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Citation	Annual Report of FY 2007, The Core University Program between Japan Society for the Promotion of Science (JSPS) and Vietnamese Academy of Science and Technology (VAST). P.433-P.436
Issue Date	2008
Text Version	publisher
URL	<a href="http://hdl.handle.net/11094/12916">http://hdl.handle.net/11094/12916</a>
DOI	
rights	
Note	

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# EFFECTS OF COMPOST TEA MAKING FROM DIFFERENTLY TREATED COMPOST ON PLANT DISEASE CONTROL

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## ABSTRACT

Antifungal activity of compost teas was evaluated *in vitro* and *in vivo* experiments. *In vitro* test, fourteen compost teas were produced using five different composts and through six different methods for compost tea production. Eleven pathogenic fungi were used as indicators of antifungal activity of compost teas. *In vivo* test, one of the compost teas used in *in vitro* test was sprayed to cucumber leaves which were infected with powdery mildew in order to evaluate antifungal activity of compost tea. From the results of the tests, it was found that all compost teas used this study showed antifungal activity and the proper application of compost teas against pathogenic fungi for obtaining optimal effects was important to know.

## KEYWORDS

Compost tea, antifungal activity, plant disease.

## INTRODUCTION

Composting is a perfect recycling technology for organic waste and produces compost which is returned into soil as a fertilizer for providing nutrients to microbes and plants in soil. Composting makes organic waste put into a large material cycle, which is an ideal recycling scheme. In Japan, food waste law was enforced in 2001 and 20 % of total food waste from large consumers such as food processing companies, supermarkets, hotels, and restaurants must be recycled by 2006. Composting will greatly contribute the recycling system of the food waste and seems to have its bright future, however, it is not true.

Use of compost is very limited in Japan. There are several reasons for the phenomenon: a) compost quality as fertilizer is not always guaranteed, b) farmers do not like to use compost as fertilizer because it was made from waste, and c) waste sometimes contains unwanted materials such as heavy metals and persistent organic compounds so that compost cannot be returned to soil. Those limitations are appeared when use of compost is thought to be only as fertilizer or soil conditioner. Other applications of compost are proposed in order to find further extension of compost's capability by USEPA: remediation of contaminated soil, biofilter, reclamation of brownfields, plant disease control, and enhancement of phytoremediation of contaminated soil.

Compost tea is a variety of water-based compost preparations or liquid compost extracts <sup>1)</sup> and is used for plant disease control on foliage and in soils <sup>2, 3)</sup>. Compost tea may be one of promised applications of compost. The purpose of this study was to investigate effects of a variety of compost teas made from different composts on plant disease control. This new tool for biological control of plant disease is under development and needs to be more studied.

## MATERIALS AND METHODS

### Composts

Dog food (Aijo-Monogatari Beef taste, Yeaster, Japan) was used as organic substance for composting and compost was produced in a composting vessel with forced air supply system <sup>4)</sup>. The dog food was grinded and powered by a home juicer mixer. The powdered dog food and seed

compost<sup>4)</sup> were mixed with the ratio of 1:1 in weight. The water content of the mixed material was adjusted to 50-55% with tap water and it was placed into the composting vessel. Composting was conducted with 9 l/min air supply. Temperature at the mid part of the compost pile was measured during composting and evaporated water from compost pile during composting (the compost water) was collected. Composts prepared in five ways summarized in Table 1.

**Table 1.** Conditions of composts.

Condition	Descriptions
A	After 10 day-composting, stored in a closed container for one month.
B	After 10 day-composting, stored in a closed container for two months.
C	After 10 day-composting, stored in an open container for one month.
D	Used right after 10 day-composting.
E	Same as condition C but trout fish was used instead of dog food.

### Compost teas

Tap water and the compost water were used for the solution for making compost tea. A compost in Table 1 was mixed with tap water or the compost water with the ratio of 1:10 in volume. Six methods for producing compost teas were proposed. Table 2 showed how to produce compost teas.

**Table 2.** Methods for producing compost teas.

Method	Descriptions
1	Dissolved in tap water or compost water and aerated for one day.
2	Dissolved in tap water or compost water and aerated for three days.
3	Dissolved in tap water or compost water and aerated for five days.
4	Used right after diluted in tap water or compost water.
5	Dissolved in tap water or compost water and left for one week without aeration.
6	Dissolved in tap water or compost water and left for two weeks without aeration.

### Pathogens

The following pathogenic fungi of plant disease were selected in order to verify antifungal activity of compost teas (Table 3). Potato dextrose agar (Kanto Kagaku, Japan) was used as a growth medium.

**Table 3.** Pathogens used in this study

Experiment	Pathogens	Plant disease caused by the pathogen
In vitro	<i>Phytophthora citrophthora</i>	Phytophthora rot
	<i>Fusarium oxysporum</i> f. sp. <i>tulipae</i> MAFF235110	Tulip bulb rot
	<i>Fusarium</i> sp.	Fusarium wilt, Root rot
	<i>Pyricularia oryzae</i>	Rice blast
	<i>Colletotrichum dimatium</i>	Anthraxnose
	<i>Sclerotinia</i> sp.	Cottony rot, white mold
	<i>Rhizoctonia solani</i>	Large patch
	<i>Fusarium oxysporum</i> f. sp. <i>tulipae</i> MAFF235105	Tulip bulb rot
	<i>Fusarium oxysporum</i> f. sp. <i>tulipae</i> MAFF305609	Tulip bulb rot
	<i>Phytophthora cactorum</i> MAFF235096	Tulip blossom blight
	<i>Pythium sylvaticum</i>	Pythium blight
	<i>Botrytis tulipae</i> MAFF237888	Botrytis blight
	<i>Fusarium proliferatum</i>	Fusarium wilt
In vivo	<i>Podosphaera xanthii</i>	Cucumber powdery mildew

MAFF: Ministry of Agriculture, Forestry and Fisheries

### In vitro experiment for antifungal activity of compost teas

Combinations between condition of compost and methods for making compost teas were performed to prepare a variety of compost teas (Table 4). Agar Dilution Method was employed for evaluating antifungal activity of the compost teas. Potato dextrose agar (19.5g) was dissolved into 500ml of

pure water, and then was provided to make 45, 49.5, 49.95, and 50ml in erlenmeyer flask. Each erlenmeyer flask was closed with aluminium foil and autoclaved (120°C, 20 minutes). After autoclaved, each erlenmeyer flask was cooled down to about 40°C and then 0, 0.05, 0.5, and 5ml of compost teas were mixed into 50, 49.95, 49.5, and 45ml of agar in the erlenmeyer flask, respectively, under sterilized condition in order to prepare control (no compost tea), 10, 100, and 1000 time diluted compost tea agar media. A 10 ml of each medium was pored into petri dishes sterilized and the process was done in triplicates. After agar media in the petri dishes were solidified, the colony disk of the fungi incubated for one-week were transferred into the petri dishes in a clean bench. Visual observation for evaluation of antifungal activity by compost teas was done after one day.

**Table 4.** Combinations for compost tea production

Combination Symbols	Conditions (Table 1)	Methods (Table 2)
A-1	A	1
B-1		1
B-5	B	5
B-6		6
C-1		1
C-2		2
C-3	C	3
C-4		4
C-5		5
D-1		1
Control-Filtration	D	1 (with filtration)
D-5		5
E-1	E	1
Control-w/o compost	-	1

#### In vivo experiment for antifungal activity of compost teas

*In vivo* experiments for antifungal activity of compost teas, the suppression on cucumber powdery mildew by compost teas was evaluated. Plastic containers with 10 cm diameter were used for the experiments. News paper cut in three square centimetres was used to close the hole located on the bottom of the container. Vermiculite (S.K.Agric, Japan) was placed in the container and two seeds of cucumber (Tokiwa Hikari 3P) were planted in each container. Two g/l of a liquid fertilizer (Hyponex, Hyponex Japan) was poured onto the vermiculite and filled in the container. Next, the container was incubated in the incubator, controlled 12 hours illumination at 20 °C, for two weeks. During incubation, the liquid fertilizer was supplied to the cucumber once in two days. After two week incubation, tap water or the compost water, 1/10 diluted Compost tea No.5, and 1/100 diluted Compost tea No.5 were sprayed onto the leaves of the cucumber. When the surface of the leaves was dried, a pathogen, *Podosphaera xanthii* was inoculated onto the leaves. After one week from the inoculation, a visual observation was taken. As the final step, the compost teas used earlier were sprayed onto the leaves once in three days. A visual observation was done on the next day from the final spraying.

## RESULTS AND DISCUSSION

### *Results of all combinations*

Antifungal activity of all combinations were summarised in Table 5. As seen in the results, the combination of Control-w/o compost did not show any antifungal activity, which proved that antifungal activity of compost tea was supplied from compost, and it could be said that the activity was related to microbes in compost, not related to chemical compounds contained in compost according to the result of the combination of Control-Filtration which was the compost tea filtrated with a 0.45µm filter paper. Biological involvement in antifungal activity of compost teas is also described in Scheuerell (2003). It could not be quantitatively evaluated but the compost condition C seemed to give the strongest activity to the compost teas and, among the condition C, the

combination C-1 showed the strongest antifungal activity. From the results here, aerobic and anaerobic methods for making compost teas did not cause significant difference on antifungal activity of the teas, however, it was found from the comparison of the antifungal activity strength that compost teas were produced aerobically, the activity of the compost tea made from tap water seemed stronger than the one of the compost tea made from compost water and vice versa when the compost teas were produced anaerobically. The combination B-1 only did not follow this trend.

**Table 5.** Antifungal activity upon compost teas produced by different procedures

Combination Symbols	Antifungal activity		Comparison of the activity strength
	Compost water	Tap water	
A-1	Yes	Yes	-
B-1	Yes	Yes	Compost water > Tap water
B-5	Yes	Yes	Compost water = Tap water
B-6	Yes	Yes	Compost water = Tap water
C-1	Yes	Yes	Compost water < Tap water
C-2	Yes	Yes	Compost water < Tap water
C-3	Yes	Yes	Compost water < Tap water
C-4	Yes	Yes	Compost water = Tap water
C-5	Yes	Yes	Compost water = Tap water
D-1	Yes	Yes	Compost water < Tap water
Control-Filtration	No	-	-
D-5	Yes	Yes	Compost water = Tap water
E-1	Yes	Yes	Compost water = Tap water
Control-w/o compost	No	No	-

## CONCLUSIONS

Following conclusions are drawn from this study.

### *In vitro* test

- All compost teas used this study showed antifungal activity.
- Compost tea made from tap water showed slightly better antifungal activity than the one made from compost water when aeration method was applied for compost tea production.
- Antifungal activity of compost tea may be strongly affected by compost used.
- Microbes in compost tea probably play critical roles on antifungal activity.
- Aeration within less than one day for making compost tea may be better.

### *In vivo* test

- The compost tea effectively controlled *Podosphaera xanthii*.
- The compost tea could not cure the leaves infected by powdery mildew but could protect young leaves from infection by it.
- It was found that antifungal effect of the compost tea was weaker than that of commercial antifungal and the compost tea had some phytotoxicity, so optimal use of compost tea including for what plants, how much, when, how often, and so on should be found out.

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This paper is the re-production of Journal of Korean Wetlands Society, Vol.9, No.1, pp.91-98, 2007.