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EFFECT OF TWO FERTILIZERS ON PRODUCTION AND PHYTOSANITARY ASPECTS IN BANANA (MUSA PARADISIACA) CULTIVATION IN BUENAVENTURA, COLOMBIA

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Abstract: The banana (*paradise muse*) is one of the most important foods in the world and plays a relevant role in the food security and sovereignty of more than 400 million people, its versatility and adaptability have allowed it to be raw material for various industries, however, this crop in The rural areas of Buenaventura, Colombia are cultivated under agroforestry systems in subsistence agriculture, in slightly acidic soils and favorable environmental conditions for the presence and proliferation of pests and diseases. The objective of this work was to evaluate the effect of two fertilizers on production and phytosanitary aspects in banana (Musa paradisiaca) cultivation in Buenaventura, Colombia. Chemical fertilizer 15-15-15 was used at a dose of 100 grams/ plant and the dose was increased after each application until reaching a dose of 300 grams/ plants and chicken manure-based compost supplemented with Beauveria bassiana at a dose of 400 grams/plants and increased. in 100 grams after each application every 45 days. To identify the pathogen, a characterization of the symptoms presented by the affected plants was carried out. In this sense, the identification of the pests was carried out based on the observed damage and the morphological description of the captured individuals. Production was evaluated taking into account into account variables such as weight, number of bananas and number of segments per bunch. This research showed that in the study areas the pests Metamasius habitats, and Cosmopolites sordidus, and the pathology caused by Mycosphaerella sp. predominate, in addition that organic fertilization is the best alternative given its low cost, ease of obtaining and contributions it makes in improving the structure and quality of soils.

Keywords:yield, compost, plant health, symptoms.

INTRODUCTION

The banana (Musa AAB Simmonds - Dominico Hartón) has Papua New Guinea as its center of origin, from where it was dispersed to Europe and then to the American continent (Caicedo, 2015). Currently, bananas are among the most important agricultural crops in the world, with an annual production volume that exceeds 39,000,000 tons; Among the most productive regions are Africa, Asia-Pacific and the Latin American Caribbean region, which contribute around 13,000,000 tons.

In that sense, 120 countries produce bananas in tropical and subtropical regions, including Colombia with third place in production with 3,077,564 tons, after Uganda with 7,204,041 tons and the Philippines with 3,224,059 tons, and first place in export volumes with 117,913 t (FAO, 2020).

In these producing areas, bananas are grown by small farmers, in which 87% of the production is concentrated, destined for self-consumption or marketing in local and/or regional markets, because these products are a source of basic food for more than 400 million people (CGIAR, 2014). The remaining 13% of world production is obtained in technical production systems for commercialization in international markets (Roux et al., 2008 and Arboleda, 2022).

Banana production is affected by pest insects, diseases and soil nutritional deficiencies. Among the most frequent and important diseases due to their potential losses include black Sigatoka (Mycosphaerella fijiensis), vascular wilt (Fusarium oxysporum f. sp. cubense race 4), plantain moko (Ralstonia solanacearum) and those caused by phytoparasitic nematodes (Radopholus similis, Helicotylenchus multicinctus, Meloidogyne incognita, M. javanica, M. arenaria, Pratylenchus araucensis, P. coffeae, P. goodeyi, P. speijeri and Rotylenchulus reniformis) (Pandales & Mosquera, 2007;Torrado Castaño,2009;Villegas, 1989; Múnera 2009; Riascos 2019; Arboleda, 2022). As for insect pests, the black weevil (Cosmopolites sordidus), striped and yellow weevil (Metamasius hemipterus and Metamasius hebetatus) stand out (Speijer et al., 2001; Arboleda, 2022). Nutritional deficiencies are corrected with the indiscriminate use of synthetic fertilizers, which increases production costs in addition to generating dependency on these products without taking into account the ecological damage caused to ecosystems with the loss of biological dynamics (Orozco, sf), the joint losses between pest insects, diseases and nutritional deficiencies of the soil can reach 100% if a timely and/or adequate management plan is not implemented, in that sense the use of biological controllers such as Beauveria bassiana for pest insects has been be an economical, efficient and ecosystem-friendly alternative. The objective of the study was to verify the effect of chicken manure-based compost on production and phytosanitary aspects in banana (Musa paradisiaca) cultivation in Buenaventura, Colombia.

MATERIALS AND METHODS

The research was carried out in the district #8 of the Buenaventura District, Valle del Cauca – Colombia, at an altitude of 14 meters above sea level, average annual precipitation of 7800mm/year with an average temperature of 28°C.

A completely randomized block design was used, with three repetitions and three treatments (Chemical fertilizers, Organic fertilizer (compost) and Control). Each treatment had 7 experimental units (plants) Table 1. Each plot had 7 useful plants planted at 4m x4m, it must be noted that a total of 132 plants were planted, of which 50% were the subject of the research, in an approximate area of 530m2.

Organic fertilizers supplemented with Beauveria bassiana at 1x108 spores/grams were applied at the time of sowing (400 grams) and subsequently every 45 days, increasing by 100 grams for each application. In the case of chemical fertilizer, it was also applied at the time of sowing. (100 grams of T-15) and then every 45 days increasing the dose after the third application to 200 grams and 300 grams/plant in the sixth application. The management and/or control of weeds was carried out with a scythe in the streets and manually in the plate, to avoid the use of herbicides and their harmful effects on soil biology. Periodically,Crop management tasks such as sanitary leaf removal and weeding were carried out.

To determine the effect of fertilizers on phytosanitaryaspects,theplantswereevaluated every 8 days to determine the presence and/or absence of pests and/or diseases present in the crop, to subsequently determine the incidence of associated health problems following the formula;**Incidence:**number of diseased plants/total number of plants *100, to finalize the effect on production, variables were measured such as: weight of the bunch, weight of a banana, number of bananas per bunch, number of segments per bunch, time from sowing to flowering, flowering time to harvest. The data obtained were subjected to an analysisof variance "ANOVA" and means separation tests using the SAS statistical package version 9.3.

RESULTS AND DISCUSSION

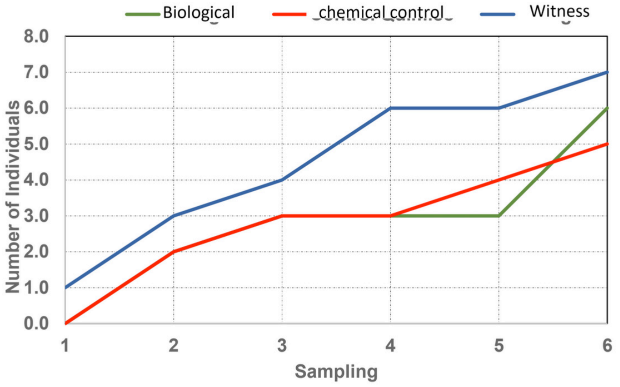
Two pests (Metamasius hebetatus and Cosmopolites sordidus) of the order Coleoptera were associated with banana cultivation regardless of whether the plants had the treatment or not. In that sense, Metamasius hebetatus was characterized by having an approximate length of 1 -1.5cm, the The thorax presented yellow spots as on the elytra, in addition, cross-shaped coloration was evident on the elytra, yellow legs, and chewing mouthparts. Figure 1A, Cosmopolites sordidus, was characterized by being black and/or dark brown in color, with an approximate size of 1.5 -2cm, elytra-type wings, thorax with characteristic lines for this species, elliptical shape, the face is prolonged in a curved beak from which the name weevil is derived. Figure 1B and 1B1, in both cases the symptoms appear as galleries in the corm, which generates wilting, chlorosis, poor development of the clusters in the aerial part of the plant, and finally the plant falls due to the weakening of the root system and corm. Figure 1C, 1C1, 1C2 and 1C3.

Figure 1. Pests and induced symptoms. A. adult Metamasius habitats, B-B1. Adults of Cosmopolites sordidus, C. weevil larva causing gallery, C1. Gallery in the pseudostem, C2. Wilting in the aerial part of the plant, C3. Plant in production affected and stunted cluster.

These findings are consistent with the results reported by Cayetano, 2019.

When he states that these two insects are the main pests associated with banana crops in many production areas, being responsible for estimated losses of more than 60% and up to 100% if A management plan is not implemented (Augura, Proyecto Repcar, 2009). Both insects generate galleries in the corm, without discriminating the phenological state of the plantation, with the larval stage being the most aggressive (Augura, Proyecto Repcar, 2009;Jimenezet al., 2018 and Armendáriz et al., 2014)

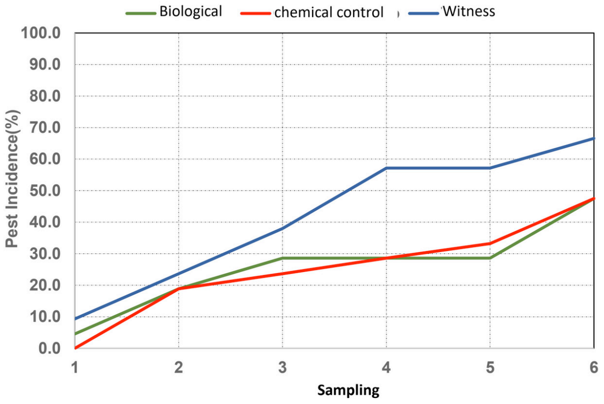
Graph 1. Shows the average number of individuals for each treatment, in this sense, for the chemical control as well as the control, pests were evident from sampling 1 (15 dps) reaching a maximum of 7 individuals (control) and 5 individuals (chemical control), in the case of biological control the presence of pest insects was observed from the fourth sampling, reaching a maximum value of 6 insects.



Graph 1. Average number of individual for each treatment.

According to the incidence of pests in graph 2, it was observed that for the control treatment the % incidence exceeded 66% of the cultivated plants, registering values above 9% from the first sampling and maintaining a trend of increase between sampling. In the case of plants treated with chemical synthesis fertilizers, the incidence was approximately 48%, showing a significant increase between sampling 1 and 2, going from 0 to 20%. The behavior of the plants treated with organic fertilizer (compost) supplemented with B. bassiana reached an incidence of around 48%, showing at the beginning (sampling 1) an incidence of 5%, however, between sampling

3 and 5 there was no increase. although a significant increase was subsequently observed, going from approximately 28.6 to 48%.



Graph 2. Incidence (%) of pests for each treatment.

In accordance withJimenezet al., 2018 and Armendáriz et al., 2014, the number of individuals is related to the degree of technicalization of the plantations, control methods implemented, origin of the seeds and their health status at the time of sowing, Therefore, the population levels in this study were moderate, however, Muñoz, 2007 indicates that the presence of these insect pests must not be allowed given that they have a high reproduction rate, which generates a very rapid population increase in a short time.

Regarding the type of fertilization used, Armendáriz et al., 2014 indicates that a source that provides NPK and minor elements must be sought, therefore, in this research T-15 was used as a source of NPK in synthetic fertilizers, and compost based on chicken manure supplemented with B. bassiana, the latter has been tested by Jiménez et al., 2018; Meyers et al., 2013; Rodríguez-González, 2014; García et al., 2018; reporting that this turns out to be an efficient control in Coleoptera populations, the infection disperses in the different stages of the insect, starting with the eggs, larvae and/or adults respectively, causing the hosts to have a decrease in appetite, incoordination of movements, paralysis and mummification, in addition to this, B. bassiana has been reported as a growth promoter, within the mechanisms that directly promote growth have been studied, the production of phytohormones, nutrient solubilization, increase in nutrient availability and production of siderophores (Joseph et al., 2012; Behie et al., 2015; Behie and Bidochka, 2014; Jirakkakul et al., 2015). These same authors indicate that, although the benefits on diseases do not directly affect the causal agent of the pathology, they do activate defense mechanisms in the plant that allow it to be tolerant to pests and pathogens.

Regarding the pathology observed, the pathogen Mycosphaerella sp. could be identified. Since it appeared as necrotic spots in the center with a chlorotic halo on the periphery, the lesions were also characterized by having a soft, dry texture and no elevation. Figure 2. Regarding the incidence of this disease, it was observed that for all treatments the presence of the pathology was evident from sampling 3, although the control treatment reached 90% in sampling 5, while in this same sampling The biological treatment reached 70% and the chemical treatment approximately 57%, although a percentage difference was observed between the treatments for sampling 5, in sampling 6 for all treatments the incidence reached 100%. Graph 3.

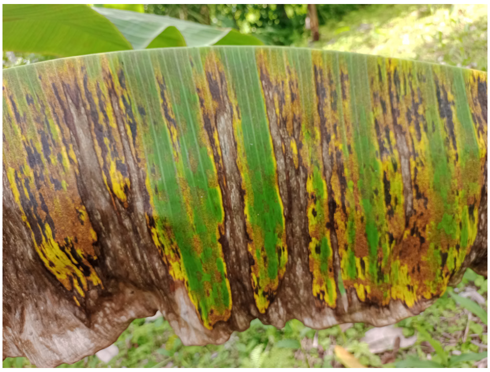


Figure 2. Symptoms caused by Mycosphaerella sp.

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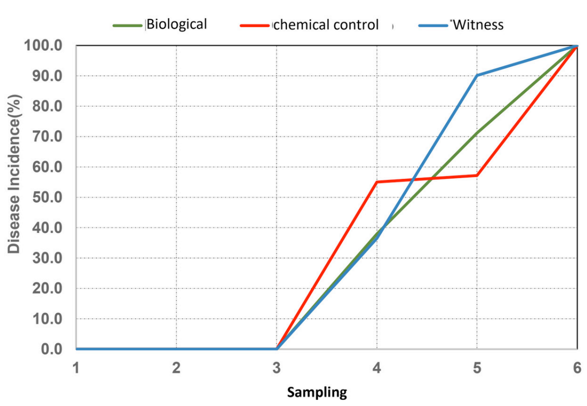
The symptomatology described above is consistent with the description suggested byJimenezet al., 2018., this same, ensures that the distribution pattern is initially random until it becomes uniform when all the plants present the disease, since, being a foliar pathology, it spreads easily by the action of water, phytophagous insects and the wind mainly, Armendáriz et al., 2014 indicate that the degree of severity of the pathology is directly related to the susceptibility of the plant material (genetic aspects), favorable environmental conditions for the pathogen and host nutrition. Agrios, 2005 reports that this pathogen is hemibiotrophic so we will initially see its biotrophic phase causing chlorosis, to finally generate necrosis (death of plant tissue), this condition allows the pathogen to establish itself in all productive areas since it can survive in harvest remains restart the pathogenic phase at the time of establishing another crop cycle.



Graph 3. Percent Incidence of Mycosphaerella sp for each treatment.

Table 1 shows the averages by treatments for the variables: incidence of the disease, incidence of pests and number of pests, where it was evident that for the incidence of the disease there were no significant differences, in that sense significant evidence was observed. for the incidence and number of pests between the chemical and biological treatments compared to the control, however between the chemical and biological there was no significant difference, which reaffirms that plant nutrition is a fundamental factor to counteract the effects of the presence of pests. pests and diseases (Behie et al., 2015).

Regarding production, it was observed that the results obtained in this researchare related to those achieved byAritzábal et al., (2010) when they indicated that the weight of the bunch is related to the amount of K available to the plant, in that sense, chemical fertilization provides this element more quickly than organic fertilizer without forgetting that in the Availability of K in a chemical source will depend on climatic conditions such as precipitation, which can generate losses due to runoff and filtration to deeper profiles where plant roots cannot reach; It is important to highlight what was reported by Dto Silva et al., (2013), where they concluded that potassium significantly increases the weight of the fruits, because K is the element responsible for the carbohydrate filling of the fruits.

Although, the yields achieved are below the national average (Colombia) table 4. which ranges between 8-10ton/ha and 20-25ton/ha in the most productive areas (Agronet, 2022), but in this area the results of organic treatment are encouraging given the low cost of compost production, type of agriculture (agroforestry systems) that turns out to be not very intensive, in addition to being associated with other plant species and the edaphoclimatic conditions that turn out to be one of the main limitations in production., Espinosa and Mite (2002) indicate that organic fertilizers not only They are important in a crop cycle, but they are a medium and long-term bet, since they improve the structure of the soil, allowing better development of the root system, improves soil aeration and generates an environment conducive to the establishment of beneficial macro and microorganisms that will establish symbiotic relationships with the

Treatment	Incidence (Diseases)		Incidence (Pests)		Number of Insects	
	Average	Cluster	Average	Cluster	Average	Cluster
Biological	30.5	to	25.6	b	3.0	b
Chemical Control	31.2	to	24.6	b	3.0	b
Witness	32.8	to	40.8	to	4.0	to

Note: Within the same column, averages with the same letter do not differ statistically.

Table 1. Mean separation test.

Source of Variation	Gli	Incidence (Diseases)		Incidence (Pests)		Number of Insects	
		CM	Pr > F	CM	Pr > F	CM	Pr > F
Sampling	5	0.4749	<.0001	0.0843	<.0001	2,584	<.0001
Treatment	2	0.0008	0.685	0.0448	<.0001	0.861	<.0001
Sampling x Treatment	10	0.0048	0.034	0.0027	0.060	0.052	0.394
Average		31.5		30.1		3.0	
CV (%)		4.90		3.94		11.2	

Table 2. Variance analysis

Source of Variation	Gli	Cluster Weight (kg/ plant)		Fruit Weight (kg)		Number of Fruits/ Cluster		Yield (kg/ha)	
		CM	Pr > F	CM	Pr > F	CM	Pr > F	CM	Pr > F
Treatment	2	20.70	<.0001	0.03863	<.0001	111.78	<.0001	8086061.07	<.0001
Average		6.42		0.36		24.9		4014.5	
CV (%)		6.3		11.2		8.5		6.3	

Table 3. Variance analysis for production.

Treatment	Cluster Weight (kg/ plant)		Fruit Weight (kg)		Number of Fruits/ Cluster		Yield (kg/ha)	
	Average	Cluster	Average	Cluster	Average	Cluster	Average	Cluster
Biologic control	6.96	to	0.40	to	26.1	to	4348.2	to
Chemical Control	7.23	to	0.37	to	26.8	to	4520.8	to
Witness	5.02	b	0.30	b	21.7	b	3138.4	b

Note: Within the same column, averages with the same letter do not differ significantly

Table 4.Mean separation testfor production.

plants, causing a decrease in production costs since they help the plant.

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