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Short comunication
PECTIMORF® EMPLOYMENT TO STIMULATE TUBERIZATION IN POTATO (*Solanum tuberosum* L.)

Comunicación corta
Empleo de pectimorf® para estimular la tuberización en papa (*Solanum tuberosum* L.)

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ABSTRACT. An experiment was carried out for two years in areas belonging to the National Institute of Agricultural Sciences (INCA) to evaluate the influence of Pectimorf® in the potato plant tuberization process, in order to evaluate the influence of Pectimorf® on the number of stems per plant and number of stolons and tubers per stem. The work consisted in applying Pectimorf® at a concentration of 10 mg L^{-1} at the time of planting, sprayed on the seed tubers and at 20, 25 and 30 days after planting the foliage and a control without application, following a completely randomized design. The plants were grown in containers of six liters capacity (two plants in each) containing a Ferralitic Red Eutric Compact soil and imported seed of the Romano variety of Dutch provenance for planting. Ten days after the last application, the following indicators were evaluated: number of stems per plant, number of stolons, and number of tubers per stem. The differences among treatments were evaluated using the confidence interval calculation of means from their standard error and means were compared using the t-student test $p<0,05$. All statistical processing was performed using Statgraphics v. 5.1 and the graphs were performed with the program SigmaPlot v. 11. The results showed influence of Pectimorf® on the induction of stolons and a greater number of tubers when applied at 25 days after planting when compared to plants that had not been treated.

Key words: growth, nutrition, potato, yield

RESUMEN. Se realizó un experimento durante dos años en áreas pertenecientes al Instituto Nacional de Ciencias Agrícolas (INCA) para evaluar la influencia del Pectimorf® en el proceso de tuberización de plantas de papa, con el objetivo de evaluar la influencia del Pectimorf® en los indicadores número de tallos por planta y número de estolones y de tubérculos por tallo. El trabajo consistió en aplicar Pectimorf® a una concentración de 10 mg L^{-1} en el momento de la plantación, asperjado a los tubérculos semilla y a los 20, 25 y 30 días después de la plantación al follaje y un testigo sin aplicación, siguiendo un diseño completamente aleatorizado. Las plantas se desarrollaron en recipientes de seis litros de capacidad (dos plantas en cada uno) los que contenían un suelo Ferralítico Rojo Éutrico Compactado y se empleó semilla importada de la variedad Romano de procedencia holandesa para la plantación. Diez días después de la última aplicación se evaluaron los indicadores: número de tallos por planta, número de estolones y el de tubérculos por tallo. Las diferencias entre tratamientos se evaluaron mediante el cálculo del intervalo de confianza de las medias a partir de su error estándar y las medias se compararon por la prueba de t-Student a $p<0,05$. Todo el procesamiento estadístico se realizó con el empleo del programa Statgraphycs v. 5.1 y los gráficos se realizaron con el programa SigmaPlot v. 11. Los resultados mostraron influencia del Pectimorf® en cuanto a la inducción de estolones y un mayor número de tubérculos cuando se realizó la aplicación a los 25 días después de la plantación al comparar con las plantas que no se habían tratado.

Palabras clave: crecimiento, nutrición, papa, rendimiento

INTRODUCTION

Pectimorf® is a bioregulator synthesized by the Oligosaccharins Laboratory of the National Institute of Agricultural Sciences (INCA) constituted by a mixture of oligopectators obtained from waste from the citrus industry (1).

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The results show that this product can not only partially or totally replace the traditional growth regulators, but in most cases, results are obtained superior to those obtained with traditional phytohormones, in the morphogenetic development of crops vegetables[A]. It is considered a powerful elicitor of defense in plants (2) and stimulating the growth of cell differentiation of different plant species, it can also activate defense mechanisms and reduce or attenuate the environmental stress of plants, as described in the patent of the product (3).

The potato (*Solanum tuberosum*, L.) is the fourth food crop in order of importance, after wheat, rice and corn. Together with these cereals, it has great relevance in the diet of the world population. It is among the ten most important foods produced in developing countries[B].

Potato production should have a more ecological approach (4), an aspect that is given great attention at the present time, considering experiences in other regions, where it is sought to increase the productivity of the potato at the cost of a high investment in agrochemicals, which ultimately affects the economy of the producer and the environment.

On the other hand, it is necessary to search for new alternatives (5) that allow a more rational use of resources, reduce production costs without affecting the quality and yields of crops, which has led to the use of biostimulants from the growth of agricultural use in different crops. Taking into account the aforementioned, this work aims to evaluate the influence of Pectimorf® on the indicators number of stems per plant and number of stolons and tubers per stem.

MATERIALS AND METHODS

The work was carried out during 2015 and 2016, using seed tubers of Romano variety of Dutch origin, in semi-controlled conditions, planted in the first half of January 2015 and first half of February 2016, for which containers were used of six liters of capacity, which were filled with a Ferralitic Red Eutric Compacted soil (6), placed in environmental conditions, in areas of the Department of Agricultural Services of the National Institute of Agricultural Sciences, located at 230 00' North Latitude and 820 12' West Longitude, at an approximate height of 138 m above sea level in San José de las Lajas, Mayabeque.

The containers were divided into five homogeneous groups of ten containers with two plants in each. Four of them were applied Pectimorf® at a concentration of 10 mg L^{-1} at the time of planting (only in 2016), sprinkling the seed tubers and 20, 25 and 30 days after planting to the foliage, while the fifth group corresponded to the witness without application. A completely randomized design was followed. After ten days of the last application, the number of stems per plant, the number of stolons and the number of tubers per stem were evaluated. The cultural care was carried out as recommended in the Technical Instructions for cultivation[C] while the irrigation was done manually, ensuring that there was no lack of moisture.

During the time that the experiments remained, the maximum, minimum and average temperatures were recorded in the Meteorological Station adjacent to the experimental area, processing the data of the three variables in a decennial manner.

The differences between treatments were evaluated by calculating the confidence interval of the means from their standard error and the means were compared by the t-Student test to $p < 0.05$. All statistical processing of data was done with the use of the Statgraphics Plus v. Program. 5.1 (7) and the graphics were made through the Sigmaplot v. Program. 11.0 (8).

RESULTS AND DISCUSSION

The temperatures constitute an important factor within the present climatic conditions, with a great influence in the behavior and development of the crop. As can be seen in Figure 1, in 2015 the temperatures showed lower values, staying longer in that condition, which favors the development of the crop.

In Figure 2 the number of average stems per plant in each of the treatments is presented. This variable is largely related to the growth and overall yield of potato plants and although in some studies this has not been fully clarified[D], many authors have corroborated this (9,10).

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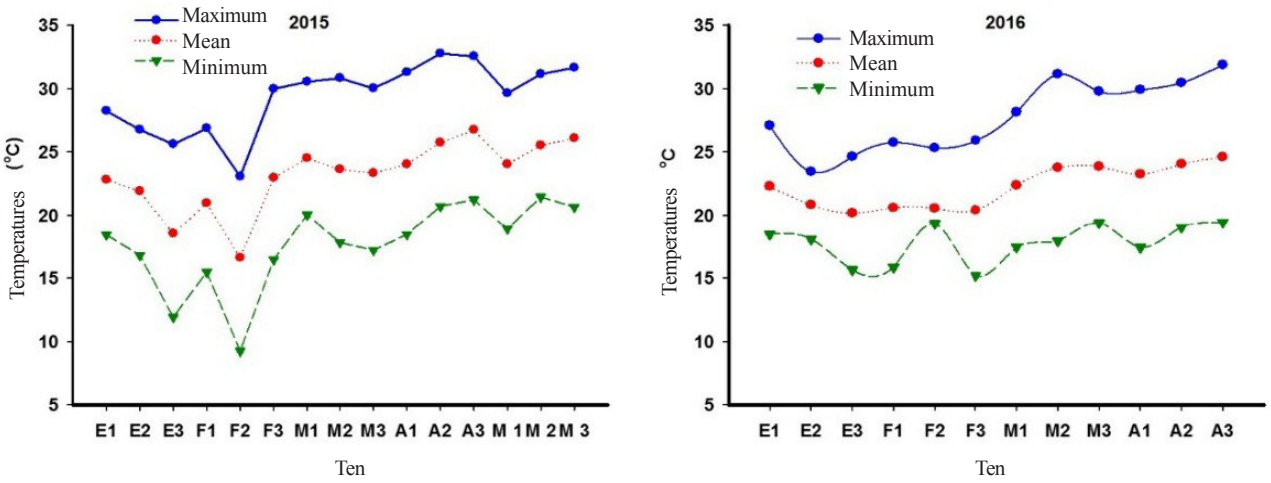

Figure 1. Behavior of the maximum, average and minimum temperatures during the two years of study

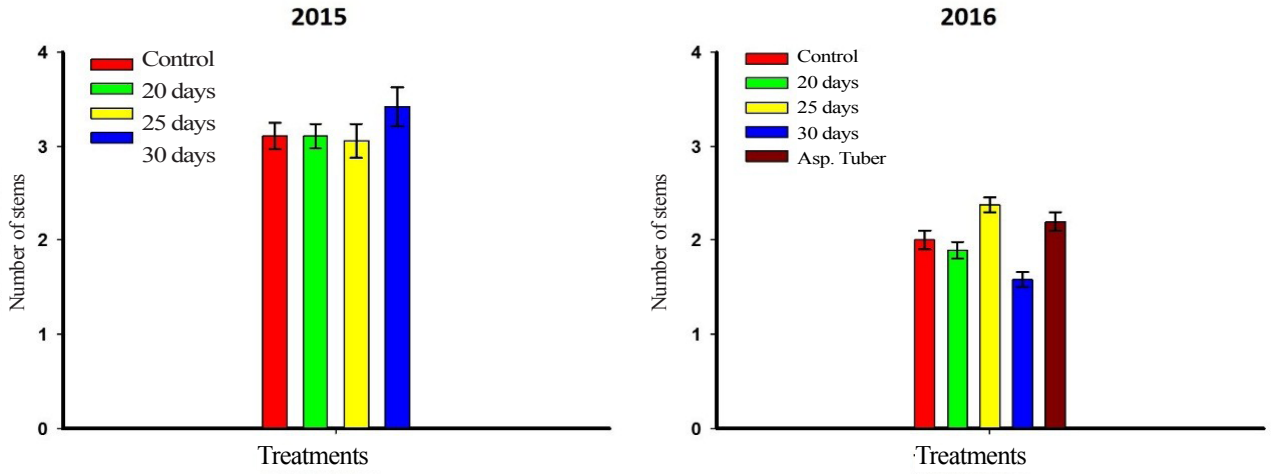

Figure 2. Number of average stems per plant for p <0.05

According to the results in 2015, the treatments did not show significant differences for this variable, finding values that were around the three stems per plant, behavior that is logical, taking into account that the applications were made after the 20 days after planting, when sprouting had already taken place. However, in 2016, when the application was made after 25 days, they showed significant differences with respect to the others, although they did not exceed the results of the previous year. The application to the tuber was also significant, even though this treatment was not carried out in 2015.

The number of stems was low in the 2016 plantation, an aspect in which the quality of the seed (11) and the time of planting that was later than in 2015 also play an important factor.

Figure 3 shows the number of stolons per stem where it is shown that in 2015 the values were between four and five, being higher in the treatment in which the application was made 30 days after planting without differences with control, but with treatments where it was applied at 20 and 25 days; these last two did not show differences with respect to control. At one point, its tip begins to swell immediately after a curvature of the stolon, as a consequence of the proliferation of the reserve tissue resulting from a rapid development and cell division, to form the tuber (12).

A similar behavior was obtained in 2016 in the rest of the treatments with respect to where the application was made 25 days after planting, which was the one that showed the values higher than the previous year.

In general, it is emphasized that the application at 25 and 30 days after planting stimulates to some extent the emission of stolons, perhaps because of the state in which the plants are at that moment and this application has a greater effect than when plants are younger.

Among the stages of cycle development of containers the potato finds the process of tuberization, which is regulated by the own characteristics of the variety, the age of the seed, the environmental factors and the action of phytoregulators, between others[E].

It is considered the beginning of the tuberization from the broadening of the stolons, this process occurs, depending on the precocity of the variety, but in the climatic conditions of Cuba it is verified in the initial stages of growth, where the assimilates produced by the foliage are used for the growth of the stolon and initiation of tuberization (13).

Many factors are known to have an effect on tuberization (14), but one of the most influential is temperature[F], which exerts an inhibitory effect on tuberization. Although these factors show consistency in their effects, it is also important to consider the variation in the response to these stimuli that depends on the genotype as well as the age and physiological state of the plant.

The number of tubers is closely related to the planting density, since each tuber-seed will give rise to a certain number of stems, which in turn will produce tubers. That is, the higher the production of stems, the higher the number of tubers per plant. This occurs to a certain extent, since the relationship is inversed on a certain number of stems to the weight of the tubers (15).

The results obtained for the number of tubers per stem are shown in Figure 4, in 2015 significant differences were observed between the treatments where Pectimorf® was applied at 20 and 25 days, influenced to a great extent by the behavior of the temperatures (Figure 1), which were favorable for that year; however, in 2016 despite having fewer stems (Figure 2), their difference was marked only when the application was made after 25 days.

[E] Tapia F. INIA, Ururi, 2014 [Internet]. [cited 2016 May 30]. Available from: http://scholar.google.com.cu/scholar_url?url=http%3A%2F%2Fbiblioteca.inia.cl%2Fmedios%2Fbiblioteca%2Fboletines%2FNR39749.pdf&hl=es&sa=T&oi=ggp&ct=res&cd=0&ei=Bl5MV92cEoXOmAGt1q6oCA&scisig=AAGBfm1FbEj0OvPAgZComVegm448Jm7qLA&nossl=1&ws=976x587

[F] Pais SM. Caracterización de fosfatasas de proteínas 2 A en *Solanum tuberosum* L. y su participación en vías de señalización asociadas a tuberización y estrés [Internet]. [Buenos Aires, Argentina]: Universidad de Buenos Aires, Facultad de Ciencias Exactas y Naturales; 2010 [cited 2016 May 30].Available from: http://digital.bl.fcen.uba.ar/gsdl-282/cgi-bin/library.cgi?a=d&c=tesis&d=Tesis_4723_Pais.

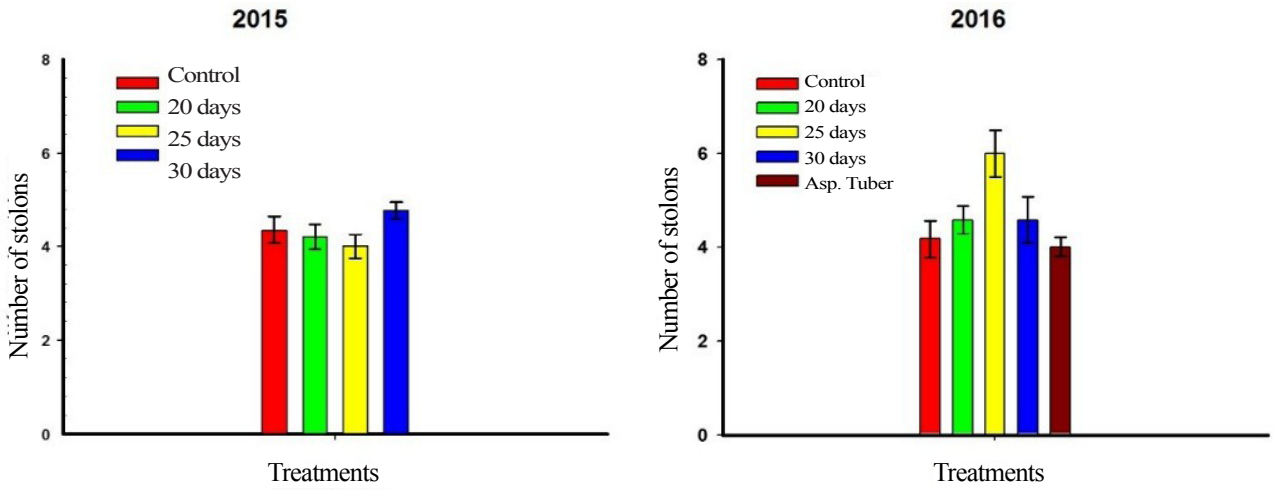

Figure 3. Number of stolons per stem for p <0.05

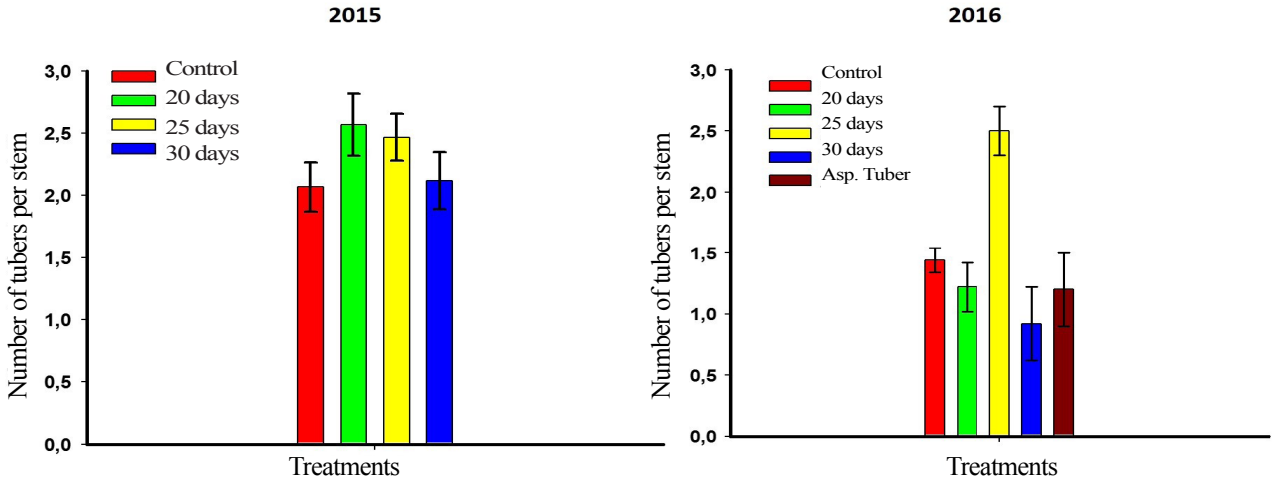

Figure 4. Number of tubers per stem in plants sprinkled with Pectimorf® in initial stages of the growth cycle and the confidence interval for the means in each treatment at p <0.05

As for the application of products to stimulate tuberization, it has been proven that these improve the vital processes of the plants, their resistance to stress and health, which translates into greater performance and better quality (16), they can improve the biochemical parameters and the resistance of the potato to adverse environmental conditions, but they are more effective when they are made in early stages after planting, not to the seed tuber (17).

CONCLUSIONS

Taking into account the results found, it can be concluded that the application of Pectimorf® stimulates to some extent the production of tubers, which is the result of the positive effect on the overall growth of the plants, although other concentrations must be assessed.

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