Korean J. Ecol., 25(6): 395~398, 2002

Allelopathy of *Tagetes minuta* L. Aqueous Extracts on Seed Germination and Root Hair Growth

Kil, Ji-Hyun[1], Kew-Cheol Shim[2]*and Kyu-Jin Lee[3]

[1]*Division of Plant Ecology, National Institute of Environmental Research, Incheon 404-170, South Korea*
[2]*Department of Biology Education, Kongju National University, Kongju, Chungnam 314-701, South Korea*
[3]*Department of Biological Sciences, Kongju National University, Kongju, Chungnam 314-701, South Korea*

ABSTRACT: Present paper showed allelopahtic effects of *Tagetes minuta* aqueous extracts on seed germination and root hair development. Allelopathy of aqueous extracts derived from *T. minuta* examined using two test plant species (*Lotus corniculatus* var. *japonicus* and *Lactuca sativa*). The seeds of test species were inoculated in petri dishes containing 0, 10, 50 and 100% aqueous extracts from *T. minuta*. At day 5, the relative seed germination ratio to control was evaluated, and the development of seedling root hairs was observed through light microscopy. Seed germination of *L. corniculatus* var. *japonicus* was significantly inhibited proportional to the concentrations of aqueous extract, but that of *L. sativa* wasn't inhibited. The inhibitory allelopathic effect of *T. minuta* was found in the development and growth of seedling root hairs. It was concluded that the inhibitory allelophatic effects have been to be investigated using various bioassay, for the allelopathy of plant species shows species-specific and organ-specific.

Key words : Allelopathic effect, Aqueous extract, Root hair growth, Seed germination, *Tagetes minuta*

INTRODUCTION

Allelopathy is a strategy for inter-specific competition (Fischer *et al.* 1994, Langenheim 1994), and even for intra-specific competition in populations (Saxena *et al.* 1996, Park 1999). Some plant species have secreted toxic natural substances. They interfere with the vital processes of plants, and inhibit seed germination and seedling growth (Balke *et al.* 1987, Kil and Lee 1987, Yun and Kil 1997, Jose and Gillespie 1998, Topp *et al.* 1998). Even such secondary compounds derived from some plants have great potentials as environmentally safe herbicides (Duke, *et al.*, 1997), and exhibit fungicidal and insecticidal activity (Kil *et al.* 1994, Dellar *et al.* 1997, Vasudevan *et al.* 1997, Topp *et al.* 1998, Lee and Kim 1999). It was reported the water extracts and volatile chemicals from some plants showed allelopathic effects such as inhibition of root and hypocotyl growth, and cell elongation and cell division of seedling tissues (Cruz-Ortega *et al.* 1988, 1998, Yoo 2000).

Tagetes species are found in numerous countries, and known to ornamental plants (Vasudevan *et al.* 1997). The plant species of *Tagetes* genus have phytotoxicity, and anti-microbial and nematocidal activity (Zygadlo *et al.* 1994, Tereschuk *et al.* 1997, Topp *et al.* 1998, Lee *et al.* 2002). *T. minuta* invaded in Korea in the 1980s, and is found widely in southern area of the Korean peninsula. But there is little ecological attention to it yet in Korea. The purpose of this study is to investigate an allelopathic potentials on seed germination, and development and growth of seedling root hairs of selected plants.

MATERIALS AND METHODS

Plant species and aqueous extracts preparation

T. minuta was used as a donor species of the aqueous extract. Receptor plant species were *Lotus corniculatus* var. *japonicus* and *Lactuca sativa*. Preparation of *T. minuta* aqueous extract was performed as follows: one liter of distilled water was added to 2-L Erlenmeyer flask containing 200 g fresh *T. minuta* material within 24 hours after being harvested. The aqueous mixture was incubated at 25°C for 24 hours and filtrated first through a 0.053 mm sieve, and then through Whatman No. 40 filter paper (Kil and Yim 1983). Whereas undiluted filtrate was defined as 100% extract, filtrates were diluted to 10 and 50% of the original extract by adding distilled water.

Bioassay and statistical data analysis

The seeds of receptor species were inoculated in petri dishes (diameter 12cm) with two pieces of filter paper containing aqueous extracts derived from *T. minuta*. The treatments were exposed to 10, 50 and 100% aqueous extracts, and the controls

* Author for correspondence; Phone: 82-41-850-8287, Fax: 82-41-850-8842, e-mail: skcshim@kongju.ac.kr

were exposed to distilled water. They were incubated at 25°C in the dark. At day 5 after inoculation, the relative seed germination ratio to control was evaluated by measuring germination ratio (Kil and Yun 1992), and the development and growth of seedling root hairs of receptor species was observed through light microscope. The experiment was replicated 3 times.

$$\text{Relative Germination Ratio (RGR, \%)} = \frac{\text{Germination percentage of treatment}}{\text{Germination percentage of control}} \times 100$$

Statistical differences among the treatments and controls were tested using one-way ANOVA (Duncan's multiple range test). Data were analysed statistically using SPSS Windows program.

RESULTS AND DISCUSSION

The effect of *T. minuta* aqueous extracts on seed germination of receptor plants is shown in Table 1. The germination of *L. corniculatus* var. *japonicus* was significantly inhibited in concentration above 50% of aqueous extracts. But, the germination of *L. sativa* wasn't inhibited. This result is not similar to previous studies (Kim 2000, Yoo 2000). Seedling growth of *L. corniculatus* var. *japonicus* and *L. sativa* was showed in Fig. 1. Seedlings of *L. corniculatus* var. *japonicus* in treatments were slightly smaller than those of control, but treatment of *L. sativa* were not different with control.

The morphological changes of root hairs of receptor plants in treated aqueous extracts were shown in Fig. 2~3. Root hairs of test plants developed well and regularly arranged in control. But, the develoment and growth of root hairs of *Lotus corniculatus* var. *japonicus* and *Lactuca sativa* seedlings decreased proportional to concentration of aqueous extracts used. Increasing aqueous extracts concentration remarkably reduced the number, length, and density of root hairs of test plant species. Especially, seedling root hairs in the 100% treatment of aqueous extracts didn't develope.

Cruz-Ortega *et al.* (1998) also observed increased vacuolation and other disruption on the root tip cells of seedlings by aqueous leachates. Because changes of cytoskeleton arrangement by allelochemicals as microtubule antagonist (Dolan 2001), development and growth of root hairs were inhibited. Root tip as well as seedling growth depends on nutrient uptake. Though seeds germinate and seedlings is like to grow early, allelochemicals retard gradually growth of seedlings by inhibiting development and growth of root hairs. Such inhibitory allelopahtic effect on the development and growth of root hairs of seedlings decrease the efficiency of nutrient uptake from the soil (Gilroy and Jones 2000). Root hairs grows rapidly as tip growth of seedling is established (Dolan 2001). Therefore, allelopathy is a powerful strategy in competition.

Table 1. The relative seed germination ratio of *Lotus corniculatus* var. *japonicus* and *Lactuca sativa* by aqueous extracts from *Tagetes minuta*

	Control	10%	50%	100%
Lotus corniculatus var. *japonicus*	100[a]	96.58±1.59[a]	89.87±6.75[b]	88.54±11.99[b]
Lactuca sativa	100[a]	100.00±0.00[a]	96.10±0.17[a]	95.72± 0.63[a]

*Homogeneous subsets are displayed by Duncan's multiple test ($p<0.05$).

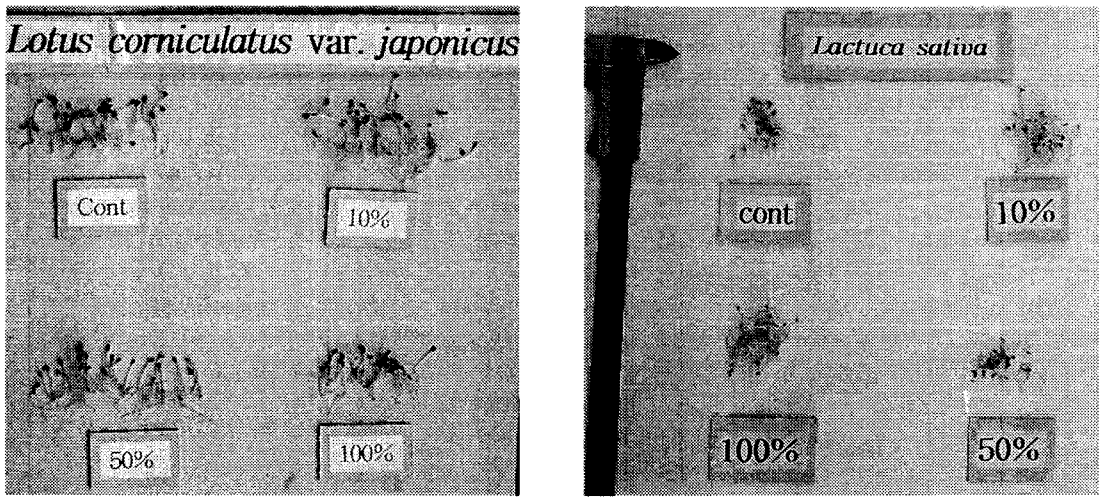
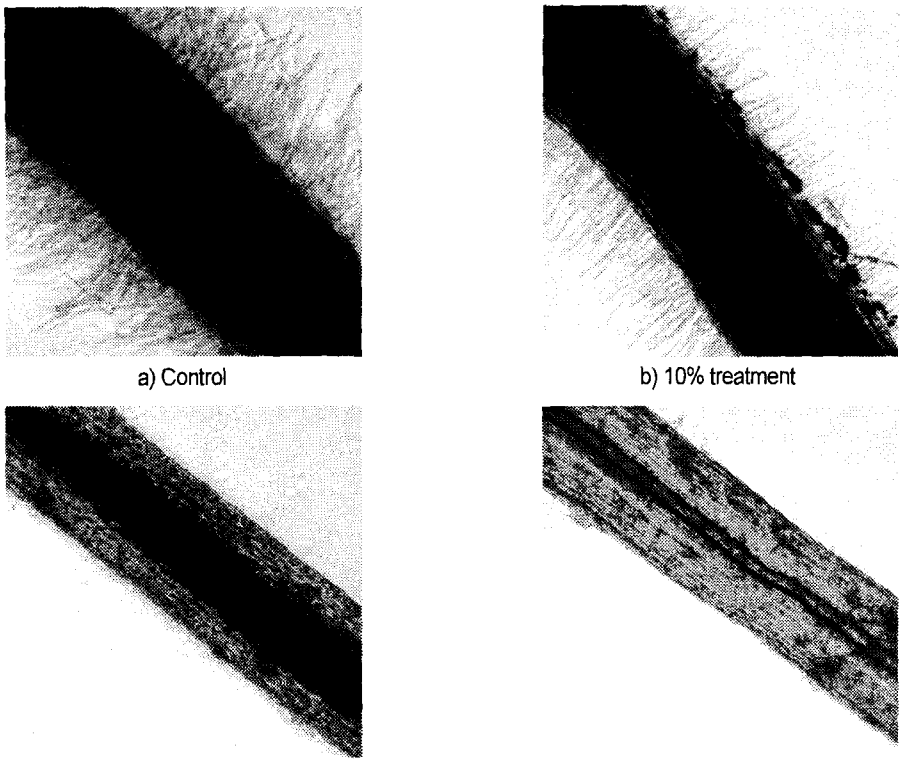


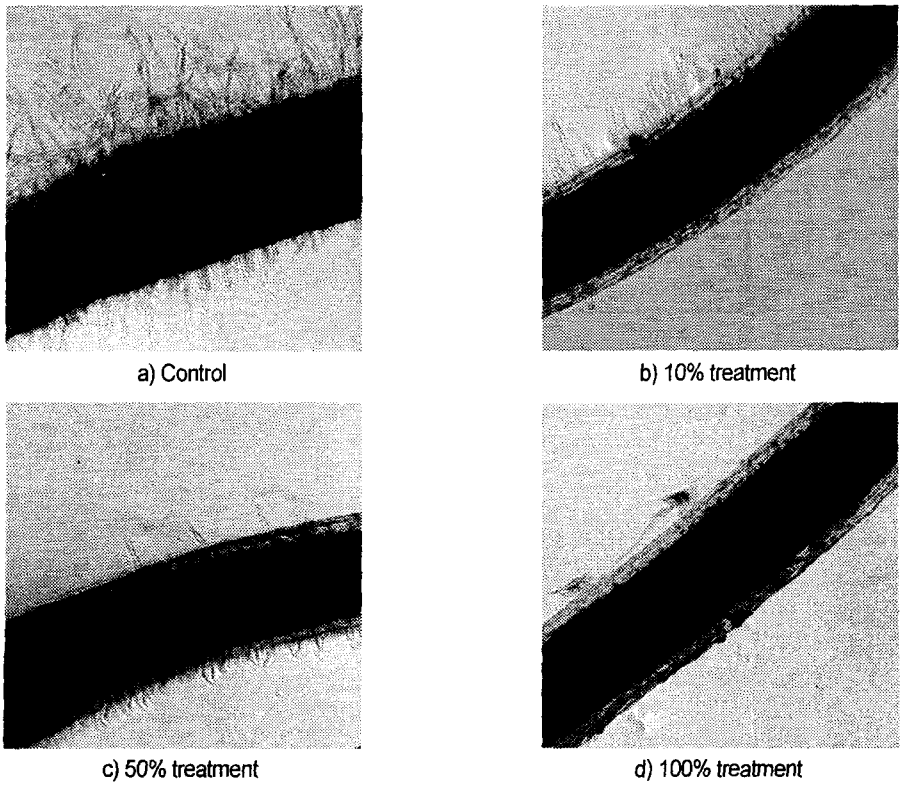
Fig. 1. The seedlings of *Lotus corniculatus* var. *japonicus* and *Lactuca sativa* exposed to aqueous extracts from *Tagetes minuta*.



a) Control b) 10% treatment

c) 50% treatment d) 100% treatment

Fig. 2. The development of root hair of *Lotus corniculatus* var. *japonicus* by aqueous extracts from *Tagetes minuta*.



a) Control b) 10% treatment

c) 50% treatment d) 100% treatment

Fig. 3. The development of root hair of *Lactuca sativa* by aqueous extracts from *Tagetes minuta*.

LITERATURE CITED

Balke, N. E., M. P. Davis and C. C. Lee. 1987. Conjugation of allelochemicals by plants: enzymatic glucosylation of salicylic acid by *Avena sativa*. *In* Waller, G. R. (*ed.*) Allelochemicals: role of in agriculture and forestry. *ACS Symposium Series 330*. Washington, D. C., American Chemical Society. pp. 214-227.

Cruz-Ortega, R., A. L. Anaya and L. Ramos. 1988. Effects of allelopathic compounds of pollen on respiration and cell division of watermelon. Journal of Chemical Ecology 14: 71-86.

Cruz-Ortega, R., A. L. Anaya, B. E. Hernandez-Bautista and G. Laguna-Hernandez. 1998. Effects of allelochemical stress produced by *Sicyos deppei* on seedling root ultrastructure of *Phaseolus vulgaris* and *Cucurbita ficifolia*. Journal of Chemical Ecology 24: 2039-2057.

Dellar, J. E., M. D. Cole and P. G. Waterman. 1996. Antifungal polyoxygenated fatty acids from *Aeollanthus parvifolius*. Journal of Chemical Ecology 22: 897-906.

Dolan, L. 2001. How and where to build a root hair. Current Opinion in Plant Biology 4: 550-554.

Duke, S. O., K. C. Vaughn, E. D. Croom Jr. and H. N. Elsohly. 1997. Artemisin, a constituent of annual wormwood (*Artemisia annua*) is a selective phytotoxin. Weed Science 35: 499-505.

Fischer, N. H., G. B. Williamson, J. D. Weidenhamerand, D. R. Richardson. 1994. In search of allelopathy in the Florida scrub. The role of terpenoids. Journal of Chemical Ecology 20: 1355-1380.

Gilroy, S. and D. L. Jones. 2000. Through form to function: root hair development and nutrient uptake. Trends in Plant Science 5(2): 56-60.

Jose, S. and A. R. Gillespie. 1998. Allelopathy in black walnut (*Juglans nigra L.*) alley cropping. I. Spatio-temporal variation in soil julone in a black walnut-corn (*Zea mays* L.) alley cropping system in the midwestern USA. Plant and Soil 203: 191-197.

Kil, B. S. 1999. Allelopathic effects of *Artemisia cappillaris* on the selected species. The Korean Journal of Ecology 22(1):59-63.

Kil, B. S. and K. W. Yun. 1992. Allelopathic effects of water extracts of *Artemisia princeps* var. *orientalis* on selected plant species. Journal of Chemical Ecology 18: 39-51.

Kil, B. S., K. W. Yun, S. Y. Lee and D. M. Han. 1994. Influence of chemicals from *Artemisia argyi* on the growth of selected species of plants and microorganisms. The Korean Journal of Ecology 17: 23-35.

Kil, B. S. and Y. J. Yim. 1983. Allelopathic effects of *Pinus densiflora* on undergrowth of red pine forest. Journal of Chemical Ecology 9: 1135-1151.

Kim, T. Y. 2000. Allelopathic potentials of *Chrysanthemum boreale*. MA. Thesis. Wonkwang Univ., Iksan, Chunbuk. 56.p.

Lee, H. J and Y. O. Kim. 1999. Antimicrobial activity of some plants containing allelochemicals. The Korean Journal of Ecology 22(1):51-58.

Lee, S. Y., K. C. Shim and J. H. Kil. 2002. Phytotoxic effects of aqueous extracts and essential oils from southern marigold (*Tagetes minuta*). New Zealand Journal of Crop and Horticultural Science 30:161-169.

Park, J. Y. Effects of allelochemicals of *Eupatorium rugosum* on seed germination, seedling growth and antimicrobial activity. MA. Thesis. Konkuk Univ., Seoul. 47 p.

Saxena A., D. V. Singh and N. L. Joshi. 1996. Autotoxic effects of pearl millet aqueous extracts on seed germination and seedling growth. Journal of Arid Environments 33:255-260.

Tereschuk, M. L., M.V. Riera, G. R. Castro and L. R. Abdala. 1997. Antimicrobial activity of flavonoids from leaves of *Tagetes minuta*. Journal of Ethnopharmacology 56:227-232.

Topp, E., S. Millar, H. Bork and M. Welsh. 1998. Effects of marigold (*Tagetes* sp.) roots on soil microorganisms. Biololgy of Fertility Soils 27:149-154.

Vasudevan, P., S. Kashyap and S. Sharma. 1997. *Tagetes*: A multipurpose plant. Bioscience Technology 62:29-35.

Yoo, H. G. 2000. Allelopathic effects of essential oils of some plant species in *Artemisia* on selected plants and microbes. Ph.D. Thesis, Wonkwang Univ., Iksan, Chunbuk. 144. p.

Yun, K. W. and B. S. Kil. 1997. The interaction of volatile chemicals and phytohormones on seed germination and seedling growth of lettuce. The Korean Journal of Ecology 20: 233-238.

Zygadlo, J. A., C. A. Guzman and N. R. Grosso. 1994. Antifungal properties of the leaf oils of *Tagetes minuta* L. and *T. filifolia* Lag. Journal of Essential Oil Research 6: 617-621.

(*Received November 8, 2002, Accepted December 10, 2002*)