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DEVELOPMENT OF BANANA PLANTS BIOFERTIRRIGADAS, WITH EMPHASIS ON SOIL MICROBIOTA

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ABSTRACT - Brazil is one of the largest producers of banana (*Musa* sp.), Accounting on average for 10% of the total world production. From this perspective, it is possible to see the need to increase their production, and among the strategies adopted, one can anticipate the acclimatization phase, through the association of banana seedlings mycorrhizal fungi. The biofertilizers commonly refer to the effluent resulting from aerobic or anaerobic fermentation of organic products supplemented with pure or mineral products. They are used in agriculture for various purposes, and its application promotes the improvement of physical and chemical properties and stimulating biological activity.

Keywords: Banana (*Musa* sp), FMA, biofertilizer

DESENVOLVIMENTO DE MUDAS DE BANANEIRA BIOFERTIRRIGADAS, COM ÊNFASE À MICROBIOTA DO SOLO

Resumo - O Brasil é um dos maiores produtores mundiais de banana (*Musa* sp.), sendo responsável em média por 10% de toda a produção mundial. Nessa perspectiva, percebe-se a necessidade de incrementar a sua produção, e dentre as estratégias adotadas, pode-se antecipar a fase de aclimatação, por meio da associação de mudas de bananeiras com fungos micorrízicos arbusculares. Os biofertilizantes comumente se referem ao efluente resultante da fermentação aeróbia ou anaeróbia de produtos orgânicos puros ou complementados com produtos minerais. São utilizados na agricultura para vários fins, e sua aplicação promove a melhoria das propriedades físicas e químicas e estimulando a atividade biológica.

Palavras - chave: Banana (*Musa* sp), FMA, biofertilizante

INTRODUCTION

Being considered one of the most consumed fruits in the world, it is always essential to develop measures aimed at better utilization of natural resources in the face of the indiscriminate use of mineral fertilizers in this culture. From the perspective of reducing production costs and contribute to the decline in consumption of natural resources of the planet, many studies have been directed to reduce or even replace mineral fertilizers by biofertilizers and fertilizers. These products, when applied in culture, act as a source of micronutrients for plants, making them more resistant to attack by pests and pathogens, acting directly on the plant-parasitic nematodes, due to the presence of toxic substances. The banana, because it is a kind mycotrophic, is, for example, associations with arbuscular mycorrhizal fungi (AMF), characterized by a mutualistic symbiosis, which generally promotes greater nutrient uptake by plants associated. It was proposed the use of bio-fertilizer applied at different stages of development of the banana in fact directed to the evaluation of plant growth and mycorrhizal colonization of roots of banana trees. The relevance of this research is to seek to improve the use of natural resources in the region in order to make farming

more profitable, however, without compromising environmental sustainability

CULTURE BANANA

The cultivation of bananas by man began in Southeast Asia since time immemorial, it is considered the "cradle of cultivation of bananas." Your rating *Musa* is divided into four edible species: dwarf or nanicão (*M. cavendishii*), bananas are high in starch consumed after cooking (*M. paradise*), include also the species with starchy, higher and with the least amount of fruit bunches (*M. corniculata*), and the rest (*M.sapientum*). There is also another option for the classification of species, considering them according to their origin, taking as its starting point the ancestors banana (*M. acuminata* and *M. balbisiana*). The count of existing chromosomes in the cell sorter is the criterion for the situation mentioned (BARSA, 2009).

The banana is characterized by a juicy and underground stem (rhizome), whose false stem (pseudostem a) is formed by sheaths of overlapping leaves. These are large, bright green color, so bright and generally oblong or elliptical. The flowers are arranged in a terminal spike, around the so-called "heart of the banana" with androgyny glomeruli, although, in practice, the glomerular function only as male superiors and inferiors, and female. It also presents shaped spathe bracts. The fruit, known as the banana is actually a falsebaga.

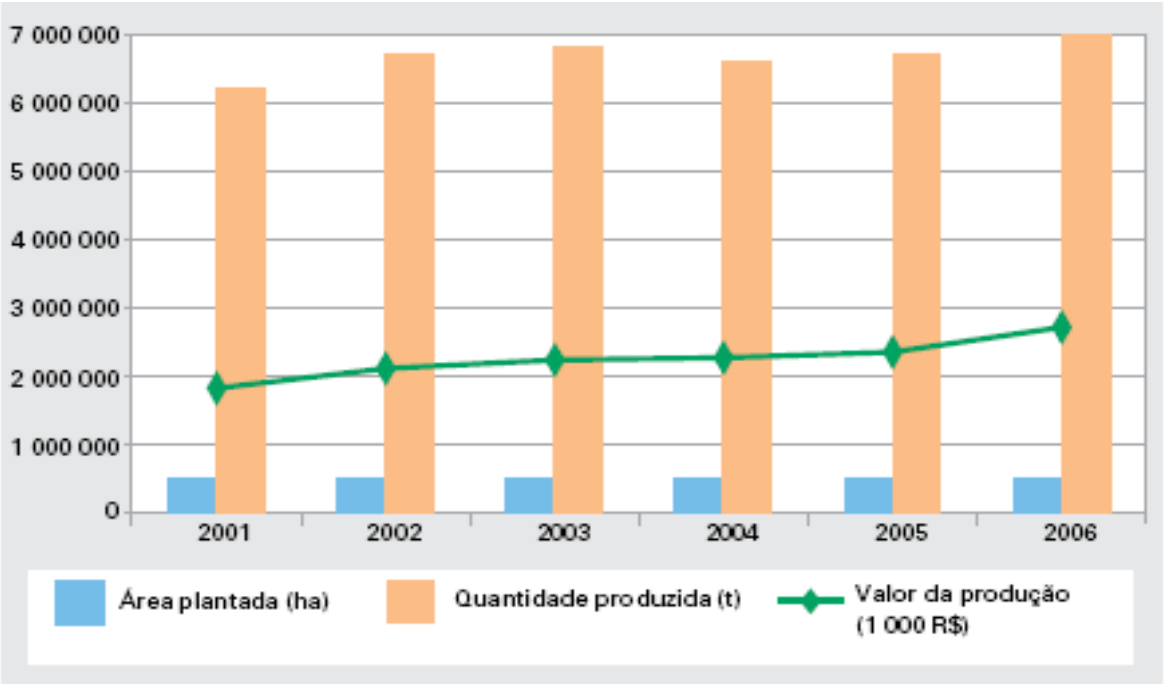
Brazil is the second largest producer, and owns about 10% of total world production. In 2007 the country produced 7,098,353 tons of banana bunches, which represented an increase of 2.04% relative to the quantity harvested in the previous year. The national average yield of the crop was 13672 kg of bunches / ha, and encompasses the different productivity of different cultivars exploited in the country (IBGE - MUNICIPAL AGRICULTURAL PRODUCTION, 2007)

Due to the daily broadcast in various regions of the world, both in the raw, cooked or fried, commercial production in plantations of Central America and South America is of great importance and is now the third fruit in the world in volume production, second only to the grape and orange (SILVA et al. 2006).

Currently the most widely cultivated varieties are: Apple, Silver, Pacovan, Silver Dwarf, Mysore, Earth and D'Angola, belonging to genomic group AAB, and Shorty, and Nanicão Grande Naine, the AAA group, used mainly for export (SILVA et al. 2006)

In 2007, Brazil was collected in a total area of 515,346 hectares, of which the six largest producing states are: Bahia, Sao Paulo, Santa Catarina, Pará, Minas Gerais and Ceará.

Table 1 shows the acreage, production value and quantity of bunches of bananas produced in 2006, according to IBGE (MUNICIPAL AGRICULTURAL PRODUCTION, PAM, V. 33, 2006).



The Brazilian production of banana is distributed throughout the national territory, and the Northeast's largest producer (40.10%), followed by North (14.35%), Southeast (28.22%), South (14, 04%), Midwest

(3.29%) (IBGE - Municipal Agricultural Production, 2007). The states of Bahia and Sao Paulo are the largest producers of fruit, concentrated 35.32% of national production. In fact Northeast, Ceara is second in number of clusters produced with 385,455 tons, surpassed only by the state of Bahia.

In 2006, the state of Bahia became the main producer of bananas, accounting for 17.0% of production in the country this state, the production grew 21.3% between 2005 and 2006, from 1,182,941 to add tons of grapes, beating São Paulo in about 7000 tons. It should be noted, however, that the average yield of crops in the state of Sao Paulo is higher than in Bahia (22,040 kg of bunches / ha, in Sao Paulo, compared with 14,641 kg / ha in Bahia) (Municipal Agricultural Production - MAP , V. 33, 2006).

Table 1 - Area planted, area harvested, quantity produced, average income, share of total national production and production value, according to the main units of the Federation of banana producers - Brazil - 2007.

Principais UF produtoras de banana	Área plantada (ha)	Área colhida (ha)	Quantidade produzida (t)	Rendimento médio (Kg/ha)	Participação no total da produção nacional (%)	Valor da produção (1000 R$)
Brasil	519.187	515.346	7.098.353	13.672	100,00	2.910.157
Bahia	90.260	89.466	1.386.016	15.356	19,53	18,91
São Paulo	52.379	52.379	1.121.261	21.407	15,80	5,34
Santa Catarina	31.090	31.090	655.973	21.099	9,24	31,63
Pará	44.572	44.552	570.951	12.810	8,04	178.271
Minas Gerais	36.753	36.745	536.576	14.560	7,56	5,82
Ceará	**42.910**	**42.910**	**385.455**	**8.983**	**5,43**	**36,97**

Fonte: IBGE — MUNICIPAL AGRICULTURAL PRODUCTION 2007.

The banana crop is second in volume of fruit produced in Brazil, surpassed only by the cultivation of orange (Municipal Agricultural Production, v. 33, 2006). Ranks third in the harvested area to 504,586 ha, preceded by orange cultivated areas and 805,903 ha of cashew 710,181 ha (MUNICIPAL AGRICULTURAL PRODUCTION, V. 33, 2006).

The banana is consumed not only as dessert, but as food. It presents per capita consumption of around 25 kg / year. Besides contributing to the diet of much of the population, socioeconomic status plays an important role both as a generator of income in determining how people in the country (FACELLI, 2003; ANNUAL BRAZILIAN FRUIT, 2003).

2006 data, the Department of Foreign Trade, Ministry of Development, Industry and Foreign Trade - SECEX - MDIC, highlighted the main exporting states: Santa Catarina (93 792 tons), Rio Grande do Norte (84,108 tons), Ceará (11,996 tons) and São Paulo (3707 tons). The main destinations of Brazilian fruit were: Argentina, United Kingdom, Uruguay, Italy, Portugal, Netherlands and Germany. In comparative analysis the following year, there was a decrease in exports in all states, as a result of the reduction in purchases from the United Kingdom and Portugal, in part due to increased prices (PEREZ, 2008).

Several authors attribute the main problems involved in banana cultivation in Brazil to the meager productive commercial variety, with appropriate size and resistance to major pests and diseases. There are references that highlight the inadequate management of soil-water-plant, changes in soil conductivity, salinity of irrigation water, low incorporation of technologies to maintain adequate levels of nutrients throughout the plant cycle, resulting in low productivity, quality fruits, loss before and after harvest. (BRAZIL et al. 2000; FACELLI, 2003; GONDIM et al. 2006; SILVA et al., 2006). Allied to this, the high levels of soil nutrients removed during the various production cycles of culture can further compromise the nutritional balance of the plant.

Prevel-Martin (1964) and Gallo et al. (1972) cited by Brazil et al. (2000) point out that the extraction of nutrients from the juvenile period until the release of the bunch is quite steep, which is why there is significant reduction in the concentration of K, N, Ca, P and Mg. Of these, K and N are directly related to growth, production and fruit quality of banana.

Damatto Junior et al. (2006) found that the levels of nutrients in banana leaves Silver dwarf showed the following order of concentration at flowering plants: K> N> Ca> Mg> S> P. In turn, the Nitrogen is the nutrient responsible for the increased number of leaves and their size, the numbers of hands and fruits of banana, for issuing and shoots growth.

ARBUSCULAR MYCORRHIZAL FUNGUS (AMF)

The arbuscular mycorrhizal associations are characterized by a mutualistic symbiosis between root and fungus, often without pathogenic state. It is a symbiosis almost universal, occurring in about 80% of plant species. When established symbiosis nutrient exchange, occurs between the fungus and host plant. The hyphae of these fungi, due to its great ability to branch, explore the soil

absorbs water and nutrients moving them to the plant (DINIZ, 2007).

It is important to note that commercial scale production of inoculum suffers effects directly related to the nature of these biotrophic fungi, as they grow and multiply only in the presence of metabolically active roots. Another limiting factor is the limited availability of technically feasible methods of inoculation of the fungus in the host (LEAL et al. 2005).

The main associations between the roots of higher plants and fungi of the order Glomales, are formed by species of five families: Glomaceae, formed by the genus *Glomus*, *Acauloporaceae*, with the genera *Acaulospora* and *Entrphospora*; *Gigasporaceae*, with the genera *Gigaspora* and *Scutellospora*, *Archaeosporaceae* with *Archeospora* the genre, and Paraglomaceae, with gender *Paraglomus* (MOREIRA & SIQUEIRA, 2006).

The importance of the associations between arbuscular mycorrhizal fungi (AMF) in fruit trees has been studied by several researchers, due to the direct relationship of this association by reducing the time of transplanting of seedlings to the field, nutrition, and its rapid development, minimizing the use fertilizer (COSTA et al, 2001; MATOS, SILVA and BRAZIL, 2002 and LEAL et al. 2005, BORGES et al, 2007).

Juniper and Abbott (2006) investigated the tolerance of mycorrhizal fungi to salt stress, found that the two isolates of *Scutellospora calospora* used to obtain maximum germination of spores in the presence of NaCl, using a concentration of 300 mM in turn there was no germination of *Acaulospora laevis* levels of salt applied.

Diniz (2007), studying the effects of inoculation with AMF on rubber plants in terms of growth and biophysical and anatomical changes, found that mycorrhizal inoculation with AMF *Glomus clarum* had a beneficial effect on the height and diameter of stems of seedlings, transpiration rates, stomatal resistance and leaf average temperature.

The banana is a kind mycotrophic, or is at any given stage of development, interaction can occur mycorrhizal fungi (AMF). However, the AMF show little or no specificity, deferential when it comes to plant-microorganism interaction. Thus, a fungus that colonize a particular plant species can colonize any that is likely to symbiosis (MOREIRA & SIQUEIRA, 2006).

In general, the early phase of acclimatization is considered the best time for inoculation of mycorrhizal fungi on seedlings, because of his transfer from a growth chamber for the green-house, that in accordance with the plant species be produced.

Lins et al. (2003), studying stages of development more suitable for inoculation with Gigaspora *margarita*, they found that this fungus has proved beneficial at any stage of growth to the model used, and the start of the acclimatization of micropropagated banana plantlets can be reduced by the use of inoculation with AMF proper substrate.

Borges et al. (2007), studying the reduction of Evil Panama (*Fusarium oxysporum* f.sp. *cubense*) in apple-banana by inoculation of AMF, also found the benefit of prior inoculation with G. *margarita*, to protect the seedling against his agent.

BIOFERTILIZER

The biofertilizers commonly refer to the effluent resulting from aerobic or anaerobic fermentation of organic products supplemented with pure or mineral products. They are used in agriculture for various purposes and its application promotes the improvement of soil physical properties, making them looser, with less density and stimulating biological activities.

These products, when applied in culture, act as a source of macro and micronutrients for plants, making them more resistant to attack by pests and pathogens (DELEITO et al. 2005).

Despite the extensive area of banana cultivation in Brazil, about 515 000 hectares, according to Embrapa, no data are available regarding the cultivated area under organic management. To be able to systematize the many different management practices, it is necessary that the organic farmer meets the Normative Instruction No. 64, December 18, 2008, referring to the organic systems of animal and plant production.

Nomura et al. (2009), by using mixtures as substrate and supplemental fertilization, attributed to chemical differences, the differential growth in seedlings of banana 'Prata Dwarf', during acclimatization. All mixtures tested could be recommended, however, the authors pointed out that the nutrient content of the mixture should indicate the need for fertilization and the most appropriate type of fertilizer, a substrate of normal or slow release.

The decrease in consumption of natural resources of the planet, and the reduction of production costs, has aroused the interest of scholars, directing them to the decreased use of mineral fertilizers, replacing them as far as possible, or biofertilizers natural fertilizers (VILLELA JUNIOR, ARAÚJO and FACTOR, 2003).

Growing concern over the indiscriminate use of fertilizers and pesticides, given the risk of a shortage of early natural reserves of some essential nutrients for agriculture, has been another factor in the search for alternatives, for example, bio-fertilizers. This substitution has provided increased productivity and control pests and plant diseases (DIAS et al.; VILLELA JUNIOR. Et al. 2003).

The authors refer also to the fact that the effect of liquid biofertilizer on yield and quality implies the improvement of productivity of some species compared to control. Delight et al. (2005) study found positive effects on the development of pepper seedlings and control of bacterial spot *Xanthomonas axonopodis* pv.

Vesicatoria. Satisfactory results were also found by Junior Villela et al. (2003) in melon plants grown without soil.

MICROBIAL BIOMASS

The microbial biomass (BMS) can be defined as a living part of the soil organic matter, with bodies smaller than 5,000 mm3. It is considered the component that regulates the transformation of organic matter and storage of nutrients through the concurrent processes of immobilization and mineralization (GONCALVES, 2007; FIALHO, 2006).

Both the quantity and quality of plant residues in production systems can cause changes in the microbial community. The microorganisms are sensitive to these changes and, therefore, become appropriate as biological indicators (ALVARENGA, SIQUEIRA, DAVIDE, 1999). The respiration rate and organic carbon and total nitrogen should be associated with these indicators to be able to assess the dynamics of organic matter (ESPINDOLA et al., 2006).

Estimates of microbial biomass immobilized nutrients possible link with fertility and productive potential. Matsuoka et al (2003) identified in their study, the reliability of the use of microbial biomass carbon, readily mineralizable carbon and the activities of the enzymes β-glucosidase, acid phosphatase and arylsulfatase sensitive biological indicators to identify changes in soil according to the different systems of land use.

The evaluation of the BM, as Powlson et al. (1987) *apud* Reis Junior e Mendes (2007) can provide early information on changes in soil organic farms, to detect changes caused by the devastation of crops and forests regenerate after removal of surface soils and to evaluate the effects of pollution with heavy metals and pesticides .

MICROBIAL BIOMASS CARBON (MBC)

The determination of microbial biomass carbon (MBC) provides assessments of the level of degradation or loss of productive capacity of a given soil due to its catalytic function (biochemical transformations in soil), and represents a labile compartment of many nutrients that are rapidly recycled with a time of very low resistance (AZEVEDO et al., 2007).

They are important, above all, to evaluate the size of the most active and dynamic reservoir of soil organic matter, which is made up of fungi, bacteria and actinomycetes (REIS JUNIOR, MENDES, 2007).

The first work done on the microbial biomass by determination of microbial C per unit weight of soil was developed by Jenkinson & Powlson 1976 (ANDREA, HOLLWEG, 2004), and describes the method of extraction of C after fumigation of soil samples with chloroform vapor and comparison with the amount of C extracted from non-fumigated samples.

The determination of CBM represents the central compartment of the carbon cycle in the soil and, according to soil and climatic condition of the ecosystem and the composition of plant residues on its surface, can act as a buffer compartment (easily available nutrients) or as a catalyst in the decomposition organic matter (MAIA, 2006). The values indicate the potential CBM reserves in the soil C, allowing to measure the accumulation or loss of C as a function of management or edaphic condition. The higher the CBM, the greater the pool of C in the soil, which reflects a lower potential decomposition of organic matter FIALHO (2005).

The values obtained in their study, Alvarenga, and David Smith (1999) inferred that all ecosystems cause changes in the ecological balance of the soil in relation to the natural ecosystem of savannah, which presented the highest values of biomass carbon, total organic carbon and of the C-microbial / organic C.

SOIL BASAL RESPIRATION (RBS)

The term soil respiration is defined as O2 uptake and / or release of CO2 by all living entities and metabolizing soil. Usually one considers the soil respiration as a result of the activity of bacteria, fungi, algae and protozoa in soil, including gas exchange, resulting from the aerobic and anaerobic metabolism. It is the method used to quantify the metabolic activity in soils. Therefore, the option of measuring CO2 instead of O2, is the fact that CO2 provides activity information for both aerobic and anaerobic microorganisms (MAIA, 2006).

The RBS is directly related to soil abiotic conditions, such as, aeration, moisture and temperature. In a comparative study, Espindola et al (2006), found in the RBS largest natural forest than in forest area cultivated, which suggests a high respiratory activity, indicative of high biological activity, which has become a desirable feature, if considered as a sign of rapid decomposition of organic waste into nutrients available to plants.

The breathing can be assessed by the release of CO2, being divided into two types: basal respiration and substrate induced respiration (MOREIRA and SIQUEIRA, 2006). Its measurement is considered an indirect estimate of the rate of decomposition of organic material or any material added to soil (ALEF, 1995; SEVERINO et al., 2004).

The rate of respiration per unit microbial biomass (BM), or metabolic quotient (qCO2) to determine the efficiency of use of ecosystem resources. Provides an indicator of significant relevance to control the factors of "stress" (unfavorable conditions such as heavy metals, nutrient limitations, low pH) as well as disturbing factors (rapid flow of environmental conditions, ie, cultivation, burning, etc.) which lead to reduced microbial efficiency.

In general, an"efficient"BM (<qCO2) has a lower respiration rate compared to the same BM"ineficiente" (> qCO2). Thus, a low indicates qCO2 economic use of energy, and presumably reflects a more stable and closer to its equilibrium state (FIALHO, 2006).

FINAL CONCIDERATIONS

It is known that the potential of arbuscular mycorrhizal fungi have with this, several studies involving the effects of these microorganisms in different cultures and at various stages of development should be conducted to better utilization of this potential. Studies involving the protection of plants and AMF there are still few, and this is a very wide field for research that can provide answers to our agriculture, which needs urgent mind strategies less harmful to man and the whole environment.

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