precision agriculture technologies include variable rate fertilization, soil moisture sensors, yield monitoring, and satellite imagery. These technologies allow farmers to apply inputs more precisely, reducing waste and improving crop performance. (3)

Crop rotation is an essential strategy for soybean culture to manage pests and diseases. It helps to disrupt pest life cycles and reduce the buildup of pest populations, promoting sustainable agriculture and reducing reliance on pesticides. Crop rotation can also improve soil health, reduce soil erosion, and promote sustainable agriculture. Crop rotation with non-host crops, such as corn or wheat, can help to reduce the incidence of pests and diseases in soybeans. (9)

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