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EFFECT OF QUITOMAX® ON CROP GROWTH AND YIELD OF BEAN (*Phaseolus vulgaris* L)

Efecto del QuitoMax® en el crecimiento y rendimiento del frijol (*Phaseolus vulgaris* L.)

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ABSTRACT. Due to the need to increase crop yields, this work was conducted to evaluate the effect of different doses and times of foliar application of QuitoMax® on growth and yield of bean (*Phaseolus vulgaris* L). Therefore, seeds from Cuba-Cueto-25 black bean variety were sown in rows spaced 70 cm and plants separated from 6 to 7 cm. QuitoMax® was applied within two crop cycle stages to a control and nine treatments at the rates of 200, 400 and 600 mg ha^{-1} both 20-25 days after sowing and at the beginning of flowering, as well as to other three treatments at the rates of 100, 200 and 300 mg ha^{-1} at the same two times above mentioned. Stem length and diameter, leaf number, pod number per plant, grain number per pod and fresh mass of 100 grains were evaluated, also crop yield per unit area was estimated. Results showed a better plant response when QuitoMax® was applied twice, highlighting the treatment with two applications of 200 mg ha^{-1}, since crop yield surpassed 20 % the control treatment.

Key words: growth, bean, chitosan, yield

RESUMEN. Dada la necesidad de incrementar los rendimientos, este trabajo se realizó con el objetivo de evaluar el efecto de diferentes dosis y momentos de aplicación foliar del QuitoMax® en el crecimiento y rendimiento del cultivo del frijol (*Phaseolus vulgaris* L). Para ello, se utilizaron semillas de la variedad de frijol negro Cuba-Cueto-25 sembradas en hileras separadas a 70 cm, en las que las plantas se distribuyeron a una distancia de entre 6 y 7 cm. Las aplicaciones de QuitoMax® se realizaron en dos momentos del ciclo del cultivo al control y a nueve tratamientos en dosis de 200, 400 y 600 mg ha^{-1}, tanto a los 20-25 días posteriores a la siembra como al inicio de la floración y en otros tres tratamientos en dosis de 100, 200 y 300 mg ha^{-1} en los dos momentos antes señalados. Las evaluaciones se realizaron en la longitud y el diámetro de los tallos, número de hojas, número de vainas por planta, número de granos por vaina y masa fresca de 100 granos, también se estimó el rendimiento por unidad de superficie. El análisis de los resultados mostró una mejor respuesta de las plantas cuando recibieron dos aplicaciones de QuitoMax®, destacándose el tratamiento en el que se realizaron dos aplicaciones de 200 mg ha^{-1}, el cual provocó un aumento del rendimiento superior a un 20 % en relación al control.

Palabras clave: crecimiento, frijol, quitosano, rendimiento

INTRODUCTION

The common bean (*Phaseolus vulgaris* L.) is a very important grain legume in the Americas and parts of Africa, where it serves as a vital source of protein, vitamins and mineral nutrients (1).

Proper management of plant nutrition and efficient pest control are two essential elements to achieve high productivity and quality of agricultural production, as the indiscriminate use of chemicals can cause damage to the environment, create resistance from plant pathogens and cause damage to human health (2) microorganisms. The biocontrol practice of plant diseases shows a viable alternative in relation to the traditional chemical method. Among the products studied for biocontrol, chitosan polysaccharide, naturally found in the cell wall of some fungi and obtained it commercially from chitin, due to its biocompatibility, biodegradability, low toxicity, high bioactivity and microbial activity (3, 4, 5, 6). Stimulating growth, development and yield in crops of interest has also been found (6, 7, 8).

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Chitosan properties have been reported with exogenous applications in the cell membrane stability and activation of antioxidant enzymes in plants exposed to water stress (9); increased antifungal activity of chitosan, a decrease of mycelial growth and sporulation of the fungus *Pyricularia grisea* sacc (10). It has also been reported spotting decreased panicle rice (*Oryza sativa* L.), to sprinkle on plants Chitosan (11).

Although not known the exact mechanisms by which chitosan stimulates growth and development of plants, it has been proposed that is involved in physiological processes, it prevents water loss via transpiration (12). In this regard, the presence of stomatal closure have been demonstrated when sprinkled plants with chitosan, suggesting that the stimulatory effect of growth, after stomatal closure could be related to an antiperspirant effect on the ground (13), stating, moreover, foliar application of chitosan in potato reduced the effects of water stress (14).

Moreover, from the results found in the cultivation of beans (*Phaseolus vulgaris* L.), noted that one of the aspects through which the chitosan was influencing reducing perspiration is that this product increases abscisic acid levels (ABA) in the treated leaves, which activates the partial stomatal closure (15). Given the aforementioned, the present work was performed with the objective to evaluate the effect of different doses and foliar application times of QuitoMax®, on growth and bean crop yield (*Phaseolus vulgaris* L.).

MATERIALS AND METHODS

the study was conducted at the experimental farm of the National Institute of Agricultural Sciences (INCA) in a Ferralitic Red Eutric Compacted (16). To run the job, seeds of the variety Cuba-Cueto-25, seeded at a distance of 0,07 m between plants and between rows to 0,70 m were used. Three doses of QuitoMax® (chitosan) were used, which were applied at two moments during crop development. The treatments were:

- ♦ Control
- ♦ 200 mg ha^{-1} at 20-25 days after sowing
- ♦ 400 mg ha^{-1} at 20-25 days after sowing
- ♦ 600 mg ha^{-1} at 20-25 days after sowing
- ♦ 200 mg ha^{-1} at the beginning of flowering
- ♦ 400 mg ha^{-1} at the beginning of flowering
- ♦ 600 mg ha^{-1} at the beginning of flowering
- ♦ 100 mg ha^{-1} at 20-25 days and 100 mg ha^{-1} at the beginning of flowering
- ♦ 200 mg ha^{-1} at 20-25 days and 200 mg ha^{-1} at the beginning of flowering
- ♦ 300 mg ha^{-1} at 20-25 days and 300 mg ha^{-1} at the beginning of flowering

At 70 days after planting the variables: length, stem diameter, number of leaves per plant and harvest time, the number of pods per plant, number of grains per pod and fresh mass of 100 grains were evaluated; the yield was estimated based on the fresh mass. Cultural and phytosanitary tasks were performed according to the points made in the technical guidelines for bean cultivation[A].

A design randomized block with four replications was used, analyzing the data, through the corresponding variance analysis. Means were compared according to the Tukey test.

RESULTS AND DISCUSSION

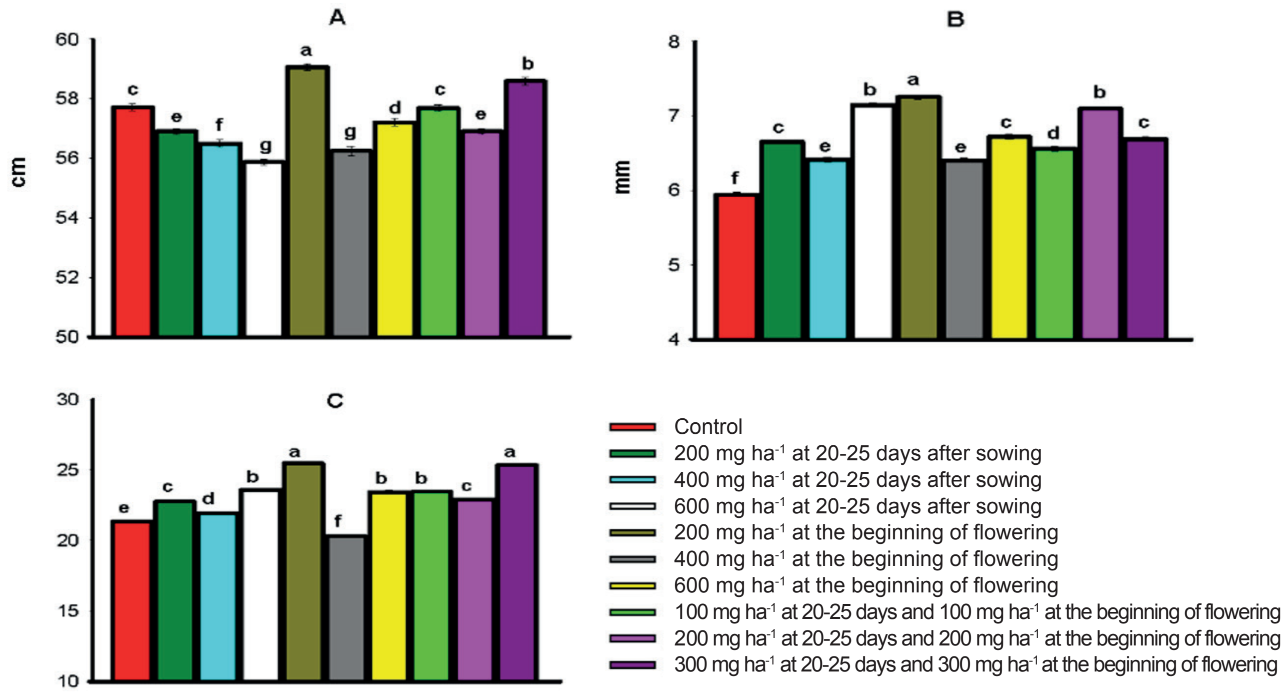
As shown in Figure 1, the growth variables evaluated were statistically different among treatments applied.

It can be seen that the length of the stems differed among all treatments, highlighting that in which the lowest dose was applied at the beginning of flowering and which received the largest share doses equally in the two moments chosen for making applications. Meanwhile, the stem diameter also expressed significant differences among treatments, it is more favored when also the lowest dose at onset of flowering, followed by those receiving 600 mg ha^{-1} at 20 to 25 days after it was applied sowing or 400 mg ha^{-1} at the two moments applied to 200 mg ha^{-1} in each one.

Finally, the number of leaves showed the highest values in the treatment that received the highest dose applied equally in both time and which has been treated with the lowest dose at the beginning of flowering.

This response shown by the number of leaves is interesting, because a larger number of leaves should represent an upper leaf surface and therefore a higher potential photosynthetic capacity, which could translate into dry matter accumulated and perhaps increased grain yield.

[A]Instituto de Investigaciones Hortícolas Liliana Dimitrova. *Guía Técnica para el cultivo del frijol*. Inst. MINAG, 2000, p. 38.



(A) Stem length (B) stem diameter (C) number of leaves

Figure 1. Length of the stems (cm), stem diameter (mm) and number of leaves in bean plants treated with different doses of QuitoMax® at different times of crop development

When analyzing the response shown by this variable, it was found that this behavior agrees with another author (8), which found favorable results in growth, expressed by the length of the stems and roots, their fresh and dry mass, surface leaf chlorophyll content and in the cultivation of beans (Phaseolus vulgaris Super Stryke), especially in its results that demonstrated the best responses with lower doses of chitosan applied, coinciding with those found in young tomato plants (*Solanum lycopersicum* L.), treated with low doses of chitosan in seed imbibition (17).

In assessing the growth of potato plants, treated with the chitosan polymer under *in vitro* conditions, positive effects were found in various growth variables, such as an increase in the number of leaves and the length and diameter of the stems (18), which was also confirmed in studies in the cultivation of beans (*Phaseolus vulgaris* L.) (8).

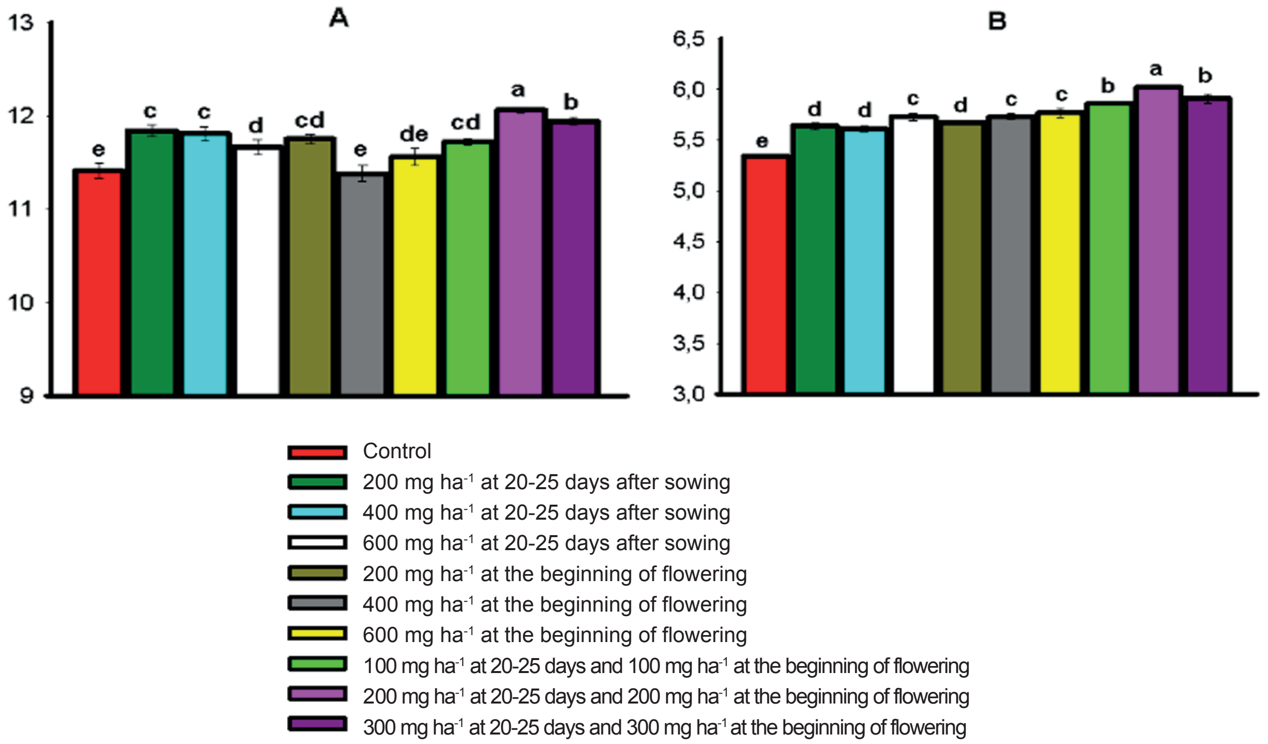
The response shown by plants treated with QuitoMax® in their growth, consistent with that reported for the tomato cultivation (*Solanum lycopersicum* L.), in which the product treated plants had a greater effect, a phenomenon that was probably connected with increased resistance to these fungal root diseases (19). They have also been reported concordant results to study the effect of chitosan applications in young corn plants (*Zea mays* L.) exposed to different types of stress (20).

When analyzing the behavior of the number of pods per plant and number of grains per pod (Figure 2) it was observed that the treatments applied reflected differences among them, excelling in both variables which were applied at the highest dose and intermediate in the two moments studied with half of the total dose at any time; similarly, the treatment in the lower dose at the beginning of flowering was used, it showed a major number of grains per pod.

This behavior is interesting, since it places the best treatments in the first instance, to those who received two applications of the product and, secondly, because it shows certain benefits when the product is applied in the growth period (20-25 days sowing), a result that power with the second application. The response shown by these variables is of great importance, as these variables are those that define yield.

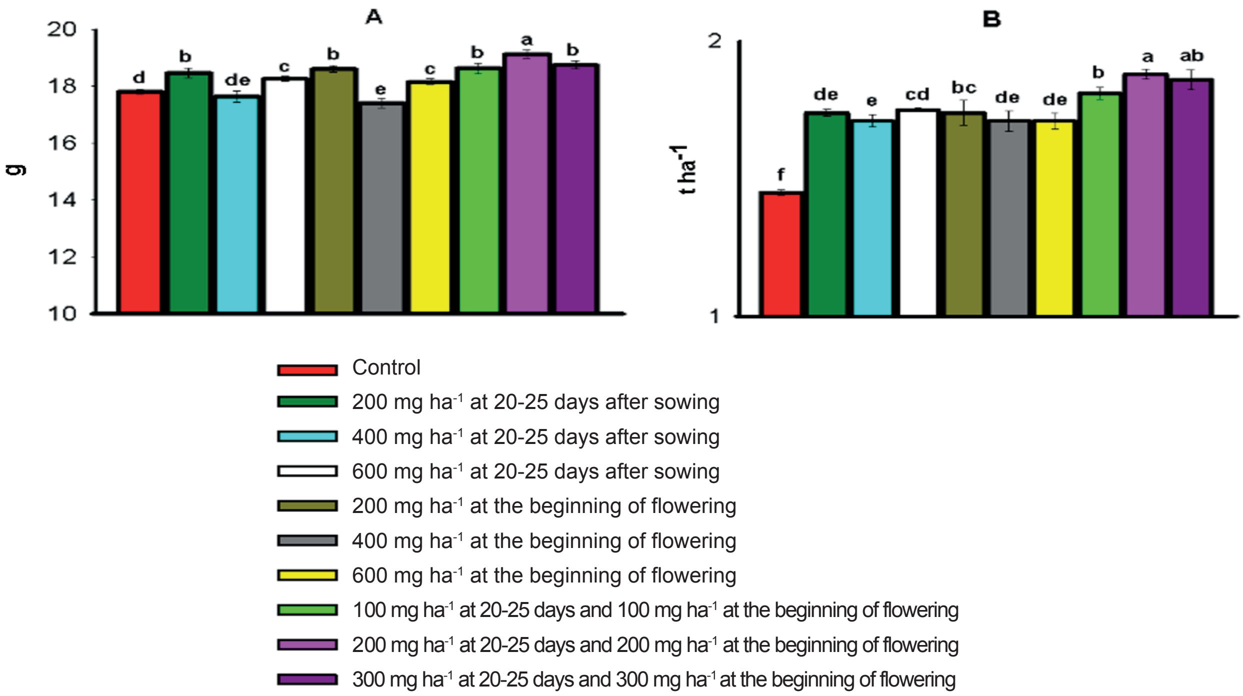
Similar answers as to increase the number of pods per plant and grains per pod were found to evaluate the effect of the Biobras-16 application in the cultivation of beans (*Phaseolus vulgaris* L.) (21), as well as to evaluate the effect of 24 epibrassinolide (22) on growth performance, antioxidant systems and cadmium content in bean plants in salt and cadmium stress conditions.

Figure 3 shows the behavior of the mass of 100 grains and the estimated yield. As can be seen, in both variables higher values were found when the plants received two applications, with the total dose halves designed for different treatments; also excels in which treatment was applied 200 mg ha^{-1} at 20-25 days and another similar to the beginning of flowering.



(A) number of pods per plant (B) grains per pod

Figure 2. Number of pods per plant and number of grains per pod in bean plants treated with different doses of QuitoMax® at different times of crop development



A) fresh mass of 100 grains (B) estimated yield

Figure 3. Fresh mass of 100 grams (g) and estimated yield (t ha^{-1}) in bean plants treated with different doses of QuitoMax® at different times of crop development

It can also be seen how the lower doses stimulated fresh mass of grains, regardless of the time that has been applied product results agree with those found by studying the response of radish (*Raphanus sativus* L.) when treated seeds with different concentrations of biostimulant Pectimorf (23).

Increases in crop yields stimulated by the application of chitosan have been reported in the cultivation of tomato (*Solanum lycopersicum* L.) (19), as well as yield and its components in the cultivation of rice (*Oryza sativa* L.) (24), also in studies that were used chitosans of different molecular weights, for the production of flowers on Orchids plants (*Dendrobium orchid*) (25), which are consistent with those reported when the effect of foliar applications of chitosan in cowpea (*Vigna unguiculata*) (26) was evaluated.

CONCLUSIONS

Of the foregoing results, it can be inferred that the application of QuitoMax® to bean plants stimulates growth of these, while providing the formation of a larger number of pods and a higher number of grains per pod, which results in a yield higher than plant not receiving treatment with this biostimulant.

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