

THE INFLUENCE OF THE INVASIVE PLANT *Taraxacum officinale* (FH Wigg) ON SOIL CHARACTERISTICS

ABSTRACT

The study which was aimed at detecting the effects of the properties of *Taraxacum officinale* on the characteristics of the soils was carried out in a garden in Use Offot Community in Uyo, Akwa Ibom state using the purposive sampling method. The samples were collected at a depth of 0-30 cm from different points in the study area, and were bulked into one composite sample. The results of the analysis of the sample showed that the soil with *Taraxacum officinale* had a neutral soil pH (7.055) as against the control soil which had a slightly acidic pH (6.72). The organic carbon, total nitrogen and available phosphorus contents were 0.78 %, 0.04 %, and 87.04 mg/kg respectively. The average cation exchange capacity (3.25 cmol/kg) was low; also the soil texture of the samples were identified as loamy sand. After data analysis, it was revealed that *Taraxacum officinale* had minimal effects on the overall physicochemical properties of the soil in which it is found.

INTRODUCTION

Invasive plants have a multitude of impacts on plant communities through their direct and indirect effects on soil chemistry and ecosystem function [1]. These plants modify the soil environment through exudates that affect soil structure and mobilize and/or chelate nutrients [2]. Plants can affect soil structure (particle aggregation) by creating pores in soil; and plant growth promotes rapid wetting and drying cycles that cause shrinkage and strengthening of the soil [3]. Some invasive species may gain a competitive advantage through the release of compounds or combination of compounds that are unique to the invaded community [2]. Studies based on meta-analysis indicates that plant invasions generally increase nutrient pools and also enhance the rate of soil processes such as litter decomposition and mineralization, possibly accelerating nutrient cycling. This is because invasive species have significantly higher, in comparison to non-invasive ones, values of performance-related traits such as physiology, leaf-area allocation, shoot allocation, growth rate, size and fitness, which are driving factors in regulating carbon and nitrogen cycles [4].

Changes in the soil properties brought about by plant invasion are problematic as they may lead to positive feedbacks that stabilize or accelerate invasion. The changes may persist after the removal of an invasive plant and limit recolonization by native plant communities. This phenomenon known as invasive plant legacy, has implications for restoration of invaded site [5].

Taraxacum officinale is among the most frequent and aggressive invasive alien plants found in natural, extensively managed and man-made habitats [6]. It is considered a transformer that change “the character, condition, form or nature of ecosystems over a substantial area” due to,

for example, excessive or limited use of resources, promotion of erosion or stabilization of soil, or accumulation of litter. However, some data indicates that the influence of invasion on ecosystems may considerably vary among transformer invasive species [7].

T. officinale is considered one of the most difficult weeds to control because its seeds are spread quickly and easily by wind. *T. officinale* has shown high tolerance to abiotic stress and efficient use of resources due to high plasticity in morphological and physiological traits [8]. Thus, when it experiences favourable abiotic conditions *T. officinale* shows enhanced abundance, physiological performance, biomass accumulation, survival and seed production [8, 9]. It was found that on French sub-Antarctic islands, where *T. officinale* was introduced, the disappearance of native plants over wide areas, due to the impact of rabbits and global warming, coincided with a demographic explosion of *T. officinale* and other introduced plants, thus resulting in the homogenization of plant communities [10].

T. officinale is a perennial plant in the sunflower family - Asteraceae. It is distributed in almost every temperate and subtropical region of the world and is typically found in the temperate climate and it grows in loose soil and open spaces [11]. The roots of this plant are cylindrical, thick and possess vertical rhizomes that form a tap root which exudes a milky juice when cut. In the upper part of the rhizome, there are semicircular scars caused by the insertions of the leaves of the previous years. Its cotyledons are pale, dull, yellowish-green, oval, and have smooth edges. Its young leaves form a basal rosette and are oval to oblong with long hollow leaf stalks (petioles). The stems are erect, about 2 to 12 inches tall, hollow, leafless, filled with milky juice, and terminate in a single flower head. The leaves of the plants are basal, bright green, thin, hairless, between 3 to 10 inches long, and jagged around the edges with lobes or teeth of various sizes and shapes. The terminal lobe is usually the largest and lobes become smaller and more deeply divided toward the leaf base. The leaf base tapers into a hollow, short petiole; and mature leaves exude a milky juice when cut or broken. *T. officinale* has bright yellow, 1- 2-inch-wide flowers form at the tips of long, hollow, flower stems. Flowers mature into fluffy white seed heads. The single-seeded fruits are brownish, narrow, about $\frac{3}{16}$ inch long, and tapering to a slender beak that is 2 to 3 times as long as the seed. At the top of the beak are soft, white, bristly hairs called pappus [11]. Although *T. officinale* is considered a weed, it has some economic benefits which include its uses in the production of food and medicines [12, 13].

Studies have shown that there are different characteristics which may be responsible for the spartial or temporal variation in soil physico-chemical properties. Some may be as a result of land use, tillage practices and littoral origin of the soil [14]. Soil properties influence vegetation, and vice versa. Selective absorption of nutrients by different plant species and their capacity to return these to the soil, brings about the changes in the biochemical properties of the soil, as well as that of the plants [15]. This research seeks to detect if the properties of *Taraxacum officinale*, have an effect on the characteristics of the soils in which they are found.



Figure 1: *Taraxacum officinale* in its natural habitat.

MATERIALS AND METHODS

Description of Study Area

The study was conducted in a garden at Use Offot, in Uyo, Akwa Ibom State which lies within the latitude $5^{\circ} 02' N$ and longitude $7^{\circ} 97' E$ in the south-south region of Nigeria. The area has an average temperature of about $24.8^{\circ} C$ and an annual rainfall of about 34.3mm. Uyo is geographically bound to the east by Uruan Local Government Area, to the west by Abak Local Government Area, Ibiono Ibom Local Government Area to the North and Ibesipko Asutan Local Government Area to the South [16].

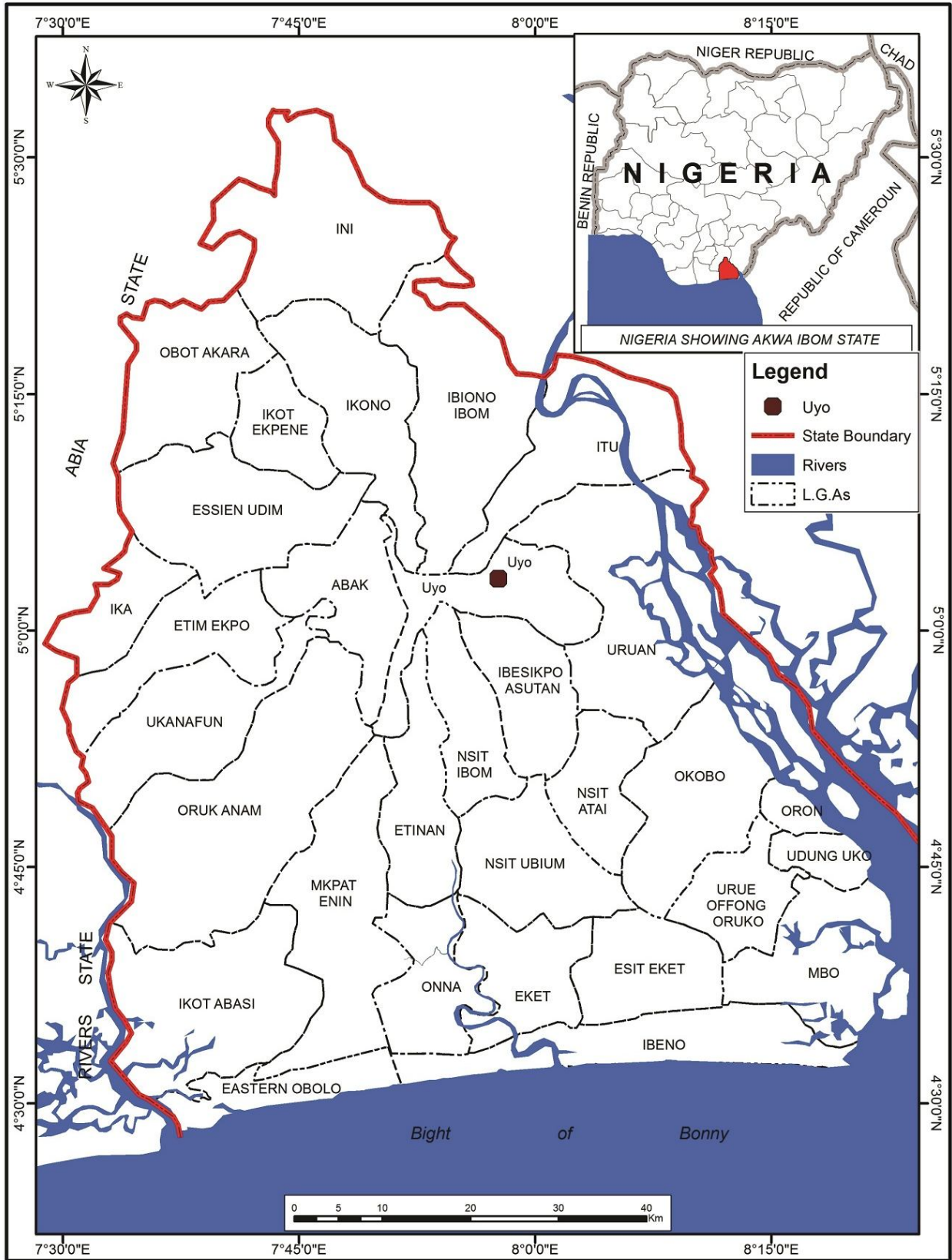


Figure 2: Map of Akwa Ibom State indicating the city in which study location is found

Soil Sample Collection

The samples were collected in July, 2021 at the study area, using a soil auger at the garden, by burrowing into the soil at the depth of 0-30 cm at different locations. The locations were chosen through the purposive sampling method, in the area which the *Taraxacum officinale* was dominant, while the control sample was collected as control from an area which lacked the invasive species. The collected samples were stored in transparent Ziploc bags and were taken to the University of Uyo, Soil science department for analyses.

Laboratory procedure for Soil Analysis

The collected samples were spread to dry for about 24 hours because the samples collected were very moist. After air drying, different tests were carried out to aid the analyses following the standard procedures outlined by the Association of Official Analytical Chemist (AOAC) [17].

RESULTS

Physicochemical Characteristics of the Soil

According to the results presented in in Table 1, the pH of the soil sample with *Taraxacum officinale* was neutral with a mean of 7.055 while that of the control soil was slightly acidic with a mean value of 6.72. The electrical conductivity levels of both soils were low. The sample containing *Taraxacum officinale* had a value of 0.49 ds/m while that of the soil without had a conductivity level of 0.87 ds/m. Soil with *Taraxacum officinale* had a higher organic carbon content of 0.78 % than that of the soil without *Taraxacum officinale* which had a percentage of 0.54 %. There was little difference in the total nitrogen content of both soils with values of 0.035 % for soil with *T. officinale* and 0.02 % for soil without *T. officinale*. Both soils had a relatively high amount of available phosphorus 87.04 ppm and 81.37 ppm for the soil with *Taraxacum officinale* and the sample without *Taraxacum officinale* respectively. Higher base saturation was observed in soil with *Taraxacum officinale* at 73.15%.

Table 1: Physicochemical Characteristics of the soil in the studied habitat

Parameters	Soil With <i>Taraxacum officinale</i>	Control (Without <i>Taraxacum officinale</i>)
Particle Size Analysis		
1.) Sand (%)	74.43	84.4
2.) Silt (%)	14.72	5.84
3) Clay (%)	10.85	9.76
Soil Textural Class	Loamy sand	Loamy sand
pH	7.05	6.72
Electrical Conductivity (S/m)	0.50	0.87
Organic Carbon (%)	0.78	0.54
Organic Matter (%)	1.35	0.93
Total Nitrogen (%)	0.04	0.02
Available Phosphorus (mg/kg)	87.04	81.37
Potassium (cmol/kg)	0.13	0.12
Calcium (cmol/kg)	1.60	2.72
Magnesium (cmol/kg)	0.60	0.40
Sodium (cmol/kg)	0.10	0.11
Exchangeable Acidity (cmol/kg)	0.83	2.20
Effective Cation Exchange Capacity (cmol/kg)	3.26	5.55
Base Saturation (%)	73.25	60.4

DISCUSSION

The results of this research showed a variation in some of the physiochemical properties of the soil samples studied. The high sand and low clay content of the soil with *Taraxacum officinale* possibly indicates a low aggregate stability of the soil and high porosity of the soil. The soil in which *Taraxacum officinale* was found had a neutral pH which corresponds with the writings of [11]. The percentage organic matter was relatively higher than that of the control soil. This may be due to the dense and strong taproot system [18] of the *Taraxacum officinale* plant, causing the compaction of soil and trapping of organic matter around the rhizosphere. The dense taproots of *Taraxacum officinale* may compete with shallow rooted plants for water.

The available phosphorus results of both soil samples were high. This may be as a result of the presence of manure or fertilizer, which may have been applied to the soil previously. *Taraxacum officinale* has been found to respond positively to high phosphorus levels, hence the justification for its spread around the area. Zaprzalka and Peters [19] found that application of phosphorus up to 84 kg superphosphate, had an increasing yield of *Taraxacum officinale* when compared to where there was no application of superphosphate. The calcium levels observed in the soil with *Taraxacum officinale* was lower than that of the soil without. This justifies the report by

Sweetster [20] that *Taraxacum officinale* can be used as indicators of soil which are low in Calcium. The low electrical conductivity of the soil may be ascribed to the inability of the soil to retain soluble salts within the rhizosphere.

CONCLUSION

Although *Taraxacum officinale* is considered difficult to control, because it spreads and grows rapidly, the results from this experiment showed that the plant poses a fairly low threat to the ecosystem. This is because the results revealed little significant differences between the physico-chemical properties of the soil samples studied. However, the soil characteristics such as pH and calcium levels are suitable and have allowed the adaptation of *Taraxacum officinale* and encouraged its spread in the area. The soil dominated by this species can be considered low in fertility, due to its low cation content.

UNDER PEER REVIEW

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