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# SHORT COMMUNICATION

# Allelopathic effects of *Canna indica* on paddy weeds

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## ABSTRACT

We evaluated the allelopathic effects of *Canna indica* on paddy weeds. Aqueous extracts (1, 2, 4, 8 %, w/v) from its powdered naturally withered aerial parts inhibited the seed germination and seedling growth of lettuce (*Lactuca sativa* L.) and two major weed spp. [barnyardgrass (*Echinochloa crusgalli* L.) and monchoria (*Monocharia vaginalis* P.)]. All *C. indica* dried powders at 50, 100, 150 $gm^{-2}$ significantly inhibited the emergence and dry weights of weeds in paddy field but had no adverse effects on growth of transplanted rice. These results showed that *C. indica* plants might be used as a natural herbicide to control weeds in paddy field.

**Key words:** Allelopathy**,** Canna (*Canna indica* L.), weed control, rice field

## INTRODUCTION

Canna (*Canna indica* L.) is an ornamental plant with rapid vegetative growth and has originated from South America. It is grown in most countries and the rapid growth rate has made it popular as gardening plant worldwide (including Japan and China). Owing to its rapid growth it produces lot of naturally withered aerial parts. Thus we are finding, how effectively to use these withered aerial parts for their insecticidal effects (5) and tolerance to contaminants (1). Recently, studies to use allelochemicals as natural substances from plants for weed control in crop production (2,6,7,8,9,13) have been widely noticed. In general, allelochemicals from plants are considered safe and beneficial to the environment and mankind, unlike synthetic herbicides, which pollutes water and soil in crop ecosystems. Residues of buckwheat (17,19), alfalfa (3,4,18), sunflower(10), hairy vetch (16) and kava (15) exerts inhibitory effects on selected weeds. In our previous studies, dwarf lilyturf (11,12) exhibited significant inhibitory effects on some weeds in paddy field in Japan and its some allelochemicals were identified (12). Study on allelopathy and herbicidal effects of *C. indica* on paddy weeds has not been conducted yet. This study aimed (i) to evaluate the allelopathic effects of aqueous extracts from *C. indica* on the seed germination and initial growth of lettuce (*Lactuca sativa* L.) and two main weed species, *viz.*, barnyardgrass (*Echinochloa crusgalli* L.) and monchoria (*Monocharia vaginalis* P.) and (ii). to determine its herbicidal effects on weeds in paddy field.

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## MATERIALS AND METHODS

Naturally withered aerial parts (stems, leaves and flowers) of *C. indica* were collected in December, 2006 from Experimental Station, Miyazaki University, Miyazaki City, Japan. The plant materials were washed with distilled water several times, dried in oven at 50°C for 48 h and ground in a homogenizer (No.TM-80, National Ltd, Japan). The dried powders were stored at -20 °C until use. Seeds of two major weed species grown in rice field, barnyardgrass (*E. crusgalli*) and monchoria (*M. vaginalis*), were collected from Farm of Miyazaki University in October 2006 and stored at -5 °C. Seeds of lettuce (*L. sativa*) cv. Great Lakes 366 were purchased from Takii Seed Co. Ltd., Japan and used in bioassay experiments.

**Laboratory bioassay**

Dried powders of test parts were separately soaked for 24 h in distilled water at 1, 2, 4 and 8 g /100 ml. The solutions were filtered through 3-layers of cheese cloth to remove the debris. The supernatants were re-filtered through No. 2 filter paper and kept in refrigerator at 5 °C until bioassay. Then dormancy-broken weed and lettuce seeds were surface sterilized in 75% alcohol solution for 30 sec and afterwards well washed with distilled water. Thirty healthy seeds were sown on one layer of filter paper placed in each Petri dish (90 mm dia) containing 10 ml of appropriate aqueous extract and kept in a growth chamber [4000 lux artificial light (7:00 -19:00) per day at 25 °C]. Distilled water was used in control. Seed germination, shoot and root lengths of weeds were recorded 10 days after sowing (DAS) for lettuce and monchoria and 5 DAS for barnyardgrass. All treatments were arranged in a completely random design with three replicates.

**Pot bioassay**

Pot experiment was conducted (April-September, 2007) to determine the allelopathic effects of *C. indica* dried powders on weed growth grown in paddy soil. Paddy clay soil was collected from the Experimental Station, Miyazaki University in March, 2007, dried in a glasshouse for about one month, grounded, mixed thoroughly and placed in Wagner pots (18 cm diam). All pots were irrigated with running tap water. Four days after irrigation, the dried powders were added in their respective pots at 0 (control), 50, 100 and 150 g $m^{-2}$ (0, 1, 2, 3 g/pot). All pots were arranged randomly with four replicates for each treatment. Number of weeds emerged in each pot were counted at 10, 20 and 30 DAT (Days after translplanting). The weeds biomass (collected at 30 DAT) was dried in oven at 75 °C for 48 h and dry weight was recorded.

To determine the effects of dried powders of *C. indica* on the growth of transplanted rice, four (30-days-old) seedlings of local rice cv Koshihikari were transplanted in each Wagner pot (18 cm dia) filled with commercial heated clay soil (without any weed seeds) to exclude the effects of weed emergence on rice growth. Powders of *C. indica* plants were applied on the surface at 0 (control), 50, 100 and 150 $gm^{-2}$. Cultivation was done as per local practices. Plant height and number of tillers of rice were recorded 15, 20 and 30 DAT, respectively. Length and the number of panicles and grain yield (dry weight) per rice plant were determined at maturity (40 days after heading). All experiments were done in completely randomized design with four replicates.

**Statistical analysis:** Analysis of variance was performed for all data except germination percentages were calculated. Comparisons between treatments were made at 0.05 probability level using the least significant difference (LSD). Inhibition percentage (%) was calculated as [(control value – treatment value)/control value] × 100.

## RESULTS AND DISCUSSION

### Germination and seedling growth

Aqueous extracts of *C. indica* plant parts at 4% concentration markedly inhibited the seed germination of all test species (Fig. 1). The aqueous extract at 8%, completely inhibited the seed germination of all test species. Low concentrations (1% and 2%) had no effects on the seed-germinations.

All extracts significantly reduced the root and shoot growth of seedlings of all test species and the inhibition increased with increased aqueous concentration. However, the degrees of inhibition of root and shoot growth varied with species tested. Aqueous extract of 8% completely inhibited the root and shoot growth of all tested species. These results showed that *C. indica* contains water soluble phytotoxins that strongly inhibited the germination and growth of test species.

### Herbicidal effects on weeds in rice field

The 50, 100, 150 $gm^{-2}$ powdered *C. indica* significantly reduced the emergence of weeds by 21.6%-63.6%, 57.8%-100%, and 79.4%-100% of control at 10, 20 and 30 DAT, respectively (Table 1 and Fig. 2). The inhibition degrees become higher when the concentrations increased and became decreased gradually with time after application. For example, the high inhibition (63.6%) of 50 $gm^{-2}$ at 10 DAT decreased to 21.6% at 30 DAT. Similarly all treatments significantly reduced the total dry weight (20.5%-86.5%) of emerged weeds 30 at DAT compared to control. These result showed that *C. indica* dried powders contains natural compounds which could inhibit the weeds growth in paddy field.

Table 1. Effects of application of Canna (*C. indica* ) dried powder on weeds density and dry matter in paddy field

| Parameter | Dried powders ($gm^{-2}$)* | | | |
|---|---|---|---|---|
| | Control | 50 | 100 | 150 |
| Weed number per plot 10 DAT | 16.5(0)a | 6.0(63.6)b | 0.0(100)c | 0.0(100)c |
| Weed number per plot 20 DAT | 37.0(0)a | 24.0(35.1)b | 6.0(83.8)c | 0.0(100)d |
| Weed number per plot 30 DAT | 51.0(0)a | 40.0(21.6)b | 21.5(57.8)c | 10.5(79.4)d |
| Total weed weight per plot (g) | 4.1(0)a | 3.3(20.5)b | 2.7(35.5)c | 0.6(86.5)d |

DAT: Days after treatment, Negative (-) and Positive (+) values are in parenthesis indicate the % stimulation (+) and Inhibition (-)over the control.* Values with same letters in a row are not significantly different at 0.05 level

### Effects on rice growth

Application of dried powder of *C. indica* parts at all rates did not inhibit all the test growth parameters of rice plants (Table 2 and Fig. 2). Conversely, application of powder at 100 and 150$gm^{-2}$ significantly increased the rice yield by 10.6% and 13.5%,

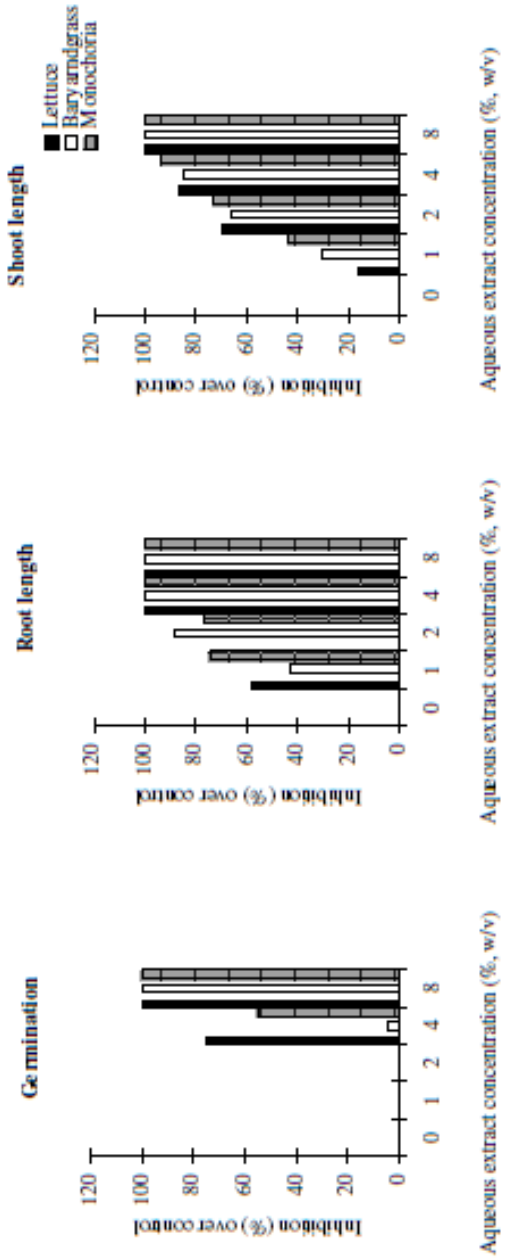


Figure 1. Effects of aqueous extracts of *C. indica* plants on germination and seedling growth of lettuce, barnyardgrass and monchoria.

Table 2. Effects of application of Canna (*C. indica* ) dried powder on rice growth and yield parameters in Paddy field

| Parameter | Dried powders ($gm^{-2}$)* | | | |
|---|---|---|---|---|
| | Control | 50 | 100 | 150 |
| Plant height (cm)15 DAT | 27.8(0)a | 26.9(3.2)a | 30.0(-7.9)a | 29.6(-6.5)a |
| Plant height (cm) 20 DAT | 35.3(0)a | 34.8(1.5)a | 38.6(-9.3)a | 36.5(-3.3)a |
| Plant height (cm) 30 DAT | 56.0(0)a | 58.9(-5.2)a | 59.4(-6.1)a | 55.9(0.2)a |
| Plant height (cm) at maturity | 94.5(0)a | 94.5(0.0)a | 91.0(3.7)a | 90.4(4.3)a |
| Panicle length(cm) at maturity | 15.1(0)a | 15.6(-3.4)a | 15.9(-5.3)a | 15.5(-2.8)a |
| Panicles per plant at maturity | 23.3(0)a | 24.4(-4.7)a | 24.8(-6.4)a | 25.1(-7.7)a |
| Grain yield per plant (g) at maturity | 50.9(0)a | 52.6(-3.7)a | 56.1(-10.6)b | 57.6(-13.5)b |
| Tillers per plant 15 DAT | 14.3(0)a | 16.0(-11.9)a | 18.7(-30.8)b | 17.7(-23.8)b |
| Tillers per plant 20 DAT | 28.3(0)a | 30.7(-8.3)a | 33.7(-18.8)b | 32.0(-13)b |
| Tillers per plant 30 DAT | 42.3(0)a | 45.3(-7.1)a | 47.7(-12.8)a | 44.3(-4.7)a |

DAT: Days after treatment, Negative (-) and Positive (+) values are in parenthesis indicate the % stimulation (+) and Inhibition (-)over the control.* Values with same letters in a row are not significantly different at 0.05 level

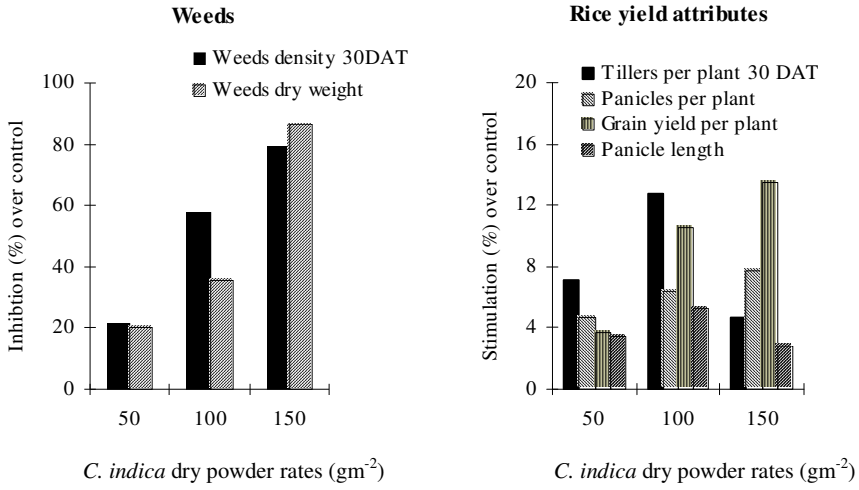


Figure 2. Effects of application of *C. indica* dried powder rates on the growth of weeds and rice yield attributes and rice yields.

respectively. This result indicated that the *C. indica* dried powders did not contain harmful allelochemicals for transplanted-rice growth, but significantly inhibited the emergence and dry weight of weeds in rice fields.

From these results, it was concluded that the dried powders from *C. indica* parts have significant herbicidal effects on weeds of rice field. For example, the 150 $gm^{-2}$ rate significantly reduced the emergence and dry weight of weeds by 79.4% and 86.5%, respectively, but increased the grain yield of rice by 13.5% (Table 2 and Fig. 2). Similar

results were reported by other allelopathic plants such as dwarf lilyturf (11), Kava (15) and buckwheat (17, 19). Apparently the herbicidal effects of *C. indica* parts could not persist at high level during the whole rice growth period, since the effects gradually decreased with time after application (Table 1). Considering that rice plants 30 d after transplanting, enters the maximum tillering stage or completed whole vegetative stage, thereafter few weeds occur in paddy field, which do not seriously affect the latter growth stage of rice plants. Thus, it could be concluded that the inhibitory allelochemicals present in *C. indica* could be used as a promising natural herbicide. In addition, future studies should be focused on identifying the specific allelochemicals in *C. indica* plants and determining the most suitable conditions for their herbicidal effects.

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