

## Enhancement of Soil Organic Carbon and Nutritional Parameters by Using Weed Based Compost

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### ABSTRACT

Weeds are undesirable plants that competed for resources with crops; thus, researching their nutritional properties contributed to establishing efficient management techniques. Different nutritional contents of weed species affect their competitiveness and susceptibility to various treatment techniques. The NPK concentrations varied significantly among weed species. Top of FormTop of FormWeeds were transformed into value-added compost by exploiting their organic content to produce a nutrient-rich soil supplement. Weeds, commonly viewed as agricultural nuisances, were successfully recycled by composting, a process that accelerates decomposition and converts organic materials into stable humus. The composting reduced garbage while producing a valuable product that improved soil fertility and health also. In this investigation, weed plants were obtained from the areas of Mullana, Ambala, Haryana. The collected weed plant samples were analyzed for physical, chemical and biological parameters such as pH, electrical conductivity (EC), moisture content (MC), plant nutritional parameters (nitrogen, phosphorus, potassium) as per the procedure documented by Indian Standards. The noxious weeds *Parthenium hysterophorous*, *Solanum nigrum*, *Calotropis procera* and *Trianthema portuculacastrum*, collected and cut into little fragments, about 1 cm in size. After that, the chopped biomass was placed in a pit for a composting experiment after a week of drying. After the 200 days of composting pH, EC, MC and TOC, total nitrogen and accessible phosphorus (P available) were all measured on one portion that had been air-dried.

**Key words:** Weeds, NPK, value-added compost, humus, soil fertility, physical, chemical, biological parameters

### INTRODUCTION

Weeds have been there since the beginning of time, adapting to harsh settings and flourishing in favourable ones. Historically, farmers used several methods to control weeds, such as manual weeding, rice tillage, cover crops, rotation, burning, and floods (Rao *et al.*, 2020). Indian farmers have used their skills to combat weeds since the beginning of agriculture. Indian researchers focused on weed management techniques based on herbicides. State agencies, colleges and extension organizations are developing and implementing weed management recommendations. Weed management technology is analyzed for environmental

impact to ensure safety and sustainability (Barua *et al.*, 2017). Hand-weeding is an ancient method of controlling weeds. It remains a popular method in India today. Unwanted plants were previously hand-picked out and destroyed.

Weed composting was an effective and sustainable method of managing undesirable vegetation while also improving the soil. Weeds, which were once regarded as a nuisance, became a valuable resource when composted properly (Kausar and Khwairakpam, 2022). The procedure required multiple procedures to ensure that weed seeds and roots did not survive and generate future infestations. Composting weeds was a practical solution for weed management and soil

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improvement. This approach not only reduced waste but also enhanced the health and fertility of the soil, leading to more productive and sustainable gardening practices. Currently, no effective approach exists to control this weed, leaving only preventive, quarantine, eradication, harvesting, and biological control options. The process of composting transforms organic material into a product that is readily available and rich in humic acids that are available to plants in an environmentally friendly manner in addition to having a low pathogenic microbial population (Soobhany, 2018).

Weeds, which are commonly viewed as pests in agricultural settings, were shown to be unusually. It is high in NPK (nitrogen, phosphorus and potassium). Both the growth of plants and the health of the soil depend on these major nutrients. Several studies have investigated the nutritional makeup of common weeds, indicating their potential as green manure or compost material. Weeds absorbed nutrients from the soil and stored them in their tissues, which were then released back into the soil after decomposition. This nutrient cycle was beneficial in preserving soil health and fertility, especially in organic agricultural systems that did not use synthetic fertilizers. Using weeds as a source of organic matter increased soil nutrient levels, promoted microbial activity and improved soil structure. Weeds like *C. procera*, *P. hysterophorus*, *S. nigrum* and *T. portulacastrum*, were known not only for their persistence and invasiveness but also for their capacity to supply essential nutrients such as nitrogen (N), phosphate (P) and potassium (Taneja *et al.*, 2023). These macronutrients were essential for plant growth and may indicate the plants' potential utility in soil enrichment and composting. The present work was based on the preparation of value added compost from different weeds, which will be cost effective, environmentally safe and simple method for increasing the production of crops.

## MATERIALS AND METHODS

Weed plants were obtained from Mullana (30.2753°N 77.0476°E.) Budhiyo, the MM (DU) campus, Mullana, Ambala, Haryana region. It is a central and biodiversity-rich phyto-geographical location in the Indian state of

Haryana. The noxious weeds *P. hysterophorus*, *S. nigrum*, *C. procera* and *T. portulacastrum* are frequently found on farms, wasteland, and by the side of the road in Mullana, Ambala, Haryana, India, were collected and cut into little fragments, about 1 cm in size. After that, the chopped biomass was placed in a pit for a composting experiment after a week of drying. Composting was carried out in a rectangular cemented pit at an ambient temperature of 25-27°C on the agricultural farm in MM (DU), Mullana, Ambala, Haryana, India. As detailed by Gusain *et al.* (2018), around 200 kg of weed mixtures, each including 50 kg of *Parthenium*, *Solanum*, *Calotropis* and *Trianthema* were poured in the pit. Quantity of water was added to sustain moisture level approximately 45-50%. To maintain the oxygen level during composting pit proper, a turning of plants cut pieces was performed at 5-day intervals throughout the 200 days. After the turning process was finished, the sample was taken, enabling a thoroughly blended sample from the compost pit. The Zhang and Sun (2016) approach was used to split the sample into two sections: The pH, EC, MC and TOC, total nitrogen, and accessible phosphorus (P available) were all measured on one portion that had been air-dried. The second portion was utilized to analyze the composted weed mixture's total potassium (K) content and water-holding capacity after being oven-dried for 48 h at 60°C.

## RESULTS AND DISCUSSION

The physicochemical analysis of a weed plant involved a comprehensive examination of its physical and chemical properties to understand its composition and potential uses. The analysis started with sample collection of eight weed plants, followed by washing, drying, and grinding the plant material to prepare it for various tests. The physical parameters of

**Table 1.** Physical parameters of weed plants

Weed plants	pH	EC	MC
<i>D. triflorum</i>	7.4±0.04	2.20±0.04	46±0.7
<i>P. hysterophorus</i>	5.2±0.06	6.81±0.04	64±0.4
<i>C. procera</i>	4.0±0.02	3.06±0.07	77±0.4
<i>A. conyzoides</i>	7.6±0.04	7.26±0.07	52±0.1
<i>A. aspera</i>	5.6±0.04	5.90±0.04	46±0.7
<i>C. sativa</i>	6.3±0.07	1.76±0.06	45±0.4
<i>S. nigrum</i>	5.6±0.07	7.02±0.01	86±0.7
<i>T. portulacastrum</i>	6.2±0.04	18.54±0.1	76±0.7

the weed plants showed the pH, moisture content and electric conductivity (Table 1). It showed that the pH values ranged from low to high (4 to 7.6), the EC values ranged from low to high (1.76 to 18.54) and the MC values varied from lower to higher (45 to 86).

The physical parameters of weed plants demonstrated that the pH value for the eight weed species. *A. aspera*: 5.6, *A. conyzoides*: 7.6, *C. procera*: 4, *D. triflorum*: 7.4, *P. hysterophorus*: 5.2, *S. nigrum*: 5.6, *T. portulacastrum*: 6.2 and *C. sativum*: 6.3. *A. conyzoides* had highest pH value, while *Calotropis procera* had lowest pH value. The electrical conductivity (EC) values for the eight weed species, *D. triflorum*: 2.20, *A. conyzoides*: 7.26, *C. procera*: 3.06, *S. nigrum*: 7.02, *P. hysterophorus*: 6.81, *A. aspera*: 5.9, *C. sativum*: 1.75 and *T. portulacastrum*: 18.54. *T. portulacastrum* had highest EC value, while *D. triflorum* had lowest EC value. The moisture content MC values for the eight weed species, *A. aspera*: 46%, *A. conyzoides*: 52%, *C. procera*: 77%, *D. triflorum*: 46%, *P. hysterophorus*: 64%, *S. nigrum*: 86%, *T. portulacastrum*: 76%, *C. sativum*: 45%. *S. nigrum* had highest MC value, while *C. sativum* had lowest MC value.

Table 2 shows that the N values ranged from low to high (0 to 3). *S. nigrum* had the highest nitrogen level (3), while *D. triflorum* had the lowest (0.01). The P values ranged from low to high (0 to 1.8). *C. procera* had higher phosphorus value (1.8) and *T. portulacastrum* had the lowest value (0.001). The K values varied from lower to higher (0 to 3). *S. nigrum* had a higher potassium value (3), while *C. sativum* had the lowest value (0.01).

**Table 2.** Chemical parameters of weed plants

Weed plants	N	P	K
<i>D. triflorum</i>	0.01±0.006	1.2±0.4	0.06±0.02
<i>P. hysterophorus</i>	2.54±0.84	0.44±0.14	1.22±0.40
<i>C. procera</i>	0.03±0.01	1.8±0.6	2±0.66
<i>A. conyzoides</i>	0.02±0.006	0.01±0.003	0.03±0.01
<i>A. aspera</i>	0.001±0.006	0.009±0.003	0.01±0.003
<i>C. sativa</i>	0.02±0.006	0.08±0.002	0.01±0.006
<i>S. nigrum</i>	3±1	0.2±0.06	3±1
<i>T. portulacastrum</i>	0.06±0.02	0.001±0.006	0.04±0.013

The nitrogen percentages for each weed plant species from highest to lowest were *S. nigrum* (3.08), *P. hysterophorus* (2.54), *T. portulacastrum* (0.06), *C. procera* (0.03), *A. conyzoides* (0.02), *C. sativum* (0.02), *A. aspera* and *D. triflorum* (0.01). Phosphorus percentages for each weed plant species, from highest to lowest were *C. procera*

(1.8), *D. triflorum* (1.2), *P. hysterophorus* (0.44), *S. nigrum* (0.20), *C. sativum* (0.08), *A. conyzoides* (0.10), *A. aspera* (0.009) and *T. portulacastrum* (0.001) and potassium percentages as *S. nigrum* (3.00), *C. procera* (2.00), *P. hysterophorus* (1.22), *D. triflorum* (0.06), *T. portulacastrum* (0.04), *A. conyzoides* (0.03), *A. aspera* (0.01) and *C. sativum* (0.01). It also showed the cumulative percentage of weed plants plotted against the cumulative percentage of nitrogen, phosphorus, as well as potassium content. The small number of weed plants account for a large portion of the total nitrogen content, the top two out of eight weed plants containing 97.7% of nitrogen content and the remaining six weed plants containing only 2.3% of nitrogen content. Similarly, in case of phosphorus and potassium top four and out of eight weed plants contained 97.4 and 97.8% of the total phosphorus and potassium contents and the remaining four and five weed plants contained only 2.6 and 2.2% of the total phosphorus and potassium contents.

Weeds were utilized for production of compost in this study. *P. hysterophorus*, *S. nigrum*, *C. procera* and *T. portulacastrum* were common weeds in Mullana, Ambala, Haryana, India. Table 3 shows the physical properties of compost from 20 to 200 days. The pH of the compost steadily increased over time; in the early days, it was acidic, but basicity emerged as it matured. Compost's electrical conductivity ranged from high to low, from 6.28 to 4.64, and its moisture content dropped as decomposition progressed.

**Table 3.** Physical parameters of compost

Days	Temperature	pH	EC	MC
20	25±0.7	5.8±0.04	6.28±0.01	63.12±0.01
40	22±0.7	6±0.7	6.14±0.04	60.06±0.04
60	18±0.4	6±0.7	5.82±0.06	58.67±0.04
80	10±0.4	6.2±0.04	5.6±0.07	57.62±0.01
100	4±0.7	6.5±0.4	4.96±0.01	55.63±0.01
120	11±0.7	6.6±0.04	4.55±0.04	50.12±0.07
140	16±0.7	7±0.7	4.53±0.04	46.53±0.07
160	26±0.4	7.2±0.07	4.5±0.07	44.66±0.07
180	28±0.4	7.4±0.04	4.55±0.04	43.23±0.01
200	29±0.4	7.5±0.07	4.64±0.01	42.53±0.04

Tables 4 and 5 report the chemical properties of compost. The mature compost had nitrogen of 2.28%, phosphorus of 1.25% and potassium of 1.98%. The compost with these properties was ready to be evaluated for its effect on crop growth.

**Table 4.** Chemical parameters of compost

Days	N	P	K
20	0.45±0.15	0.06±0.02	0.06±0.02
40	0.5±0.16	0.08±0.02	0.08±0.02
60	0.57±0.19	0.09±0.03	0.1±0.03
80	0.7±0.23	0.1±0.03	0.13±0.04
100	0.79±0.26	0.18±0.06	0.16±0.05
120	1.28±0.42	0.31±0.10	0.36±1.2
140	1.63±0.54	0.8±0.26	1.36±0.45
160	2.14±0.71	1.06±0.35	1.52±0.50
180	2.2±0.73	1.18±0.39	1.68±0.56
200	2.28±0.76	1.25±0.41	1.98±0.66

**Table 5.** Chemical parameters of mature compost

Sample	Chemical parameters			
	Nitrogen	Phosphorus	Potassium	C:N ratio
Compost	2.28±0.011	1.25±0.004	1.98±0.005	0.57±0.019

**Table 6.** Physical parameters of mature compost

Sample	Physical parameters			
	pH	EC	MC	WHC
Compost	7.95±1.13	4.64±0.66	42.53±6.07	45.31±6.47

Table 6 presents the physical properties of aged compost. The mature compost had a pH of 7.95, an electrical conductivity (EC) of 4.66, moisture content (MC) of 42.53% and water holding capacity of 45.31%. The compost with these properties was ready to be evaluated for its effect on crop growth.

In the present study, physio-chemical properties of weeds as well as compost were analyzed at different times of composting, such as moisture, electric conductivity, pH and temperature, N, K and K. According to Nozhevnikova *et al.*, (2019), composting is the exothermic chemical oxidation of different organic wastes in the presence of air, which involves microorganisms. Microbial decomposition stabilizes, matures, and deodorizes organic materials, resulting in a humus-substance-rich product that can be utilized as an organic soil conditioner and is easy to store and distribute. Crop productivity requires a sufficient supply of nitrogen, phosphorus, potassium and other important nutrients. To increase soil fertility and crop productivity, farmers regularly employed the composting technique to stabilize organic matter in the soil (Karimi *et al.*, 2024).

Compost is evaluated for viability and quality for use in agriculture using physico-chemical

analysis. This type of investigation typically looks at the following: pH, EC, organic matter content, moisture content, nutritional levels (such as potassium, phosphorus and nitrogen), and the heavy metals present (Rahman *et al.*, 2020). The recommended pH range for composting was between 6 and 8, as this will affect the availability of nutrients and microbial activity. Electrical conductivity demonstrates that salt may affect plant growth at appropriately high concentrations. The organic matter level is essential since it improves soil structure while providing nutrients. Compost has the potential to fertilize since plants need nitrogen, phosphorus and potassium, all of which are found in sufficient levels. Moisture concentration affects microbial development and the breakdown process; the optimal range is 40-60%. Finally, three heavy metal levels must be evaluated on a regular basis to ensure they remain within safe ranges, preventing soil contamination and posing a risk to plants and animals.

Numerous studies describe these important traits for physicochemical analysis. To check the stability and maturity of the compost, pH and EC are very important factors (Bernal *et al.*, 2017). Compost's physico-chemical study includes determining its bulk density, porosity, microbiological appearance, and carbon-to-nitrogen ratio, among other basic characteristics that were previously discussed. A key factor in the strength and maturity of compost is the carbon and nitrogen ratio. The lower the ratio, faster the decomposition and the greater the nitrogen loss, while a higher ratio indicates a higher nitrogen level for microbial growth.

Using weeds as a source of organic matter increased soil nutrient levels, promoted microbial activity and improved soil structure. Weeds like *C. procera*, *P. hysterophorus*, *S. nigrum* and *T. portulacastrum*, were known not only for their persistence and invasiveness but also for their capacity to supply essential nutrients such as nitrogen (N), phosphate (P) and potassium (Taneja *et al.*, 2023). These macronutrients were essential for plant growth and may indicate the plants' potential utility in soil enrichment and composting. *P. hysterophorus*, often known as congress grass, had significant amounts of nitrogen, phosphate and potassium. *Parthenium* has been shown in

studies to accumulate significant nitrogen, which improves soil fertility when decomposed. Its phosphorus level, while varied, promoted plant growth and development. *Parthenium* contains enough potassium to boost soil health, making it an effective component in composting processes. *S. nigrum*, or black nightshade, was another herb with a high nutritional value. *S. nigrum* contained substantial amounts of nitrogen, phosphate and potassium, which aided the nutrient cycle when utilized as mulch or compost. *C. procera*, often known as the apple of sodom, was good at storing nitrogen, phosphate and potassium. Its high nitrogen content helped to nourish the soil by functioning as green manure (Souza *et al.*, 2017). *Calotropis* phosphorus and potassium levels also improved soil health, although the plant's poisonous qualities required careful management. *T. portulacastrum*, also known as horse purslane, had significant levels of nitrogen, phosphate, and potassium (Jimoh *et al.*, 2024). Its nitrogen content made it particularly useful for improving soil fertility. *Trianthema* contains phosphorus and potassium, which promote many physiological functions in plants and improve soil nutrient availability when composted (Naikwade, 2019). The weeds high nitrogen, phosphorus and potassium content emphasized their potential utility in enhancing soil fertility and supporting sustainable agricultural practices such as composting, mulching and soil enrichment, all of which contribute to increased soil fertility and plant development (Mechergui *et al.*, 2021). In addition, weed compost contributed significantly to carbon sequestration. By reintroducing organic matter into the soil, it helped to collect atmospheric carbon dioxide, thereby contributing to climate change mitigation. The higher organic content improved soil fertility over time, resulting in more productive and sustainable farming methods. Weed compost's natural breakdown process also reduces greenhouse gas emissions when compared to standard garbage disposal methods (Naikwade, 2019).

## CONCLUSION

The weed compost helped promote sustainable waste management by recycling organic waste that would otherwise have ended up in

landfills. This procedure not only reduced waste volume but also turned it into a useful resource for gardeners and farmers. Weed composting has several environmental benefits; including reduced dependency on chemical inputs and increased soil biodiversity. Weed compost has been utilized in a variety of agricultural and horticultural techniques. It was an efficient soil additive for gardens, lawns and crop fields, increasing soil health and plant vitality. Farmers and gardeners discovered that introducing weed compost into their soil management procedures increased crop yields and stimulated plant development. Its use also decreased the need for chemical soil conditioners and supported a more organic farming strategy. Overall, weed compost provided a complex answer to a number of environmental and agricultural issues. Its benefits included improving soil health and plant development, as well as supporting sustainable waste management and environmental conservation. Individuals and communities were able to embrace more sustainable and environmentally friendly behaviors by using weed compost, contributing to a healthier earth.

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