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Original article

Effect of VIUSID® Agro on lettuce (*Lactuca sativa*, L.) under urban organic garden conditions

Efecto de VIUSID® Agro en el cultivo de lechuga (*Lactuca sativa,* L.) en condiciones de organoponía

Neysis Pérez-Fernández*, Osberto Gutiérrez-Gevara, Mireldi Fonseca-Pérez

Universidad de Las Tunas. Ave. Carlos J. Finlay s/n, Las Tunas, Cuba. CP. 75200

ABSTRACT: The work was developed in the urban organic garden "Mercasa", Las Tunas; in the period from the first day to December 27, 2019, with the objective of evaluating the effect of different doses of VIUSID® Agro on the yield of lettuce crop, cv. Fomento-95, under urban organic garden conditions. A completely randomized design with four treatments (control without application and application of VIUSID® Agro at 0.15, 0.20 and 0.25 ml L^{-1} of water) was used. The following morphoagronomic variables were evaluated: plant height, leaf length and width, stem diameter, number of leaves, root length, mass per plant and yield. The data obtained were subjected to a simple analysis of variance using the Statgraphics statistical package. The best results obtained in most of the morphological and yield variables evaluated corresponded to the VIUSID® Agro dose of 0.15 ml L^{-1} of water, with greater economic feasibility.

Key words: application rate, biostimulants, vegetables.

RESUMEN: El trabajo se desarrolló en el organopónico “Mercasa”, Las Tunas; en el período comprendido del día primero al 27 de diciembre de 2019, con el objetivo de evaluar el efecto de diferentes dosis de VIUSID® Agro en el rendimiento del cultivo de la lechuga, cv. Fomento-95, en condiciones de organoponía. Se empleó un diseño completamente aleatorizado con cuatro tratamientos (control sin aplicación y la aplicación de VIUSID® Agro a razón de 0,15; 0,20 y 0,25 ml L^{-1} de agua. Se evaluaron las siguientes variables morfoagronómicas: altura de la planta, largo y ancho de la hoja, diámetro del tallo, número de hojas, largo de la raíz, masa por planta y el rendimiento. Los datos obtenidos se sometieron a un análisis de varianza simple con el empleo del paquete estadístico Statgraphics. Los mejores resultados obtenidos en la mayoría de las variables morfológicas y de rendimiento evaluadas correspondieron a la dosis de VIUSID® Agro de 0,15 ml L^{-1} de agua, con una mayor factibilidad económica.

Palabras clave: dosis de aplicación, bioestimulantes, hortalizas.

INTRODUCTION

In Cuba, in view of the need to increase the consumption of vegetables by the population, urban organic garden and intensive orchards were established and developed as forms of production to achieve high yields and commercialization throughout the year, guaranteeing the varied nutrition of the population (1).

Among the vegetable species grown under these conditions, lettuce (*Lactuca sativa*, L.) stands out. This vegetable, in its different forms and colors, is one of the most common and consumed worldwide. At present, it is grown outdoors, in greenhouses, in soil or hydroponically, to avoid the limitations caused by climatic, light and soil conditions (2). This species is grown in all provinces, both in state enterprises, cooperatives, orchards, urban organic gardens and small privately owned areas that, in turn, guarantee the consumption of the populations near them (3).

World lettuce production is 24,976,032 million kilograms, over an area of 1,016 million hectares. China produces 54.64 % of the world total; USA 15.17 %; India 4.4 %; Spain 3.6 % and Italy 2.84 %, with average yields of 2 016 kg per square meter (4).

*Author for correspondence: neysis@ult.edu.cu

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In 2019, vegetable production in Cuba was one million 252 thousand tons (5). Despite the high acceptance of this vegetable by the population and the constant effort of producers to increase their productions, in the country and, in particular, in Las Tunas, yields continue to be low, around 3 kg m^{-2}, when compared with those obtained in other countries of the world, such as China (14 kg m^{-2}) (6,7). As a result, consumption needs are not met, hence the importance of obtaining year-round crops with higher yields (2-5).

In recent years, obtaining high crop yields has been limited by different factors, such as: low proportion of irrigated areas, incidence of pests, eroded soils and few inputs for fertilization. It is necessary to search for new technologies to obtain higher yields without the use of mineral fertilizers, since they are economically costly and their excessive and continuous use affects soils and the environment. Among these alternatives that can be used by organic agriculture, the use of biostimulants stands out, in order to achieve an ecologically sustainable agricultural development, which allows a low-cost production that does not pollute the environment and maintains soil conservation with fertility and biodiversity (8,9).

Numerous researches demonstrate the efficacy of plant growth stimulators in different crops, with yield increases, as improvers, soil and environmental conservation. Plant growth stimulators used include, for example, VIUSID® Agro, NutraGreen® and Phyllum® (10-13).

This biostimulant, VIUSID® Agro, is used in different areas of agronomy as a plant growth precursor. This product is an ecological alternative to reduce or replace the use of contaminating products and contains, among other substances, malic acid, monoammonium glycyrrhizinate, amino acids, phosphates, vitamins and minerals, subjected to a biocatalytic process of molecular activation; this process increases the biological activity of the molecules and the biochemical reactivity of all its molecules, which increases its effectiveness without altering its properties and improves the conditions of initial growth, giving rise to a greater quantity and quality of fruit per plant. It is harmless to the environment and non-toxic (14,15).

To determine the influence of biostimulators on the growth and productivity of crops, particularly lettuce, the objective of the research was to evaluate the effect of different doses of VIUSID® Agro on morphological variables and the yield of a lettuce cultivar developed under urban organic garden conditions, in order to contribute to increasing yields.

MATERIALS AND METHODS

The work was carried out in the urban organic garden "Mercasa" in Las Tunas municipality, from December 1 to 27, 2019, with the objective of evaluating the effect of three doses of the biostimulant VIUSID® Agro on morphological and yield variables of the lettuce crop, cultivar Fomento 95.

A completely randomized design with four treatments and four replicates was used for the experimental set-up. The treatments corresponded to a control without application and to the application of VIUSID® Agro, at a rate of 0.15, 0.20 and 0.25 ml L^{-1}. To select the doses used, the one recommended by Catalysis S.L., manufacturer of the product and used by (16) in conditions different from those of this research, was taken as a basis.

The plant growth stimulator VIUSID® Agro, of Spanish origin, was applied with a 16 L Matabi knapsack. Three applications of VIUSID® Agro were made, at 7, 14 and 21 days after transplanting.

Each experimental plot consisted of five furrows and was 1 m wide by 20 m long, for an experimental area of 800 m^2. The planting distance used was 0.15 m x 0.10 m.

Seedlings were selected with homogeneous height and transplanted on December 1, 2019. Harvesting was done manually 27 days after transplanting. The phytotechnical tasks, except those related to fertilization, were carried out according to the technical guide for lettuce crop production (2).

The sprinkler irrigation technique was used. One irrigation was made immediately after transplanting and the following irrigations were made twice a day until harvest.

Weed control was carried out manually 10 days after transplanting; from this point on, the indications of the technical guide for the production of the crop were followed (2).

For the detection of pests, sampling was carried out every seven days. The English flag method (17) was used to monitor the causal agents of pests.

The values of the climatic variables prevailing during the experimental period were taken from the Provincial Meteorological Center from Las Tunas (18). The maximum temperature was 30.3 ºC and the minimum 23.1 ºC, with a relative humidity of 75 %. During the stage, 6 mm of rainfall occurred.

A total of 30 plants per plot were taken for the measurements, that is, ten plants from the three center rows. The outer furrows were discarded to avoid the edge effect (19).

The morphological and yield variables evaluated were: plant height (cm), root length (cm), leaf length and width (cm), stem diameter (cm), number of leaves per plant, plant fresh mass (g) and agricultural yield (kg m^{-2}).

The statistical package STARGRAPHICS centurion XV version 15.2.14 was used to evaluate the results, and Tukey's multiple range test for 5 % significance was used to compare means. Data transformations were applied to the quantitative variables in order to reduce the standard error and ensure normality (10).

RESULTS AND DISCUSSION

The analysis of the effect of VIUSID® Agro is made, where it is demonstrated that the application of the product surpassed the control treatment, in 50 % of the studied variables. It can be due to the plant response to the application of amino acids, also associated to the formation of biologically active substances, which act stimulating the

vegetation, which is of great interest in critical periods of the crops or in those crops of highly intensive production as in greenhouses and hydroponic crops (10).

Its effect on the morphological variables evaluated showed the best performance with the application of VIUSID® Agro at a dose of 0.15 ml L^{-1}, with significant differences from the other treatments. The lower values corresponded to the control without application, although in the variable stem diameter there were no differences for the doses of 0.20 and 0.25 ml L^{-1} (Table 1). This may be due to the better absorption of nutrients, since this product activates or stimulates the physiological functions of the plant and its application allows a better use of nutrients. The application of VIUSID® Agro with different doses has achieved good results in the *R. sativus* crop, which obtained the best performance with significant differences from the rest of the treatments, with the 0.7 L ha^{-1} dose, so it positively influenced the morphological and productive indicators of this crop (20).

Another author (21) also obtained lower heights when he studied the influence of three biostimulants applied to the foliage on the yield of lettuce, cultivar "Romana", in the area of Pueblo Viejo, Ecuador. This author used three leachates, including earthworm humus, but at higher doses (8, 10 and 15 L ha^{-1}) than in this study.

Several authors reported the positive effect of Quitomax® on the tomato crop (*Solanum lycopersicum* L.) and the evaluation of its effect on yield and nutritional value, due to the application of biostimulants, which enhance auxins and intervene in the process of plant reproduction, related to natural hormones and resistance to fungal diseases in plants (22).

VIUSID® Agro has a stimulating effect on the plant height and the dose better 0.15 ml L^{-1} in relation to the others and the control without application. This can be because in the composition of VIUSID® Agro is found zinc, which intervenes in the growth of plants and when this is applied, alone or combined with other nutrients in formulations of agricultural use, favorable yields are obtained (16,23). The results obtained with the dose of 0.15 ml L^{-1} coincide with those of different authors who, in the cultivation of beans, obtained similar results with the use of different doses of VIUSID® Agro (24-26), which shows the stimulating effect that different doses applied to various crops can have.

Some of the biostimulants, such as VIUSID® Agro, due to the fact that in their formulation they contain free amino acids which have a low molecular weight, are transported and absorbed quickly by the plant, taking advantage of the synthesis of proteins, saving a great amount of energy, which is concentrated in the increase of production (14). This agrees with the results obtained with the dose of 0.15 ml L^{-1} of VIUSID® Agro, which obtained the greatest leaf width.

Similarly, the best result in terms of the number of total leaves was achieved when VIUSID® Agro was applied at a dose of 0.15 ml L^{-1}, with a significant difference among the other treatments. A component of VIUSID® Agro is folic acid, which acts as a transporter and is important in the metabolism of amino acids and in the synthesis of nitrogenous bases required for the formation of new tissues (14). This justifies the high leaf production obtained with the 0.15 ml L^{-1} dose, with respect to the control and the other doses.

Regarding the number of non-commercial leaves, the control treatment without application was the one with the highest number of commercial leaves discarded. The dose of 0.15 ml L^{-1} achieved the best result, because if it is taken into account that, in the case of lettuce, where the agricultural fruit is constituted by the leaf system, and this parameter is the most important, the lowest number of leaves discarded was with this dose (Table 2).

When comparing these results with authors (27) who evaluated the cultivation of lettuce (*L. sativa* L.) under urban organic garden and semiprotected systems, they obtained that the number of commercial leaves of the Fomento 95 and Black Seeded Simpson varieties was higher under urban organic garden conditions when compared with semiprotected conditions. When compared with the results of this research (10,15), regarding the number of total leaves, it is shown that they are superior with the application of VIUSID® Agro with the dose of 0.15 ml L^{-1} and differs from the remaining treatments. This research with the dose of 0.15 ml L^{-1}, with significant differences with the control without application, agree with those proposed (14), so that the application of VIUSID® Agro favored obtaining leaves of better quality, reducing losses, achieving better productive results. The doses 0.20 and 0.25 ml L^{-1} do not present significant differences between them, but they do differ from the control of VIUSID® Agro.

Table 1. Effect of different doses of the biostimulant VIUSID® Agro on the growth of lettuce, cv. Fomento 95, under urban organic garden conditions

Treatments	PH	LL	LW	SD
Control without application	39.6 c	20.35 d	10.6 c	5.76 b
0.15 ml L^{-1}	48.55 a	28.0 a	14.5 a	7.265 a
0.20 ml L^{-1}	43.75 b	23.5 c	11.75 b	6.145 ab
0.25 ml L^{-1}	44.2 b	26.95 b	11.9 b	6.09 b
C.V %	16.71	12.70	16.83	29.69
SE ±	0.61	0.62	0.45	0.40

Means with different letters differ significantly, $P < 0.05$

PH: Plant height (cm). LL: Leaf length (cm). LW: Leaf width (cm). SD: Stem diameter (cm)

Root length analysis was performed, where there were no significant differences between the doses and the control without application (Table 2). Although statistically there was no difference, the results were positive in this variable, since this favored a better absorption of the nutrients available in the soil. Several authors refer, when evaluating the effect of the growth promoter VIUSID® Agro on the lettuce crop under production conditions and with low inputs, that the rooting factor in L. sativa behaved with better results with doses between 0.7^{-1} L ha^{-1} (28), which agrees with the results achieved.

In relation to the total mass of the plant, the dose of 0.15 ml L^{-1} of VIUSID® Agro, with significant differences between the control without application and the other doses; the rest of the applied doses, 0.20 and 0.25 ml L^{-1} did not present significant differences between them and the control. This phenomenon could be due to the mechanisms of action of this bioproduct, which are based on its biostimulant action, with the presence of auxins and amino acids of auxinic action, whose function can affect both the foliar and root system, as well as the improvement of soil fertility (14).

When analyzing the economic effect of the product application at different doses (Table 3) on *L. sativa*, L., it was observed that the treatment where the dose of 0.15 ml L^{-1} was applied showed the lowest cost (0.05) per weight of production and the greatest gain (70.18) with respect to the control and the other doses.

The highest productive efficiency was reached with the 0.15 ml L^{-1} variant of VIUSID® Agro, which coincides with several authors (28) when evaluating VIUSID® Agro as an alternative for the increase of agricultural production, which obtained similar results to those reached in this research, although in other crops. The application of the dose 0.15 ml L^{-1} influenced, positively, in the yield that reaches a higher profit in relation to the production cost; which coincides with several authors that refer the economic benefits with the application of stimulants of vegetal growth, especially when they are used in combination and is attributed to the joint effect of a series of components of VIUSID® Agro submitted to the process of molecular activation that confers more energy to the molecules (14). The results obtained coincide with this approach, since where the 0.15 ml L^{-1} dose was applied, a higher yield was obtained.

CONCLUSIONS

The use of VIUSID® Agro at a dose of 0.15 ml L^{-1} on lettuce plants, cv. Fomento 95, shows the best results in morphological variables, yield and economic feasibility

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Table 2. Effect of different doses of the biostimulant VIUSID® Agro on the growth of lettuce, cv. Fomento 95, under urban organic garden conditions

Treatments	NTL	NNCL	RL	TW
Control without application	16.2 b	5.7 a	5.8 b	0.31 b
0.15 ml L^{-1}	20.15 a	1.85 c	6.545 ab	0.56 a
020 ml L^{-1}	15.2 b	3.65 b	7.045 a	0.26 b
0.25 ml L^{-1}	15.95 b	3.25 b	6.295 ab	0.30 b
C.V %	31.77	18.0	26.8	0.43
SE ±	1.13	0.24	0.37	0.02

*Means with different letters are significantly different, P < 0.05

NTL: Number of total leaves. NNCL: Number of non-commercial leaves. RL: Root length (cm). TW: Total weight (Kg)

Table 3. Economic evaluation of the application of the biostimulant VIUSID® Agro on the growth of lettuce, cv. Fomento 95

Treatments	Yield (kg m^{-2})	PV m^{-2} ($)	Cp m^{-2} ($)	C/$	G/ ($ m^{-2})
Control without application	6.2	29.10	3.88	0.13	35.54
0.75 ml/5 L	11.2	35.71	3.90	0.05	70.18
1.00 ml/5 L	5.2	23.81	3.92	0.11	30.47
1.25 ml/5 L	6.0	21.16	3.94	0.10	35.74

PV=Production value, Cp=Cost of production, C/$=Cost per weight, G=Gain

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