Nutrients content in compost from water hyacinth and its effect on germination and growth of wheat

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— Abstract —

The main objective of the study was to assess the effect of compost from *Eicchornia crassipes* and employ soil fungi viz *Trichoderma*, *Rhizopus* and *Aspergillus* in composting as cheap effective management options and to see the effect on germination and growth of wheat plant applying the water hyacinth. Compost was prepared using soil and water hyacinth in three different proportions specifically, 50:50, 25:75 and 75:25 (Soil: Water hyacinth) respectively in which 10^7 cfu/ml unit spore suspension of *Trichoderma*, *Rhizopus* and *Aspergillus* were employed.Each 10ml PD broth and *Trichoderma* spore suspension from the market was inoculated. Initially soil fungi were isolated using soil plate method then transferred to Potato dextrose broth for spore suspension. Nitrogen (N), Phosphorus (P) and Potassium (K) content in compost were analyzed. Further the application of compost on field application was assessed on wheat. Length of seedling, root length and biomass were examined in the greenhouse for four weeks using fifty one pot plants with different treatments including cow dung and organic manure from market. Meanwhile three pots were used without any treatment as control. The result revealed that nitrogen was $2.66 \pm 0.16\%$ in *Rhizopus* treated compost. Potassium and phosphorus were found higher in 75:25 (Soil: Water hyacinth) and *Trichoderma* treated compost i.e 2.36 ± 0.04 and 2.52 ± 0.06 respectively. Cow dung followed by *Trichoderma* treated pots showed highest growth of the test plant.

Key words : *Eichhornia crassipes*, fungi, compost, nitrogen, potassium, phosphorus

INTRODUCTION

Water hyacinth (*Eichhornia crassipes* (Mart.) Solms) (Family Pontederiaceae) is regarded as one of the troublesome weeds native of Brazil and Ecuador. It is one of the '100 world's worst invasive alien species' (Lowe *et al.*, 2000; Bhattacharya and Kumar, 2010; Rakotoarisoa *et al.*, 2015). It is a free floating macrophyte that prefers growing in fresh water ponds and slow moving waterways (Parolin *et al.*, 2012). It can become a serious threat to biodiversity in aquatic ecosystems and can disturb the developmental activities (Lata and Veenapani, 2011).

Manual removal of any weed is a short term solution for small scale and this option is less effective to the large area since water hyacinth fastly rejuvenates. Moreover the chemical control causes serious environmental and health problems (Calvert, 2002; Mangas-Ramirez and Elias-Gutierrez, 2004). Compost of such a weed can serve for two purpose: (i) The removal of the weed and (ii) use as resource. The compost of water hyacinth can help to minimize the use of costly chemical fertilizer (Prasad *et al.*, 2013; Osoro *et al.*, 2014). Bacteria, fungus and actinomycetes play vital role in bioconversion of weed biomass into organic manure (Geetha, 2009). Most of the fungi are saprophytic, capable of degrading cellulose and lignin (Thorn *et al.*, 1996; Sivaramanan, 2014). Fast and effective decomposition of organic materials into stabilized compounds is achieved by microorganism although the precise role of certain microbes is unknown (Fuchs, 2010). The C:N ratio and water holding capacity increases on the fungal inoculated samples of cellulolytic wastes (Hart *et al.*, 2002; Sivaramanan, 2014). Its manure consists of acceptable composition of N, P, K, pH which is beneficial for agricultural lands to grow crop plants (Kafle *et al.*, 2009). However, such type of study was not attempted in Nepal. Hence, this study was objectively carried out to assess the effect of *Eicchornia crassipes* and utilize soil fungi like *Trichordema*, *Rhizopus* and *Aspergillus* in composting to find effective management options and to analyze the germination and growth performance of wheat applying the compost of water hyacinth.

Materials and Methods
Study area

Chitwan Annapurna Landscape (CHAL) is located in Gandaki river Basin and consists an area of 32,057 sq km. It includes six major rivers and 19 districts of Central Nepal. This area exhibits climatic diversity of subtropical to lowland region and cold dry Trans-Himalayan region (Nepal, 2013; Shrestha and Gautam, 2014). Three sites a in CHAL were selected for the study i.e., Ghailaghari pond of Chitwan and Begnas and Rupa lakes of Kaski (Fig. 1). The water hyacinth is serious problem in these lakes. Different geographic co-ordinates and altitude of the study area are presented in Table 1.

Materials and Methods

Preparation and sterilization of compost

Fresh biomass of water hyacinth (WHB) collected from the sites were washed thoroughly to remove dirt and dust on them. Biomass was chopped into 2cm to 4cm pieces and dried in shade for three days. Dried garden soil was then sieved to remove unnecessary stone particles. Chopped water hyacinth was mixed with soil in three different proportion in plastic bags, i.e., 50:50, 25:75 and 75:25 (soil: water hyacinth) and each weighing 800g. These water hyacinth-soil materials were autoclaved at 121°C temperature in 15 lb/in^2 pressure for the purpose of sterilization (Johnson and Sekhar, 2012).

Isolation and inoculation of fungal strains

Fungal isolation method from soil of kitchen garden compost was carried out using soil plate method recommended by Warcup (1950). The petridishes

Table 1: Geographic Co-ordinates of study area in Nepal

Sites (District)	Longitude/Latitude	Altitude (m)
Ghailaghari (Chitwan)	N 27° 33' 34.2" E084° 19' 58.8"	151
Begnas (Kaski)	N 28° 10' 16.6" E084° 06' 52"	678
Rupa (Kaski)	N 28° 08' 40.3" E084° 06' 29.1"	613

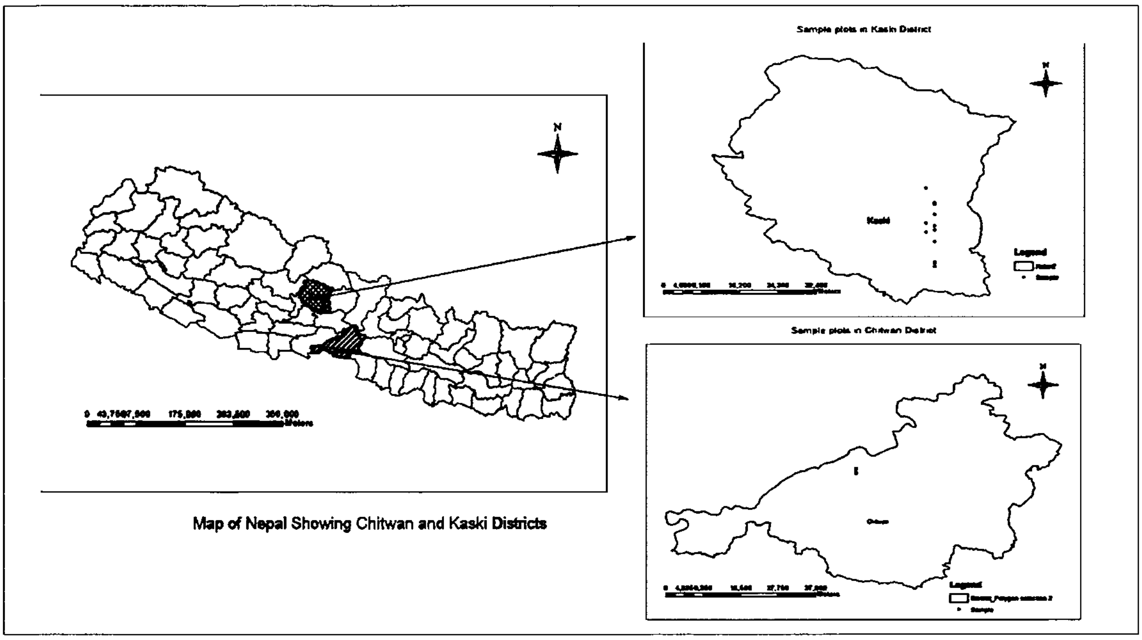

Figure 1: Map representing Study areas

were incubated at 23°-25°C for the growth of fungal colony. *Trichoderma, Rhizopus and Aspergillus* were identified on the basis of microscopic and macroscopic morphological characters. First, pure culture of respective soil fungus were obtained by transferring a single hyphae to the petridish containing Potato dextrose agar (Watanabe, 2002). Triplicate for each pure culture was maintained, which were inoculated in PD broth media for spore suspension. The inoculated PD broth was incubated maintaining temperature of 23°-25°C to increase spore of the respective fungi. Suspension of *Trichoderma viride* from market was also used separately for composting.

Ten mm (10^7 cfu/ml) of spore suspension of each fungi was inoculated in three different compositions of compost. Fungal cfu/ml unit was determined by counting spores using haemocytometer. Altogether 45 samples (triplicate for each 15 treatments) were maintained for treatment purpose. Meanwhile nine samples without any fungal inoculation and sterilization were considered as the control sets. This experiment was done for two months starting from 6 September 2016 under the sterile conditions.

Nutrient analysis of the compost

The chemical quantity of N, P, K in the two month old water hyacinth compost after inoculation of fungi were determined following the standard protocol at private laboratory Agricultural Technology Centre (ATC), Kathmandu. The following chemical and physical analyses of slurry/compost was made: Total nitrogen (N%) using Kjeldahal Methods, phosphorus determination using colorimetric determination and potassium determination by flame photometry.

Greenhouse experiment

Green house experiment was carried out from November 20 to December 18, 2016 in Central Department of Botany, Tribhuvan University, Kirtipur to assess the effect of different treatments on growth and development of a test plant wheat (*Triticum aestivum* L). Ten seeds per pots were sown in fifty four equal sized pots with different treatments. Cow dung and organic manure were also used for comparative study. Three pots were used as control. Each pots containing 1.5kg soil was applied with 150g compost except control. Five plants were removed from each pot after seed germination. Shoot length, root length and biomass were calculated. The shoot length was measured between day 7^{th} 14^{th}, 21^{th} and day 28^{th} days after slowly. The root length was measured after 28 days. The plants were dried for the measuring biomass after harvesting.

Statistical Analysis

All the data were entered in MS Excel 2013 and analyzed using IBM SPSS version 20. The one-way ANOVA and multi ranged test (Duncan test) was used to examine effect of different compost proportion on growth of wheat.

Result and Discussion

Nutrient analysis of the compost

Chemical analysis of compost was done evaluating the proportion of N, P,and K. The soil fungi inoculated compost showed higher nutrient content in comparision to control. The Proportion of nitrogen, potassium and phoshphorus was found increased in 75:25. water hyacinth (soil: compost) in comparison to others ($P<0.05$). Nitrogen was found higher in *Rhizopus* treated compost while the phosphorus and potassium were found increased in *Trichoderma* (soil) treated compost. The nitrogen is essential for the fungus since it is used by fungi to degrade the plant biomass (Jusoh *et al.*, 2013). Mahanta *et al.*, (2012) reported 1.82%e nitrogen in *Eichhornia* biomass using cellulose degrading microorganism while during present study, the percentage was found to be 2.66 ± 0.16% in *Rhizopus* treated compost (Table 2).

Higher content of phosphorus is an indication of the higher microbial activity (Prasad *et al.*, 2013). This

Table 2: Nitrogen in water hyacinth-soil compost having different treatments of fungi.

Treatments with	Nitrogen (%) Compost proportions (WH-soil)		
	25:75	50:50	75:25
Control	0.82 ± 0.02	0.93 ± 0.03	1.06 ± 0.03
Trichoderma (natural in soil)	1.25 ± 0.01	1.15 ± 0.03	1.97 ± 0.06
Aspergillus	1.01 ± 0.02	1.06 ± 0.03	2.14 ± 0.02
Rhizopus	1.06 ± 0.07	1.04 ± 0.01	2.66 ± 0.16
Trichoderma (Commercial)	1.01 ± 0.01	1.07 ± 0.04	2.41 ± 0.12

Table 3: Phosphorus in water hyacinth compost having different treatments of fungi.

Treatments with	Phosphorus (%) Compost proportions (WH-soil)		
	25:75	50:50	75:25
Control	0.72 ± 0.02	0.90 ± 0.00	1.03 ± 0.02
Trichoderma (natural in soil)	1.78 ± 0.11	1.89 ± 0.07	2.36 ± 0.04
Aspergillus	1.03 ± 0.01	0.99 ± 0.01	1.91 ± 0.04
Rhizopus	1.01 ± 0.02	1.14 ± 0.07	1.95 ± 0.03
Trichoderma (Commercial)	1.01 ± 0.02	1.29 ± 0.02	1.81 ± 0.04

Table 4: Potassium in water hyacinth compost having different treatments of fungi

Treatments with	Potassium (%) Compost proportions (WH-soil)		
	25:75	50:50	75:25
Control	1.05 ± 0.04	1.16 ± 0.03	1.68 ± 0.02
Trichoderma (natural in soil)	0.98 ± 0.01	1.20 ± 0.03	2.52 ± 0.06
Aspergillus	1.02 ± 0.04	1.12 ± 0.03	2.10 ± 0.10
Rhizopus	1.15 ± 0.05	1.32 ± 0.02	2.52 ± 0.04
Trichoderma (Commercial)	0.99 ± 0.04	1.74 ± 0.03	2.31 ± 0.02

result showed 2.36 ± 0.04 of phosphorus in compost 75:25 (WH: soil) Treated with Trichoderma in compost (Table 3). The study done by Lekshmi and Viveka (2011) showed that phosphorus was 0.11 ± 0.01% and 0.12 ± 0.01% phosphorus while composting the water hyacinth using *Trichoderma viradae* and *Trichoderma harzianum* respectively. Potassium is one of the nutrient which is easily available with the mineralization of organic matter (Louisa and Taguiling, 2013). Potassium level was found high in *Rhizopus* treated 75:25 compost having 2.52 ± 0.06% (Table 4). The use of *Trichoderma viridae* and *Trichoderma harzianum* in composting showed 0.15 ± 0.01% and 0.16 ± 0.01%, respectively (Lekshmi and Viveka 2011). This can be applicable to any cereal crops.

Effect on wheat plant in pots having different treatments

The shoot growth of wheat plant was found to be increased in compost of water hyacinth. The shoot length was recorded 22.73cm in pots on 28th day having wheat plants treated with cow dung (Fig 2). The highest root length of wheat plant was 8.80 ± 0.00cm on 28th day in pots having cow dung compared to root length was 5.87 ± 0.16cm in control (Fig. 3). Biomass was found to be 0.65g in pots having cow dung but it was only 0.27g in pots without any treatment ($p<0.05$, Fig. 4).

Water hyacinth tends to increase the productivity of Lagos spinach, tomato plant, *Amaranthus viridis* and *Brasicca juncea* (Kafle *et al.*, 2009; Lata and Veenapani, 2011; Mashavira *et al.*, 2015; Sasidharan *et al.*, 2013). According to Vidya and Girish (2014), the length of shoot of wheat plants at day 15 was found to be 15.99cm which is nearly similar to the value of shoot length in this experiment, i.e., 17.60cm at day 14. *Trichoderma* enhances the nutrient uptake and crop productivity (Harman *et al.*, 2004). *Trichoderma* treated plants showed more effective growth in comparision to the inoculations of *Aspergillus* and *Rhizopus*. The N, P, K increases in compost due to microbial degradation by inoculated fungi enhancing the plant growth.

CONCLUSION

Inoculation of different fungi improves NPK contents in compost. The nutrient content increases with increasing biomass of water hyacinth in compost proportion. *Trichoderma* treated compost and cowdung enhance the growth of plant. Water hyacinth compost hence acts as cheap source for improving soil quality for agricultural benefits.

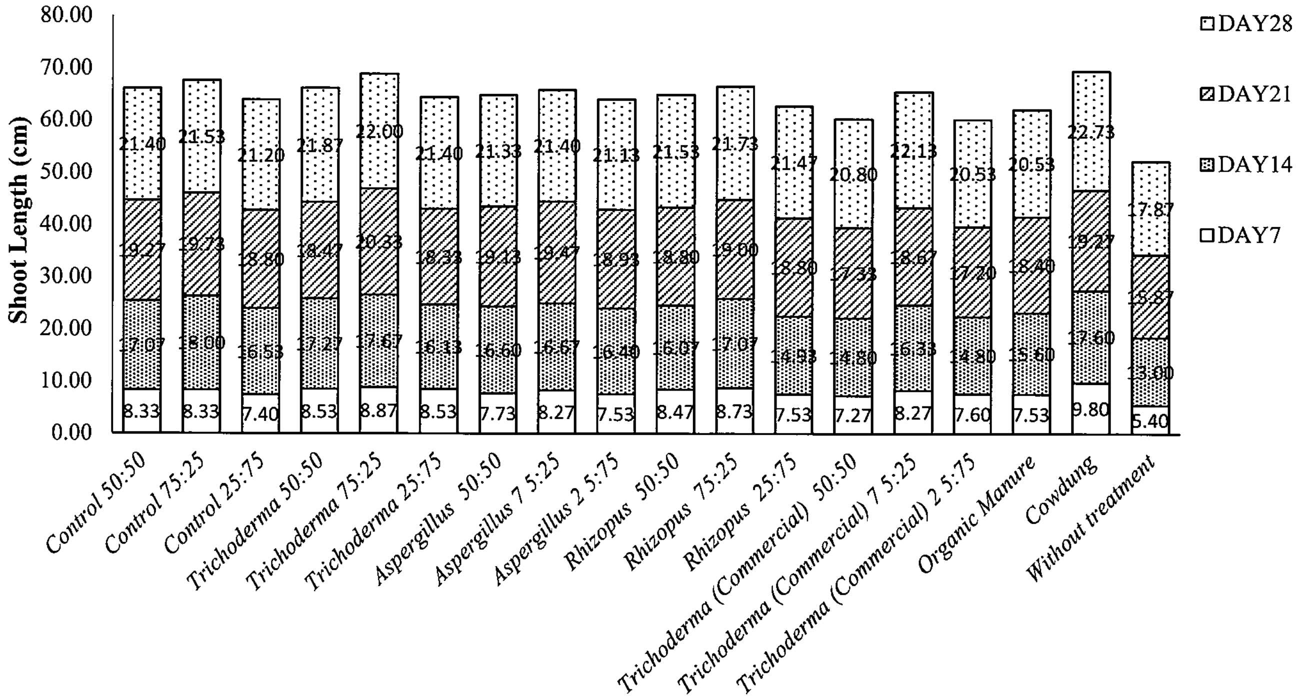

Figure 2: Growth of wheat shoot at different time duration (days)

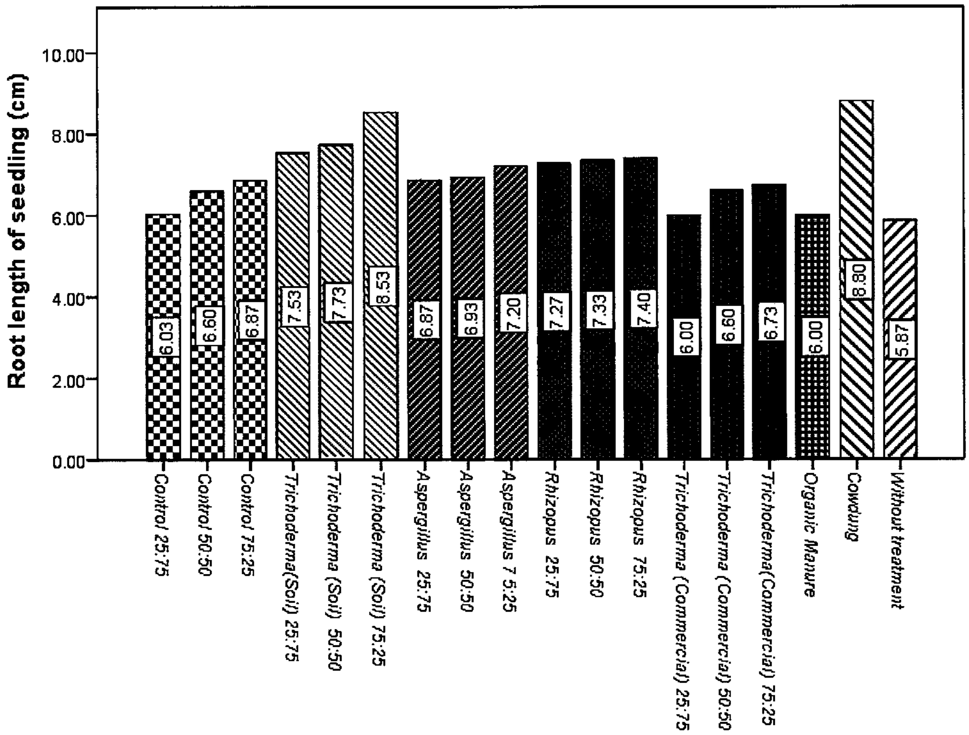

Figure 3: Plant root length of on wheat on 28th day in different treatments of compost

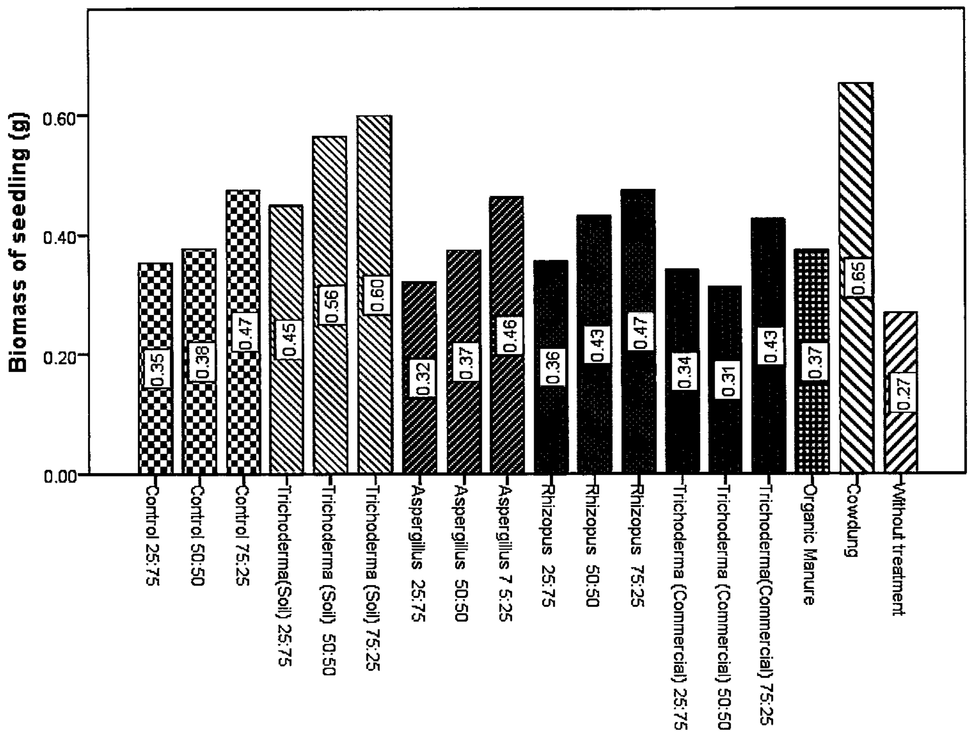

Figure 4: Biomass of wheat plant in different treatments of water hyacinth compost

ACKNOWLEDGEMENTS

This work was supported by the United States Agency for International Development (USAID) and Future Innovation Lab for the Integrated Pest management (IPM), through a grant awarded for the "Participatory Biodiversity and Climate Change Assessment for Integrated Pest Management in the Chitwan Annapurna Landscape" project (agreement No. AIDOAA-L-1500001). We are thankful to Dr. Muniappan Rangaswamy (Virginia Tech, USA) for encouragement and to Prof. M. Siwakoti (Head of CDBTU) for encouragement.

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