

WAY OF COMPOST APPLICATION FOR ORGANIC FARMING

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ABSTRACT

Application of composts is an alternative of synthetic agrochemicals for eco-friendly farming. Work is limited on the effective and economic way of compost application in Bangladesh. A study was done at the Field Science Center, Saga University, Japan with green tea waste – rice bran compost (GRC) application. Radish (*Raphanus sativus* L.), spinach (*Spinacia oleracea* L.) and komatsuna (*Brassica rapa* var. *pervidis*) were used as test plants. GRC was applied at 1.0 kg m⁻² by mulching on soil after seeding. It enhanced seed germination, seedling growth and improved crop yield of spinach and radish grown in a controlled condition. Among the two application methods, post-sowing mulching (PSM) reduced water loss from upper soil surface, thus enhanced seed germination and better growth compared to pre-sowing incorporation (PSI) system. This study also suggests that improper compost incorporation to soil may impair seed germination, seedling growth and likely crop yield.

INTRODUCTION

Organic amendments in agriculture have contributed immensely to converting much of the fragile land of the world into stable productive zones (Svotwa et al., 2009). Composting is a viable means of transforming various organic wastes into products that can be used safely and beneficially as bio fertilizers and soil conditioners in organic farming systems. Over time, yearly additions of compost create a desirable soil structure, making the soil much easier to work, lowering bulk density, reducing soil erosion and improving soil fertility (FAO, 1987).

In a previous study, 30:70 ratio of green tea waste and rice bran (v/v) produced the best compost quality that enhanced spinach growth and controlled weeds (Khan et al.,

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2009). But research on the effective and economic way of application of this compost for maximizing yield and quality not yet has done. Hence, research is needed to determine it and to replace or supplement chemical fertilizers for vegetables production. Considering the above facts, this study was designed to determine the effective way of compost application in an organic farming system for vegetables production.

MATERIALS AND METHODS

The experiments were conducted consecutively for two seasons (autumn and spring) under greenhouse and laboratory conditions at the Field Science Center, Saga University, Japan (33° 18' 20" N and 130° 20' 12" E).

Compost application

Pre-sowing incorporation (PSI) and post-sowing mulching (PSM) of compost at 0.5, 1.0 and 2.0 kg m⁻² were used and compared with control (0 kg m⁻²). In PSI, compost was incorporated with the soil at 6 cm depth before seeding and for PSM, compost was applied on the upper soil surface after sowing of seeds.

Effect of compost water extract on seed germination

The effects of compost water extracts on seed germination were evaluated through seed germination test. A crude aqueous extract was prepared by stirring 100 g of oven dried (60°C for 24 hr with forced air circulation) ground sample with 1000 ml of distilled water for 12 hrs and kept overnight. Then the suspension was centrifuged at 3000 rpm for 30 min and the supernatant was used for bioassay. The concentrated water soluble fractions of compost was diluted with distilled water from 10⁻¹⁰ to 10⁻¹. Twenty-five seeds of komatsuna (*Brassica rapa* var. *pervidis*) were used germination test in which seeds were imbibed in 5 ml of either solution of compost water soluble fraction or distilled water (control) in a covered 9 cm petridish on a double sheet of sterile filter paper (Advantec No. 2) and incubated at 25°C for 72 hrs under completely dark conditions.. Electrical conductivity (EC) of the respective concentrations of compost extract was measured and calculated the correlation coefficient between seed germination percentages after 12 hours incubation period and EC of the respective concentrations. The experimental design was a completely randomized design (CRD) with the treatment replicated five times.

Evaluation of plant growth and quality

Ninety-six seeds of spinach (*Spinacia oleracea* L.) var. Jiromaru (Takii seeds, Japan) and radish (*Raphanus sativus* L.) var. Hatsuka daikon, JA, Japan were sown in a 45 L pot (84.5 cm x 28.0 cm) at early October for autumn and early March for spring. The treatments were consisted of control (only soil), 0.5, 1.0 and 2.0 kg m⁻² of compost as PSI or PSM. Pots were watered to approximately field capacity. After seed germination, 32 plants pot⁻¹ were kept maintaining 15 cm line to line and 5 cm plant to plant distances. Plant height, leaf area and dry weight and root length, root

diameter and root dry weight were measured at 30 days after seeding. Additionally, nitrate and iron concentrations in fresh spinach leaves were also determined spectroscopically (Tagliavini et al. 2000) using the Merck RQflex (E. Merck D 64271 Darmstadt, Germany) with specific tests (nitrate test n. 1.16971 and iron test n. 1.16982).

Statistical analyses

Statistical analyses were performed using SAS package version 6.12 (SAS Institute, 1996). Differences among the treatments were determined by LSD.

RESULTS

Effect of compost extract on seed germination

In vitro seed germination of komatsuna using different concentrations of GRC water extracts (10^{-10} to 10^{-1}) showed that there was no significant differences among the treatments including control after 24 hours of incubation. Negative effect on seed germination was found at 10^{-1} concentration compared to control up to 12 hrs of incubation (data not shown).

Effects of compost on seedling emergence

Germinations radish and spinach seeds under different treatments are illustrated in Fig. 1. Speed of germination was faster in radish than in spinach. In case of application method, PSM was better than PSI to enhance seed germination. Application of compost at 1.0 kg m^{-2} as PSM was the best among the treatments. Increased PSI application rate reduced germination percentages for both the tested crops. Application of GRC at 2.0 kg m^{-2} as mulching also reduced seed germination compared with control.

Effect of compost on plant growth and quality

Increased GRC application rate favored plant growth and PSM system showed significantly better performance than PSI system (Table 1).

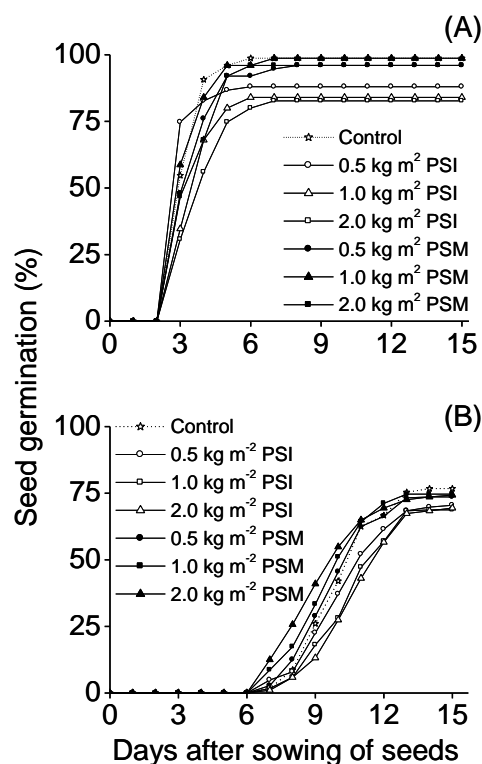


Fig. 1. Effects of GRC application methods and rates on seed emergence of radish (A) and spinach (B) under greenhouse condition

Table 1. Effect of compost application methods and rates of GRC^a on growth of spinach and radish under greenhouse condition, averaged over two consecutive seasons (autumn and spring)

Treatments (kg m ⁻²)	Spinach			Radish		
	Plant height (cm)	Leaf area (cm ² plant ⁻¹)	Dry weight (g plant ⁻¹)	Root length (mm)	Root diameter (mm)	Dry weight (g root ⁻¹)
PSI						
0	8.26	23.51	0.02	23.47	21.10	0.47
0.5	14.47	90.68	0.06	30.05	28.33	0.88
1.0	15.05	100.10	0.09	31.81	30.72	0.93
2.0	18.01	166.72	0.10	34.28	37.20	1.36
PSM						

Treatments (kg m ⁻²)	Spinach			Radish		
	Plant height (cm)	Leaf area (cm ² plant ⁻¹)	Dry weight (g plant ⁻¹)	Root length (mm)	Root diameter (mm)	Dry weight (g root ⁻¹)
0	8.26	23.51	0.02	23.47	21.10	0.47
0.5	15.33	118.54	0.07	27.17	32.17	0.85
1.0	20.74	219.52	0.12	32.72	37.26	1.25
2.0	22.59	256.55	0.19	38.60	37.80	1.39
LSD (<i>p</i> =0.05) Appli. method x rate	1.52	22.38	0.04	5.36	4.30	0.04

^aGRC: Green tea waste – rice bran compost originated from 30% green tea waste and 70% rice bran (v/v and dry basis) PSI = Pre-sowing incorporation; PSM = Post-sowing mulching.

Only spinach quality in terms of nitrate and iron contents was determined in this study and data are shown in Table 2. Nitrate content was increased significantly with higher rate of compost application for both the systems. But, PSM system provided significantly lower nitrate contents in spinach than PSI system. Rate of iron accumulation was inconsistent with both the systems.

Table 2. Nitrate and iron contents in spinach leaves as influenced by GRC^a application methods at variable rates; averaged over two consecutive seasons (autumn and spring)

Treatments (kg m ⁻²)	Nitrate (mg 100 g ⁻¹ fresh weight)	Iron (mg 100 g ⁻¹ fresh weight)
PSI		
0	44.0	3.3
0.5	70.0	3.3
1.0	290.0	2.5
2.0	471.0	2.2
PSM		
0	44.0	3.3
0.5	31.0	2.4
1.0	275.0	2.6
2.0	370.0	2.5
LSD (<i>p</i> =0.05) Appli. method x rate	21.38	0.62

^aGRC: Green tea waste – rice bran compost originated from 30% green tea waste and 70% rice bran (v/v and dry basis) PSI = Pre-sowing incorporation; PSM = Post-sowing mulching.

DISCUSSION

The quality and acceptability of agro-industrial wastes as soil amendment can be greatly improved through composting. Details studies on the physico-chemical and microbial properties of GRC have already done (Khan et al., 2007, 2009). But substantial studies are lacking for economic and efficient ways of GRC application.

PSM method provided better performance in enhancing seed germination and seedling growth might be due to conservation of soil moisture that favored plant growth and development. Optimum soil moisture is one of the essential elements for seed germination under field condition; both high and low moisture content affects the seed germination and seedling growth (Agami, 2008; Foshee et al., 1996). In the present investigation, up to 1.0 kg m⁻² in PSM method maintained the optimum soil moisture for seed germination and seedling growth compared with other treatments. Excessive moisture and physical pressure at 2.0 kg m⁻² under PSM system reduced seed germination percentages. High concentrations of GRC water extract inhibited seed germination might be due to greater concentration of allelochemicals or high EC (Woodell, 1985; Zia and Khan, 2004).

Plant growth and quality of test crops were also affected by GRC application rates. The increase in soil available nutrients because of higher amounts of GRC favored plant growth up to a certain level and then reduced plant growth due to increase in EC levels, especially in PSI method. Nitrate content in spinach was also affected by the GRC treatments. Besides, soil available nitrogen is one of the major factors that influence plant nitrate content especially in spinach (Khan et al., 2007).

CONCLUSIONS

This study demonstrated the effective way of compost application at 1.0 kg m⁻² by mulching on soil after sowing of seeds that enhanced seed germination and seedling growth, improved crop productivity and quality of spinach and radish under controlled conditions.

ACKNOWLEDGEMENTS

We are grateful to the Ministry of Education, Culture, Sports, Science and Technology (MONBUKAGAKUSHO), Japan for providing a scholarship to Mohammad Ashik Iqbal Khan, and thankful to the JA Beverage, Saga Co. Ltd., Japan for providing green tea waste.

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