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RESEARCH ARTICLE

EFFECTS OF DIFFERENCE COMPOSITION ON GROWTH OF TOMATO (*LYCOPERSICON ESCULENTUN* MILL.) UNDER GREENHOUSE CONDITION

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ABSTRACT

This study was examined effects of difference composition on seedling quality and growth of tomato plant as well as concomitant evaluated the influences of mixture of medium composition with rice husk ask and coconut fiber. The result showed that biomass allocation, including shoot weight and root volume was affected by medium composition on seedling stage. In addition, a mixture of cattle manures composted with rice hush ash and coconut fiber under the rate 1:1:1 by volume respectively, gave the highest value of germination rate, plant height, leaf number, and plant biomass and it was found to provide optimum conditions for seedling performance of tomato plant.

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INTRODUCTION

Organic agriculture improves the physical, chemical, and biological characteristics of the soil by addition of organic matter to the soil (Arancon *et al*., 2004). Research in these areas is invaluable for organic growers, especially since soil science is a relatively new field of study (Helm and Salmon, 2002). Nowaday, the used peat moss is common in the world and its is used extensively as a soilless potting substrate in horticulture because of its desirable physical characteristics and high nutrient exchange capacity (Raviv *et al*., 1986). However, in recent years there has been increasing environmental and ecological concerns against the use of peat because its harvest is destroying endangered bog ecosystems worldwide (Barkham, 1993) and (Robertson, 1993). Cattle manure compost has several benefits. In addition to eliminating harmful ammonia gas and pathogens (like E. coli), as well as weed seeds, cattle manure compost will add generous amounts of organic matter to your soil. By mixing this compost into the soil, you can improve its moisture-holding capacity. This allows to water less frequently, as the roots of plants can use the additional water and nutrients whenever needed.

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Additionally, it will improve aeration, helping to break up compacted soils. Cattle manure compost also contains beneficial bacteria, which convert nutrients into easily accessible forms so they can be slowly released without burning tender plant roots. Cattle manure compost also produces about a third less greenhouse gases, making it environmentally friendly (Arancon *et al*., 2006).

Vermicompost (VC), rice husk ask (RHS) and coconut fiber (CF) are environmental friendly materials. VC has many favourable physicochemical characteristics, making it suitable for mixture in substrates including high porosity, and good aeration, drainage and water holding capacity (WHC) (Edwards and Burrows, 1988). In addition, compost manure, rice hush ash (RHA) and coconut fiber (CF) are usually used in substrates mixture. CF is a mixable material with high cation exchange and water holding capacities (WHC) and often be used in soilless culture techniques that are sterile (Inden and Torres, 2004). CF has also been demonstrated to be suitable for being used in substrates through numerous production trials (Inden and Torres, 2004; Evans and R.H.S. 1996). RHA could increase effective P availability in the soil. Rice hulls ash has a high proportion of silica, about 18-22% by weight, which can improve pH of soil and tolerance some kind of pathogens in the soil.

Therefore, the objective of this study is to investigate effects of compost manure combination with coconut fiber and rice husk ash.

MATERIALS AND METHODS

Raw materials and treatments

Tomato growth experiment was conducted in greenhouse condition at National Pingtung University of Science and Technology, Taiwan. The Compost manure is commercial production, which was produced from rice waste by Fumao biotechnology Co., Ltd., Taiwan. Own Peat moss was imported from other countries. Five medium mixtures were used by mixing compost manure with rice husk ash (RHA) and coconut fiber (CF) with the proportion (1:1:1 by volume), including Peat moss: RHA: CF (T1); Vermicompost: RHA: CF (T2); Cattle manure compost: RHA: Coconut fiber (T3); Chicken manure compost: RHA: CF (T4); Hog manure compost: RHA: CF (T5). The experiment was designed in Complete Random Block Design (RCBD) with three replications per treatment. One seed was sowed in each hole and 64 holes fully filled per tray as one replication.

Chemical, biological and physical characterization of different media

Initial seeding medium samples were extracted and determined physical properties, including water holding-capacity (WHC), electrolytic conductivity (EC), pH, macronutrients concentration (N, P, K, Ca, Mg), and micronutrients concentration (Fe, Zn) (Gary *et al*., 1993). Additionally, pH and EC of the other medium were determined using a double distilled water suspension of each medium in the ratio of 1:10 (w:v) (Inbar *et al*., 1993) that had been agitated mechanically for 2 hours.

WHC of different medium was determined by adding five samples of 100 g from each of the medium to PVC-columns fitted with fine mesh cloth at the bottom. The samples were water-logged for 48 hours and allowed to drain. The samples were weighed both before and after drying in an oven at 60°C for 4 days (Atiyeh *et al*., 2001). WHC (% volume) was calculated as ((wet weight - dry weight)/volume) x 100 (Inbar *et al*., 1993). The mineral N concentrations (NH_4- N and NO_3-N) in each of medium were determined calorimetrically in 5g extracts, using a modified indophenol blue technique (Sims *et al*., 1995). The nutrients elements (P, K, Ca, Mg, Fe and Zn) were analyzed by ICP- AES after element extraction in HCl acid 0.1N solution.

Seeding germination, growth and biomass development

Seeding germination was expressed as number of seedlings emerged related to number of seeds sown every day after sowing. Plant height was measured in 5 days interval from medium surface to over shoot height. After 30 days of sowing, 10 seedling plants per replication (30 plants per treatment) was harvested randomly and separated into shoot and root for investigating fresh weight. These samples then were dried in oven at 60^0C for 48 hours to determine dry weight and analysis shoot tissues mineral nutrient concentration. Total nitrogen was determined on a 0.2g sample as per Kjeldahl after 96% H_2S0_4 hot digestion (Bremner, 1996).

The nutrients elements (P, K, Ca, Mg, Fe and Zn) were analyzed by ICP- AES after element extraction in acidic (H_2S0_4) solution. Root volume (cm^3) was measured by the method of submerging root into a measuring cup with water.

Data analyses

Data was subjected to a one way analysis of variance to test for Least Significant Differences (LSD) and all analyses were performed using SAS (Statistical Analysis System) package (SAS Procedures Guide, 1990)

RESULTS AND DISCUSSION

The chemical, physical characterization of media

Information on pH, EC value and WHC of different treatments was presented in Table 1. There was a fluctuation in pH value, ranging from 5.82 to 6.74 units. However, previous studies showed that vermicompost from cattle manure had pH 6.0 (Jordao *et al*., 2002) and 6.7 (Alves and Passoni, 1997). These differences in pH are probably related to raw materials used for vermicomposting (Alves and Passoni, 1997).

The highest electrolytic conductivity (EC) was 3.31dS.$m^{-1}$and lowest level was 2.41dS.m^{-1} in T2 and T1, respectively. According to Warncke (1986) showed that the optimum EC of medium for plant growth was from 0.75 to 3.5 dS.m^{-1}. The total porosity was significantly different among treatment; the highest total porosity was T1 (88.3%). These could be because of different total porosity and types of pores in each medium (AC, 1998).

Table 1. Chemical and physical of different composition rate mixtures with RHS and CF

Treatment	pH (1:10)	EC (dS.m^{-1})	WHC (%)	Total porosity (% volume)	Mass wetness (gg^{-1})
T1	5.82d	2.41c	80.9a	88.3a	3.11a
T2	6.74a	3.28a	60.1d	67.8c	2.98b
T3	6.12c	3.05b	65.5b	70.2b	2.25c
T4	6.32b	3.31a	61.8c	66.8c	2.04d
T5	6.10c	3.09b	62.3c	69.5b	1.96d
LSD 0.05	0.15	0.52	7.42	15.4	0.21

Notes: EC, electrolyte conductivity; WHC, water holding capacity; LSD, least significantly difference. Means followed by the same letters do not significantly differ ($p<0.05$).

A significant difference in concentration of available macro-micronutrient analysis by 0.1N HCl acid between various media was presented in Table 2. Macronutrient concentration, including N, P, K, Ca and Mg was significantly different among treatments.

The highest value of macronutrient concentration was showed in T2, except Ca.In contrast, the corresponding figure of micronutrient analysis was indicated in T1 and T3 (Table 2).

Table 2. Concentration of available macro and micronutrient in analysis by 0.1N HCl solution from different media

Treatment	N	P	K	Ca	Mg	Fe	Zn
	(g/ kg dry weight)					(mg/ kg dry weight)	
T1	0.22d	2.54d	2.92d	6.22d	2.16b	282.3a	112.1a
T2	0.90a	9.86a	6.87a	6.71c	6.25a	171.7c	90.06c
T3	0.35bc	3.15c	3.75b	5.44e	2.11c	267.3ab	112.6a
T4	0.38b	3.48b	3.81b	7.52a	2.07c	143.1d	100.5b
T5	0.31c	3.22c	3.55c	6.88b	2.2b	114.3e	110.6b
LSD 0.05	0.15	2.24	1.34	1.13	0.34	25.8	17.8

Notes: LSD, least significantly difference. Means followed by the same letters do not significantly differ ($p<0.05$).

Morphological and chemical parameter of tomato seedling

Germination process is an internally regulated period, influenced mainly by many factors such as light period temperature, moisture content, chemical elements, and physical characteristic of medium (Kucera *et al*., 2005). Seedling germination rate was significantly different among treatments (Fig.1) Germination periods in T1and T3 were earlier than other treatments. Additionally, the highest germination rate in was recorded in T3 around 92.5% while T2 gave the lowest value for germination rate in 59.5%.

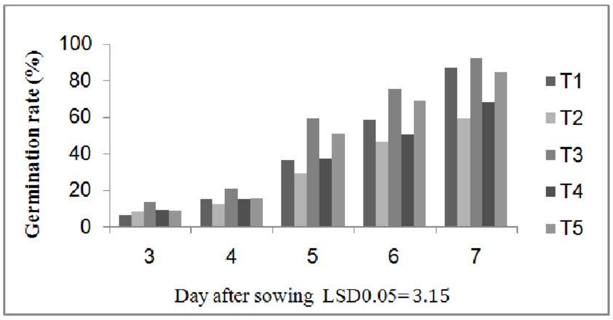

Figure 1. Seedling germination rate in Graces

The Table 3 showed that the diameter, plant height and leaf number of plant was similar value in T2 (2.25mm, 3.66cm, 3.4leaf) and T3 (2.23mm, 3.62cm, 3.05leaf), respectively. By comparison, T3 (cattle manure compost into rice husk ash and coconut fiber by volume) showed the highest value not only in fresh, dry weight of shoot but also root volume, with 8.74 g/plant, 1.01 g/plant and 2.99cm^3/plant, respectively. Conversely, the lowest value was recorded in T5of root diameter, plant height and leaf number with1.56mm, 3.25cm and 3.08leaf, shoot fresh, shoot dry and root volume in T1 with 2.69g/plant, 0.28g/plant and 1.05cm^3/plant, respectively. Gutierrez-Miceli, Santiago-Borraz (Gutierrez-Miceli *et al*., 2007), also reported that tomato had greater plant height, stem diameter and leaf number when grown in 1:3 and 1:4 (VC: soil) than in other media. The incorporation of VC into germination media up to 20% (v/v) enhanced shoot and root weight, leaf area, and shoot: root ratios of both tomato and marigold seedlings (Bachman and Metzger, 2008).

The Table 4 showed that the shoot tissue macro-micronutrient concentration of tomato seedling among various media after 30 days of sowing. There were significant difference found in shoot mineral nutrient analysis, the highest N, P, K, Mg concentration was in T2 with 14.4g/kg, 8.33g/kg, 21.1g/kg and 5.48g/kg, respectively.

Table 3. Effects of different media on morphological characteristic growth of tomato seedling

Treatment	Seeding diameter (mm)	Plant height (cm)	Leaf number (leaf)	Shoot weight (g/plant)		Root Volume (cm^3/plant)
				Fresh	Dry	
T1	1.95b	3.25c	2.95d	2.69d	0.28d	1.05e
T2	2.25a	3.66a	3.40a	5.62b	0.62b	1.88c
T3	2.23a	3.62a	3.05c	8.74a	1.01a	2.99a
T4	1.97b	3.44b	3.27b	4.39c	0.42c	1.69d
T5	1.56c	3.25c	3.08c	5.95b	0.59b	2.81b
LSD 0.05	0.21	0.25	0.19	1.06	0.15	0.35

Notes: LSD, least significantly difference. Means followed by the same letters do not significantly differ ($p<0.05$).

Table 4. Effects of different media on concentration of total macro- micronutrient in the shoot of tomato seedling after 30 days of sowing

Treatment	N	P	K	Ca	Mg	Fe	Zn
	g/ kg					mg/ kg	
T1	8.72d	5.14d	14.2e	4.3a	3.34d	289.5b	314.4d
T 2	14.4a	8.33b	21.1a	2.7d	5.48a	210.2d	322.5c
T 3	10.2c	9.87a	19.2b	3.4b	2.76e	322.7a	381.4a
T 4	12.8b	7.69bc	16.9c	3.1c	4.55c	255.2c	311.3d
T 5	10.3c	6.74c	15.3d	3.4b	5.21b	269.7c	350.6b
LSD0.05	4.3	2.1	4.6	1.4	2.8	36.5	30.1

Means followed by the same letters do not significantly differ ($p<0.05$).

However, the highest Fe and Zn concentration was in T3 (322.7mg/kg and 381.4mg/kg), respectively.

Conclusion

The different medium components affected the quality and growth of tomatoes seedlings. It could be employed to maximize the germination rates and healthy plant growth of tomato plant. Specifically, compounding rate of cattle manure compost (1: 1: 1 by volume) into RHS and CF, improve the chemical and physical properties, enhance porosity and aeration of media, increase germination rate (92.5%). In conclusion, cattle manure compost as a medium supplement increased seedling quality and growth of tomato variety.

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