Original Research Article

APPLICATION OF BIOFERTILIZERS IN COVER OF AND ITS EFFECTS ON ORGANIC MAIZE

ABSTRACT

The objective of the present study was to verify the effect of two doses of the biofertilizer 'Supermagro' applied in cover, in the presence and absence of cured bovine urine in the maize crop as well as the effect in the application of biofertilizer 'FertBokashi'.' The experimental design used was of randomized blocks with four replicates. The treatments constituted of: cover application of 'Supermagro' in the dose of 6% (recommended dose); cover application of 'Supermagro' in the dose of 12%; cover application of 'Supermagro' in the dose of 6% + cured bovine urine 3%; cover application of 'Supermagro' in the dose of 12% + cured bovine urine 3%; cover application of cured bovine urine 3%; use of the biofertilizer 'FertiBokashi' in the dose of 0,5% of dilution) and control. It was found that plant height, stem diameter, ear length, and number of kernels per row did not differed statistically from the control. For the parameters: height insertion of the first ear, thousand grain mass, and productivity, the treatments differed from the control. The biofertilizer Supermagro in the dose of 12% together with applications of cured bovine urine; bovine urine alone and the FertiBokashi allowed an average increase of 20% in the maize production in relation to the area without application.

Keywords: Zea mays, alternative agriculture, cured bovine urine.

1. INTRODUCTION

The organic agriculture concept may be easily defined as the adoption of agricultural practices which aim to reach the maximum as possible the natural conditions of the environment. The term organic is used to designate a non-conventional system of cultivation, based in ecologic principles, being a productive system that seeks the preservation of nature and life, preconizing the rational use of natural resources, using traditional methods of cultivation and ecologic technologies. The cultivation techniques involve practices that favor the equilibrium between soil the climatic conditions and the plant [1].

Seeking for a more sustainable production an agricultural development, farmers have been using even more organic inputs, instead of using the synthetic ones. There are many byproducts that can be used in as biofertilizers in **the** ecologic agriculture. Such products still need some validation information to be used. The organic fertilizers are composed of

materials derived from the decomposition of urban, rural, vegetable or animal raw materials, which may be produced in an aerobic or anaerobic environment or from a mixture of organic materials (fruits, milk, manure), minerals (macro and micronutrients) and water [2,3].

According to Barros et al. [4], the biofertilizer on its liquid form allows a better and faster absorption, being of great utility in crops that need of higher amounts of nutrients in a small period of time, considering that the flux of nutrients that are immobilized from the soil are essential in the maintenance of the fertility in organic cultivation systems.

Among the mostly used products in **the** alternative agriculture, it can be highlighted the 'Supermagro' biofertilizer and the bovine urine, besides the materials from dust powder. These products are widely because they make available in an efficient way the nutrients for plants and for adding a higher biological resistance due to the equilibrated nutrition necessary according to the trophobiotic theory [5].

The 'Supermagro' is a biofertilizer that was developed by the agricultural technician Delfino Magro, with collaboration from the Ecologic Agricultural Center from the Rio Grande does Sul state (CAE-RS) as a biofertilizer rich in mineral salts of secondary origin [6].

As a foliar fertilizer, it is generally recommended a concentration between 2% and 5% in the spraying volume (1 L of biofertilizer to each 20 liters of water). Considering that the biofertilizers prepared with the 'Supermagro' must not be applied in concentrations above 10% because it can harm the leaves tissue, also making them to fall [7]. For the maize crop, it is recommended a dose of 6% of 'Supermagro' being it defined by Burg and Mayer [8] as the most efficient dose**, h**. However, little is still known about its use in the maize crop.

The bovine urine is an agricultural input that helps farmers to reduce the need for industrialized products, especially in an agroecological production system. It might be used as a liquid biofertilizer, being possible to stimulate the plant growth and rooting, besides acting as a natural alternative technique in the control of pests and diseases. However, despite being a well indicate practice for the production system, it requires further research into its effects when applied to plants.

In this context, the use of bovine urine, allied to other methods and products, can contribute to **increase** increasing the productivity of an agroecological and organic system, due to the necessity in the development and application of fertilizers capable of minimizing the use of industrialized inputs [9].

The objective of the present study was to verify the effect of two doses of the biofertilizer 'Supermagro' applied in cover, in the presence and absence of cured bovine urine in the maize crop as well as the effect in the application of biofertilizer 'FertBokashi'

2. MATERIAL AND METHODS

2.1 Place of experiment

The experiment was conducted in the Agroecological Experimental Station professor Alcibíades Luiz Orlando, located in Entre Rios do Oeste city, belonging to the 'Universidade Estadual do Oeste do Paraná**'.**.' The geographic coordinates of the area were 54º01'45'' W and 24º 31'42'' S, with average altitude of 420 m.

The weather in the region is classified, according to the Koppen classification, as Cfa subtropical with hot summers and tendency to concentration of rainfalls, and winters with low

frequency of frosts. The soil from the experimental area is classified as an Oxisoil with clayey texture [10].

2.2 Experimental design

The experimental design used was of randomized blocks with four replicates. The treatments constituted of: cover application of 'Supermagro' in the dose of 6% (recommended dose) (T1); cover application of 'Supermagro' in the dose of 12% (T2); cover application of 'Supermagro' in the dose of 6% + cured bovine urine 3% (T3); cover application of 'Supermagro' in the dose of 12% + cured bovine urine 3% (T4); cover application of cured bovine urine 3% (T5); use of the biofertilizer 'FertiBokashi' in the dose of 0,5% of dilution (T6); and control (T7).

2.3 Experiment conduction

2.3.1 Crop managements

Maize was sowed in October 11th, 2017, being used the hybrid IPR 164, which was mechanically sowed with a 13 row sower, in a row spacing of 50 cm, with a sowing depth of 4 cm and 2,75 seeds per linear meter (55.000 seeds ha^{-1}). The fertilization was made with an organic compound chicken **bed** bed-based, enhanced with sulfur, potassium **sulphate** sulfate and reactive natural phosphate (0-8,2-8).

Three mechanical harrows with a flail mower were made to remove weeds from the space between plots, plus three manual harrows in the space between rows.

2.3.2 Biofertilizers preparation

The biofertilizer 'Supermagro' was previously produced, used for its composition: 1% volume of zinc sulphate; 1% calcium chloride; 1% magnesium sulphate; 0,15% manganese sulphate; 0,025% cobalt sulphate; 0,05% sodium molybdate; 0,5% boric acid; 0,7% hydrated lime; milk; brown sugar; 0,1% bone powder; 25% fresh bovine manure and water to complete the volume of the chosen recipient. The compound was made y gradually adding the ingredients, weekly, starting from the manure, milk, brown sugar and then added the macro and micronutrients. This production process took 60 days, and at its end, it was waited 30 days for full fermentation in a closed recipient, being it opened and homogenized five times along this process [11].

The bovine urine was collected from the experimental farm of the university, being immediately packed into a closed recipient (anaerobic medium), until it was used, following the recommendation from the [12]. The biofertilizer was made available by the company Korin, which works with resources and defense of **the** natural agriculture.

2.3.3 Biofertilizers application

The biofertilizers were mechanically applied with a tractor and a sprayer. The 'Supermagro' and the bovine urine were applied twice in the crop cycle, in the vegetative stages V4 and V6 of maize plants. The applications were separately made, following the area division and their respective treatments. Adding both products, it was used around 200 liters of the mixture in all the area, in each application.

The 'FertiBokashi' was applied three times in its respective treatment (T6), in the phenological stages, V4, V5, and V6 of maize plants, following the manufacturer's recommendations.

2.3.4 Evaluations made

The maize production components evaluated were: plants height, first ear insertion height, stem diameter, ear length, number of kernel rows and number of kernels per row to estimate the number of grains per ear. The production components evaluation was made by collecting 10 plants from the central rows of each treatment. Plants height and height of insertion of the first ear were made with a metric tape, from the soil surface up to the flag leaf or to the first ear (main ear).
Stem diameter was quantified with the aid of a digital caliper, being measured the same plants which the height was evaluated. The population density was verified through the counting of plants in random spots in the area, being counted in line the number of plants per linear meter and used the average to estimate the plants per unit of area.

The counting of the number of kernel rows and number of kernels per row was manually made. The crop yield was made by weighing the grains from the area evaluated, which was posteriorly converted to kilograms per hectare.

2.3.5 Statistical analysis

The results obtained were tabulated and submitted to analysis of variance and the comparison of means by the Dunnett test at 5% of probability, with the aid of the statistical analysis software SAS (Statistical Analysis System).

3. RESULTS AND DISCUSSION

It was found that plant height, stem diameter, ear length, and a number of kernels per row did not differed statistically from the control. For the parameters: height insertion of the first ear, **thousand** thousand-grain mass, and productivity, the treatments differed from the control. The application of biofertilizer "Supermagro" in the dose of 6% + cured bovine urine favored the first ear insertion height. The number of kernels per ear and the productivity **were** was higher when the "Supermagro" at 12% + cured bovine urine was applied. The biofertilizer "Fertibokashi" showed a better result for **thousand** thousand-grain mass and productivity when compared to the control (Table 1).

The application of the biofertilizer "**supermagro**super macro" at 12% + cured bovine urine, as well as the application of cured bovine urine at a 3% dilution, and the biofertilizer 'fertibokashi', promoted an average increase of 20% in the yield when compared to the control. Such results corroborate with the ones found by Costa et al. [13], who also found positive results in the yield of maize consorted with beans, when a 5% solution of cured bovine urine was applied on the crop.

Table 1. Plant height (cm), first ear insertion height (cm), stem diameter (cm), ear length (cm), number of kernels per ear, **thousand** thousand-grain mass (g) and yield (kg ha^{-1}) for the application of different biofertilizers applied alone or in combination.

Treatments	Plant height	1st ear insertion height	Stem diameter	Ear length	Kernels per ear	1000 grain mass	Yield

	--------m--------		--dm--	---cm---		---g---	kg/ha
Sup. dose 1	2,07^{ns}	1,08b	27,33^{ns}	18,65^{ns}	464,75b	360,94b	5500b
Sup. dose 2	2,03^{ns}	1,12b	25,84^{ns}	18,35^{ns}	469,99b	362,50b	5225b
Sup. dose 1+Ur.	2,15^{ns}	1,25a	27,27^{ns}	18,07^{ns}	457,73b	351,56b	5361b
Sup. dose 2+Ur.	2,14^{ns}	1,18b	26,47^{ns}	18,37^{ns}	497,77a	368,75b	5961a
Bovine Urine	2,10^{ns}	1,16b	27,23^{ns}	18,31^{ns}	490,23a	362,50b	5812a
Fertbokashi	2,14^{ns}	1,15b	26,90^{ns}	18,15^{ns}	449,22b	375,00a	5808a
Control	2,09^{ns}	1,13b	27,30^{ns}	17,56^{ns}	460,09b	346,87b	4859b

* Means followed by different letters, lowercase in the column, differ from each other by Dunnett's test (P≤0.05). (Sup dose 1. - Supermagro at 6%; Sup dose 2 - Supermagro at 12%; Ur – cured bovine urine).

Araújo et al. [14] found similar results in coffee with the application of crescent doses of the "Supermagro" biofertilizer, where the maximum yield was obtained in the doses of 14,6 and 16,2% of dilution.

Silva et al. [15] found that the use of bovine urine associated **to** with other biofertilizers provided a better development to beans, result that corroborates with the ones found in this study. Its use improved the parameters: initial growth, dry mass, and in the chlorophyll pigments. Cesar et al. [16] also observed the benefits of bovine urine when it was sprayed in cucumbers, where its use improved the **crop initial**initial crop development.

When evaluating the application of the biofertilizer under different dilutions in maize, Pavinato et al. [17] found increases in the plants dry mass, in the dose of 3 and 6% of dilution. However, in the dose of 12% the dry mass production was reduced due to **a** foliar toxicity**,** ; on the other hand, in the present study, it was the best dose for the grains production.

Contrary results were observed by Verona et al. [18] that found no effects from the "Supermagro" biofertilizer applied on leaves of strawberries. Also, in another experiment, these authors found that the 5% dilution of the biofertilizer reduced the plant's yield due to phytotoxicity.

Plucinski Filho and Godoy [19], testing the application of different biofertilizers in beans, also found no meaningful difference in the application of cured bovine urine and "supermagro" in the recommended dose when compared to the control for the yield parameter. In addition, no phytotoxic effect was observed when the applied doses were higher than the recommended ones, without affecting the yield.

Opposite to the results observed, Pereira et al. [9] noticed that crescent doses of bovine urine harmed the tomatoes development when compared to the control. The highest concentration (5%) caused the worst results for all productive characteristics evaluated for this crop, among them the germination, emergence, population of abnormal plants, non-germinated seeds, germination velocity rate, and dry and fresh mass.

The "FertBokashi" biofertilizer is a Bokashi based product that resulted in higher productivity when compared to the control**, h**. However, no scientific researches were found using this product.

4. CONCLUSION

The biofertilizer Supermagro in the dose of 12% together with applications of cured bovine urine; bovine urine alone and the FertiBokashi allowed an average increase of 20% in the maize production in relation to the area without application

COMPETING INTERESTS DISCLAIMER:

Authors have declared that no competing interests exist. The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company; rather it was funded by personal efforts of the authors.

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