# The effect of *Penicillium notatum* on plant growth

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Phuwiwat, W. and Soytong, K. (2001). The effect of *Penicillium notatum* on plant growth. Fungal Diversity 8: 143-148.

The effect of *Penicillium notatum* (KMITL 99) on the growth of Chinese mustard (*Brassica campestris* var. *chinensis*), Chinese radish (*Raphanus sativus* var. *longipinnatus*) and cucumber (*Cucumis sativus*) were investigated. Results showed that *P. notatum* (KMITL 99) isolated from rhizosphere soil gave higher plant yields of Chinese mustard than the non-treated ones. The Chinese mustard grown in sterilized planting medium mixed with *P. notatum* at a concentration of $16.59 \times 10^6$ spores/ml. resulted in the highest plant heights. Plant height, root length, root diameter, fresh and dry weights of the shoots, roots and total plant dry weights increased gradually as the inoculum of *P. notatum* (KMITL 99) applied increased. At the concentration of $27.66 \times 10^6$ spores/ml., the highest growth and yield of Chinese radish was significantly higher than that of non-treated plants. *Penicillium notatum* (KMITL 99), however, had no effect on the growth of cucumber plants.

**Key words:** *Brassica campestris var. chinensis*, Chinese mustard, Chinese radish, plant growth stimulants, *Raphanus sativus* var. *longipinnatus*.

## Introduction

Species of *Penicillium* are ubiquitous saprobes, whose numerous conidia are easily distributed through the atmosphere and are common in soils. In soil analyses, using dilution plate techniques, *Penicillium* species are detected with high frequency (Domsch *et al.*, 1993). However, very little is known of interactions between *Penicillium* species and other soil fungi, or even on plant growth. *Penicillium* species generally occurr at greater soil depths than species of other genera, and have low concentrations in rhizosphere soils (Domsch *et al.*, 1993). Some species of *Penicillium* are well known for their activities to produce antibiotics (e.g. Penicillin), and therefore *Penicillium* sp. is one of the best researched genera, with regard to biochemistry. All strains of *Penicillium* so far tested are able to solubilize metaphosphates and utilize them as phosphorus sources (Picci, 1965). Many species have been shown to contain mycoviruses (Bozarth, 1972). There are some reports that *Penicillium* species can suppress root pathogens; *Penicillium chrysogenum* has been reported to be able to control *Verticillium* wilt of tomato, when roots are dipped in a spore suspension before planting (Dutta, 1981). *Penicillium notatum* has also been reported to inhibit and reduce the number of rust pustules in wheat caused by *Puccinia graminis* f. sp. *tritici* (Mishra and Tiwari, 1976). Little is also known about plant growth stimulants produced by *Penicillium* spp. The objective of this study was therefore to investigate whether *P. notatum* (KMITL 99) can promote plant growth of Chinese mustard (*Brassica campestris* var. *chinensis*), Chinese radish (*Raphanus sativas* var. *longipinnatus*) and cucumber (*Cucumis sativus*). The optimum concentration of spore suspensions for promotion of plant growth was also investigated.

## Materials and methods

### *Fungal isolate*

*Penicillium notatum* (KMITL 99) was isolated from rhizosphere soil of planted Chinese mustard (*Brassica campestris* var. *chinensis*) using the dilution plate technique on Czapek's agar (2g sodium nitrate, 1g potassium dibasic phosphate, 0/5g potassium chloride, 0.5g magnesium sulphate, 17g agar and 1,000 ml of distilled water). The isolates were then kept at the Mycological laboratory, KMITL, Bangkok, Thailand.

### *Testing for plant growth*

*Penicillium notatum* (KMITL 99) was cultured on potato dextrose agar (PDA) and incubated for 14 days at room temperature (27-30 C). Planting medium was prepared by mixing sand to coconut dust and fiber to organic compost, in the ratio of 2:2:1 by volume. Medium was sterilized at 121 C for 20 minutes for 3 consecutive days and placed into 12 inches diameter plastic pots. Fourteen days old *P. notatum* plates were harvested and added to the planting medium at concentrations of $5.53 \times 10^6$, $11.06 \times 10^6$, $16.59 \times 10^6$, $22.13 \times 10^6$ and $27.66 \times 10^6$ spores/ml at a rate of 50 ml/pot. Planting medium without the addition of *P. notatum* was used as a control. All pots were moistened with sterile water and covered with plastic sheets and left for 15 days before planting. The effect of *P. notatum* on growth of the Chinese mustard, Chinese radish and cucumber were carried out. Pots were arranged in a completely randomized design (CRD), and the experiment was repeated 5 times. Ten seeds of each plant were sown in each pot and the plants were thinned randomly to 1 seedling per pot after emergence. Chemical fertilizers or pesticides were not applied in these experiments.

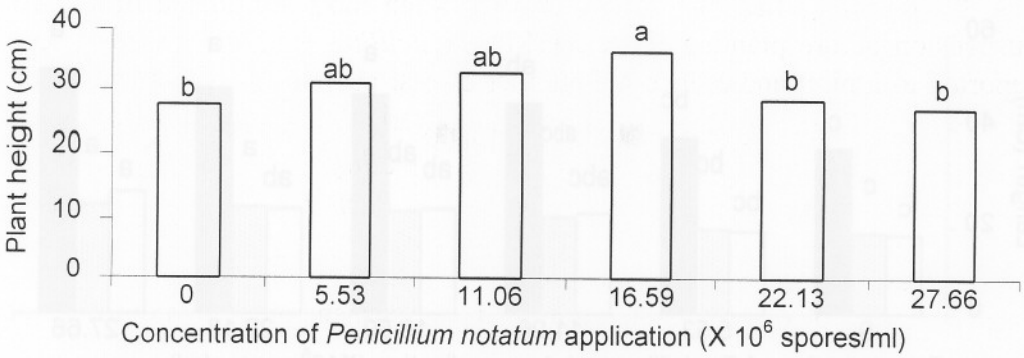


**Fig. 1.** The effect of *Pencilium notatum* at 6 concentrations on the height of the Chinese mustard (*Brassica campestris* var. chinensis). Means having the same letter are not significantly different by DMRT (P = 0.05).

### *Statistical analyses*

At harvesting, the plant height, root length, root diameter, fresh and dry weights of the root and shoots were measured at 57 days for the Chinese mustard, 58 days for the cucumber and 73 days for the Chinese radish. The average mean of growth parameters from five replicated experiments were subjected to analysis of variance and treatment means were computed by Duncan's new multiple range test at P = 0.05 and P = 0.01 respectively.

## Results

The effect of *P. notatum* (KMITL 99) on growth of Chinese mustard was only observed in plant height (Fig. 1). The plant height gradually increased when the concentration of *P. notatum* added was increased from 5.53 × $10^6$ spores/ml to 16.59 × $10^6$ spores/ml. Further increases in concentrations of *P. notatum* to 22.13 × $10^6$ and 27.66 × $10^6$ spores/ml., however, resulted to gradual reduction of the plant height. Application of *P. notatum* at a concentration of 16.59 × $10^6$ spores/ml. resulted in plant growth that was significantly higher than the control (P = 0.05). Similar trends were observed in the other parameters measured but no significant differences were recorded. There was significant effect on growth of the Chinese radish when *P. notatum* was added. The Chinese radish shoot length, root length, total length (Fig. 2), root diameter (Fig. 3), fresh and dry weights of shoot, root and total weight (Figs. 4, 5) gradually increased as the concentrations of *P. notatum* applied increased from 5.53 × $10^6$ spores /ml to 27.66 × $10^6$ spores/ml. The highest growth and yield of Chinese radish occurred when *P. notatum* were added at the concentration of 27.66 × $10^6$ spores/ml, significantly higher than the control. There was no significant effect on growth of the cucumber plants when *P. notatum* was added at any concentration.

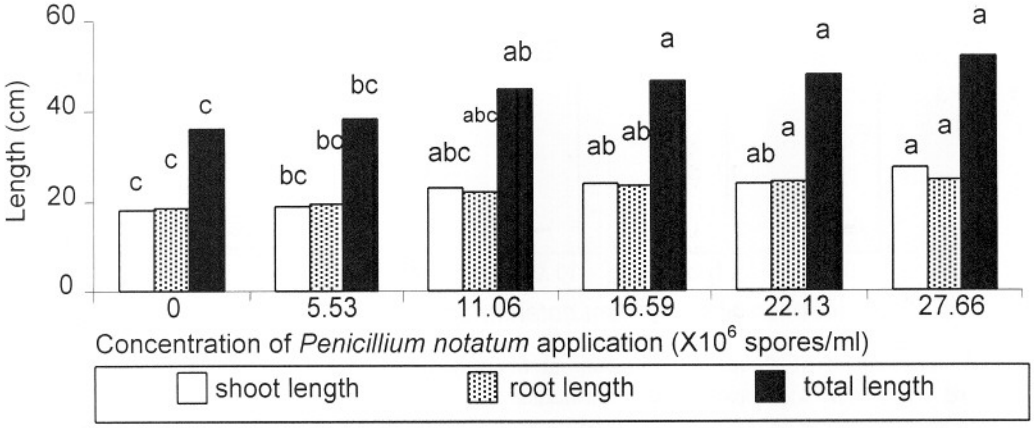


**Fig. 2.** The effect of *Penicillium notatum* at 6 concentrations on the shoot, root and total length of the Chinese radish (*Raphanus sativus* var. *longipinnatus*). For the length of each part, means having the same letter are not significantly different by DMRT (P = 0.05).

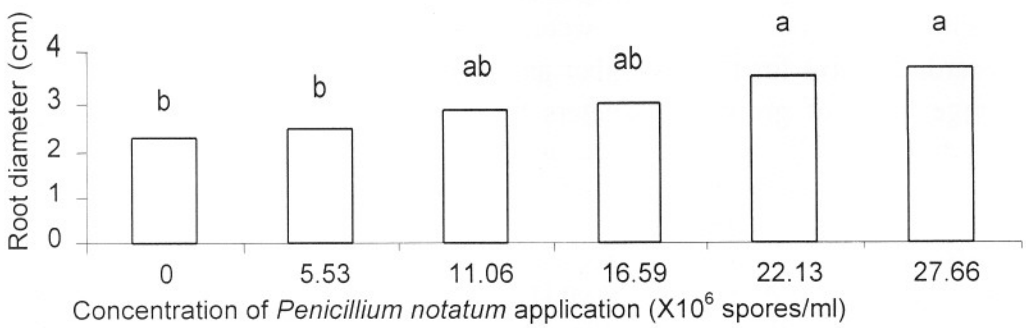


**Fig. 3.** The effect of *Penicillium notatum* at 6 concentrations on the root diameter of the Chinese radish (*Raphanus sativus* var. *longipinnatus*). Means having the same letter are not significantly different by DMRT (P = 0.05).

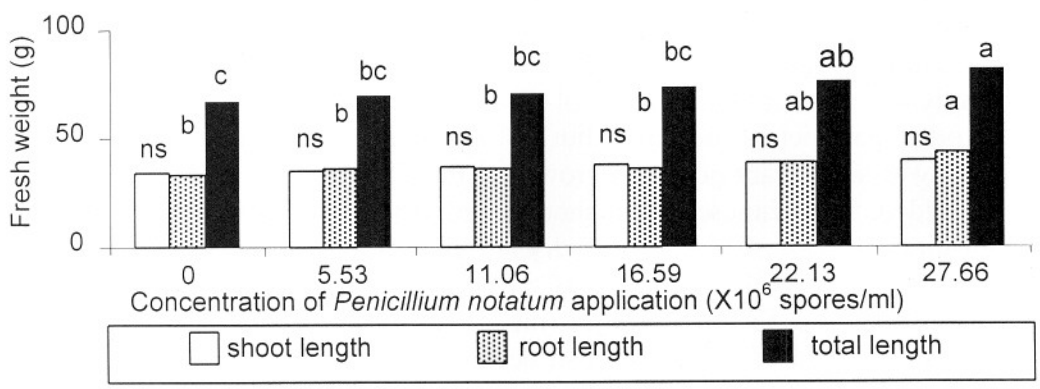


**Fig. 4.** The effect of *Penicillium notatum* at 6 concentrations on the shoot, root and total fresh weights of the Chinese radish (*Raphanus sativus* var. *longipinnatus*). For the fresh weight of each part, means having the same letter are not significantly different by DMRT (P = 0.05).

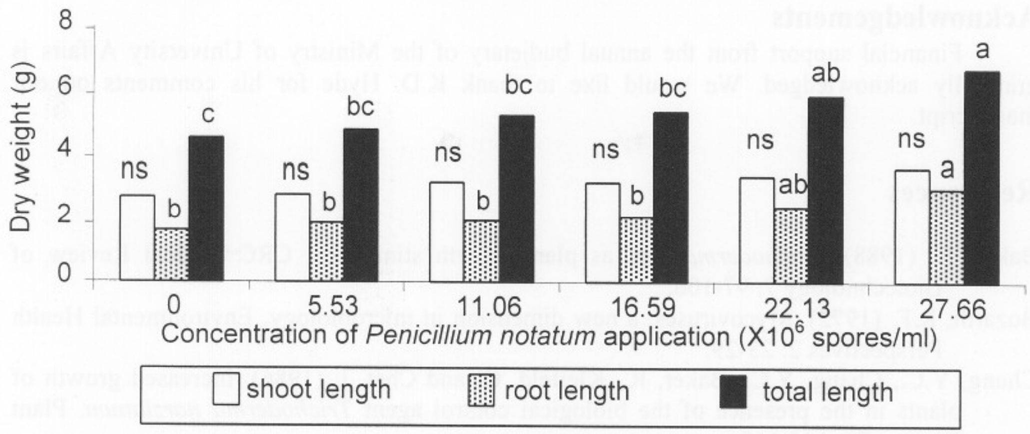


**Fig. 5.** The effect of *Penicillium notatum* at 6 concentrations on the shoot, root and total dry weights of the Chinese radish (*Raphanus sativus* var. *longipinnatus*). For the dry weight of each part, means having the same letter are not significantly different by DMRT (P = 0.05).

## Discussion

The results of these experiments reveal the potential of *P. notatum* (KMITL 99) for increasing plant growth, especially in the Chinese radish. The type of growth promotion may be similar to that produced by the addition of *Trichoderma* spp. which have been found to enhance the growth of various plants (Chang *et al*., 1986; Paulitz *et al*., 1986; Windham *et al*., 1986; Baker, 1988; Kleifeld and Chet, 1992; Ousley *et al*., 1994 a,b; Phuwiwat and Soytong, 1999 a,b; Harman, 2000).

The increased plant growth induced by *Trichoderma* spp., has been found to be dependent on many factors such as plants, the strain of *Trichoderma* used, the form of inoculum, the concentrations of inoculum applied, and the soil environment (Paulitz *et al*., 1986; Baker, 1988; Kleifeld and Chet, 1992; Ousley *et al*., 1994a,b). In this study, *P. notatum* (KMITL 99) had no significant effect on the growth of Chinese mustard and no effect on the growth of cucumber plants. However, there are no previously reports that *P. notatum* could enhance plant growth. Some reports have shown that *P. chrysogenum* is able to control *Verticillium* wilt of tomato (Dutta, 1981). Interestingly, Mishra and Tiwan (1976) reported that *P. notatum* could inhibit and reduce the number of rust pustules in wheat caused by *Puccinia graminis* f. sp. *tritici*. It would be interesting to test this specific strain of *P. notatum* (KMITL 99) for biological control of plant pathogens. Further investigations are needed to determine the potential of this fungus on the growth promotion of different crop plants. The effective strains should be selected and the suitable concentrations for plant growth promotion should be investigated. Moreover, the soil environment that is suitable for promoting plant growth should also be studied.

## Acknowledgements

Financial support from the annual budjetary of the Ministry of University Affairs is gratefully acknowledged. We would like to thank K.D. Hyde for his comments on our manuscript.

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(Received 20 October 2000, accepted 10 July 2001)