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Application of Bio-stimulants in Banana Vitroplant Production (Musa sp.)

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ABSTRACT

This research took place between February and April 2016, at the Center of Vitroplant Acclimatization of the Bio factory run by the Seed Company of Camaguey, in order to apply different bio-stimulants and evaluate the growth indicators observed during implementation of bio-organic alternatives to banana (Musa sp.) vitroplant production Polyethylene bags were used in the experiment, and the substrate contained 50% humus and 50% compost. The FHIA-03 variety was planted, following a completely randomized design with four treatments and four replicas. Natural Liquid Humus (NLH), Improved Liquid Humus (ILH), and Fortified Liquid Humus (FLH) were used as bio-organic products. Plant size, stem thickness, and leaf quantity were measured. All the data were statistically processed through simple variance analysis (ANOVA) to determine the significant differences. The Duncan multiple range test (P≤0.05), with 95% significance, was used for comparison of means. Data variance analysis was performed by SSPS, version 11.5.1, for Windows. The Duncan multiple range test (p:0.05) was performed when significant differences were observed. The application of bio-organic products containing FLH produced the highest benefits to crops for the indicators evaluated.

KEY WORDS/: Musa, vitroplants, bio-stimulants, liquid humus

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INTRODUCTION

Cuban agriculture is engaged in deep and inevitable changes mostly driven by economic reasons. The concept of green revolution must be put aside today because it is not in concert with environmental protection. Recent agronomic, economic and social studies have shown the real opportunities of large-scale development for sustainable agricultural systems that combine technical feasibility, economic viability and social acceptance (Funes, 2009).

The quantity, quality and variety of foods are still insufficient to meet the domestic demands of Cuba, whose imperative is to cut down imports. Therefore, food production through sustainable means is top priority for the government (Vázquez and Funes, 2010).

Micropropagation is a term used to define different techniques applied for in vitro plant multiplication. The resulting plants must be phenotypically and genotypically identical to their foster plants. The most commonly used procedure for commercial plants is axillary bud formation, because of the genetic stability of the material generated, and the simplicity in the application of the method to different species (National Group of Varied Crops, 2004).

The use of bio-organic primers in agriculture has been encouraged by the emergence of new agroecological trends. In Cuba, it has increased in recent years, along with new programs that apply such products (filtered liquid humus from cattle manure, azotobacter, phosphorin, Ecomic, and more recently, FitoMas E and Bayfolan forte). All of them provide essential elements for plant growth and development (López et al., 2011).

Certainly, plantain and banana are two of the most important sources of carbohydrates in the Cuban diet. They can be produced all the year and therefore, are key crops in any self-supply program.

Vitroplant production is very important due to sanitary issues in relation propagation by traditional methods and low multiplication coefficients in the species which hinder fast propagation of promising clones with high quality healthy plants (National Group of Varied Crops, 2004).

Therefore, the aim of this research is to apply enriched or combined bio-organic primers to enhance efficiency during plantain vitroplant acclimatization, based on previous production research. It must allow a larger and more effective offer, and a high quality product. Similarly, it will provide technology for plant nutrition until they are fully grown and developed, ready for plantation in new areas.

MATERIALS AND METHODS

Location of the experimental area: this research took place between February and April, 2016, at the Center of Vitroplant Acclimatization of the Biofactory run by the Seed Company of Camaguey, Cuba, located between 21024´05´´ north latitude and 77053´25´´ west longitude, 100 meters above sea level.

The local climate is humid subtropical, interior plain with seasonal humidity and high evaporation; the annual precipitation average is 1 265.5 mm, evaporation is 2 140.0 mm, annual average temperature is 24.8 ºC, and the relative humidity average is 81% (National Institute of Hydraulic Resources, 2014).

Table 1 Experimental scheme

Treatment	Products	Dose
1	Witness	-
2 (NLH)	Natural liquid humus	1.5 L ha-1
3 (ILH)	Improved liquid humus	1.5 L ha-1
4 (FLH)	Fortified liquid humus	1.5 L ha-1

Forty-eight plants were evaluated in each treatment (192 total plants) at the acclimatization area of the biofactory, using a Latin square design with 4 treatments and 4 replicas in semi controlled conditions.

Polyethylene bags were filled with 50% wormcasting and 50% compost. The plants (phase III rooting FHIA-03) were planted 1 cm deep. Irrigation (microjet) was made daily in two sections; water consumption was 134 L/day. The application of bio stimulants was made onto the leaves at an early morning hour.

Measurements

- Number of leaves: Leaf counts were made on the 30^{th} and 60^{th} days to 48 plants per treatment.
- Plant height: measurements were made on the 30^{th} and 60^{th} days to 48 plants per treatment, using a measure tape.
- Stem width: measurements were made using a caliper gauge on the 30^{th} and 60^{th} days.

Characterization of water and substrates

Table 2 Main physical and chemical features of the water used for irrigation

		mmol L^{-1}						
pH	C E dSm^{-1}	Ca^{+2}	Mg^{+2}	Na^{+}	K^{+}	CO_3^{-2}	HCO^-_3	Cl^-
7.89	0.59	0.83	3.11	0.96	0.07	0.0	2.9	1.5

Source: Soil Laboratory, Camaguey (2016)

Table 3. Main features of the substrate

pH	C E dSm^{-1}	Ca %	Mg %	P %	K^+ %	N %	O. M. %	Moisture %
7.74	1.10	1.32	1.15	0.65	0.60	2.38	55.05	44.60

Source: Soil Laboratory, Camaguey (2016)

Substrate analyses were made by the aqueous method, according to the methodology for sample analysis of the organic substrate (National Department of Soils and Fertilizers (1992)). Water analyses were made according to standard 690 for chemical analysis (MINAG, 1984).

Sampling was made at the beginning of the experiment, in order to characterize the physical and chemical composition of water (Table 1) and the substrate (Table 2).

Statistical analysis

SSPS 11.5.1 was used for data assessment, with simple variance analysis. The multiple Duncan´s ranges were applied for significance (0.05 %).

RESULTS AND DISCUSSION

Plant height at 30 and 60 days

Figure 1 shows evaluation of plant height on the 30th and 60th days, with significant differences between the treatments studied. The best treatment was number 4, with 8 cm and 16 cm, respectively; then treatments 2 and 3, with 6 cm and 7 cm, respectively. Treatment 1 only reached 3 and 7 cm, respectively, the poorest result. All the previous was possible thanks to the beneficial effects of primers in terms of cytochinine, auxine and humic acid contribution, with an effect on plant growth. According to Guenkov (1989), plant nutrition is important for organ formation and other biological and physiological processes to grow and develop. The absence of any nutrient could cause negative impacts.

Similar results were achieved by Lozada (2014), using the same products on carrots, with significant differences in treatment 4, using greater amount of nutrients (fortified liquid humus). Also García *et al*., 1999, had similar results. Their comparative studies of two kinds of garden produce treated bioproducts, reported heights of 37.0 - 43.0 cm.. This behavior shows the response of certain biotypes and the expression of individual features according to the environmental conditions. Similar results were also accomplished by López and Montejo (2012) who applied the organic primer to the same crop in protected crop houses. The most significant differences were reported in treatment 4, with the highest values.

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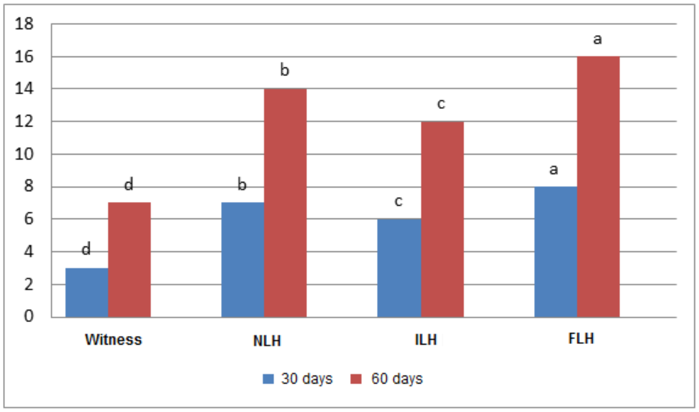

Fig. 1. Plant height at 30 and 60 days.

Notes: a, b, c… different letters differ for p≤ 0.05% E Sx 30 days: 0,125 E Sx 60 days: 0,3682
NLH: Natural Liquid Humus FLH: Fortified Liquid Humus NLH: Natural Liquid Humus ILH: Improved Liquid Humus

Number of leaves at 30 and 60 days

The number of leaves is a vital element to be considered within the physiological aspects of acclimatization. Table 4 shows the results, with statistical significance for treatment 4, with the best behavior (5 and 8 leaves on the 30th and 60th days, respectively). Clearly, the nutrition conferred by the fortified liquid humus had a positive effect on plant development; the witness only produced 3 and 6 leaves, respectively, the poorest result. Guenkov (1989) claimed that plants must make a well-developed leaf system to develop larger fruit in greater quantities, which can be achieved with the proper amount of nutritious substances.

Research made by INSAN (1996) revealed an apparent analogy between plant development and the application of humic substances in terms of plant mineral nutrition.

Table 4. Number of leaves at 30 and 60 days

Treatments	30 days	60 days
Witness	3 c	6 c
NLH	4 b	7 b
ILH	4 b	7 b
FLH	5 a	8 a

Notes: a, b, c… different letters differ for p≤ 0.05% E Sx 30 days: 0,125 E Sx 60 days: 0,2394
NLH: Natural Liquid Humus FLH: Fortified Liquid Humus NLH: Natural Liquid Humus ILH: Improved Liquid Humus

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Stem thickness at 30 and 60 days

Figure 2 shows stem thickness in treatment 4 (0.68 and 0.51 cm on days 30 and 60, respectively); it showed the best statistical behavior, with significant differences in comparison to the rest. Similar results, were achieved by Palacios (2006) in protected crop systems (3.5 - 5.0 cm), in tomato (variety 30-57), using bio-organic alternatives through the leaves and fertilizing irrigation. It coincided with results accomplished Castillo (2014) in tomato, also obtained the best results in treatment 4 (4.7 and 4.9 cm, on the 30th and 60th days, respectively), using fortified liquid humus.

Similar results, were also reached by Pérez (2012), using plant growth primers in beans. The treatment using fortified liquid humus showed the best results, marking a positive effect of bioproducts on crop nutrition, and their positive effects when applied onto the leaves.

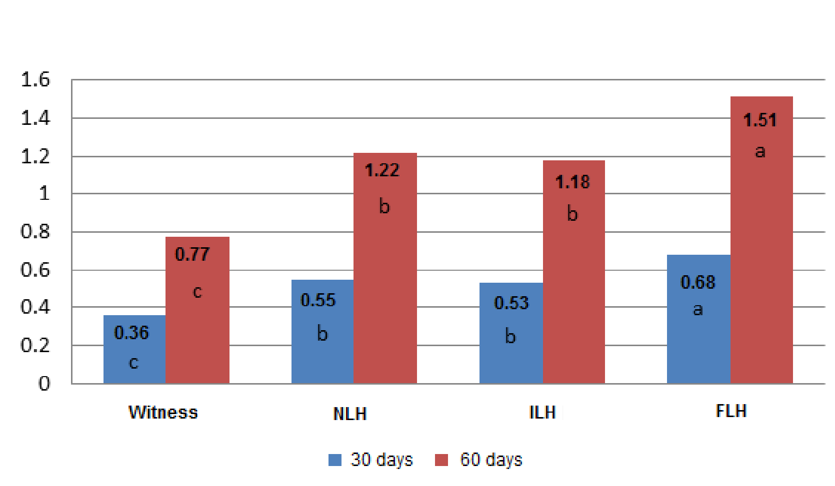

Fig. 2: Stem thickness (cm) at 30 and 60 days.

Notes: a, b, c… different letters differ for p≤ 0.05% E Sx 30 days: 0,3084 E Sx 60 days: 0,1239

NLH: Natural Liquid Humus FLH: Fortified Liquid Humus NLH: Natural Liquid Humus ILH: Improved Liquid Humus

CONCLUSIONS

Growth during plantlet acclimatization of plantain responded positively to the application of bio stimulants. The best results of vitroplant growth indicators were observed with the application of fortified liquid humus.

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