



Determination of the plant nutrient contents in parthenium (*Parthenium hysterophorus* L.) and saline – sodic soil reclamation of U.P. India

Trilok Nath Rai¹, Kedar Nath Rai², Sanjeev Kumar Rai³, Jyoti Rai⁴, Traloki Singh⁵

¹ Department of Soil Science & Agricultural Chemistry, Krishi Vigyan Kendra (ICAR-CSSRI), Dhikunni, Sandila, Hardoi, Uttar Pradesh, India

² Associate Professor and Head, Department of Soil Science & Agricultural Chemistry, Kamla Nehru Institute of Physical and Social Sciences, Sultanpur, Uttar Pradesh, India

³ Department of Soil Science & Agricultural Chemistry, Kamla Nehru Institute of Physical and Social Sciences, Sultanpur, Uttar Pradesh, India

⁴ Department of Botany, from A.P.S., University, Rewa, M.P., India

⁵ Department of Agronomy, Krishi Vigyan Kendra (ICAR-CSSRI), Dhikunni, Sandila, Hardoi, Uttar Pradesh, India

Abstract

The experiment was carried out in the Sultanpur District of the U.P Region. 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. In order to fulfill the designated purpose, the parthenium plants were gathered prior to flowering and chopped into smaller pieces. Based on this, it can be concluded that the preparation of the compost and the sources of the material used 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. 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. For the major essential plant nutrients, exchangeable bases also exhibit a similar trend. After being prepared and harvested, the parthenium compost was subjected to a final laboratory analysis. 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. This weed used as reclamation of saline-sodic soils in, U.P.

Keywords: Total N, nutrients, parthenium, parthenium compost & environmental sound

Introduction

The aggressive alien weed species Parthenium (*Parthenium hysterophorus* L., *Asteraceae*) is native to America [29], but it has since spread widely throughout Asia, Africa, and Australia [28]. In the 1970s, parthenium weed was first unintentionally brought to Ethiopia. *Parthenium hysterophorus* is a species of flowering plant in the family *Asteraceae*. It is native to the American tropics. Common names include Santa-Maria, Santa Maria feverfew, whitetop weed, and famine weed. In India, it is locally known as carrot grass, congress grass or gajar ghas or dhanura. 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 [21, 15]. 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 [20].

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 [21]. 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. *P. hysterophorus* has a very high potential for remediating soils polluted with

Cd and Pb. Phytoextraction employing *P. hysterophorus* is a cost-effective and possible remedy for the cleanup of Cd and Pb polluted soils. This crop also used as phytoremediation of saline alkali soils in U.P., India.

According to [3, 11] 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 [25]. 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 [25]. In addition to competing with pasture and crop species, parthenium weed has been linked to human and animal health risks [18]. 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 [23, 4, 12], parthenium is a species that is spreading and has a significant impact on biodiversity, agriculture, and natural ecosystem production. According to several studies [1] 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 at Sultanpur.

Material and Methods

The city of Sultanpur (which gives its name to the district) lies in latitude 26 degree 15 minutes north and longitude 82 degree 05 minutes east on the right bank of Gomti about 61 km south of Faizabad, 42 km north of Pratapgarh and 138 km south-east of Lucknow (Figure 1). It is on the branch line of Lucknow-Jaunpur section of the Northern Railway (broad gauge) passing through Sultanpur, Jafrabad and Jaunpur. Another branch line of the same railway connects it with Faizabad and Allahabad. Metalled road connects it Faizabad, Shahganj (district Jaunpur), Jaunpur, Pratapgarh, Raebareli and Lucknow. District road connects Sultanpur with Amethi. The original town was situated on the left bank of the Gomti. It is said to have been founded by Kusa, son of Ram, and to have been named after him Kusapura or Kusabhavanpur. This ancient city has been identified by General Cunningham with the Kusapur mentioned by Hiuentang, the Chinese traveller. He states that there was in his time a dilapidated stupa of Ashoka and that Buddha taught here for six months. There are Buddhist remains still visible at Mahmoodpur, a village, 8 km distant to the north-west of Sultanpur. The town subsequently fell into the hands of Bhars, who retained it until it was taken from them by Muslims in the 12th century. About seven hundred and fifty years ago, it is said, two brothers, Sayid Muhammad and Sayid Ala-ud-Din, horse dealer by profession, visited eastern Avadh and offered some horses for sale to Bhar Chieftains of Kusabhavanpur, who seized the horses and put the two brothers to death. This came to the ear of Ala-ud-Din Khilji, who would not allow such an outrage to pass unpunished. Gathering a mighty force, therefore, he set out for Kusabhavanpur and took revenge by killing most of the Bhars by strategem adopted after a long drawn siege. Kusabhavanpur was reduced to ashes and the town of Sultanpur, so called from the rank of the victor, rose upon its ruins. This town was finally raised to the ground during the military operations connected with the reoccupation of the province in consequence of the inhabitants having been concerned in the murder of British officers at the outbreak of the freedom struggle of 1857. Before annexation a military station and cantonment were established on the right bank of the river in a village then known as Girghit but

more commonly called by officials Sultanpur or Chhaoni Sarkar and by the rustic population Kampu or the Camp. The present town of the Sultanpur has been developed at this site. In this city there are two parks, one maintained by Soldiers', Sailors' and Airmen's board and other privately maintained known as Chimanlal Park. A library called Vinayak Mehta library, aided by Municipal Board is the only library in the city. It is run by the Vinayak Mehta Library Trust Association and contains over 10,000 books. In Chowk there is a clock tower. On the bank of Gomti is Sitakund, where Sita bathed as she accompanied her husband (the Lord Rama) on his exile. Bathing fairs are held there in Chaitra and Kartika. In civil lines opposite the collectorate is a church known as Christ Church which was opened and consecrated on the 16th November 1869. Next to the church, on the south side, stands Victoria Manzil, built in commemoration of the first jubilee of Queen Victoria. Now its is called as Sunder Lal Memorial Hall and it houses the office of the Municipal Board. A stadium, named as Pant stadium has been built in the city in 1954-55. There is 955 mm of seasonal rainfall and 12.5 to 45.5°C for mean annual minimum and maximum temperatures, respectively [30]. It is a alluvial soil. For the Sultanpur, September to January is considered the monocropping season (main season). Although farmers also produce horticultural crops, pulses, and oil crops, the sultanpur district is highly suited for the production of cereals.

According to the Central Statistical Agency's population projection, as cited in [31] the district's total population by 2011 was projected to be 2431490 (1226650 males and 1204840 females).

Topography

The surface is generally level, being broken only by ravines in the neighborhood of the rivers. The central portion is highly cultivated; while in the south are widespread arid plains and swampy marshes. Minor streams are the Kandu, Pili, Tengha and Nandhia. Apart from this, the Garbhiya Nala, Mazui Nala, Jamurya Nala, and Bhat Village Karkharva, Sobha Mahona etc. are lakes. The land of Sultanpur district is generally plane except some regions around the Gomti River which drains almost the whole district. However, the southern part of Sultanpur drains towards Sai River flowing through the Pratapgarh district.

Climate

The climate of this district is characterized by a hot summer and a pleasant cold season. The climate is semi-arid with very hot summer and equally cold winter season. During the summer months i.e. May-June, the maximum temperature goes beyond 44 degree Celsius and in winter months of December & January, it is around 3-4 degree Celsius. Winds are generally light to moderate with some strengthening during later part of the summer and monsoon season. Winds are mostly from the east or south-east during the period from May to September. The average annual rain fall is about 900 to 1000 mm and confined mainly during July to September. The rainfall in general increases from the south-west towards the north-east and about 80-85 per cent of the annual rainfall is received during the south-west monsoon months June to September, July being the rainiest month. Hail and Dust Storms are observed only during March to June.

Soil

Alluvial soils generally cover the major portion of the district. They have developed an alluvium deposited by the Gomti and its tributaries. The soils are neutral to moderately alkaline and calcareous and have sometimes, well developed clay accumulation in the sub-soils. The large areas of barren waste are striking characteristics of the district. Tahsil Sultanpur has the greatest area of such land. Most of this area is of a very unproductive nature and consists of wide usar plains, which are specially noticeable in the south and the east of district. Nothing grows on such land, not even grass. Most of the land affected by soil erosion in the district lies in the water sheds of the rivers Gomti, Mangar, Majhai and Sai.

Land Use Pattern

The mainstay of the population is still agriculture and more than 90 percent of families have excess number of persons engaging themselves in agricultural related activities. Out of the total geographical area, about 67% is devoted to Agriculture. The culturable and non-culturable waste land contributes 14.85 % and 18.21 % respectively. The main occupation of the people is agriculture, the crop pattern was all alike on the usual pattern of harvesting two crops rabi and kharif. But zaid crop are also found in this district.

Agro-Ecological Situations

As per the survey of the district, it has been observed that agro-ecological situations are directly correlated with physiographic situations, land quality and availability of irrigation facilities of the area. Broadly, the farming situations have been divided into four i.e. productive plain, sodic, ravenous and waterlogged conditions. The first three conditions, are further divided into two i.e. irrigated and rain fed. The waterlogged areas are temporarily or permanently submerged in nature. Bore well is the major source of irrigation (48.5%) followed by canal (38.65%) and public tube wells (9.17%)^[9].

Crop and cropping pattern

The agriculture of the district does not differ much from that of neighbouring districts. The main harvests of the district are known by the usual names kharif (autumn) and the rabi (spring) crops. The kharif crops are sown in the beginning of hot weather and reaped after cessation of the rains; the rabi crops are sown in October–November and reaped in March–April. The zaid or intermediate harvest which reaped before the summer rains is not of great importance in the district. Among the kharif crops paddy is the most important in point of the area under it. Other kharif crops are arhar, maize, urd and mung. The rabi crops consists of wheat, barley, gram and pea grown.

Rice is the most important crop of kharif and accounts for 34.78% of the total cropped area. The degree of dominance is comparatively less in the north-western part than the south-western part of the district. The next most important cereal crop is wheat which occupies nearly 25% area of the total cropped area and well distributed all over the district. Other crops like barley and millets occupied 4% and 5% of the gross cropped area respectively. Pluses cover only 15% of the total gross cropped area. Gram is the most important crop and accounts for 18% followed by pigeon pea (3.19%),

field pea and lentil. Mustard is the main oil crop grown in rabi, mixed with gram, pea, wheat and lentil. Sugarcane is cultivated as cash crop and occupies only 1.82% of the total gross cropped area. Cultivation of horticulture crops, specially the vegetables are mainly restricted to traditional families except potato, onion and sweet potato which are widely grown by majority of the farmers in the district. Potato occupies only 1.23% of the total gross cropped area followed by onion, sweet potato and other vegetables. Among the fruit crops Mango occupies a maximum area (15,517 ha) followed by guava (81 ha), aonla and jackfruit. The cultivators of the district had the services of seed godowns, fertilizer depots, rural godowns, insecticide depots, seed farm, cold storages and agriculture service centre. For storage of crops there were many warehousing godowns, among which some were managed by Food Corporation of India and State Warehousing and by State government.

Live stocks and fisheries

Animal husbandry is yet another sector which supports economy after agriculture. The domestic animal of local variety is found in the district. The cattle bovines, buffaloes, sheep, goats (he and she), pigs, poultry birds are the other animals. The condition of live- stock is worst in problem areas due to shortage of feed, fodder and occurrence of diseases. Nowadays, poultry farming has become important in the district with increasing demand of poultry products. Animal Husbandry departments make arrangement for supply of fowls to those interested in poultry farming.

The district has an immense potential for fresh water fisheries through large system of rivers and inland water bodies. Gomati River is an important source of fishes which covers a length of 207 km in the district. There are 5,636 ponds with water spread area of about 4,500 ha. The most prized species are the Anwari or Mullet and Rohu which are found in abundance in the Gomti. Majority of the fisherman population is concentrated in the village along the bank of Gomati River. Catching and selling of fishes is the main source of their livelihood. Housewives are mainly involved in rope making from Saccharum species which grows widely in the ravine areas.

The Need

As a whole, district is characterized by typical socio-economic and agro ecological situation. The majority of the farming community falls under marginal and small categories with fragmented holding scattered at different locations and poor resources. The soil condition of the district is inherently productive but a good proportion of land is beset with productive hazards as stated earlier.

Thus, there is a constant need for vertical as well as horizontal improvement of agriculture production in an integrated manner to uplift the socio-economic condition of the farming community. The majority of farming community suffers with a number of problems such as low level of knowledge, poor credit facility, input support, poor condition of soil, fragmented holdings and unemployment. Keeping in view the above, the following thrust area have been prioritize and taken into consideration for improvement of agriculture development in the district.



Fig 1: Map of the study area

1. Material used for compost preparation

Different crop residues that were readily available in the area were used to make compost, including grasses, sorghum, wheat, paddy straw, water hyacinth 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. In a similar manner, other organic wastes, like ash, were employed in order 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 were the total amount and combination ratio of materials used in the formation of compost. In order to speed up the composting process, all of the green biomass from the parthenium weed was freshly harvested and chopped into small pieces.

2. Compost Preparation

A 1.5 m × 1.5 m × 1.5 m pit was prepared in the home garden of the farmer. To keep the stacking process at 65% 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 65 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 25 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 25 days, the temperature was recorded. Compost preparation was done using pit composting techniques, and the composting process lasted for sixty-five days.

3. 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 sultanpur to determine the compost quality. Using a pH meter and electrical conductivity, the pH and EC of compost were determined in the supernatant

suspension of a 1:2.5 soil to water ratio [32]. Utilizing [27] to calculate organic carbon. [33] Kjeldahl method were used to calculate total nitrogen.

Total exchangeable bases (Ca²⁺, Mg²⁺, K⁺, and Na⁺) were measured using a flame photometer, atomic absorption spectrometry (AAS) for Mg²⁺ and Ca²⁺, and flame photometry for K⁺ and Na⁺ [34]. The method used to calculate cation exchange capacity (CEC) was [6, 10] 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

1. Certain chemical characteristics of parthenium compost

1.1. 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 [11], who reported that the pH range for compost was 6.8–8.41. According to research conducted by [18, 10] a higher pH is associated with a higher K level, which is what caused the high Electrical Conductivity (EC). The entire range of electrical conductivity (EC) values, which range from 0.00056 to 0.00062 (dS/m) ds/m (Table 1), did not show any significant variation. According to [17, 14] 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 [16], the breakdown of organic materials may release mineral salts like phosphates and ammonium ions, which could explain the rise in EC.

1.2. 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%), while 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 [14, 19]. 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, [7, 14] 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 [14], 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 [22]. study also demonstrated that parthenium, being a plant high in protein, is beneficial for soil and animal feed.

Table 1: Organic matter and some macronutrient

Treatments	pH (1:2.5)	EC (dS/m)	OM (%)	TN (%)	CEC (cmo (+)/kg)	C: N
T1	7.17	0.00062	35.2	1.83	34.8	11.2
T2	7.26	0.00056	36.1	1.91	46.2	11
T3	7.27	0.00058	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

1.3. 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 combine farm yard manure plus crop residue (1.98%), and nitrogen was recorded from the compost that was made. Findings from related research by [35, 10, 1].

2. 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 (cmol (+)/kg), 1.30 to 3.25 (cmol (+)/kg), 1.51 to 1.86 (cmol (+)/kg), and 0.24 to 0.33 (cmol (+)/kg), respectively. The Parthenium biomass combination of wheat straw and farm yard manure yielded the highest value in all cases, comparatively speaking, then compost made from Parthenium biomass plus animal manure or Parthenium biomass plus wheat straw. In agreement with this [25] 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 [2] findings, which showed that parthenium compost made from mixed farmyard manure and parthenium biomass considerably increased the exchangeable bases (Ca, Ma, and K).

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

**Fig 2:** Awareness about *Parthenium* for sodic soil reclamation

Conclusions and Recommendations

These days, parthenium (*Parthenium hysterophorus*) is extensively dispersed throughout the agro-ecosystem 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. By composting parthenium, it 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 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. This weed recommended for reclamation of saline-sodic soils in, U.P.

Abbreviations

EC: exchangeable cation and electrical conductivity
Om: organic mater
TN: Total Nitrogen
CEC: cation exchange capacity
C: N-carbon to nitrogen ratio
PBS: present of base saturation
NGO: non-Governmental organization

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