Journal of Agricultural Science and Food Technology
Vol. 1 (6), pp. 72-77, November, 2015
ISSN: 2449-1815
Research Paper
http://pearlresearchjournals.org/journals/jmbsr/index.html

Overcoming the Challenge of *Parthenium Hysterophorus* through Composting

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Accepted 21 October, 2015

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ABSTRACT

***Parthenium hysterophorus* weed is dominant in many parts of Ethiopia's expansion became beyond the control of the smallholder farmers and the government. It is also a challenge in the life and agricultural practice of the farmers. There have been *Parthenium* eradication campaigns through uprooting and burning, but it is still spreading. Recently farmers are using *Parthenium* for compost making. The hypothesis of this study of compost making is one main potential in controlling *Parthenium* weed. For this purpose four combinations of biomass were used for preparing compost from the *Parthenium* weed alone and with other materials. Compost samples were collected from each compost pit, sieved and then analyzed. A germination test was done in order to find out if any of the *Parthenium* seeds were viable. The results of the experiment and laboratory analysis have revealed the situation in the macro-nutrient content of the compost, its yield status on seed germination. However, this research indicated that further investigation is required to diversify its uses.**

Key words: *Parthenium*, Compost, Agriculture, Yield, Weed and Biomass.

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INTRODUCTION

Weeds have much influence on the crop yields and socio-economic conditions of human being particularly in the tropical agriculture. *Parthenium hysterophorus*, which is locally called *Qinche* in most parts of the Tigray Region, where the study area was conducted, is native to the Gulf of Mexico and has spread into many parts of the world (Patel, 2011; Veena and Shivani, 2012; Vyom et al., 2009). Its introduction to Ethiopia is by army vehicles during the Ethiopia and Somalia war of 1976 to 1977, and with food-aid of the Great Ethiopian drought 1984/5 (Tamado, 2001). After introduction, it had only been observed in the eastern part of the country following the main roads from the ports of Assab and Djibouti, but now it has spread throughout the country, especially in the Rift Valley area, lowlands of northern Shewa, southern Wollo and the Alamata-Mohoni areas of southern Tigray. *Parthenium hysterophorus* has negative impacts on human; animal health; the economy and the environment (Seier et al., 2000; Kishor et al., 2010a; Kishor et al., 2010b; Patel, 2011; Veena and Shivani, 2012; Anil, 2014).

It is unpalatable to the livestock, quickly dominates both native and planted pastures (Ayele et al., 2014) It produces large quantities of seeds and colonizes areas

with poor ground cover, because its seeds are light and easily dispersed by wind, by vehicles; machinery; livestock; flooding; in food-grain and in fodder (Tamado, 2001). Therefore, it threatens biodiversity (Kishor et al., 2010b; Anil, 2014). Some studies also showed many people suffering from severe allergic reactions (Petal, 2011; Veena and Shivani, 2012; Seier et al., 2000). Normally weeding in the tropical farmers took much time and labor. It also reduced crop yield (Kishor et al., 2010b). *Parthenium* is one of the weeds, which reduces production and increases management costs (Anil, 2014). For example, it is estimated that 50% of all labor input into crop production in sub-Saharan Africa is weeding (Tamado, 2001). Crop yield loss from weeds has been estimated at 10% in the less-developed and 25% in the least-developed countries (Tamado, 2001).

In India yield decline due to *Parthenium* infestation has been estimated to be as high as 40% (Kishor et al., 2010a; Khosola and Sobti, 1981). According to Tamado (2001) there is 41 to 97% sorghum yield loss due to *Parthenium* infestation in Eastern Ethiopia. In many places of the world attempts to control *Parthenium* infestation have been practiced through eradication campaigns but the rate of successes is low. This is because it colonizes new lands faster than it can be controlled. But biological and chemical controls are not economically feasible for most small-scale farmers (Tamado, 2001). Nowadays, *Parthenium* is becoming useful for many purposes such as green leaf manure; as a biopesticide because it is repellent; as an organic matter and as a raw material for making compost (Kishor et al., 2010a). Since 1996, the Institute for Sustainable Development (ISD) in collaboration with the local agricultural experts of the Bureau of Agriculture and Rural Development of Tigray has been training smallholder farmers in preparing and using of compost (Kishor et al., 2010a). Therefore, the main objective of the study is to find out if *Parthenium* weed can be used as biomass for making compost and has an effect on crop production.

MATERIALS AND METHODS

This study was conducted between May and October of 2006. The compost making and field trials were undertaken in the Selam Bikalsi Farmers' Training Center (FTC) located near to the Alamata Town, Northern Ethiopia. Four combinations of biomass were used for preparing compost from the *Parthenium* weed. These were: (1) about 100% green *Parthenium* with sufficient water to moisten the biomass was used. But no other plant materials; animal dung; manure, or urine were added (2) about 75% of equal amounts of green and dry *Parthenium* mixed and 25% other plant materials; animal manure; urine and water (3) about 100% dry *Parthenium* with sufficient water to moisten the biomass, but no other plant materials; animal dung; manure or urine were being added; and (4) about half (50%) dry and another 50% green *Parthenium*, with sufficient water were added to moisten the biomass, but no other plant materials; animal dung; manure or urine were being added.

The green biomass from the *Parthenium* weed were freshly picked during compost preparation, while the dry *Parthenium* refers to the weed that were air-dried for more than one month. To facilitate the composting process all the biomass used were cut into pieces. Compost samples were collected from each compost pits. The samples were sieved and then analyzed for its Electrical Conductivity (EC); pH; Organic Carbon (OC); Nitrogen (N); Phosphorous (P) and Potassium (K) and Cation Exchange Capacity (CEC) in the Water Works Design and Supervision Enterprise of the Ministry of Water Resources, Ethiopia. The analyses were conducted as follows: Electrical Conductivity was measured based on 1:5 extract from soil: H_2O suspension (Richards, 1954; Estefan et al., 2013; Soil Survey Staff, 2014); assessing the pH of the H_2O (1:2.5) according to the method of Schlichting et al. (1995). Organic carbon was determined by a modified Walkley-Black procedure (Smith and Welden, 1940; Haluschak, 2006; Estefan et al., 2013), while organic matter was obtained by a calculation of 1.724 x per centage of carbon (Baruah and Barthakur, 1997; Haluschak, 2006).

Wet digestion using the Kjeldahl procedure (Haluschak, 2006) was used to measure the total nitrogen, while Olsen's method was used to determine available phosphorus (Olsen et al., 1954; Estefan et al., 2013). K was measured by a flame photometer (Rowell, 1994; Haluschak, 2006). CEC was determined by the ammonium acetate method (Black, 1965; Estefan et al., 2013; Soil Survey Staff, 2014). A germination test of 100 seeds which were picked from the compost were planted in beds to find out if any of them was viable. The field experiment was carried out with farmers' variety maize called Berihu. There were four sub-plots-having a size of 126 m^2 for each type of compost prepared from *Parthenium*. Three samples were taken from each sub-plot. Then the yields were analyzed by excel.

RESULTS AND DISCUSSION

Expansion and Eradication

Based on the field assessment *Parthenium* is spread into about 97% of the cultivated fields of farmers in Alamata. It was observed first in the food-aid distribution center within the study area during the 1984/5 drought of

Table 1. Parthenium controlling techniques used by informant farmers (n=78).

Practices	Informants	
	Number	Percentage
Burning and uprooting	72	92
Compost	32	41
Household fuel	17	22
Animal feed	36	46

Source: Field survey.

Table 2. Observation results of different mixtures in making compost using Parthenium.

Biomass used	Date made	Date opened	Observation
100% Green *Parthenium*	May 2006	October 2006	Not decomposed and dark in color
75% green and dry *Parthenium* (1:1) and 25% other composting materials	May 2006	October 2006	Well decomposed, good smelling, color and structure
100% dry *Parthenium*	May 2006	October 2006	Well decomposed; seeds visible.
50% green *Parthenium* and 50% dry *Parthenium* at 1:1 ratio	May 2006	October 2006	Decomposed but not the stems of the *Parthenium*

Ethiopia. But now it is continuing spreading into farms and grazing lands, and invading the forest ecosystems in the studied area by climbing up to the Alamata slopes. Many *Parthenium* control techniques are being practiced in this study including, burning and uprooting; making compost; household fuel and animal feed (Table 1). Controlling *Parthenium* by uprooting and burning holds the highest (92%). Although practicing compost making from *Parthenium* is a new idea, it is practiced by many farmers in the studied area. It is rarely used as household fuel because it irritates human eye when used as fuel at home. Even though *Parthenium* is not palatable for animals (Ramaswami, 1997) about 46% of the interviewed farmers said that it was used as animal feed during feed shortage. But farmers complained that it is toxic and their meat and milk is tainted, which is similar to the studies carried by Ramaswami (1997), Seier et al. (2000) and Veena and Shivani (2012).

Many countries have been trying to control weeds, especially *Parthenium* weed by different mechanisms (biological and economical) (Mulatu et al., 2009). However, they were not economically feasible for most small-scale farmers (Tamado, 2001). Moreover, most single applications were not effective or had only short-term effect (Huwer et al., 2000), and this does not easily fit into the broad category of weed control in the specific cropping patterns or systems of smallholder farmers (Tamado, 2001). Long-term control requires a combined application of a number of different technologies (Huwer et al., 2000). However, sometimes weeds have significant importance. For example, some of the consulted farmers take it positively, that it is used as controlling wind erosion during dry seasons. Such use was practiced in some countries; for example, an exotic invasive species of *Parthenium* called Bitou bush was planted for sand dune stabilization in the Australian deserts between 1950's and mid 1970's (Cother and Donnelly, 2000). The report by Kishor et al. (2010b) also indicated that it offers a great potential for usage as pesticides, because they are comparatively safer for the environment.

Compost

Parthenium weed is easily available for compost making for most of the farmers in the studied area (Table 1). But at present 41% of the farmers in the studied area use *Parthenium* for compost making. Table 2 gives the four types of compost preparation, dates and observations made when compost pits were opened. The compost prepared from 75% of equal amounts of green and dry *Parthenium* mixed and 25% of other composting materials was well decomposed, no seeds and other biomass were visible. While the pit with 100% green *Parthenium* did not decompose, instead it became compacted. Seeds were observed in the pit with 100% dry *Parthenium* biomass. None of the seeds taken for germination test were germinated within six months. The seeds may be died due to the heat, moisture and microbial activities inside the pit. This is in accordance with the result of a study undertaken in India (ICAR, 2005). The availability of *Parthenium* seeds was very low, about 1 to 3 seeds per 300 g compost.

Nutrient Potentials

The pH level ranged between 7.7 and 7.9 (Table 3) of all the *Parthenium* composts, this showed that all were weakly alkaline. The highly exchangeable cation also

Table 3. Nutrient status of parthenium compost different by their biomass used.

Type of compost	pH H_2O (1:2.5)	EC (ms/cm) (1:2.5)	OC (%)	TN (%)	C:N	Available P (mg P_2O_5/kg comp.)	Available K (mgK_2O/kg comp.)
75% green and dry *Parthenium* mixed and 25% other composting materials	7.71	1.76	4.92	0.24	21:1	342.20	6680.52
100% dry *Parthenium*	7.92	4.71	8.72	0.43	21:1	392.90	10218.40
50% green *Parthenium* and 50% dry *Parthenium*	7.90	3.86	7.87	0.44	18:1	369.20	8481.27

Table 4. An average yield of three samples each from local farmer's variety of maize in Selam Bikalsi FTC, Alamata 2007**.**

Biomass description in the pits	Average yield (kg) per hectare	
	Grain	Straw
100% green *Parthenium*	2015	7052.5
75% of green and dry mixed *Parthenium* and 25% other composting materials	2687	9404.5
100% dry *Parthenium*	1107	3874.0
50% green *Parthenium* and 50% dry *Parthenium*	1685	5897.5
Average	1873.5	6557.1

Source: Field data.

showed the existence of more soluble salts in the compost. This result is supported by the work of McLaurin and Wade (1999) that "the pH of most yard waste compost is usually between 7.0 and 8.0." The study carried by Spiers and Fietje (2000), also revealed that the higher pH goes with a higher K level, which was responsible for the high Electrical Conductivity (EC) (Table 3). The C: N ratio of *Parthenium* compost is between 18 and 21. A C: N ratio >15 is an indication of limited N availability due to immobilization in soil (Gutser et al., 2005). In matured compost the lowest C:N ratio, below 6 to 7 (Gutser et al., 2005), is an indication that materials were humified and stable, were suitable for field application (Manna et al., 2001), and had higher short-term effect in the soil (Gutser et al., 2005). The organic carbon, which is an indicator of organic matter, and total nitrogen of all the compost were at good status (Table 3). The compost prepared from *Parthenium* only had higher content of EC, OC, N, P, and K. The report by Veena and Shivani (2012) also showed *Parthenium* was good for soil and animal feed because it is protein rich weed.

The available potassium of the compost prepared from *Parthenium* was high especially from 100% dry *Parthenium* (Table 3). The study conducted in India by Channappagoudar et al. (2007), also indicated similarl higher results from *Parthenium* at it was before flowering stage that is, 29.5 g kg^{-1}, 8.2 g kg^{-1} and 13.9 g kg^{-1} of N, P and K, respectively. The compost prepared by mixing with other composting materials had lower nutrients, but it had fast decomposition. A study conducted in India by chopping *Parthenium*; adding urea; dung slurry and fungal inoculation in a pit revealed that it contained 1.05, 0.84, 1.11 and 2.88% N, P, K and organic carbon, respectively (ICAR, 2005). Highest N content was in the composts prepared from *Parthenium with* 2.95% was reported by Channappagoudar et al. (2007). Available phosphorous of all the compost ranged from 309 to 376, was at a high level for crop demand (Landon, 1991).

Yield

The highest grain and straw yield were from the compost prepared from 75% of green and dry *Parthenium* mixed at 1:1 ratio, and 25% of other composting materials (Table 4). The *Parthenium* compost applied to the main crops recorded the highest yield of 1917 kg ha^{-1} and 1285 kg^{-1}, as compared to other organic waste composts and application of NPK alone. Similar results were recorded by Ramaswami (1997) and Kishor et al. (2010a), which indicated that the high concentrations of elements such as (N, P, K, Fe, Mn, Cu and Zn) in composted *Parthenium* increased the yield of many agricultural crops. However, there was significant reduction in plant height; tillers; root volume of plant; and ultimately grain and straw yield of maize, due to 100% N application of *Parthenium* compost (Kishor et al., 2010b). This could be

due to the higher C; N ratio that affected the availability of nutrients for crop growth.

CONCLUSIONS AND RECOMMENDATIONS

Parthenium infestation still continuing fast, affecting grazing lands and crop yield. Further impact should be studied to see other challenges and co-benefits of *Parthenium*. Compost making is showing encouraging results with good nutrient level except for the high C: N ratio. Therefore, this study recommends enhancing farmers by training for on quality compost making and working further to improve the C: N ratio to be below 10, which is good for faster mineralization. From the result of the farm trials with farmer variety of maize showed the highest result. It also requires continuing test for the yield results on most important crops in lowlands, for example, sorghum; teff and finger millet. Germination tests on the compost also showed that the *Parthenium* seeds did not remain viable for six months. However, it is advised to conduct researches on germination testes for longer period.

ACKNOWLEDGMENTS

Our thanks go to the Institute for Sustainable Development, Alamata Wereda Agriculture and Rural Development office and Bureau of Agriculture and Rural Development of the Tigray Region (Ethiopia). Again our sincere thanks and appreciation are due to the International Foundation for Sciences (IFS) for offering research grant.

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