การศึกษาผลของไคโตซานฉายรังสีต่อการเจริญเติบโตและผลผลิตของต้นพริก

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บทคัดย่อ

งานวิจัยนี้ศึกษาผลของไคโตซานที่ผ่านการฉายรังสี หรือโอลิโกไคโตซาน ที่มีต่อการเจริญเติบโตและผลผลิตของต้นพริก โดยการฉีดพ่นใบของต้นพริกด้วยโอลิโกไคโตซาน เปรียบเทียบการเจริญเติบโตและผลผลิตของต้นพริกที่ใบได้รับการฉีดพ่นด้วยไคโตซานกับต้นพริกที่ใบไม่ได้รับการฉีดพ่นด้วยไคโตซาน ผลการทดลองแสดงให้เห็นว่าการฉีดพ่นใบของต้นพริกด้วยโอลิโกไคโตซานที่ความเข้มข้น 80 ส่วนในหนึ่งล้านส่วน มีความแตกต่างทางสถิติอย่างเห็นได้ชัดในส่วนของความสูงของต้นพริก น้ำหนักรวมของผลพริกทั้งหมด จำนวนรวมของเมล็ดพริกทั้งหมด จำนวนรวมของเมล็ดพริกสีเขียวทั้งหมด จำนวนรวมของเมล็ดพริกสีแดงทั้งหมด และน้ำหนักเฉลี่ยของพริกต่อเมล็ด ผลการทดลองแสดงให้เห็นว่าผลผลิตเพิ่มขึ้นสูงสุดกว่าร้อยละ 34 นอกจากโอลิโกไคโตซานจะช่วยป้องกันการแพร่ระบาดของเพลี้ยแล้ว ยังช่วยร่นระยะเวลาการเก็บเกี่ยวผลผลิตของต้นพริกได้อีกด้วย ผลการทดลองทั้งหมดโดยรวมแสดงให้เห็นว่าการฉีดพ่นใบของต้นพริกด้วยโอลิโกไคโตซาน ช่วยเร่งการเจริญเติบโตและเพิ่มผลผลิตของต้นพริกอย่างเห็นได้ชัด

คำสำคัญ : ไคโตซานฉายรังสี ต้นพริก การเจริญเติบโต ผลผลิต

Application of Irradiated Chitosan on Thai Chili's Growth and Productivity

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Abstract

Effects of oligochitosan on growth and productivity of Thai chili plants were investigated. The foliar spraying of oligochitosan was applied. The growth and productivity of these oligochitosan-treated chili plants were compared with those of untreated chili plants. The results showed that the application of oligochitosan, at the concentration of 80 ppm, displayed significant effects, statistically, on chili plant height, total weight of chili, total number of chilies, total number of green chilies, total number of red chilies and weight per chili. The results also showed that productivity increased up to 34%. The oligochitosan exhibited not only the ability to protect aphid infection but also the ability to shorten the harvest time of chili plants. The treatment of chili plants by oligochitosan clearly displayed positive effects on chili's growth and productivity.

Keywords: irradiated chitosan, thai chili, growth, production

1. Introduction

Chitin is a long-chain polymer of N-acetylglucosamine, a derivative of glucose. Chitin is the main component of the exoskeletons of arthropods such as crustaceans (e.g. crabs, lobsters and shrimps) and the beaks of cephalopods, including squid and octopuses. Chitin is proven useful for several medical and industrial purposes. Chitosan is a partially acetylated glucosamine biopolymer, derived from deacetylation of chitin. It is composed mainly of ß-(1-4)-linked 2-deoxy-2-amino-d-glucopyranose units and partially of ß-(1-4)-linked 2-deoxy-2-acetamido-d-glucopyranose. Chitin has low solubility and resists to chemical because of its strong micelle resulting from the intramolecular hydrogen bonding or intermolecular bonding between hydroxyl and acetamide groups. The poor solubility severely limits the applications of chitin. Unlike chitin, chitosan is sensitive to chemical reactions due to the presence of reactive NH_2 group at position C2 and two hydroxyl groups at position C3 and C6, respectively, of the 2-deoxy-D-glucose residue. The presence of an amino group in chitosan renders it soluble in weak acids such as dilute acetic acid, lactic acid and citric acid. In addition, chitosan has many unique properties such as biodegradability, bioactivity, biocompatibility and non-toxicity. Therefore, chitosan has several benefits for various commercial applications. Nevertheless, the high molecular weight and high crystallinity of chitosan limit its solubility. Low molecular weight chitosan and oligochitosan have received more attention. Several methods have been attempted to prepare low molecular weight chitosan or oligochitosan. Chemical hydrolysis, enzymatic degradation and irradiation have been used in attempts to produce low molecular weight chitosan and oligochitosan. Acids or base hydrolysis is an effective and low-cost process but change in the degree of deacetylation, chemical waste and reproducibility are disadvantages. Enzymatic degradation is an effective way to achieve specific cleavage under mild conditions. However it requires multiple steps, particularly, enzyme preparation and product purification which are not convenient for the mass production. In the case of radiation, although significant expertise and a specific operating system are required, the simplicity of the process and the single-step preparation without purification are highly attractive.

Some properties such as hydrophilicity of oligochitosan are improved. Besides, oligochitosan has some interesting biological properties. Oligochitin and oligochitosan are resistant to bacteria and microorganism[1,2] and reported to promote growth and enhance plants yield[3,4]. Evan and Kent[5] reported that chitosan can bind and react with various microorganisms. In addition, Olsen et al.[6] studied the effects of chitosan on the inhibition of various microorganism growths. Their results indicated that the contact between microorganism and chitosan is the key factor for reduction of microorganism growth. This result is consistent with Evan and Kent's report which mentioned the inhibition of microorganism and bacterial growth as a result of the binding of chitosan with bacterial and microorganism cells. This stems from the fact that chitosan is a positive charge polymer, having an ability to form ionic bond with the negative charge lipids.

Matsuhashi et al.[7] studied the antibacterial activity of oligochitosan induced by radiation on *Escherichia Coli*. Their results indicated that chitosan irradiated at 100 kGy in dry state is antibacterial to *E. Coli*. Chitosan oligomers notably affected the growth of coffee seedlings under greenhouse conditions and in the field by enhancing content of chlorophylls, carotenoid and mineral nutrient uptake. In addition, chitosan oligomer decreased the rate of fallen fruits[8]. Effects of chitosan on the growth and yield of Fara bean were investigated[9]. The results showed that chitosan enhanced not only the plant growth but also the productivity. In this research, our goal is to study the effects of irradiated chitosan on the growth and production of Thai chili in order to evaluate the possibility of its use as a plant growth promoter.

2. Experiments

2.1 Preparation of Chitosan

Chitin was prepared from shrimp shell. The crude dried shrimp shell was deproteinized by boiling with 1 N NaOH solution for 1 h and subsequently washed with water. The deproteinized shell was treated with 1 N HCl at ambient temperature for 1 h for demineralization. Then, the deproteinized shell was rinsed until it was acid-free, after which it was dried in an air oven. The dried chitin was boiled in 12.5 N NaOH solution for 1 h. Then, the mixture was stirred at room temperature for 3 h, filtrated, washed with water and dried in an air oven.

2.2 Preparation of low molecular weight chitosan

The low molecular weight chitosan was obtained by irradiating chitosan flake with gamma radiation at a total dose of 25 kGy.

2.3 Preparation of oligochitosan

The low molecular weight chitosan was dissolved in 2% lactic acid (v/v) to obtain the mixture with the concentration to 30 g/L. Concentrated H_2O_2 solution was added to the low molecular weight chitosan solution to obtain the final concentration of H_2O_2 of 0.3% (v/v). The mixed solution was then irradiated at a total dose of 10 kGy. The viscosity-average molecular weight of oligochitosan was approximately 15,000 dalton as determined by measuring the intrinsic viscosity of polymer solution $[\eta]$ of oligochitosan solution using an Ubbelohde viscometer, 531 10/I by Schott Instruments. The solvent used is 0.2 M acetic acid – 0.15 M ammonium acetate solution with $K = 9.66 \times 10^{-5}$ dm^3/g and $\alpha = 0.742$.

2.4 Effect of oligochitosan on chili's growth and production

The experiment was carried out with randomized complete block design (RCBD) with four replications. Chili seeds were implanted in Petri dishes for three days, and then the seedlings were transplanted into 35-cm-diameter clay plots. The foliar spraying of 20, 30, 40 and 80 ppm oligochitosan mixed with fertilizer (16-16-16) was applied. The control group used for this experiment was the chili plants sprayed with tap water mixed with fertilizer. The foliar spraying with irradiated chitosan was done once a week. The effects of oligochitosan solutions on growth and productivity of Thai chili plants were investigated in term of plant height, total number of chilies, total weight of chili, total number of green chilies, total number of red chilies, harvest time and weight per chili. All data were subjected to analysis of variance according to the experimental design used in this study. Least Significant Difference (LDS) was utilized to compare the different means of treatment.

3. Results and Discussions

3.1 Effect of Oligochitosan on Thai Chili's Growth

The results in Table 1 and Figure 1 show that oligochitosan enhanced the height of the chili plants. The optimum concentration of oligochitosan for height increase of chili plants was 80 ppm.

The chili plants treated with 80 ppm of oligochitosan showed significant differences, statistically, in chili height over the control plants.

Table 1 Effect of Oligochitosan on the Height of Chili Plants.

Concentration of Oligochitosan (ppm)	**Chili Height**	
	1 month (cm)	**2 months (cm)**
0	5.51 ± 0.78^{b}	9.25 ± 1.40^{c}
20	6.00 ± 1.18^{ab}	15.81 ± 1.76^{b}
30	6.04 ± 1.05^{ab}	16.56 ± 2.22^{ab}
40	6.19 ± 1.15^{ab}	17.95 ± 3.39^{ab}
80	6.73 ± 0.77^{a}	18.53 ± 3.05^{a}

Note: Data are means of ten replicates. Different superscripts in the same column are significantly different between the treatments at 5% level according to Duncan's new Multiple Range Test (DMRT).

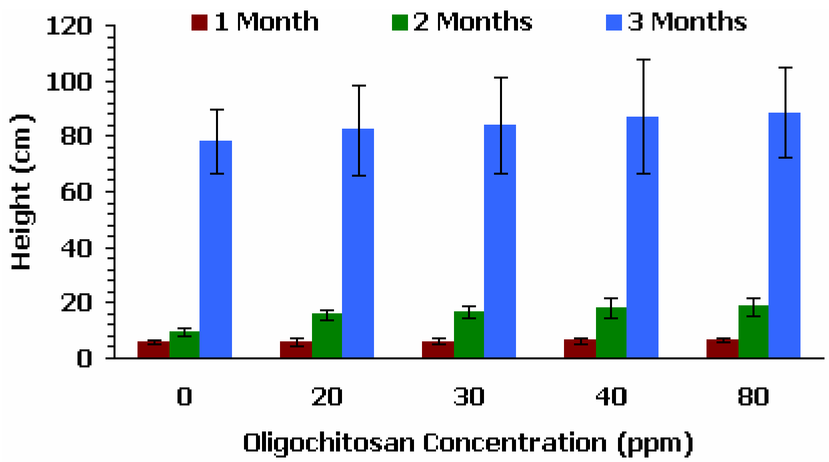

Figure 1 Effect of oligochitosan on the height of chili plants.

3.2 Effect of Oligochitosan on Chili's Production

Table 2 and Figure 2 show the effect of oligochitosan on chili's production. The results showed that the treatment of chili plants with oligochitosan enhanced the productivity. Total weight of chili, total number of chili, total number of green chili, total number of red chili and weight per chili increased significantly for the chili plants treated with 80 ppm oligochitosan compared to the control group, as can be seen in Figures 3 – 6. It was found that there was 34% increase in total weight of chili compared to the control. Chili plants treated with oligochitosan displayed an ability to protect aphid infection. It was found that the untreated chili plants were badly damaged by aphid infection as shown in Figure 7. The untreated chili plants exhibited various aphid damages such as decreased growth rates, mottled leaves, yellowing, curled leaves and finally death. The removal of sap creates a lack of vigor in the chili plant and aphid saliva is toxic to chili plants. Aphids frequently transmit disease causing organisms like plant viruses to chili plants. Additionally, oligochitosan advanced flowering time. At 70 days after seedling, chili plants treated with oligochitosan already gave chili, while the untreated chili plants just began flowering. The harvest time of chili plants treated with oligochitosan was three weeks shorter than the untreated chili plants.

Table 2 Effect of Oligochitosan on Chili's Productivity.

Conc.	**Total weight of chili (g)**	**Total number of chili**	**Total number of green chili**	**Total number of red chili**	**Weight per chili (g)**
0	61.10 ± 54.21^{c}	101.10 ± 78.86^{b}	93.20 ± 77.43^{b}	7.90± 9.52^{b}	0.56±0.13^{b}
20	83.10 ± 63.31^{bc}	114.10 ± 65.13^{b}	104.20 ± 71.40^{ab}	9.90± 16.03^{b}	0.79±060^{ab}
30	129.80 ± 34.80^{ab}	167.70 ± 51.78^{ab}	147.60 ± 32.81^{ab}	20.10±26.54^{ab}	0.79± 0.12^{ab}
40	131.00 ± 26.13^{ab}	168.40 ± 77.12^{ab}	152.80 ± 63.13^{ab}	9.80±6.77^{b}	0.84±0.23^{ab}
80	180.10 ± 82.18^{a}	192.40 ± 95.36^{a}	158.60 ± 75.62^{a}	39.60±61.41^{a}	0.99± 0.23^{a}

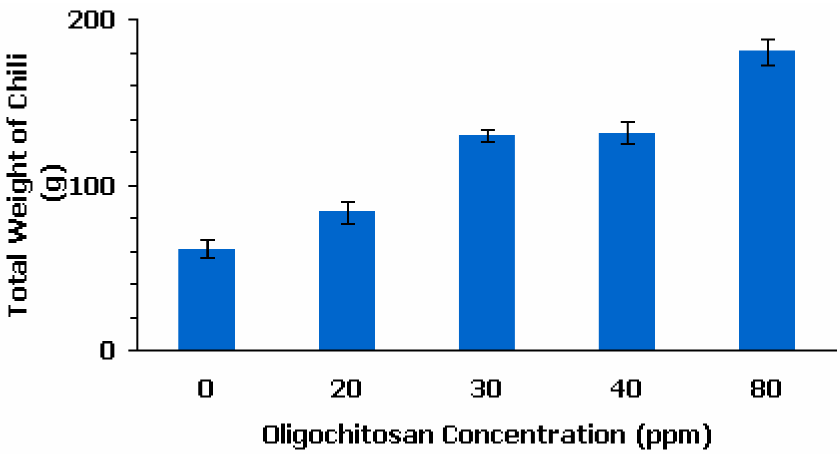

Figure 2 Effect of oligochitosan on total weight of chili.

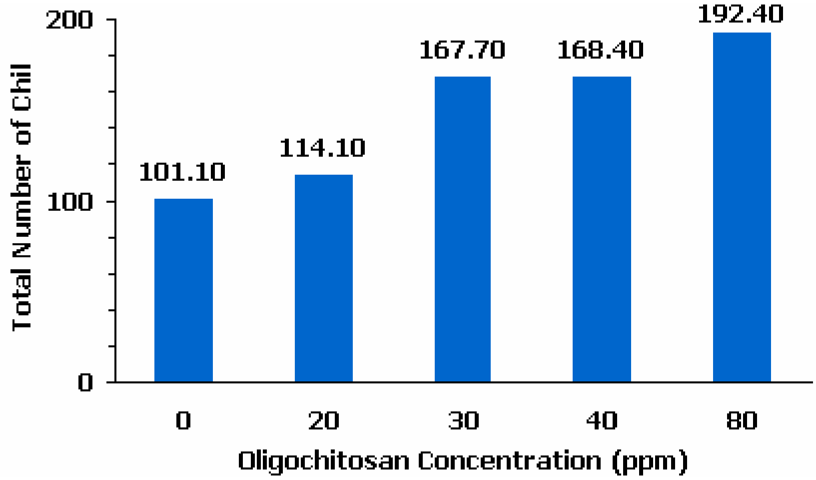

Figure 3 Effect of oligochitosan on total number of chili.

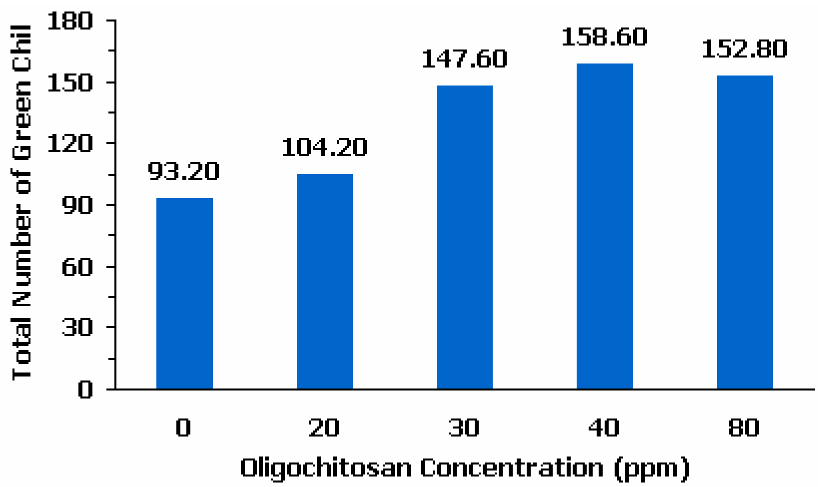

Figure 4 Effect of oligochitosan on total number of green chili.

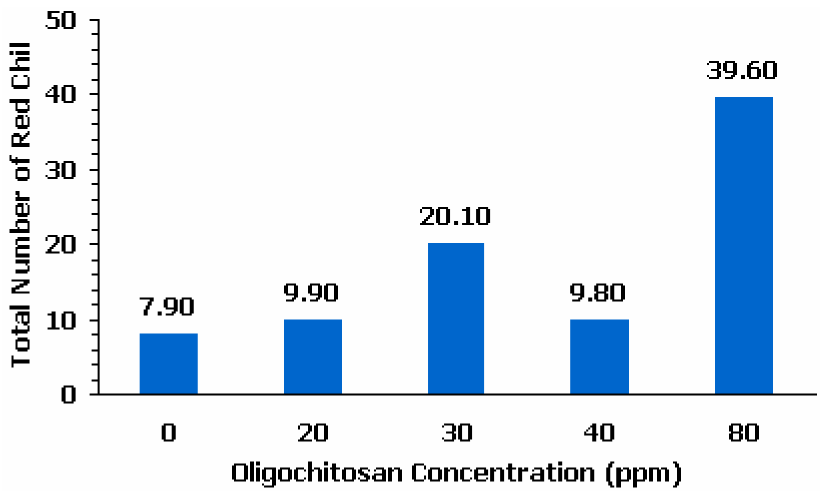

Figure 5 Effect of oligochitosan on total number of red chili.

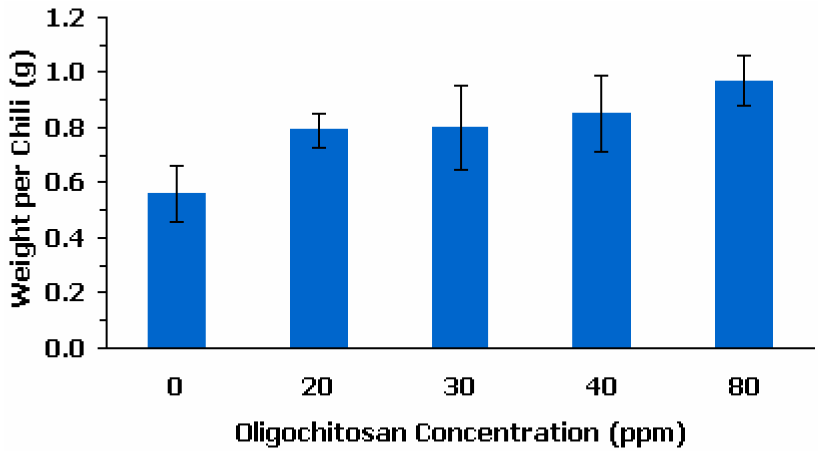

Figure 6 Effect of oligochitosan on weight per chili.

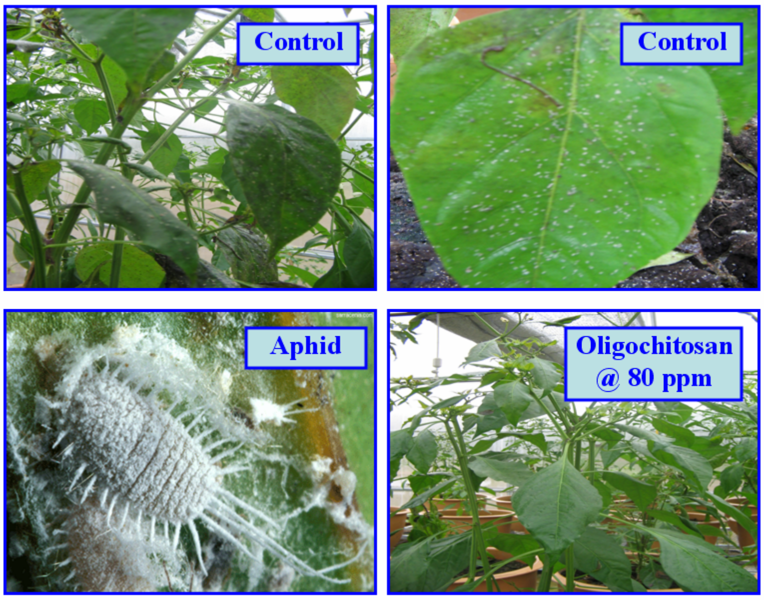

Figure 7 Effect of oligochitosan on aphid inflection.

5. Conclusion

The application of oligochitosan at 80 ppm combined with the fertilizer showed significant effects, statistically, not only on chili's growth but also on chili's productivity. The oligochitosan displayed ability to protect aphid infection in chili plants. Additionally, oligochitosan can also shorten the harvest time of chili plants for three weeks. The treatment of Thai chili plants with 80 ppm oligochitosan mixed with the fertilizer showed positive effects on Thai chili's growth and productivity, compared with the untreated chili plants. These results suggest its potential use in agriculture purposes as chili's growth promoters.

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