Advanced Journal of Environmental Sciences
Volume.15, Number 7; July-2024;
ISSN: 2837-3928 | Impact Factor: 8.16
https://zapjournals.com/Journals/index.php/ajes
Published By: Zendo Academic Publishing

ORGANIC AND MINERAL FERTILIZATION STRATEGIES FOR IMPROVED SOYBEAN PRODUCTION

[1]Carlos Eduardo Silva, [2]Mariana Gabriela Oliveira and [3]Felipe Henrique Costa

Article Info
Keywords: Soybean Farming, Brazil, Goiás, Grain Harvest, Agricultural Production
DOI
10.5281/zenodo.12930621

Abstract
Soybean (Glycine max L.) farming is of paramount global and socioeconomic significance, especially in Brazil, where it is cultivated across all states. As the primary agricultural commodity in the country, its economic impact is substantial, driven by its diverse range of products derived from its grains (MAPA, 2016). The 5th monitoring report of the Brazilian grain harvest for the 2022/2023 period, published by CONAB (2023), highlights Goiás' prominent role in national soybean production. In the 2021/2022 harvest, Goiás ranked third in the country with a production of 28,834.4 thousand tons, following Mato Grosso and Paraná. This data underscores the critical contribution of Goiás to Brazil's soybean industry and its significant position within the global agricultural market.

INTRODUCTION

Soybean (*Glycine max L.*) farming holds significant global derived from its grains (MAPA, 2016). It is the primary socioeconomic importance within the chain of products agricultural commodity in Brazil, cultivated across all states.

According to the 5th monitoring of the Brazilian grain harvest 2022/2023 published by CONAB (2023), Goiás ranked third in national production in the 2021/2022 harvest, with 28,834.4 thousand tons, trailing behind only Mato Grosso and Paraná.

Achieving high production/productivity is the outcome of assertive management, primarily associated with plant nutrition through soil fertilization. Mineral fertilizers are the most commonly used pathway for plant nutrition. However, their extensive use, coupled with the scarcity of non-renewable resources, has led to increased costs and higher prices.

Hence, investigating different fertilizer sources as alternatives for fertilization is imperative to ensure more efficient and sustainable agricultural production management (Santos et al., 2008; Chae et al., 2018).

[1] State University of Goiás, Goiás, Brazil.
[2] Federal University of Goiás, Goiás, Brazil.
[3] Goiano Federal Institute, Rio Verde Campus, Brazil.

In line with the need to explore different sources and promote sustainability, various sectors of agribusiness, including farms, generate abundant waste that can facilitate nutrient reuse (Cruz, 2019). Repurposing these organic residues, along with the addition of concentrated mineral fertilizers, yields organomineral fertilizers, also known as (FOM) (Brasil, 2009; Crusciol et al., 2020). Organomineral fertilizers represent a technological resource as they combine minerals and organic residues. Consequently, their utilization can offer an innovative alternative in grain production by optimizing natural resources and generating cost savings (Silva, 2006).

Moreover, another critical aspect in agricultural production, which remains insufficiently explored in the literature, is determining the most suitable method of fertilizer application. This depends on various factors, including the phosphorus source, soil conditions, and the crop itself. Phosphatic fertilization methods encompass broadcasting on the surface, with or without incorporation; application in the sowing furrow; band application; and pit application (Sousa et al., 2004).

Therefore, aiming to mitigate environmental degradation, reduce production costs, enhance nutrient absorption in the soil, and achieve high productivity, this study aimed to evaluate the production components of soybeans subjected to organo-mineral and mineral fertilization, with and without soil incorporation.

METHODOLOGY

The experiment was conducted in a field experimental area at Farm Camarão located in the municipality of Palmeiras de Goiás-GO, at latitude 16.19.8058634°S and longitude 49.9770175° W. The climate of the experimental site is tropical, characterized by a rainy season in summer and a dry season in winter, with an average annual temperature of 24.5°C and average annual precipitation of 1,289 mm. The experimental design employed was randomized complete blocks with five treatments (T1: Control – no fertilization; T2: Organo-mineral fertilization with soil incorporation; T3: Organo-mineral fertilization without soil incorporation; T4: Mineral fertilization without soil incorporation; T5: Mineral fertilization with soil incorporation) and 5 replications, totaling 25 experimental units, each consisting of 3.5 × 3.5 m. The sowing was mechanically done using the M7110 IPRO cultivar, characterized by its early maturing nature with a growth cycle of 102 to 112 days, an indeterminate growth habit, and resistance to lodging.

The sowing took place in the 2022/2023 agricultural season on October 20, 2022, with a spacing of 0.5 m between rows, resulting in 23 plants per linear meter. Seed treatment involved the application of fungicide and insecticide for protective action (pyraclostrobin), systemic treatment (thiophanate-methyl), and contact and ingestion treatment (fipronil).

Fertilization was carried out on the day of planting based on the soil analysis and classification results of the experimental area. For treatments involving mineral fertilization, 200 g of monoammonium phosphate (MAP), containing 10 to 12% ammoniacal nitrogen (N) and 50 to 54% P2O5 (phosphorus), were used in each experimental unit.

For treatments utilizing organo-mineral fertilization, 600 g of Fertsolum, composed of 4 parts nitrogen, 14 parts phosphorus, and 8 parts potassium, were applied to each experimental unit. After fertilization distribution and incorporation were carried out manually, potassium chloride (KCl) was uniformly applied at a rate of 200 kg ha^{-1} thirty days after emergence. For phytosanitary management, a post-emergence herbicide application was conducted thirty days after planting, followed by three preventive applications of the fungicide + insecticide combination. Harvesting took place manually on January 30, 2023, seven days after desiccation, marking the completion of a 102 days cycle with a moisture content of 16%.

Plants were collected at ground level and transported to the seed analysis laboratory of the State University of Goiás - Western Campus, Palmeiras de Goiás. Various analyses were conducted, including counting the number of pods per plant, number of grains per pod, and number of grains per plant. Productivity analysis was performed using the formula: Plants/hectare (thousand/ha) multiplied by pods/plant multiplied by grains/pod multiplied by weight of thousand grains (of soybeans at 13% moisture) divided by 60000.

The obtained data were analyzed using the SISVAR statistical program, where tests for normality and homogeneity of variances were conducted using the Shapiro-Wilk test. Contrasting treatments were identified by performing ANOVA, followed by Tukey's post hoc test to pinpoint differences between treatments.

RESULTS AND DISCUSSION

The coefficients of variation (CV%) ranged from 6.24 to 15.15%, consistent with the findings of Carvalho et al. (2003), who suggest a maximum CV% of up to 16% for variables associated with production components (Table 1).

For the variable number of pods per plant, the mean obtained was 45.62 pods. The standout treatment was Organo-mineral Fertilization with soil incorporation, with the highest mean of 61.52 pods, followed by Mineral Fertilization with soil incorporation, which had a mean of 54.44 pods. Although there was a significant difference between the two, it is evident that soil incorporation, regardless of the fertilizer source used, influences plant response compared to no incorporation. Supporting this, Mineral Fertilization without soil incorporation exhibited the lowest response in terms of the number of pods (31.08). While it might be expected for the control treatment to show the lowest response as it received no fertilization, the experiment was conducted in an area that had been cultivated with soybeans for over ten years. Therefore, considering the maintained fertility of the area, the obtained result is justifiable. Resende (2016) corroborate this by suggesting that residual effects from successive fertilizer applications in maintenance fertilizations within a no-tillage system (NTS) contribute to enhancing nutrient stocks in the cultivation environment.

The number of grains per plant is directly related to the number of pods per plant, as pods are necessary for grain formation. Given this relationship, it is reasonable to expect similar treatment responses. Thus, the treatment with the highest mean for the number of grains per plant was Organomineral Fertilization with soil incorporation (163.60), followed by Mineral Fertilization with soil incorporation (137.96). Conversely, the control treatment (94.80) and Mineral Fertilization without soil incorporation (79.84) showed lower means for this variable.

Among the production components, productivity holds significant importance, particularly for producers, as it guides major management decisions. Productivity was expressed in 60 kg ha-1 bags (Figure 1).

Productivity exhibits a similar pattern to the other production components. The standout treatment was Organomineral Fertilization with soil incorporation, yielding 275.94 bags of 60 kg ha-1, representing an increase of 88.79 bags compared to the same fertilization source without soil incorporation. Guesser et al. (2021) assert that organomineral fertilizer formulated with lignite organic matrix can effectively replace traditional mineral fertilization in soybean cultivation while also increasing organic carbon values in lowland soils. Leaving fertilizer on the soil surface makes it more prone to evaporation and leaching, resulting in reduced absorption by plants. Given the environmental conditions and characteristics of the cultivar used in this study, the optimal approach is to incorporate the fertilizer into the soil, regardless of its mineral or organomineral origin. Mineral fertilization without soil incorporation yielded the lowest productivity response (134.66), a result possibly influenced by heavy rains and high radiation. By not being incorporated into the soil, the fertilizer is more susceptible to evaporation and leaching, leading to decreased concentrations in the soil, which hinders nutrient absorption by plants and subsequently affects productivity.

Table 1. Number of pods per plant (NPP), number of grains per pod (NGPod), number of grains per plant (NGPlant), referring to four different fertilizations and one control in soybean cultivation.

Treatment	NPP	NGPod	NGPlant
Control	37.00d	2.72a	94.80d
MFw	31.08e	2.68a	79.84e
OFw	44.08c	3.00a	110.96c
Mfi	54.44b	2.84a	137.96b
Ofi	61.52a	2.84a	163.60a
Average	45.62	2.82	117.43
CV%	7.88	15.15	6.24

Control: Fertilization without MFw: Mineral Fertilization without incorporation, OFw: Organo-mineral Fertilization without incorporation, MFi: Mineral Fertilization with incorporation, and OFi: Organo-mineral Fertilization with incorporation. Source: MATA, 2023. Significance (p>0.05) was observed for all analyzed variables except for the number of grains per pod.

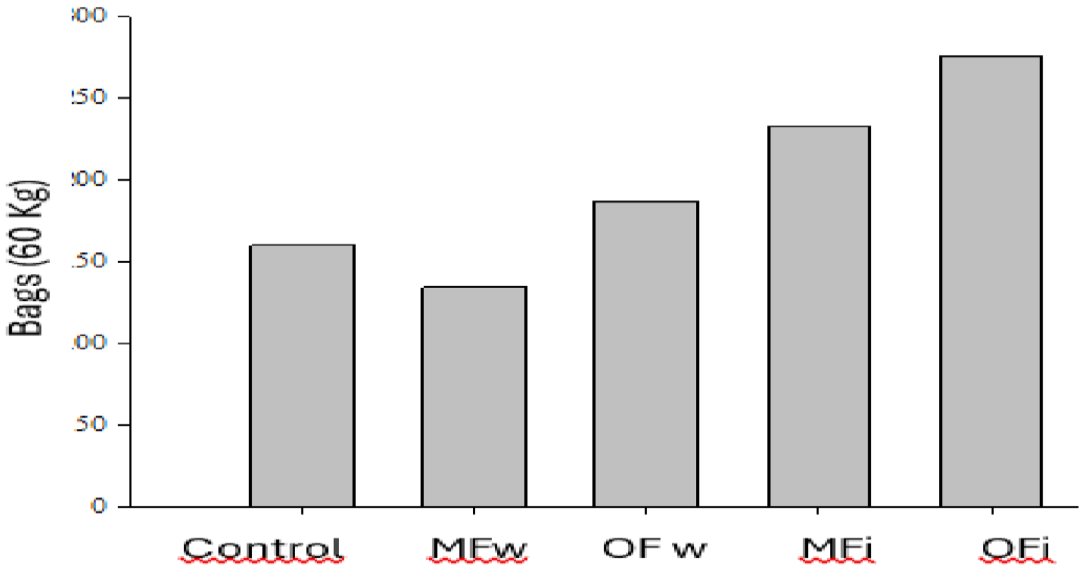

Figure 1. Soybean productivity subjected to four fertilization treatments and one control in 60 kg ha^{-1} bags. Control: Fertilization without MFw: Mineral Fertilization without incorporation, OFw: Organomineral Fertilization without incorporation, MFi: Mineral Fertilization with incorporation, and OFi: Organomineral Fertilization with incorporation.

Conclusion

Organo-mineral fertilization with soil incorporation outperformed all other treatments in this study, except for the number of grains per pod, where no significant difference was observed. This indicates that organomineral fertilizer has the potential to replace mineral fertilizer and enhance soybean productivity.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests

REFERENCES

Brasil (2009). Law No. 6,894, of 1980 - art. 3; Decree No. 4,954, of 2004 - art. 1; IN SDA No. 23, of 2005 - art. 1. Diário Oficial, Brasília/DF, No. 142, Jul 28.

Carvalho CGP, Arias CAA, Toledo JFF, Almeida LA, Souza Kiihl RA, MF Oliveira, Hiromoto DM, Takeda C (2003). Proposal for classification of coefficients of variation regarding soybean yield and plant height. Pesquisa Agropecuária Brasileira, Brasília (38):187-193.

Chae H, Noh H, Song WS (2018). Efficiency and effectiveness of vitamin C-substrate organo-mineral straight fertilizer in lettuce (*Lactuca sativa* L.). Chemical and Biological Technologies in

Agriculture (5):1.

CONAB-COMPANHIA NACIONAL DE ABASTECIMENTO (2023). Monitoring of the Brazilian Grain Harvest, Brasília, DF, v. 10, **crop** 2022/23, n. 5, fifth survey, February.

Crusciol CAC, Campos MD, Martello JM, Alves CJ, Nascimento CAC, Pereira JCDR, Cantarella H (2020). Organomineral Fertilizer as Source of P and K for Sugarcane. Scientific Reports 10.

Cruz NFFS (2019). Grain productivity and nutrient accumulation in soil fertilized with animal waste during nine crops. 55f. Dissertation (Master in Energy Engineering in Agriculture) - Western Paraná State University, Cascavel.

MAPA-Ministry of Agriculture, Livestock and Supply (2016). Projections of Agribusiness Brazil 2015/16 to 2025/26 Long-Term Projections. 7th edition.

Resende AV (2016). Built fertility soils: characteristics, functioning, and management. Agronomic Information, Piracicaba 156.

Santos DR, Gatiboni LC, Kaminski J (2008). Factors affecting phosphorus availability and management of phosphate fertilization in no-tillage soils. Ciência Rural, Santa Maria (38):576-586.

Silva AJ (2006). Residual effect of organic and mineral fertilization in sesame (Sesamum indicum, l) cultivation in the second year. 48f. Dissertation (Master in Soil and Water Management) - Center for Agricultural Sciences, Federal University of Paraíba, Areia.

Sousa DMG, Lobato E, Rein TA (2004). Phosphorus fertilization. In: SOUSA, D.M.G.; LOBATO, E. Cerrado: Soil correction and fertilization. Planaltina, Embrapa Cerrados pp. 147-168.