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Characterization of Parthenium (*Parthenium hysterophorus* L.) Compost for Plant Nutrient Contents at Ginir District of Bale Zone, South-Eastern Ethiopia

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Abstract

The experiment was conducted in the Ginir District of the Bale Zone in the Oromia Region in the southeast of Ethiopia. Thus, the objective of this study was to evaluate the major plant nutrients in compost made from *parthenium* combined with wheat residue and farmyard manure, as well as its overall quality and nutrient contents. To fulfill the designated purpose, the *parthenium* plants were gathered before flowering and chopped into smaller pieces. Based on this, it can be concluded that the preparation of the compost and the material sources play a significant role, especially since different materials and methods were used throughout the study. The *parthenium* compost was thus made separately for each of the following three categories or treatments: *parthenium* biomass plus farm yard manure, *parthenium* biomass plus crop residue and *parthenium* biomass combination with both farm yard manure and crop residue. After being prepared and harvested, the *parthenium* compost was subjected to a final laboratory analysis. Using conventional laboratory techniques, the main chemical properties, including pH, EC, OC, TN, available P, CEC, exchangeable bases (Ca, Mg, K and Na) and micronutrients (Fe, Mn, Cu and Zn), were measured. The obtained results for the nutrient content characterizations were: pH; Ec; OM; TN; CEC; 7.1 to 7.27; 0.000058 to 0.000062 ds/m; 35.2 to 37.8%; 1.83% to 1.98% and 34.8 to 53.2 $cmol^{+}$/kg, respectively. Exchangeable bases exhibit a similar trend for the major essential plant nutrients. The results indicated that the compost had a high concentration of plant nutrients and varied significantly between the three *parthenium* compost preparation methods. *Parthenium* compost, therefore, offers multiple benefits, including high nutrient contents, weed control capabilities and generally environmentally sound uses of organic fertilizers.

Keywords: Total N • Nutrients • *Parthenium* • *Parthenium* compost • Environmental sound

Introduction

The aggressive alien weed species *Parthenium* (*P. hysterophorus* L., *Asteraceae*) is native to America [1], but it has since spread widely throughout Asia, Africa and Australia [2]. In the 1970s, *parthenium* weed was first unintentionally brought to Ethiopia. In 1988, *parthenium* was discovered for the first time in Ethiopia, at Dire-Dawa in the east and later in the northeast, close to Desse [3]. Major hubs for the distribution of food aid, it was thought that *parthenium* weed seeds were brought in from subtropical North America to contaminate grain food aid during the famine of the 1980s [4].

Later, it quickly spreads throughout the entire nation, along roads and railroads in grazing areas and on arable land, having a significant impact on biodiversity, crop production and animal husbandry [5]. The central rift valley of Ethiopia, as well as the nearby areas of the Afar Region, East Shoa, Arsi and Bale in southern Ethiopia, are currently home to a large *parthenium* population.

According to Anbalagan M and Manivannan S [6] and Jelin J and Dhanarajan MS [7], composting could be a helpful substitute for converting this species' biomass into a material that could be utilized as a soil conditioner. Utilizing sustainable manures in agriculture is a component of organic farming. While production was increased by using more chemical fertilizers, the soil's fertility was decreased because there wasn't enough organic matter in the soil. Using organic materials is advised to counter this. A promising method for recycling wastes and weeds is composting, which produces a product that enhances crop productivity and soil fertility without endangering the environment. It is simple to use, safe for the environment and helps with pollution issues [8]. Composting is a waste management technique that has been around for at least a century and it is currently gaining attention from all over the world for its ability to reduce the amount of accumulated waste and use weeds [8]. In addition to competing with pasture and crop species, *parthenium* weed has been linked to human and animal health risks [9]. Crop growth and development can be inhibited, if not completely controlled, by *parthenium*. Farmers in the Bale zone refer to it as "Anamalee," which means "Only me" in Afaan Oromo, because of its aggressive coverage (Personal Communications). As per various authors Shashie A, et al. [10] and Kumari P, et al. [11], *parthenium* is a species that is spreading and has a significant impact on biodiversity, agriculture and natural ecosystem production. According to several studies [12], *parthenium* compost possesses twice as much nitrogen, phosphorus and potassium as farm yard fertilizer, making it useful for both weed eradication and organic fertilizer supplies.

Despite an abundance of locally accessible *parthenium* weed and a sufficient quantity of various essential macro and micro plant nutrients, farmers in the study area do not compost *parthenium*. Furthermore, very few, if any, scientific studies have been done on the application of *parthenium* as a compostable material and its potential for better crop production instead of its eradication. To specifically characterize the quality and nutrient contents of compost made from *parthenium* combined with wheat residue and farmyard manure in terms of major plant nutrients, this study was conducted.

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Materials and Methods

As part of the Bale highlands in the Oromia Regional State in southeast Ethiopia, the study was carried out in the Ginnir District. At 07° 15′ N latitude and 40° 66′ E longitude and 1972 meters above sea level, Ginnir is located 519 kilometers away from Addis Ababa (Figure 1). There is 531 mm of seasonal rainfall and 13.4 and 25.5 °C for mean annual minimum and maximum temperatures, respectively [13]. It is a vertisol soil. For the ginger, September to January is considered the monocropping season (main season). Although farmers also produce horticultural crops, pulses and oil crops, the Ginir district is highly suited for the production of cereals (Figure 1).

According to the Central Statistical Agency's population projection, as cited in Boja M, et al. [14], the district's total population by 2021 was projected to be 203,751 (103,592 males and 100,159 females). The district's topography lies between 1200 and 2406 meters above sea level.

Data from the district agricultural office show that the district's land configuration is classified as plain, making up about 85% of the total, followed by mountainous areas (3%), rugged and gorge areas (12%) and hills and valleys (approximately 15%). In the same way, the district's land use data shows that 30.5% of the land is arable or cultivable, 31.2% is pasture, 35.6% is forest and 2.7% is deemed to be swampy, mountainous, or otherwise unusable (GDAB).

Material used for compost preparation

Different crop residues that were readily available in the area were used to make compost, including grasses, sorghum, haricot bean, wheat, teff and maize straws, as well as a combination of straws and grass for bedding. An equal quantity of farmyard manure was added to each substrate. To prepare the pit for composting, the gathered substrates were chopped and added. Biomass from *Parthenium* weeds, crop residue and farmyard manure from the experimental site were the materials used in this experiment. *Parthenium* weed was gathered early in the rainy season, just before flowering and chopped into tiny pieces no larger than 2.5 cm. To keep the necessary C/N ratio in the process, wheat straw was employed as a good source of carbon. Similarly, other organic wastes, like ash, were employed to make better-balanced compost and utilize the waste. *Parthenium* to wheat straw ratio = 1:2.78 and *Parthenium* to cow dung ratio = 1:27.78 was the total amount and combination ratio of materials used in the formation of compost. To speed up the composting process, all of the green biomass from the *parthenium* weed was freshly harvested and chopped into small pieces.

Compost preparation

A 1 m × 1 m × 1 m pit was prepared in the home garden of the farmer. To keep the stacking process at 60% moisture, water was sprayed. They were kept in a semi-aerobic environment and had a top layer plastered with a mixture of soil, dung and wheat straw. A turning was performed after a month and the moisture content was kept constant. When the pit was built in the shade, good quality compost was produced in 45 to 60 days at the ideal temperatures and rates of decomposition. The compost unit is built using materials that will last for the duration of the process. Before they reached flowering, the *parthenium* plants were gathered, mechanically chopped into 1-2-inch pieces and allowed to decompose for around 20 days with agricultural and animal waste. The climate was ideal and regular watering kept the temperature and moisture levels stable. Once the materials had been combined for 20 days, the temperature was recorded. Compost preparation was done using pit composting techniques and the composting process lasted for sixty days.

Parthenium compost laboratory analysis

Parthenium samples of compost were taken from every compost pit. Following sifting, the samples were examined in soil laboratories at the Baatuu and Sinana Agricultural Research Centers to determine the compost quality. Using a pH meter and electrical conductivity, the pH and EC of compost were

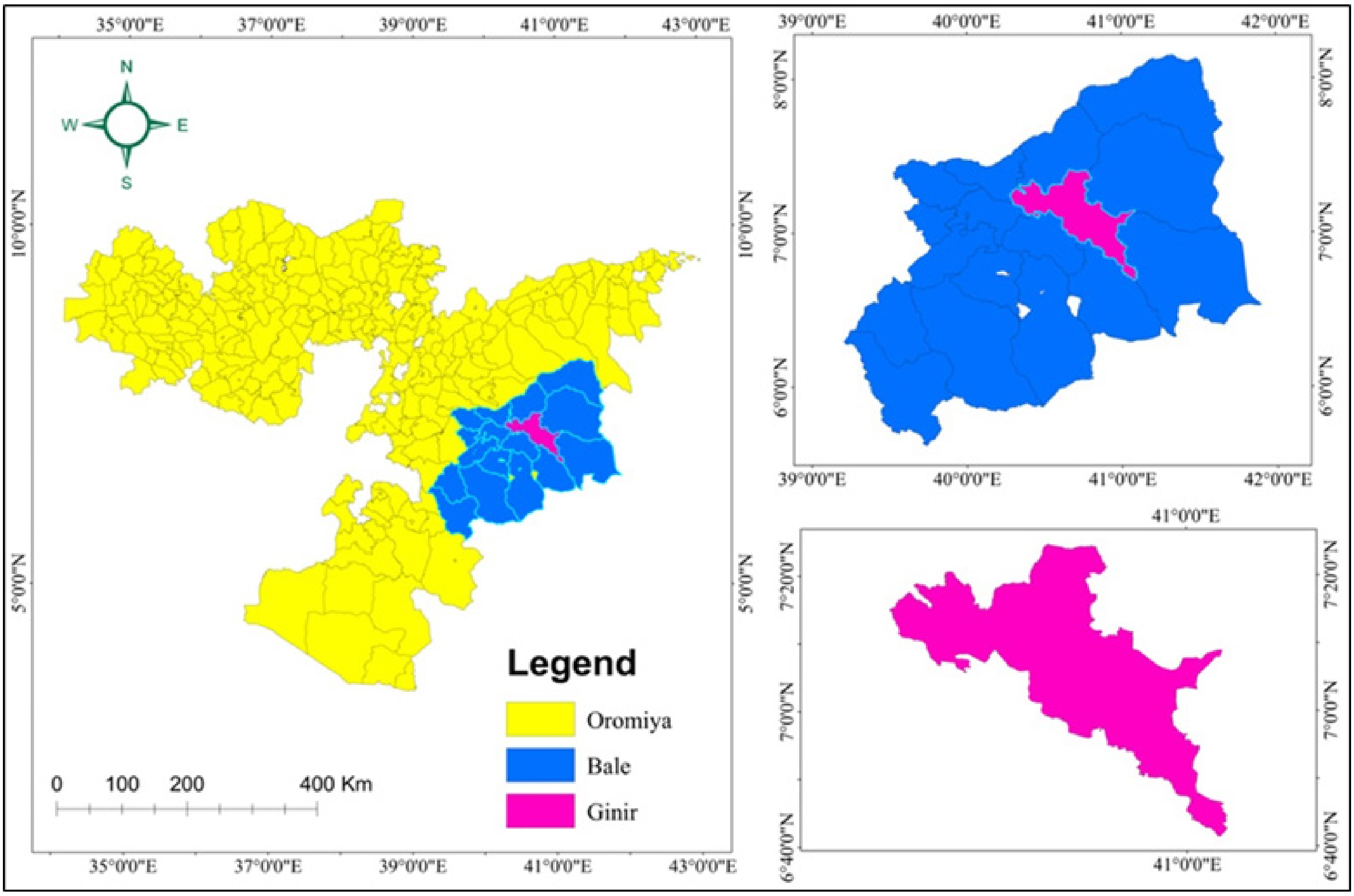

Figure 1. Map of the study area.

determined in the supernatant suspension of a 1:2.5 soil-to-water ratio [15]. Utilizing Walkley and Black to calculate organic carbon. Jm B [16], Kjeldahl method was used to calculate total nitrogen.

Total exchangeable bases (Ca^{2+}, Mg^{2+}, K^+ and Na^+) were measured using a flame photometer, Atomic Absorption Spectrometry (AAS) for Mg^{2+} and Ca^{2+} and flame photometry for K^+ and Na^+ [17]. The method used to calculate Cation Exchange Capacity (CEC) was Chapman. Hailu Araya MH, et al. [18] conducted a germination test on 100 seeds that were selected from the compost and planted in beds to determine which ones were viable.

Results and Discussion

Certain chemical characteristics of *parthenium* compost

Electrical conductivity and pH: The results of the laboratory analysis showed that the combination of farm yard manure and *parthenium* biomass with animal manure and wheat straw produced the highest (pH value) and lowest (pH value), respectively (Table 1). This result is consistent with that of Jelin J and Dhanarajan MS [7], who reported that the pH range for compost was 6.8-8.41. According to research conducted by Hailu Araya MH, et al. [18] and Spiers TM and Fietje G [19], a higher pH is associated with a higher K level, which is what causes high Electrical Conductivity (EC). The entire range of Electrical conductivity (Ec) values, which range from 0.000056 to 0.000062 (dS/m) ds/m (Table 1), did not show any significant variation. According to Santamaría-Romero S, et al. [20] and Eshetu M, et al. [21] EC values of *Parthenium* compost were free from salinity. This slight increase in potassium ions (K^+) and other ions during the course of decomposition may be the cause of the EC increase. According to Huang, the breakdown of organic materials may release mineral salts like phosphates and ammonium ions, which could explain the rise in EC.

Organic matter, Cation Exchange Capacity (CEC) and C: N Ratio: According to the analyzed results, the compost made from *Parthenium* compost plus farm yard manure had the lowest mean values of organic carbon (35.2%). In comparison, the compost made from *Parthenium* compost plus crop residue had the highest mean value of organic matter (37.8%) (Table 1). When compared to the availability of organic matter in garden soil, the organic content of all types of compost is generally high. This result is consistent with research conducted by Eshetu M, et al. [21] and Geremu T, et al. [22]. Each type of *parthenium* compost showed a low C: N ratio. A low C: N ratio suggests a higher mineralization rate. The results show that *parthenium* compost made from *parthenium* biomass plus crop residue had the lowest percentage (11%) while *parthenium* compost made from farm yard manure plus crop residue had the highest percentage (11.4%) (Table 1). This result is in line with the findings of two other authors, Eshetu M, et al. [21] and Kifle D, et al. [23] who reported that vermicompost had a lower C: N ratio than regular compost.

The *parthenium* compost produced using all treatment methods had a very high CEC, ranging from 34.8 to 53.2 $cmol^+ kg^{-1}$. This outcome supported the research by Eshetu M, et al. [21], which discovered that conventional compost contained 33.23 to 65.43 $cmol^+ kg^{-1}$ of CEC. Higher concentrations of EC, OC, NT and CEC were found in the compost made from *parthenium* combined with farm yard manure and crop residue. Kushwaha VB and Maurya S [24] study also demonstrated that *parthenium*, being a plant high in protein, is beneficial for soil and animal feed.

Total nitrogen: In this study, the *Parthenium* weed's major nutrient composition was estimated to be lowest from *Parthenium* compost plus farm yard manure (1.83%), highest from *Parthenium* compost combined farm yard manure plus crop residue (1.98%) and nitrogen was recorded from the compost that was made. Findings from related research by Ameta SK, et al. [12], Hailu Araya MH, et al. [18] and Chandrashekhar MB, et al. [25] (Table 1).

Parthenium compost's exchangeable bases (Ca, Mg, K and Na)

As was determined by Table 2, the results of the analysis indicated that the values for exchangeable bases (Ca, Mg, K and Na) varied from 4.56 to 5.40 (col (+)/kg), 1.30 to 3.25 (col (+)/kg), 1.51 to 1.86 (col (+)/kg) and 0.24 to 0.33 (col (+)/kg), respectively. The *Parthenium* biomass combination of wheat straw and farm yard manure yielded the highest value in all cases, comparatively speaking than compost made from *Parthenium* biomass plus animal manure or *Parthenium* biomass plus wheat straw. In agreement with this Channappagoudar BB, et al. [26] finding Compared to *parthenium* compost plus farm yard manure compost, the *parthenium* compost made with a combination of farm yard manure and other crop residue was generally richer in exchangeable cations. The outcome was in line with Khan A and Fouzia I [27] findings, which showed that *parthenium* compost made from mixed farmyard manure and *parthenium* biomass considerably increased the exchangeable bases (Ca, Ma and K) [28-31] (Table 2).

Conclusions and Recommendations

These days, *parthenium* (*P. hysterophorus*) is extensively dispersed throughout the agroecosystem and has emerged as a significant threat to land productivity and agricultural output. Although numerous attempts have been made by the government and various NGOs to stop or slow its growth, no appreciable shift has yet been seen. Composting *parthenium* weed is a novel way to extract maximum benefit and, as a result, limit the weed's spread. In terms of macro and micronutrients, compost is preferable to farm yard manure. They contribute significantly to the fertility of the soil and raise crop yields. Composting *parthenium*, can be used as an organic manure that effectively stops its alarming spread. The current study identified methods for controlling weeds and for using environmentally friendly technologies to support sustainable crop production and soil productivity. The compost made from *parthenium* biomass, when combined with crop residue and farm yard manure, had higher nutrient contents than compost made solely from *parthenium* biomass. In general, it should be advised to raise public awareness, particularly among farmers, of the impact of *Parthenium* hysterophorus on agricultural productivity, ecosystem health and management strategies. More research

Table 1. Organic matter and some macronutrients.

Trt	pH-H_2O (1:2.5)	EC (dS/m)	OM (%)	TN (%)	CEC (cmo(+)/kg	C: N
T1	7.17	0.000062	35.2	1.83	34.8	11.2
T2	7.26	0.000056	36.1	1.91	46.2	11
T3	7.27	0.000058	37.8	1.98	53.2	11.4

T1= Parthenium compost + farm yard manure; T2= Parthenium compost + crop residue, T3= Parthenium compost + farm yard manure + crop residue

Table 2. Exchangeable basic cations.

Trt	Exchangeable Basic Cations (cmol (+)/kg)				PBS (%)
	Ca	Mg	K	Na	
T1	4.56	1.30	1.51	0.24	21.87
T2	4.80	2.00	1.68	0.31	19.1
T3	5.40	3.25	1.86	0.33	20.38

Where T1= Parthenium compost + farm yard manure; T2= Parthenium compost + crop residue, T3= Parthenium compost + farm yard manure + crop residue is generally required to determine the optimal rate of *Parthenium* compost application and how it affects crop yields and the physical and chemical characteristics of soil in field settings.

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Conflict of Interest

No conflict of interest was disclosed by the author.

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