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Full Length Research Paper

Effect of composts or vermicomposts on sorghum growth and mycorrhizal colonization

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Rice straw compost (RSC) and rice straw vermicompost (RSVC) were prepared and four weeks after maturity used for plant growth studies using sorghum as host plant under glasshouse conditions. Both RSC and RSVC were applied at different concentrations with and without arbascular mycorrhizae (AM) (*Glomus* spp.) as additional inoculants for plant growth and mycorrhzial colonization in roots. RSC or RSVC applied at 2.5 t ha^{-1} showed significant improvement in shoot length (1-12%), leaf area (20-34%), plant biomass (9-27%), root volume and mycorrhizal colonization. When RSC or RSVC were applied at concentrations of 5 t ha^{-1}, there was decrease in plant biomass with RSC+AM and RSVC+AM, when compared to the application of RSC and RSVC alone. Similar observation was found even when they were applied at 10 t ha^{-1}. However, application of RSC or RSVC along with AM at 5 and 10 t ha^{-1} did not show any inhibitory effect on mycorrhizal colonization but did decrease the dry matter of plant. The study shows that the application of microbial inoculants along with higher concentrations of composts may not be synergistic for plant growth.

Key words: Composts, vermicomposts, arbascular mycorrhizae, sorghum, root colonization.

INTRODUCTION

Compost is prepared by biological degradation of plant and animal residues under controlled, aerobic conditions (Eghball et al., 1997). Traditional composting process involves an initial stage conducted at moderate temperatures (10-40°C), during which the labile organic matter is rapidly consumed by mesophilic microorganisms, followed by a stage when thermophilic microorganisms drive the temperature up to 60°C at which lipids, proteins and complex carbohydrates are consumed and broken down. During the final curing stage, when the material cools down, mesophilic organisms are able to recolonize and break down the remaining recalcitrant organic matter (Chefetz et al., 1996) . However, in recent years, researchers have become progressively interested in using another biological process, termed vermicompost i.e., described as “biooxidation and stablilization of organic material involving the joint action of earthworms and mesophilic microorganisms” (Aira et al., 2002).

However, both composts and vermicomposts have been widely used in traditional agriculture and horticulture and have beneficial effects, on soil structure or soil biota (Subler et al., 1998; Carpenter- Boggs et al., 2000). Bene-fits of compost application in agriculture mainly result from its content of organic matter, plant nutrients, promo-ting plant growth and inhibiting root pathogens/soil-borne plant diseases (Hoitink, 1980; Alvarez et al., 1995; Perner et al., 2006). Compost is known to be product rich in microorganisms that help the plants to mobilize and acquire nutrients (Postma et al., 2003). A group of soil microorganisms that live in very intimate contact with the root are the arbascular mycorrhzal (AM) fungi. These fungi are known to assist the plant in uptake of nutrients and to improve plant growth (Douds et al., 2005) in low P soils. There are only few studies of effect of compost supplements on mycorrhizal and nonmycorrhizal plant seedling. Sainz et al. (1998), however, pointed out that compost additions may reduce mycorrhizal colonization and therefore activity of AM fungi; whereas Cavender et al. (2003) has shown that vermicompost stimulated mycorrhizal colonization in sorghum roots. The objective of the present study was to evaluate the effect of rice str-

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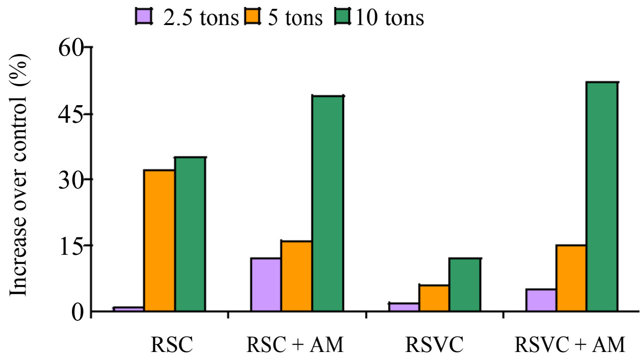

Figure 1. Effect of compost or vermicompost applied at different concentration on shoot length of sorghum in glasshouse conditions.

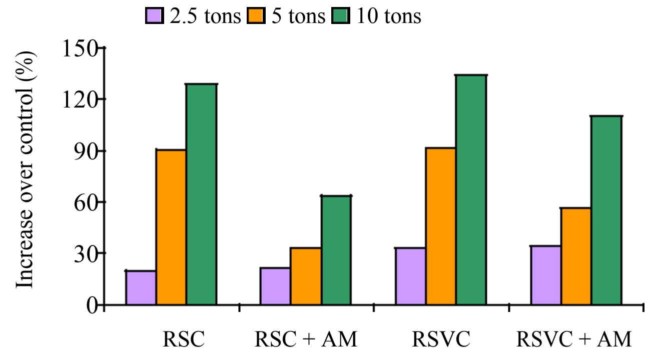

Figure 2. Effect of compost or vermicompost applied at different concentrations on leaf area of sorghum in glasshouse conditions.

aw compost (RSC) and rice straw vermicompost (RSVC) with a range of different concentrations on sorghum growth and colonization of sorghum root by mycorrhizae under glasshouse conditions.

MATERIALS AND METHODS

Rice-straw compost (RSC) was prepared in heaps (5 m long x 1.5 m wide x 1.5 m height) of 500 kg capacity. Five to 10 kg bundles of air-dried rice-straw were tied up in plastic nets and soaked in water (every 1 kg dry straw soaked in 1.5 L water) for 2 to 3 min and then allowed to drain for five minutes. Moistened straw was allowed to stay in a heap and covered with polythene sheet to reduce evaporation losses and to prevent it from getting extra moisture from rain during the composting period.

Rice straw vermicompost (RSVC) was prepared in cement cylinders (90 cm diameter x 50 cm height) using rice straw soaked in 1% cow dung slurry. After two weeks, about 500 earthworms (*Eisenia fetida*) were released into the same tank. Seven layers of rice straw of 10 cm thickness were added after decomposition of lower layer. RSC and RSVC were used separately to evaluate the growth of sorghum (sweet stalk) (ICSV 93046) under glasshouse conditions in a pot study. Unsterilized low P soil of BR1D at International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) was used as potting medium in 21 cm diameter plastic pots. Treatments were arranged in a completely randomized block design with six replications. Both the composts were applied @ 2.5, 5 and 10 tones (t) ha^{-1} per pot. Arbascular mycorrhizal (AM) fungi, *Glomus* spp., was prepared as sand inoculum and applied at the rate of 1% and mixed evenly to the soil before filling up the pots. Harvesting of the plants was done 45 days after sowing and plant growth parameters such as shoot length, leaf area and root volume (water diplacement method) were recorded. Mycorrhizal colonization of roots in terms of percent infection was measured according to the method of Phillips and Hayman (1970).

RESULTS

Rice straw compost or rice straw vermicompost were applied separately along with AM to evaluate plant growth of sorghum in glasshouse conditions. Increase in shoot length ranged between 1-12% when either the compost or vermicompost was applied at 2.5 t ha^{-1} (Figure 1). RSC applied at 5 t ha^{-1} showed significant improvement in shoot length (32% over control). When both the compost samples were applied separately at 10 t ha^{-1} the increase in shoot length was 12% with RSVC and 35% with RSC, whereas in presence of mycorrhizae, it was 49% with RSC and 52% with RSVC (Figure 1). When both the composts were applied at 2.5 t ha^{-1}, increase in leaf area with RSC was 20-21% whereas RSVC was 33-34% with and without mycorrhizal inoculation respectively (Figure 2). RSC applied at 5 and 10 t ha^{-1} showed similar improvement in leaf area. However in presence of AM, the increase in leaf area was almost doubled with RSVC+AM when compared to RSC+AM (Figure 2).

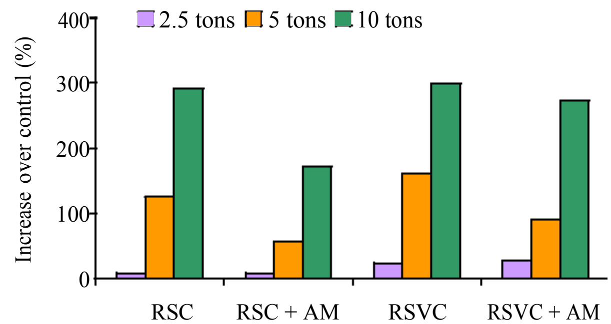

Figure 3. Effect of compost or vermicompost applied at different concentration on plant biomass of sorghum in glasshouse conditions.

When RSC or RSVC were applied at 2.5 t ha^{-1} alone and in combination with AM, plant biomass (dry weight) was marginally similar (Figure 3). At 5 t ha^{-1}, there was decrease in plant biomass with RSC+AM and RSVC+AM, when compared to the application of RSC and RSVC alone (Figure 2). Similar observation was found even when RSC or RSVC were applied at 10 t ha^{-1}. Increase in root volume was observed with increase in compost concentration; however RSC+AM showed lower root volume when compared to the other treatments used in the study (Table 1). It was observed that uninoculated roots showed around 15% mycorrhizal colonization which

Table 1. Effect of composts applied along with arbascular mycorrhizae (AM) on root volume and mycorrhizal association in roots of sorghum cultivar ICSV (93046).

Treatments	Root volume (mL)	AMcolonization (%)
Control	4.3	15
AM	4.3	37
RSC 2.5 t	5.1	33
RSVC 2.5 t	4.4	31
RSC 2.5 t + AM	5.3	53
RSCV 2.5 t + AM	6.6	35
RSC 5 t	9.5	61
RSVC 5 t	7.9	67
RSC 5 t + AM	12.0	69
RSVC 5 t + AM	9.1	76
RSC 10 t	19.1	62
RSVC 10 t	13.8	67
RSC 10 t + AM	21.5	72
RSVC 10 t + AM	17.9	77
Mean	10.1	54
LSD (P=0.05)	2.28	13.82
CV%	19.70	21.60

Means of six replicates are given and data calculated per plant. RSC = Rice straw compost, and RSVC = rice straw vermicompost. Composts applied at the rate of 2.5, 5, 10 t ha^{-1} (t = tones). AM = arbascular mycorrhizae (*Glomus* spp). was used.

might be due to natural infection. Compost or vermicompost application at 2.5 t ha^{-1} showed around 16-18% in absence of AM inoculation and 20-38% when AM was inoculated (Table 1). However, application of RSC and RSVC along with AM at 5 and 10 t ha^{-1} did not show any inhibitory effect on mycrorrhizal colonization but did decrease the dry matter of plant (Table 1).

DISCUSSION

Our experiments have shown that composts and vermincomposts have considerable potential for improving plant growth significantly when used as amendment to soil. RSC and RSVC showed improvement in shoot length, leaf area and plant biomass (Figures 1, 2 and 3). Previous studies have shown that composts promoted the growth of marigold and tomato seedlings in glasshouse conditions (Atiyeh et al., 2000a). In this study, there was not much variation in plant growth promotion due to application of compost or vermicompost. RSVC applied at 10 t ha^{-1} did not show any stimulatory effect on plant growth when compared to RSC. The effect of compost or vermicompost on plant growth depends on the source of material used for compost or vermicompost preparation, role of microorganisms and nutrient content (Jack and Thies, 2006). Microbial activities result in release of mineral nitrogen in ammonium form during composting and in nitrate form that is readily available for plant during vermicomposting (Atiyeh et al., 2000b).

In the present study it was also observed that due to increase in compost concentration root volume and mycorrhizal colonization also increased (Table 1). Previous study by Bhowmik and Singh (2004) has shown that plant-growth-promoting rhizobacteria (PGPR), viz. *Azospirillum* sp., *Azotobacter chroococcum*, *Pseudomonas* spp. when inoculated along with *Glomus mosseae* showed significant improvement in root volume. It seems more likely that the nutrient content of vermicompost stimulated fungal development but not growth of plant. Previous work by Cavender et al. (2003) showed that nutrients present in vermicomposts stimulated the fungal colonization, but at the expense of plant growth. Sylvia et al. (1998) estimated that as much as 20% of the total carbon assimilated by the plant may be allocated to mycrorrhizal fungi. Thus, application of composts used in the studies at higher concentrations was antagonistic, rather than synergistic to plant growth.

Compost and vermicompost showed improvement in plant growth at concentration of 2.5 and 5 t ha^{-1}. However, addition of mycorrhizae along with composts or vermicomposts at higher concentrations decreased the plant growth. In order to recommend supplementation of composts at higher concentrations and with additional microbial inoculants such as mycorrhizae should be studied in detail before applying for field and soil conditions.

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