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Physiochemical Properties of Soils Associated with Selected Asteraceae Species

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ABSTRACT

Members of the family Asteraceae are widespread weeds that can influence their surrounding soil environment. However, there is limited information on how these species affect soil physicochemical properties. This study evaluated the physicochemical properties of soils associated with selected Asteraceae species—Ageratum conyzoides*,* Tridax procumbens*,* Emilia sonchifolia*,* Chromolaena odorata*, and* Vernonia cinerea *in order to assess their potential influence on soil quality and nutrient availability. The immediate environment where the selected weeds species of Astereacea family under study were collected, using soil auger, depth of 15 cm (top soil) was used for the soil analysis. The data obtained were analysed using computer moderated Duncan multiple range test (DMRT). The results showed that soils in the immediate environment of the selected Asteraceae species*—Tridax procumbens*,* Emilia sonchifolia*,* Chromolaena odorata*,* Ageratum conyzoides*, and* Vernonia cinerea*—had higher concentrations of nitrogen, phosphorus, potassium, and organic carbon, as well as greater porosity, compared to surrounding soils without these plants. Based on the findings of this study, the selected Asteraceae species appear to positively influence soil physicochemical properties. Their presence was associated with higher nutrient concentrations and improved soil structure, suggesting that plant–soil interactions involving these species may contribute to enhanced soil quality and nutrient availability within their immediate environment.*

Keywords: Soil, Asteraceae, Physicochemicals, Species

INTRODUCTION

Asteraceae is one of the two largest families of flowering plants, with certainly more than 15,000 species. The only other family of comparable size is the orchidaceae. The Asteraceae is cosmopolitan in distribution, but partial to open or semi open habitats rather than deep woods. In most parts of the temperate zone, including our region, they are by far the largest family. Many genera and species are cultivated for ornament.

The flower heads vary from small to large, and are often brightly colored. The number of flowers in a head is seldom less than 5, and ranges upward into the hundreds or even more than a thousand, as in the common cultivated sunflower. A few species have only a single flower in each head. *Echinops* and some other genera are one-flowered, individually involucrate heads aggregated into a secondary head with a secondary involucre. Compound heads with more than one flower in each individual head also occur in some genera, such as *Elephantopus*.

In the Asteraceae, it has been observed that some plants species like *Tragopogon dubius, Tripleurospermum perforate, Chamomilla inodora, Matricaria inodora, Tripleurospermum inodorum Ageratum conyzoides* etc contains many phytochemicals: Flavonoids, chromenes, benzo Furans and terpenoids (Ming, 1999). These phytochemicals are generally phenolics (such as tannins), alkaloids, steroids, terpenes, saponins, and quinones (Dayan, *et al.,* 2009).

Thus, evidence has showed that plants release a diversity of phytochemicals into the environment. Despite so much phytochemical diversity, phytochemicals can be broadly characterized into phenolics and terpenoids. They are released by volatilization, root exudation, death and decay of plants, and leachation from living or decaying residues (Anaya, 2006; Xuan *et al.,* 2005). After release, phytochemicals are involved in a variety of metabolic processes (Xuan *et al.,* 2005).

Sequel from the above aforementioned points it has been observed that plant species contains some phytochemicals like flavonoids, chromenes, benzo furans, terpenoids etc. and these phytochemical substances released by the plant enter into the soil. Once released into the soil by the donor plant, phytochemicals enter a complex plant-soil system in which diverse factors affect their availability. The properties of these physicochemicals in the soil is relatively unknown to an extent. Hence studying the soil properties associated with asteraceae species is quite scanty. It is against this background that; the present study was undertaken to determine the possible physicochemical properties of soils associated with weeds like *Ageratum conyzoide, Tridax procumbems, Emilia sonchifolia, Chromolaena odorata* and *Vernonia cinerea* from the family of Asteraceae.

RESEARCH METHOD

The research project was done in the Department of Integrated Science, School of Science, Nwafor Orizu College of Education, Nsugbe, Anambra State, Nigeria which falls within the humid tropical rainforest agro-ecological zone of Nigeria. Anambra state has two distinct seasons, namely: Rainy season between April to October (7 months) with mean precipitation of 602 mm and the dry season is between November to March (5 months). The seasons are brought about by two predominant winds that rule the area, the south western monsoon winds from the Atlantic Ocean and the north eastern dry winds from across the Sahara Desert.

The natural vegetation in Anambra State is tropical dry or deciduous forest which in its original form comprised tall trees with thick undergrowth and numerous climbers. The tropical trees present are silk cotton trees, iroko and oil bean trees, etc., which are deciduous, shedding their leaves in dry seasons. The original vegetation can only be found in inaccessible places and in shrines

The soil collection was done using the standard method as described by (Haase, 1992; Ukpong, 1994). In the immediate environment where the selected weeds species of Astereacea family under study were collected, using soil auger, depth of 15 cm (top soil) was sampled. All the soil samples collected were further broken into small pieces, stones and gravels were discarded and the soil was mixed thoroughly prior to use. Only about 2 kg of the original composite sample was taken at random, placed in a polythene bag and taken to the laboratory for analysis

In the laboratory, large a lumps were further broken up and the soil was finally spread out on a large sheet of paper on a bench and allowed to air dry. When air dried, the soil sample was ground on bench surface with the aid of a wooden roller which allowed the aggregate particles to be crushed but no actual broken down occurred. The sufficient ground soil was sieved through a 2 mm sieve. The sieved soil was store in labelled small calico bag ready for analysis. Thus, a portion of the soil sample was set aside for analysis of physicochemical properties of the soil.

Determination of Soil pH

The determination of soil pH was done as described by Rhoades (1982) using the spectro-plus electrode pH meter direct measurement technique. In this regard, 10 g of the soil sample was mixed with 25 ml distilled water in a clean dry 50 ml glass and allowed to stand at room temperature for 30 minutes being stirred every 10 minutes. Meanwhile, the pH meter was switched on and allowed an equilibration time of 10minutes. It was then calibrated with buffered solutions of pH 4.00 and 7.00 respectively. it was ready for use.

To measure the soil pH, the electrode (i.e sensor) of the meter was dipped into the soil mixture in the beaker. Care was taken to ensure that the sensor was not touching the beaker either at the walls or at the bottom. The pH value was read directly from the screen of the instrument when the figures became steady. Readings of the samples were repeated three times to ensure reproducibility and that the instrument was in good working condition (Ibitoye, 2008 and Carter, 1992).

Determination of Percentage of Soil Organic Matter

This was carried out on 0.5 mm sieved soil samples. The Walkley-Black titrimetric method was used (Walkley & Black, 1994; Ibitoye, 2008). One gram of sieved soil was weighed out in triplicated and transferred to 500 ml conical flask. By means of pipette, 10 ml of 1 N potassium dichromate solution (49.04 g of $K_2Cr_2O_7$ made up to 1 litre with distilled water) was added. The flask was swirled gentle to mix.

Twenty ml of concentrated sulphuric acid was added rapidly using a graduated cylinder. the soil was swirled gently until soil and reagents were mixed, after which it was swirled more vigorously for 1 minute. The flask was rotated again and allowed to stand for 30 minutes.

After standing for 30 minutes, 100 ml of distilled water was added to dilute the mixture. Ten ml of 85 % ortho-phosphoric acid, 0.2 g sodium fluoride and 3-4 drops of diphenylamine indicator were added. The excess dichromate was titrated using 0.5 N ferrous ammonium sulphate (prepared by dissolving 196.1 g Fe $(NH_4)_2.6H_2O$ in 800 ml water containing 20 ml concentrated sulphuric acid and diluted to 1 litre), until a green colour was reached. The colour changes were dark green to blue to light green.

Two reagent blanks were run using the same procedure except that no soil was used. Soil samples calculation formulae used.

(a) Milliequivalent of oxudisable material per gram (Meq.Ox/g) =

$$\frac{\text{ml of } Fe^{2+} \text{ for blank-ml } Fe^{2+} \text{ for sample x normality of } Fe^{2+}}{\text{Wt of soil in gram}}$$

(b) % Carbon = Meq. ox/g x 0.003 x 100 x f
Where f = correction factor
Therefore % carbon = Meq. ox/g x 0.399

(c) % organic matter = % C x 1.729

For all the calculation, ml of Fe^{2+} for blank (average of 2 readings) = 22.15 and stand normality of Fe^{2+} = 0.5 (Carter, 1992; Ibitoye, 2002).

Determination of Total Percentage Soil Nitrogen

The available nitrogen in the soil was done according to the steam distillation after Kjeldahl digestion at 370^o C.

Reagents.

1. Sulphuric acid, concentration H_2SO_4 reagent grade
2. Digestion catalyst- mix together 1000 g of ground sodium sulphate (reagent anhydrous Na_2SO_4) or potassium sulphate, and 25 g cupric sulphate (reagent anhydrous CuSO4) 10 g of sodium selenium (Se) powder.

Procedure:

1. Weighed 3.0 g of soil, was added into a 75 ml volumetric digestion tube.
2. A tablet of digestion catalyst was added and mixed thoroughly with the dry soil.
3. Ten mil of concentrated H_2SO_4 was added to the soil catalyst mixture. Note that, it is essential that all dry material be completely moisture and thoroughly mixed with the acid to ensure complete digestion.
4. Blank solutions were prepared for each set of sample analysed by following step 2-3 above using no soil.
5. Tubes were placed on a digestion block at 15^0C. Samples were checked every 20 minutes for foaming. After one hour (or more, if foaming persists), temperature raised to 25^0c and continue digestions for one hour. After one hour at 25^0C and heat until samples were completely digested, usually about two additional hours. At completion, mineral soil was grayish-white while organic soil was blue-green in colour.
6. Samples were removed from block and left under a fume hood to cool. Then 10-20 ml distilled water was added to each tube to keep the samples from hardening.
7. The ammonium nitrogen content of the digest solution was determined with a rapid flow analyser, which relies on ammonium to complex with salicylate to form indophenols blue. This colour was intensified with sodium nitroprusside and measured at 600 nm. The samples were analyse on an autoanalyser by continuing with steps 8-9 below to determine total nitrogen using calculation in this method.
8. Samples were brought to volume with deionized water in 75 ml digestion tubes and mixed.
9. Clear digested solutions were analysised either by allowing samples to settle overnight and pipetting an aliquot or by filtering through and acid washed filtering apparatus fitted with What-man filter paper. Digest solution were refrigerated prior to analysis.

Calculation

$$\text{Percentage total nitrogen} = (\text{ppm } NH_4 \text{ +- N in digest solution}) \frac{\text{x 75 ml}}{\text{Sample size (g)}} \text{ x } \frac{1}{10.000}$$

The Kjeldahl method outlined by Carter (1993) was modified by eliminating the water from the digestion step. One further modification was the determination of NH_4-N spectrophotometerically rather than by kjeldahl distillation and titration (Ibitoye, 2008 and Koptsik *et al.,* 2003).

RESULTS AND DISCUSSION

Result of the soil analysis showed that the immediate environment where the selected weeds were found had the concentration of nutrients: nitrogen (0.19±0.01 %), soil pH (6.14±0.02), potassium (0.07±0.00 meq/100 g), organic carbon (0.65±0.03 %), porosity (44.607±0.081 %), phosphorus (14.50±0.11 ppm).

Table 1: The Soil Nutrients Status of the Immediate Environment of the Selected Weeds

Plots	Nitrogen (%)	Soil pH	Potassium (meq/100g)	Organic carbon (%)	Porosity (%)	Phosphorus (PPM)
	0.19±0.01	6.14±0.02	0.07±0.00	0.65±0.03	44.61±0.08	14.50±0.12

Values were significantly different at $P<0.05$.

Discussion

The results of the physicochemical properties of soils associated with selected *Asteraceae* species showed significant variations in the immediate soil environment where the plants were found. The results indicated the presence of several soil properties at varying concentrations, including higher total nitrogen content, mean equivalent per gram of potassium, parts per million of phosphorus, percentage porosity, and percentage organic carbon.

The presence of these soil properties, particularly high levels of soil carbon (C), nitrogen (N), phosphorus (P), and pH, in the immediate environment may be attributed to increased input of organic matter through plant residues (litter) in the area. The accumulation and decomposition of litter contribute to nutrient enrichment and improvement of soil fertility. This observation agrees with earlier studies which reported that decomposition rate influences soil nutrient content (Díaz et al., 2004) and that most organic matter input into soil occurs through litter fall (Singh & Singh, 1993).

Furthermore, soil physicochemical properties such as organic matter content, nutrient availability, and pH play a crucial role in regulating microbial activity and nutrient cycling. Increased organic matter enhances microbial processes, improves soil structure, and promotes nutrient availability, thereby supporting plant growth. The interaction between soil nutrients, pH, and microbial activity creates a balanced and efficient soil ecosystem, leading to improved nutrient solubility, uptake, and overall soil fertility.

CONCLUSION

Based on the findings recorded in this study, it was concluded that the selected weed species—*Tridax procumbens*, *Emilia sonchifolia*, *Chromolaena odorata*, *Ageratum conyzoides*, and *Vernonia cinerea*—positively influence soil quality and nutrient availability in their immediate environment. This improvement in soil fertility may be attributed to the contribution of organic matter through plant residues and litter deposition, which enhance soil physicochemical properties such as nitrogen, phosphorus, potassium, organic carbon, pH, and soil porosity. These conditions promote microbial activity, improve soil structure, and create a healthier soil environment where nutrients are more available for plant uptake.

RECOMMENDATION

Based on the findings of this study, it is recommended that the selected *Asteraceae* weed species (*Tridax procumbens*, *Emilia sonchifolia*, *Chromolaena odorata*, *Ageratum conyzoides*, and *Vernonia cinerea*) should be encouraged and appropriately managed for sustainable soil improvement. Government and agricultural stakeholders should promote their use in farming systems as sources of organic matter through plant residues, green manure, or compost materials, as they enhance soil physicochemical properties and improve nutrient availability in an eco-friendly manner. This approach can serve as a sustainable alternative to synthetic soil amendments.

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