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Analysis of Litterfall Biofertilizer and Basalto Powder in *Zea mays* Culture

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Abstract

The objective of this work was to evaluate the compound based on litterfall and basalt powder on the corn crop, in a comparison of physical and chemical soil changes, in order to search development based on the knowledge of nature and natural sources that offer the improvement in the growth of plants for the purpose of organic production. The soil applications were made with aqueous solutions—the mixture in % of the compound and the remainder of the water. Four concentrations (25, 50, 75 and 100% for a 500 ml measurement) of the organic compound and control with 500 ml of water was performed. A total of five corn plants were used for each dosage. The planting was done in lines of 5 plants for 5 dosages (5 × 5). The applications occurred in the pre-planting (directly in the soil, before receiving the seeds) and after every five days.

Keywords: biofertilizer, compound, corn, organic, organic production

1. Introduction

When environmental sustainability is added to agriculture, the production lines demand management alternatives with technologies that are less aggressive to the environment. It becomes a challenge to develop sustainable agrosystems that can compete in terms of quality and quantity.

The use of organic inputs presents great results in soil fertility, pest control, and diseases. There are materials with great potential use, for example, the biofertilizers that stand out among the main inputs used in agroecological systems (Darolt, 2002).

In the years 2000/2001, Trani et al. (2013) carried out research with vegetables using the bokashi compound. The difference between the greenhouses that received and the ones that did not receive the compound was visible due to the large growth of the vegetables that received the application of the compound in grating to the others.

According to Ribeiro et al. (2017), the essence of agroecology is in the rural man knowledge which must not be ignored but used to contribute to science. Deeper researches about this subject have allowed a greater perception regarding the dosages for different types of cultures; possible microbiological waste left in the plant; the management and use as fertilizer and its influence on crop productivity.

By Lima et al. (2015) perception, any organic material can be reduced in its actual size by small animals and by the putrefaction of organisms, present in it or coming from the soil. Thus, its role as a supplier of nutrients (like most waste), consists basically of the material used in the preparation. Emphasizing the effect of these compounds as conditioning agent of the soil thus improving physical characteristics such as water retention, plasticity, and porosity.

The development of safer technologies in the environmental area is an international trend and is urgent for the cultivation of vegetables, for the synthetic products are generally used indiscriminately. Among them, the use of fermentation process products, such as biofertilizers, stands out (Bettoni et al., 2014; Kaseker et al., 2014; Röder, 2014).

Thereby, oilseeds production by using environmentally safer technologies and these kinds of technologies have gained market share. According to Chen et al. (2016), the oilseeds culture has reached prominence in recent years because of the demand for renewable energy increase.

In this context, the objective of this study was to analyze the efficacy of an organic compound when applied in an oilseed crop in a short period of time.

2. Method

The study was performed in a propriety located in Ramilândia, Paraná, at latitude S and 54°01′31″ longitude W of Greenwich, with an approximate elevation of 580 m (IBGE, 2016).

The region's climate is characterized as Subtropical Mesothermal (Cfa), with warm summers, infrequent frosts and the tendency of concentration of rain in the summer months, without a defined dry season. The average temperature in the coldest month is below 18 °C and the average for the hottest month is above 22 °C (Caviglione et al., 2017).

At that region, the orders of the predominant soils are Nitosols and Litholic Neosols (Embrapa, 2012).

There was a solid step and a liquid step up to the end of the process, taking 45 days for the product to be ready.

The first stage was characterized by the solid state of fertilizer, prepared from 01 bottle of 50 L of leaves and decaying woods from the forest (litterfall). To this material was added the same amount of wheat bran; 0.5 kg of brown sugar; 0.5 kg of basalt powder; 0.5 L of milk to accelerate the metabolic process, which was produced anaerobically. All ingredients were mixed and water was added until it became slightly moist (40-50% moisture). The material remained stored in the bottle, covered with dark plastic to prevent light and air entry. In the first stage, the fermentation was of 30 days in a covered place.

The second stage was characterized by the liquid state. The previous phase mixture resulted in a solid material similar in odor and texture to corn silage. The material was deposited in a 150 L container where 20 L of water was added; 1 kg of wheat bran; 2 kg of molasses and 2 L of water. The mixture was stored until the beginning of the fermentation, the remaining space was filled with the bottle with water. The material remained stored for more 15 days before the first application. The final product was filtered, the solid part was discarded as a fertilizer for fruit trees.

The sample of the biofertilizer was collected after the maturation of 45 days. The collect was performed in a sterile plastic bottle and transported to the laboratory for the analysis.

Samples obtained after the fermentation process were used for the chemical analysis, which were carried out at the Laboratory of Environmental and Instrumental Chemistry of Unioeste, Campus of Marechal Cândido Rondon. The phosphorus contents were obtained by colorimetry and the potassium, by flame photometry, the pH was in $CaCl_2$ and the nutrients by atomic absorption.

Five soil samples, identified according to the treatment received, were collected. In the samples the presence of nutrients and soil fertility shown by the base saturation index were analyzed. Physical and chemical tests were made in the samples. The results of the sum of bases (mol/dm^3) were submitted to the test of variance.

The Calcium and magnesium contents were determined by the KCl 1 N extraction solution, potassium was determined using Mehlich-I (0.05N HCl + 0.025N H_2SO_4). The potential acidity (H + Al) was obtained by extraction with 1 N calcium acetate at pH 7.0. After that, the following parameters were obtained: base sum (SB = Na + K + Ca + Mg), cation exchange capacity (CTC = SB + H + Al) and base saturation percentage (V = CTC) × 100).

The zea mays were cultivated in an open field, in five rows with five copies each. The first application of the compound was in pre-planting, then applied every five days. The application was performed with five repetitions, considering four types of dosages and one control (0, 25, 50, 75 and 100%). 500 ml of the compound was used per copy.

During the application process of the compound in the cultivars there was no handling of weeds and insects. The intent was to observe whether the compound had properties as herbicide and pesticides. Despite showing characteristics regarding these factors, the results were irrelevant to the research.

The plants after the cultivation were used to feed the cattle of the property, due to the short application period did not present corn ear production.

The results obtained were applied to Minitab software for analysis of variance and comparison of means obtained during the research.

3. Results and Discussions

The biofertilizer produced from litterfall and basalt powder presented nutrient variability, demonstrating great availability of some elements in relation to others.

The results of base saturation (V%) found did not show significant differences. The test presented the results for F = 0.002222 and for critical F = 5.192168, without significant results.

Table 1. Average, variance and significance of the statistical analysis of plant height (cm) of maize treated with different concentrations of biofertilizer

% Sample	Plants/Application	Average	Variance	F	P
0%	5	117.18	372.122	2.09	< 5
25%	5	124.28	68.737		
50%	5	117.88	398.257		
75%	5	107.76	465.268		
100%	5	95.58	185.312		

The average values of the chemical compounds in the biofertilizer from burlap and basalt powder are presented in Table 2, showing variability in the found compounds.

Table 2. Chemical composition of the biofertilizer after fermentation

Description of Sample	Analysis								
	N	P	K	Ca	Mg	Cu	Zn	Mn	Fe
	mg L^{-1}								
A-1	54.60	3.03	153.50	133.50	59.50	0.03	0.41	2.67	17.20

The compound is characterized as a mixed biofertilizer (mixture of two or more simple elements or compound) and its value as fertilizer depends on its total nutrient content and soil solubility. According to Amaro (2019) for cover fertilization the biofertilizer must provide macronutrients (N, P, K, Ca, Mg, S) at higher levels than micronutrients (Cu, Zn, Mn, Fe, Mo, B, Cl) this is needed in smaller quantity.

Table 2 shows that the compound shows the majority of macro and micronutrients. Since the levels of macronutrients present in the formulation are higher than that of micronutrients, fulfilling what was expected.

The accumulation of organic particles increases the leaching of the soil to polyvalent cations (Ca, Mg and Al) in relation to monovalent (K), as shown by Pavinato (2008). Thus, the great amount of K resulted from the decomposition of organic waste is present in the soil exchange and satisfies the loads generated by the pH increase and Al leaching. However, in systems with low accumulation of organic waste, preferentially the leaching is for K since it becomes freer in solution due to the lower adsorption force. In the results of the chemical analysis all the samples presented Ca and Mg levels higher than the presence of K as shown in Table 3.

Table 3. Calcium, magnesium, aluminum, potassium and soil pH contents after biofertilizer treatments

Dosage (%)	Ca	Mg	Al	K	pH in $CaCl_2$
	cmol/dm^3				
0%	5.33	1.64	0.03	0.62	4.67
25%	5.51	1.66	0.13	0.58	4.81
50%	4.46	1.68	0.06	0.58	4.85
75%	6.48	1.36	0.12	0.57	4.90
100%	7.79	1.61	0.10	0.59	4.80

The soil samples of the dosages presented some variations, the 50% dosage with lower OM rate (30.29 g/kg) and the highest at 100% (45.37 g/kg). The increase of the organic matter (OM) in the soil makes it difficult for microorganisms to act due to less contact with the soil which results in slower decomposition. This also causes the large accumulation of waste, which can generate continuous production of organic compounds of low molecular mass, resulting in long term fertility not only in the decomposition.

As shown by Pavinato et al. (2008) and Barros (2013), they point out the difficulty of the action of microorganisms due to the maintenance of residues, but due to the protection exerted by the residue it becomes possible to produce continuously organic compounds that bring positive effects to fertility due to its low mass molecular.

The removal of natural vegetation from an area for the implementation of agricultural systems decreases the total organic carbon (TOC), which is caused by the reduction of the amount of organic waste. This factor changes the soil organic matter dynamics, which can lead to a fast reduction of the organic matter content.

The biofertilizer application time did not show significant alterations in the contents of TOC, but there was a difference in the carbon and organic matter values as the dosage of the compound increased (Table 4).

The amount of organic matter present in the soil is considered by many researchers as the main stabilizing agent of soil aggregates. According to Vincente et al. (2012), the amount of organic matter present in the soil is considered as the main stabilizing agent of soil aggregates.

Table 4. Carbon content and soil organic matter after treatments with biofertilizers

Dosage (%)	C (g/dm^3)	OM (g/Kg)
0%	19.70	33.96
25%	21.00	36.20
50%	17.57	30.29
75%	23.75	40.85
100%	26.38	45.37

The phosphorus levels showed an increase as the applied dosage increased, but they still remained low. This could have been caused by the presence of basalt powder in the composition of the biofertilizer used, which has silica that decreases fixation of the element in both plants and soil. However, the basalt powder presents a slow release of nutrients, showing a change in results even in short term, but showed low significance when submitted to the variance test.

The clay, sand and silt values showed changes in physical analysis, increasing according to the dosage of the compound used. Those values are directly related to the amount of organic matter in each dosage. According to Pellegrini (2005), soil aggregation is positively related to the organic matter content and directly influences the clay content. Braga (2012) shows by analyzes that in more weathered soils has a greater predominance of clays of low activity, where the organic matter content goes from low to medium, reducing the levels of cations exchange capacity. However, with increased clay content there is an increase in organic matter content and the ability to exchange cations. According to Braga (2012), sandy soils present low content of organic matter and capacity of exchange of cations, where the loss of nutrients by leaching is higher.

Table 5. Soil composition after treatments with biofertilizers

Dosage (%)	Clay	Sand	Silt
Soil type: 3-Very clayey			
0%	61.45	17.70	20.85
25%	64.35	17.10	18.55
50%	63.10	18.80	18.10
75%	53.75	23.75	22.50
100%	51.25	25.00	23.75

According to Abreu et al. (2007), micronutrients are fundamental elements for the growth and development of plants, but are required in smaller quantities when compared to the macronutrients.

Regarding micronutrients, the results presented variations according to the dosage, as shown in Figure 1, and had large variations in some as the dosage increases. The availability and the amount that they present in the soil will depend almost exclusively on the mineralogy of the rocks that originated it, which closely links the clay contents with the number of micronutrients.

Vian et al. (2012) states that the clay content, organic matter and pH indexes are directly related to soil availability. According to the author, clay soils with pH between 5.0 and 6.5 have a lower probability of micronutrient deficiency.

However, Abreu et al. (2007) states that higher soil pH rates cause micronutrients to decrease in the soil, especially with Cu. Thus, we noticed by the results that with the decrease of the clay contents there was increase in the presence of Cu.

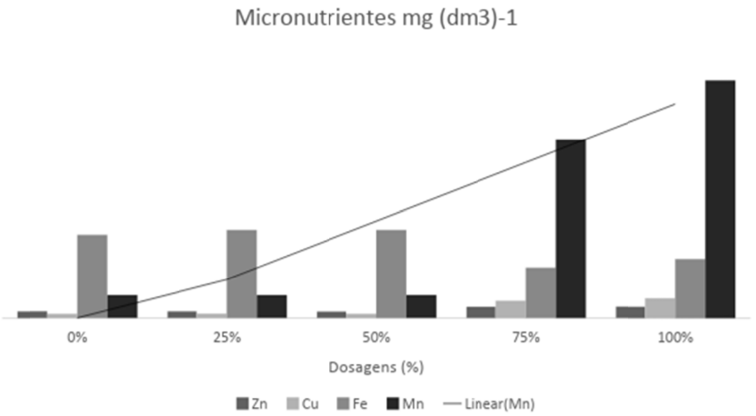

Figure 1. Results of micronutrients present in the organic compound

For the plants, the presence of iron helps the formation of chlorophyll and the oxygen transport. Iron was the element that presented an expressive and stable amount in all dosage samples. Copper is essential for photosynthesis and chlorophyll production, and shows a small increase in higher dosages. Manganese, which is also important for the process of photosynthesis and the production of amino acids, showed significant increase in the higher dosages of the compound. Zinc was stable and had a variation in two larger dosages. Zinc is the element responsible for the growth and development of the plant. Conceição (2015) affirms all these factors and warns that all in high concentrations are toxic to the plant, in the majority cause inhibition of the growth and causing damages to the dry matter production of the aerial part. As shown in Table 1, we see that micronutrient levels are low without showing toxicity to the plant.

Table 6. Soil composition after treatments with biofertilizers

Treatment	pH (H_2O)	Ca^{2+}	Mg^{2+}	K^+	$H+Al^{3+}$	SB	CTC	V (%)
0%	5.28	36.04	11.09	4.19	7.20	7.59	14.79	51.32
25%	5.40	36.86	11.10	3.88	7.20	7.75	14.95	51.84
50%	5.45	32.04	12.07	4.17	7.20	6.72	13.92	48.28
75%	4.90	40.07	8.41	3.53	7.76	8.41	16.17	52.01
100%	4.80	42.45	8.77	3.22	8.36	9.99	18.35	54.44

The large presence of organic matter in the soil decreases the presence and the fixation of iron. The negative interaction of nitrogen and the excess of other elements drastically reduces the absorption of copper. Commonly, a small amount of manganese is available in the soil for plants, occurring generally in organic soils or the ones with neutral or alkaline reactions. Figure 1 shows a high increase of element contents as the dosage increases. The zinc that appears in a subtle way is closely associated with organic matter in the soil. The potential acidity is of non-exchangeable acidity due to pH indices below 5.5.

4. Conclusion

The results in the physical and chemical analysis express an increase in nutrients and organic matter content, as well as physical changes.

The dosage of 25% showed the best results in the development of the plant and in the physical and chemical analysis of the soil in relation to the others.

The low values change can be due to the short period of the compound application, mainly considering that the rock powder slows the absorption of nutrients. In order to confirm effectiveness, it is necessary to apply the whole planting cycle until the plant harvesting period.

References

Abreu, C. A., Lopes, A. S., & Santos, G. C. G. (2007). *Fertilidade do solo*. Sociedade Brasileira de Ciência do Solo.

Amaro, G. B. (2019). *Adubos e Fertilizantes*. Agência Embrapa de Informação Tecnológica (AGEITEC). Retrieved from https://www.agencia.cnptia.embrapa.br/gestor/pimenta/arvore/CONT000gn08zc7m02wx5ok0liq1mqw825isw.html

Barros, J. D. S. (2013). Contribuições da matéria orgânica do solo para mitigar as emissões agrícolas de gases de efeito estufa. *Polêmica! Questões Contemporâneas*.

Bettoni, M. B., Fabbrin, E. G., Dos S., Procopiuk, M., & Mógor, A. F. (2014). Crescimento de mudas de orégano submetidas a doses e frequências de aplicação de Ácido L-glutâmico em sistema orgânico. *Revista Brasileira de Plantas Medicinais, 16*(1). https://doi.org/10.1590/S1516-05722014000100012

Braga, G. N. M. (2012). *Argila e Matéria Orgânica na Análise do Solo*. Na Sala Com Gismonti. Retrieved from https://agronomiacomgismonti.blogspot.com/2012/06/argila-e-materia-organica-na-analise-do.html

Caviglione, J. H., Kiihl, L. R. B., Caramori, P. H., & Oliveira, D. de. (2017). *Cartas Climáticas do Paraná* (V. 10). Retrieved from http://www.iapar.br/modules/conteudo/conteudo.php?conteudo=597

Chen, W., Wu, F. E., & Zhang, J. (2016). Otential production of non-foode biofuels in China. *Renewable Energy, 85*, 939-944. https://doi.org/10.1016/j.renene.2015.07.024

Conceição, G. M., Ruggieri, A. C., Silva, M. C. C., Rodrigues, M. S., Silva, R. P., & Silva, E. R. (2015). Teores de micronutrientes (B, Cu, Fe, Mn e Zn) em espécies de Poaceae de uma área do cerrado maranhense. *Brazilian Geographical Journal.*

Darolt, M. R. (2002). *Guia do produtor orgânico: Como produzir em harmonia com a natureza*. IAPAR, Brazil.

EMBRAPA (Empresa Brasileira De Pesquisa Agropecuária). (2012). *Mapa simplificado de solos do estado do Paraná*.

IBGE (Instituto Brasileiro De Geografia e Estatística). (2019). *Pesquisa Nacional por Amostra de Cidades: Ramilândia*. Instituto Brasileiro de Geografia e Estatística (IBGE), Brazil.

Kaseker, J. F., Bastos, M. C., Consalter, R., & Mógor, Á. F. (2014). Alteração do crescimento e dos teores de nutrientes com utilização de fertilizante organomineral em cenoura. *Revista Ceres, 61*(6). https://doi.org/10.1590/0034-737X201461060011

Lima, B. V., Caetano, B. S., Souza, G. G., & Souza, C. S. S. (2015). The organic fertilizer and its relation with the agriculture and the environment. *A Pesquisa Frente a Inovação e o Desenvolvimento Sustentado*.

Pavinato, P. S., & Rosolem, C. A. (2008). Effects of organic compounds produced by plants on soil nutrient availability. *Revista Brasileira de Ciência do Solo*.

Pellegrini, A., Rheinheimer, D. S., Duarte, F. M., Barreto, U. F. R., Reichert, J. M., & Reinert, D. J. (2005). *Variações nos teores de argila natural e matéria orgânica e estabilidade de agregados decorrentes da aplicação de calcário* (Centro de Ciências Rurais, Departamento de Solos, Universidade Federal de Santa Maria, Brazil).

Ribeiro, D. S., Silva, N. R., Tiepolo, E. V., & Vargas, M. C. (2017). Agroecologia na educação básica: questões prepositivas de conteúdo e metodologia. *Revista Educação em Agroecologia*.

Röder, C. (2014). *Efeito da aplicação de um fermentado bacteriano contendo ácido L-glutâmico no crescimento, produtividade e alterações bioquímicas em batata cultivada no sistema orgânico*.

Trani, P. E., Terra, M. M., Techio, M. A., Teixeira, L. A. J., & Hanasiro, J. (2013). *Adubação orgânica de hortaliças e frutíferas*. Instituto Agronômico (IAC).

Vian, A. L., Santi, A. L., Cherubin, M. R., Eitelwein, M. T., & Damian, J. M. (2012). *Distribuição espacial de micronutrientes em áreas de latossolo irrigado e sequeiro manejadas com agricultura de precisão*. Enciclopédia Biosfera, Centro Científico Conhecer.

Vicente, T. F. S., Pedrosa, E. M. R., Rolim, M. M., Oliveira, A. K. S., & Souza, A. M. P. L. (2012). Relações de atributos do solo e estabilidade de agregados em canaviais com e sem vinhaça. *Revista brasileira de Engenharia Agrícola e Ambiental, 16*(11). https://doi.org/10.1590/S1415-43662012001100010

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