**Short communication**

# Foliar Application of Oligo-Chitosan Improves Morphological Character and Yield in Rice

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**Abstract**

A semi-field experiment has done at Atomic Energy Research Establishment campus from April 2015 to July 2015. In this study, investigate the potential of oligo-chitosan on rice plant. Chitosan was applied foliarly to rice field and water was use when needed. Foliar application of o-chitosan improves the morphological parameter that is plant height, number of effective tillers per plant [1], panicle length and yield of rice with compare to control.

***Keywords***: morphological parameter, foliar application, plant height, panicle length

## 1. Introduction

Chitosan has a wide range of application, such as in waste water treatment, in medicine and cosmetics, food, functional food and agriculture [1-4]. The production of chitin/chitosan is currently based on crab and shrimp shells obtained as a food industry waste. The global annual estimate of shellfish processing waste is more than one million metric tons [1]. Thus, disposal of selfish wastes has been a challenge for most of the shellfish–processing countries. Bangladesh, the largest Delta country in the world, have 724 km long coastal belt. Day by day, the prawn cultivation area is increasing and its area is about 203,071 hectares. Present production of prawn/shrimp in Bangladesh is about 750,000 MT/y. Around 3,00,000 people are directly involved in prawn production, marketing and associated activities in addition to 4,00,000 people of prawn post-larvae fishing. Therefore, production of value-added products such as chitin/chitosan, oligomers and their derivatives for utilization in different fields is of most interest. Study on preparation of low molecular weight (Mw) chitosan and oligo-chitosan by irradiation (ɤ-rays, electron beam) has been carrying out in many radiation processing research centers due to their beneficial properties and potential applications in different fields. The weight average molecular weight from 10,000 to about 100000 is low molecular weight chitosan, while molecular weight of oligo-chitosan is generally less than 10000. Chitosan prepared from chitin by the deacetylation process has generally high molecular weight which in many cases limits its application. The low Mw chitosan and its oligomer have some special biological properties which are different from that of the ordinary high Mw chitosan such as antioxidant property [5, 6], antimicrobial property [7-10], antitumor activity [11], immunity stimulation for animal [12, 13] and for plant growth [14-16]. A variety of techniques including chemical and enzymatic hydrolysis, radiation degradation processes can be used to prepare low Mw chitosan and its oligomer as described by Makuchi [17]. However, radiation (ɤ-rays, electron beam) is a useful tool for degradation of polymer from the viewpoint of environmentally friendly processing technology [18]. Chitosan has a wide scope of application. With high affinity and non-toxicity, it does not harm human beings and livestock. Chitosan regulates the immune system of plants and induces the excretion of resistant enzymes. Moreover, chitosan not only actives the cells, but also improves its diseases and insect resistant ability [19]. The purpose of this study is to determine the effect of oligo-chitosan on morphological features and yield attributes in rice.

## 2. Materials and Methods

A field experiment was conducted at the Atomic Energy Research Establishment (AERE) area in the year 2015. Each experimental plot size was $2.5\times2.5m^2$. The experiment was done with randomized complete block with four replications. BINA Dhan-14 seeds were soaked with 100 ppm o-chitosan for 24 hours whereas the control seeds were soaked in distilled water. Four different concentrations were used in this experiment that is 0, 40, 80 and 100 ppm oligomeric chitosan and four times foliar spray after germination (on day 3, 17, 55 and 70 at field stages) were carried out. In the control treatment only water was sprayed. Plant height, number of effective tiller per plant, panicle length, total grains per panicle, 1000-grain weight 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.

## 3. Results and Discussion

Seed soaking in oligo-chitosan before planting tends to stimulate plant height. Plant height does not show any statistically significant differences between control and 40 ppm oligo-chitosan sprayed plants. But for 80 and 100 ppm oligo-chitosan sprayed plants show significant differences

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with compared to control (Table1). Ouyang and Langali reported that foliar spraying chitosan increased plant height and leaf area of chinese cabbage plants [20]. From Table 1 it is observed that number of effective tillers per plant, panicle length, total grains per panicle and thousand grain weights also show significant differences between control plants and foliar sprayed chitosan plants. It is also found that (Table 1) with o-chitosan the yield of rice shows good result with compare to control. With 100 ppm o-chitosan the yield of rice in terms of t/ha is 8.3 whereas in control it is 6.0 t/ha. The increase of yield with chitosan in terms of control is 38%.

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

| Treatment (cm) | PH | NET/P (cm) | PL | TG/P(g) | TGW yield | Straw yield | Grains yield | Total |
|---|---|---|---|---|---|---|---|---|
| Control | 89.25b | 12.5d | 21.33d | 100.8d | 20.33d | 3.24d | 3.04d | 6.0 |
| 40 ppm | 89.33b | 14.58c | 22.75c | 111.4c | 23.38c | 3.58c | 2.40c | 6.8 |
| 80 ppm | 97.00a | 16.25b | 25.17b | 119.4b | 25.17b | 3.89b | 3.70b | 7.4 |
| 100 ppm | 100.0a | 17.50a | 27.27a | 126.4a | 26.75a | 4.38a | 4.15a | 8.3 |
| LSD value | 5.05a | 0.69 | 0.97 | 2.53 | 0.92 | 0.12 | 0.13 | 0.26 |
| CV | 6.47 | 5.49 | 4.82 | 2.66 | 4.66 | 4.11 | 4.64 | 9.28 |

PH = Plant height, NET/P = No. of effective tillers /plant, PL = Panicle length, TG/P = Total grains /panicle,
TGW = 1000 grain weight

## 4. Conclusion

It is concluded that foliar application of oligo-chitosan increased the yield of rice with compare to control. Therefore, application of oligo-chitosan at 100 ppm may be recommended for rice cultivation. However, more experiments should be conducted in different locations and seasons to draw a valid conclusion regarding the chitosan foliar application for yield improvement of rice.

## Refferences


1. D. Knorr, Recovery and Utilization of Chitin and Chitosan in Food Processing Waste Management, Food Technology, Vol. 45, 114-122, (1991).
2. S. Hirano, Chitin Biotechnology Applications, Biotechnology Annual Review, **2**, 237-258 (1992).
3. F. Shahidi, J. K. V. Arachchi and Y. J. Jeon , Food Applications of Chitin and Chitosan, Food Science & Technology, **10,** 37-51 (1999).
4. M. N. V. R. Kumar, A review on Chitin and Chitosan Applications, Reactive & Functional Polymers, **46**, 1-27 (2000).
5. H. Tomida, T. Fujii, N. Furutani, A. Michihara, T. Yasufuku and K. Akasaki, Antioxidant Properties of Some Different Molecular Weight Chitosans, Carbohydr. Res., **344**, 1690-1696 (2009).
6. T. Feng, Y. Du, J. Li, Y. Hu and F. J. Kennedy, Enhancement of Antioxidant Activity of Chitosan By Irradiation, Carbohydr. Polym., **73**, 126-132 (2008).
7. N. Liu, X. G. Chen, H. J. Park, C. G. Liu, C. S. Liu, X. H. Meng and L. J. Yu, Effect of Mw and Concentration of Chitosan on Antibacterial Activity of *Escherichia coli*, Carbohydr Polym., **64**, 60-65 (2006).
8. L. Y. Zheng, J. F. Zhu, Study on Antimicrobial Activity of Chitosan With Different Molecular Weights, Carbohydr. Pplym., **54**, 527-530 (2003).
9. Y. Jeon, P. Park, S. Kim, Antimicrobial Effect Of Chito-Oligosaccharides Produced By Bioreactor, Carbohydr. Polym., **44**, 71-76 (2001).
10. S. Matsuhashi and T. Kume, Enhancement of Antimicrobial Activity of Chitosan By Irradiation, Journal Sci. Food. Agric., **73**, 237-241 (1997).
11. C. Q. Qin, Y. M. Du, L. Xiao, Z. Li and X. H. Gao, Enzymic Preparation of Water Soluble Chitosan And Their Antitumor Activity, International J. Biol. Macromol., **31**, 111-117 (2002).
12. L. Luo, X. Casi, C. He, M. Xue, X. Wu and H. Cao, Immune Response, Stress Resistance and Bacterial Challenge in Juvenile Rainbow Trouts Oncorhynchus Mykiss Fed Diets Containing Chitosan-Oligosaccharides, Curr. Zool., **56**, 416-422 (2009).
13. R. L. Huang, Z. Y. Deng, C. B. Yang, Y. L. Yin, M. Y. Xie and G. Y. Wu, Dietary Oligo-Chitosan Supplementation Enhances Immune Status of Broiler, J. Sci. Food Agric., **87**, 153-159 (2007).
14. N. Q. Hien, Radiation Degradation of Chitosan and Some Biological Effects, Radiation Processing of Polysaccharides, IAEA-TECDOC-1422, IAEA, Viena, Austria, 125-136 (2004).
15. A. T. Rodriguez, M. A. Ramirez, R. M. Cardenas, A. N. Hernandez, M. G. Velazquez and S. Bautista, Induction of Defense Response of Oryza Sativa L. Against Pyricularia Grisea (Cooke) Sacc. By Treating Seeds With Chitosan And Hydrolyzed Chitosan, Pest. Biochem. Physiol., **89**, 206-215 (2007).

16. H. Yin, X. Zhao and Y. Du, Oligo-chitosan: A Plant Diseases Vaccine-A Review, Carbohydr. Polym., **82**, 1-8 (2010).
17. K. Makuuchi, Critical Review Of Radiation Processing of Hydrogel and Polysaccharides, Radiat. Phys. Chem., **79**, 267-271 (2010).
18. M. Haji-Saeid, A. Safrany, M. H. O. Sampa and N. Ramamoorthy, Radiation Processing of Natural Polymers: The IAEA contribution, Radiat. Phys. Chem., **79**, 33-57 (2010).
19. S. H. Doares, T. Syrovets, E. W. Wieler and A. Ryan, Oligogalacturonides and Chitosan Activate Plant Defense Gene Through The Octadecanoid Pathway, PNAS, 92, 4095-4098 (1995).
20. S. Ouyang and X Langali, Effect of Chitosan on Nutrient Quality and Some Agronomic Characteristics of Non-Heading Chinese Cabbage, Plant Physiol. Commun., **39**(1), 21-24 (2003).