Short communication

Application of Oligo-Chitosan in Leaf Vegetable (Spinach) Production

Salma Sultana[1], Nirmal Chandra Dafader[1], Md. Humayun Kabir[2], Fatema Khatun[1], Mazibur Rahman[1] and Jahangir Alam[1]

[1]*Nuclear and Radiation Chemistry Division, Institute of Science and Technology, Atomic Energy Research Establishment, Savar, Dhaka*
[2]*Plant Biotechnology and Genetic Engineering Division, Institute of Food and Radiation Biology*
Atomic Energy Research Establishment, Savar, Dhaka

Abstract

Chitosan is a natural biopolymer which stimulates growth and increases yield of plants as well as induces the immune system of plants. The experiment was performed with randomized complete block design with four replications. Two treatments were done as follows: no chitosan application, seed soaking and foliar spraying with chitosan solution. The results showed that application of chitosan by seed soaking and three times foliar spraying significantly increased spinach yield over control. 100 ppm oligomeric chitosan show statistically significant differences when compared with the control.

***Keywords*:** chitosan application, seed soaking, foliar spray

1. Introduction

Chitosan is a natural biopolymer modified from chitin, which is the main structural component of squid pens, cell walls of some fungi and shrimp and crab shells. Chitosan is inherent to have specific properties of being environmentally friendly and easily degradable. Bangladesh is a world-leading exporter of frozen shrimps. Therefore, there are abundant raw materials for chitosan production. Chitosan has a wide scope of application. With high affinity and non-toxicity, it does no harm human beings and livestock. Chitosan regulates the immune system of plants and induces the excretion of resistant enzymes. Moreover, chitosan not only activates the cells, but also improves its disease and insect resistant ability [1]. Chitosan has strong effects on agriculture such as acting as the carbon source for microbes in the soil, accelerating of transformation the process of organic matter into inorganic matter and assisting the root system of plants to absorb more nutrients from the soil. Chitosan is absorbed to the root after being decomposed by bacteria in the soil. Application of chitosan in agriculture, even without chemical fertilizer, can increase the microbial population by large numbers, and transforms organic nutrient into inorganic nutrient, which is easily absorbed by the plant roots [2, 3]. The objectives of this study were to determine appropriate applications for increasing spinach yield.

2. Materials and Methods

The experiment was done with randomized complete block with four replications. The treatments were Tr 1 no chitosan application (control), Tr 2 seed soaking and foliar spraying with oligomeric chitosan solution. Each experimental plot size was 3×3 m^2. Spinach seeds cv. Lal Teer seed company were soaked in oligomeric chitosan solution at the concentrate of 100 ppm for 24 hours before planting for Tr 2 whereas spinach seeds in the control treatment were soaked in distilled water. For treatment 2, three different concentrations used in this experiment that is 50, 75 and 100 ppm oligomeric chitosan and three times foliar sprayed after germination. In the control treatment only water sprayed. The seed rate was 7.5kg/hector and the replication was 3. Plant height, leaf length, leaf width, no. of leaves and yield were recorded at harvesting time. All data were subjected to analysis of variance according to the experimental design used in this study and least significant difference (LSD) was utilized to compare the different means of treatment.

Corresponding author : sultanasalma71@yahoo.com

3. Results and Discussion

Growth

3.1 Plant Height

Plants heights were influenced by varying methods of application. Seed soaking in chitosan solution before planting tended to stimulate plant height and also increase the plant height with increasing the concentration of oligo-chitosan. Plant height of spinach on control is 24.2 cm, whereas with increasing the concentration of oligo-chitosan 50, 75 and 100 ppm the plant height were 31.4 cm, 34.3 cm and 43.1 cm respectively (Table1).

Table 1. Effect of different levels of oligo-chitosan on some morphological characters and yield in spinach

Treatments	Plant height (cm)	No. of leaf /plant	Leaf length (cm)	Leaf width (cm)	Yield (ton/hector)
Control	24.2 c	10.6 c	20.9 c	10.5 d	6.6 c
50 ppm	31.4 b	13.7 b	26.4 b	13.9 c	10.1 b
75 ppm	34.3 b	14.1 b	29.0 ab	16.3 b	12.0 b
100 ppm	43.1 a	16.3 a	31.3 a	18.1 a	18.0 a

3.2 Leaf Length

Leaf length of spinach plants was significantly different from treatments with control. However, soaking the seeds

in chitosan solution before planting and soil application four times tended to show the maximum value of leaf length over the control. Leaf length of spinach on control is 20.9 cm, whereas as with increasing the concentration of oligomeric chitosan 50, 75 and 100 ppm the plant heights were 26.4 cm, 29.0 cm and 31.3 cm respectively (Table1) that corresponds to the study [4] that chinese cabbage seeds incorporated with chitosan at the rate of 0.4-0.6 mg/g of seed followed by foliar spraying at 20-40 mg/l reacted with increased plant height and leaf area of chinese cabbage plants.

3.3 Leaf Width

On control, the average leaf width is 10.5cm whereas with 50, 75 and 100ppm oligomeric chitosan the average leaf widths are 13.9 cm, 16.3 cm and 18.1 cm, respectively which indicates that leaf width of spinach plants increase with increasing the concentration of oligomeric chitosan.

3.4 Leaf Numbers Per Plant

Leaf number per plant increased with increasing the concentration of oligo chitosan. The maximum leaf numbers obtained from 100 ppm chitosan solution. A similar result [5] showed that node and branch numbers of soybean increased after application of chitosan in the soil. Ohta, *et al.* [6] also reported that the application of soil mixed with chitosan 1%w/w at sowing remarkably increased flower numbers of *Eustoma grandiflorum*.

3.5 Yield

The maximum yield has achieved by applying 100 ppm oligo chitosan. The average yields were 18 ton/hector on 100 ppm oligo-chitosan, whereas the control was 6 ton/hector. The statistically significant differences were detected among treatments. This result could explain that application of chitosan by incorporation in soil showed the maximum yield since chitosan- availability periods in soil were longer than those of foliar spraying. Moreover, chitosan had positive ionic charges which chemically bind with plant nutrients that showed a negative ionic charge resulting in a slowly released action in spinach plants which closely contributed to yield increasing. There were many reports supporting this result such as the report Krivtsov *et al.* [7] found that panicle numbers and yield of wheat *(Triticum aestivum* L.) were increased after application of polymeric or oligomeric chitosan.

4. Conclusion

This study implies that application of 100 ppm polymeric chitosan by seed soaking before planting and 100ppm foliar spray oligomeric chitosan tended to stimulate growth and significantly increased three spinach yields over control.

References

1. S. H. Doares, T. Syrovets, E. W. Wieler and A. Ryan, Oligogalacturonides and Chitosan Activate Plant Defensive Gene Through The Octadecanoid Pathway, *PNAS*, **92,** 4095-4098 (1995).
2. D. Somashekar and J. Richard, Chitosan Properties and Applications: A Revie, *Bioresour. Technol*., **55,** 35-45 (1996).
3. B. Bolto, D. Dixon and R. Eldridge, Ion Exchange For The Removal of Natural Organic Matter, *Reactive and Functional Polymers,* **60,** 171-182 (2004).
4. S. Ouyang and X. Langlai, Effect of Chitosan on Nutrient Quality and Some Agronomic Characteristics of Non-Heading Chinese Cabbage, *Plant Physiol. Commun.,* **39(1),** 21-24 (2003).
5. J. Harada, S. Arima, H. Shibayama and R. Kabashima, Effect of Chitosan Application on Growth and Seed Yield of Soybean, *Marine & Highland Bioscience Center Report,* **2,** 15- 19 (1995).
6. K. Ohta, T. Asao and T. Hosokl, Effect of Chitosan Treatments on Seedling Growth, Chitinase Activity Flower Quality in *Eustoma grandiflorum* (Raf) Shinn. Kairyou Wakamurasaki, *J. Horticultural Sci. Biotechnol*., **76 (5),** 612-614 (2001).
7. G. G. Krivtsov, N. A. Loskutova, N. S. Konyuknova, E. I. Khorkov, N. V. Kononenko and B. F. Vanyushine, Effect of chitosan Elicitors on Wheat Plants, *Biol. Bull., Russian Academy of sciences***., 23,** 16-21 (1996).