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Short communication
EFFECT OF QUITOMAX® ON YIELD AND ITS COMPONENTS OF RICE CULTIVAR (*Oryza sativa* L.) VAR. INCA LP 5

Comunicación corta
Efecto del QuitoMax® en el rendimiento y sus componentes del cultivar de arroz (*Oryza sativa* L.) var. INCA LP 5

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ABSTRACT. Chitosan is used in agriculture for its antifungal effect, lengthens the life of fruits and vegetables, it stimulates the growth of crops. Due to the need to increase crop yields in rice (*Oryza sativa* L.) this work was carried out with the objective of evaluating different times and forms of application of QuitoMax® in the final plant height and yield components in cultivar¨INCA LP 5″. This treatment was performed to the seed at a concentration of 1 g L^{-1} and foliar spray at a dose of 360 mg L^{-1} at two ages at 25 and 60 days after germination (dag). Statistical software STATGRAPHICS version 4.1 was used in the Windows environment to analyze the results. The best response of the cultivar was obtained when treating the seed and when they received the two foliar applications of QuitoMax®.

Key words: bioestimulant, glucosamine, chitosan, chitin

RESUMEN. La quitosana es utilizada en la agricultura por su efecto antifúngico, alarga la vida de anaquel de los frutos y vegetales, estimula el crecimiento y rendimiento de los cultivos. Dada la necesidad de incrementar los rendimientos en el cultivo del arroz (*Oryza sativa*, L.) se realizó este trabajo con el objetivo de evaluar diferentes momentos y forma de aplicación del Quitomax®, cuyo principio activo es la quitosana, en la altura final de la planta y componentes del rendimiento del cultivar INCA LP 5. Para ello, se realizó tratamiento a la semilla con una concentración de 1g L^{-1} y aspersiones foliares a una dosis de 360 mg L^{-1} en dos momentos a los 25 y 60 ddg. Para el análisis de los resultados se empleó el programa estadístico STATGRAPHICS versión 4.1 en ambiente Windows. La mejor respuesta del cultivar se obtuvo al tratar la semilla y cuando recibieron las dos aplicaciones foliares de Quitomax®.

Palabras clave: bioestimulante, glucosamina, quitosano, quitina

INTRODUCTION

In today's agriculture, intense work is being done to find products that favor the growth and development of crops, as well as to increase yields, in addition to the fact that the active ingredients are of natural origin, biodegradable and do not cause damage to the environment.

In this case, it finds chitosan deacetylated derivative of chitin, which is a polysaccharide widely distributed in nature as a component of the cell wall of some crustaceans and fungi (1). It is a linear copolymer formed by units of glucosamine and to a lesser extent of N-acetyl D-glucosamine joined by β 1-4 bonds.

This compound has been used for soil modification, production of biodegradable films and antimicrobial packaging (2-4). Its effect has also been proven as a stimulator of germination and yields in different crops (5-7).

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Chitosan has the ability to be biodegradable, biocompatible non-toxic, with a broad antimicrobial activity, where it acts directly on some pathogens by inhibiting mycelial growth thereof and protecting plants from disease attack, by stimulating the mechanisms of defense, so it is considered a very attractive compound (8-11).

In rice cultivation, it has been proven that chitosan, depending on its chemical characteristics and its concentration, achieves the physiological stability of the seed during ten months of storage (12). Also when applied to the seed, soil and foliar at different times increases the yields of the plant (13). In other investigations, the effect on the control of diseases that affect seed quality has been determined (14).

In Cuba, this compound has been used for several years in different crops with encouraging results (15-17). In the case of rice, numerous investigations have been made regarding the direct effect of chitosan on fungi that affect this crop and the defense mechanisms that are stimulated in the protection against *Pyricularia grisea*, Sacc., the most important pathogen of this crop.

Taking into account the aforementioned, the present work was carried out with the objective of evaluating the effect of different doses and moments of QuitoMax® foliar application, on the growth and yield of rice cultivation (*Oryza sativa* L).

MATERIALS AND METHODS

The experiment was carried out at the Los Palacios Base Scientific Technological Unit in Pinar del Río belonging to the National Institute of Agricultural Sciences (INCA), located in the southern plain of the Pinar del Río province. The soil on which they were developed is classified as Hydromorphic Gley Nodular Petroferric (18).

The experiment was developed during the months of February to July in the years: 2013, 2014 and 2015. The cultivar INCA LP 5 of short cycle, obtained in Cuba (19), was used, applying a completely randomized design with four repetitions in plots of 3 x 3m the seeding density used was 120 kg ha^{-1} of seed and the agrotechnical management was performed according to technical instructions for this crop (20).

The product applied was QuitoMax®, whose active principle is chitosan, which is prepared by the group of Bioactive Products belonging to the Department of Plant Physiology and Biochemistry of the National Institute of Agricultural Sciences (INCA). Two 360 doses and 1000 mg L^{-1} were applied at different times.

The treatments applied were the following:

1- Untreated seed
2- Seeds treated with water 15 min
3- Seeds treated with Q 1 000 mg L^{-1} 15 min
4- Seeds treated with Q 1 000 mg L^{-1} 15 min + 25 dag (360 mg L^{-1})
5- Seeds treated with Q 1 000 mg L^{-1} 15 min + 25 dg (360 mg L^{-1})+60 dag at the beginning of flowering (360 mg L^{-1})

dag: days after germination

The evaluations carried out were: final height, number of panicles/plants, full grains/panicles, empty grains/panicles, weight of 1000 grains, incidence of diseases and industrial quality (% whole grains).

The data obtained were subjected to a simple classification variance analysis and the means were calculated by Tukey's Multiple Range Test (21) at 5 % probability of error and the statistical program STATGRAPHICS version 5.1 was used in the Windows environment (22).

RESULTS AND DISCUSSION

The height of the plant was not affected by the treatments applied (Table I). Similar results were obtained in Thailand (23), which observed that chitosans of different molecular masses do not affect the height of the rice plant. However, other scientists evaluated the effect of chitosan on Chinese pumpkin (*Benincasa hispida*) cv. Hybrid Dwarf No. 1 in which they found that coating the seed with a dose of 0,4-0,6 mg g^{-1} and a foliar application of 20-40 µg mL^{-1} increased the height of the plant and the area foliar of this crop (24).

Tabla I. Efecto del Quitomax® sobre la altura de las plantas del cultivar INCA LP 5

Tratamientos	Altura (cm)
Semilla sin tratar	$98,2^{NS}$
Semillas tratadas con agua 15 min	$98,1^{NS}$
Semillas tratadas con Q1000 mg L^{-1} 15 min	$99,2^{NS}$
Semillas tratadas con Q 1000 mg L^{-1} 15 min + 25 ddg (360 mg L^{-1})	99^{NS}
Semillas tratadas con Q 1000 mg L^{-1} 15 min + 25 ddg (360 mg L^{-1}) + 65 ddg (360 mg L^{-1})	$99,3^{NS}$
EE±	1,5

^{NS} There are no significant differences

Table II shows the response of the variables that define the yield and its components in the crop, where QuitoMax® had a positive influence on them in the cultivar INCA LP 5 and the best treatment was the 5.

Table II. Effect of Quitomax® application of on the yield and its components in the cultivar INCA LP 5

Tratamientos	Cantidad de panículas.m^{-2}	Granos llenos por panícula	Peso 1000 granos	Rendimiento t ha^{-1}
1	340,3^{c}	68,8^{c}	27,9^{c}	4,80^{e}
2	340,1^{c}	69,1^{c}	27,23^{c}	4,88^{d}
3	342,7^{b}	76,45^{b}	28,05^{b}	4,95^{c}
4	342,4^{b}	76,85^{b}	28,09^{b}	5,0^{b}
5	344,1^{a}	80,75^{a}	28,83^{a}	5,2^{a}
EE ±	1,0***	0,1***	0,25***	0,12***

Different letters differ significantly p≤0,05

Regarding the amount of panicles per m^2 that is one of the components of the most important performance, significant differences were evidenced. The maximum number of panicles was obtained in the treatment where the product was applied to the seed and the two foliar sprays were carried out at different times; while the lowest number of panicles was achieved in treatments 1 and 2 in which QuitoMax® is not applied. In this sense, some authors found that the number of panicles in rice cultivation increased when the chitosan solution was applied with water at a rate of 0,4 g/50 cm^3 (25).

With the QuitoMax® application of the seed and the two foliar sprays at different times (treatment 5) as many filled grains, grain weight and 1000 performance with significant difference to the other treatments are obtained. Similar results were observed by a group of researchers (23), applying polymeric chitosan at a concentration of 20 ppm to the rice seed but with four leaf sprays.

Also in Vietnam it was shown that applying chitosan at a dose between 10 and 15 ppm every ten days up to 120 dag in different rice areas showed an increase in growth, yield and protection against diseases of this crop (26).

According to studies conducted by the application of chitosan stimulates the physiological processes in the plant and increases the size of the cells, which makes the nutrients more assimilable by the plant and increases its growth and development, which brings with it an increase in yields, These authors suggest doses between 300 and 600 mg ha^{-1} for the use of chitosan as a biostimulant (27).

In addition, chitosan has been shown to have effects on agriculture as a carbon source of soil microorganisms, accelerates the transformation of organic to inorganic matter and allows the root system of the plant to absorb more nutrients from the soil. It also regulates the immune system of the plant, protects the plants against diseases before and after the harvest. It influences the increase of antagonistic microorganisms and biological controls, as well as the symbiotic interaction plant-microorganism interaction and the regulation of growth and development.

CONCLUSIONS

The QuitoMax® application to the rice cultivar INCA LP 5 stimulates the yield in soil and climatic conditions of Los Palacios municipality in Pinar del Río.

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