# EFFECTS OF NEEM (*Azadirachta Indica)* PLANTATION ON SOIL CHEMICAL PROPERTIES IN SEMI-ARID AREA OF KATSINA STATE, NORTHERN NIGERIA

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**Abstract**

This study investigates the impact of *Azadirachta Indica* plantation on soil chemical properties in semi-arid area of northern Katsina state. Soil samples were collected at 0-15cm and 15-30cm depth and analyzed for the major soil chemical properties using standard field and laboratory techniques. It was found that there was no significant difference in the chemical properties tested at 0 to 15cm depth, but at 15 to 30cm depth there is significant difference in CEC and P. The study also indicated that *Azadirachta Indica* plantation has more positive impact on sub surface soil than on surface soil, this may be due to run off and percolation on surface soil. CEC as an important fertility indicator, it is significantly higher in sub surface than surface soil, therefore fertility improvement is more likely to be seen in sub surface soil than in surface soil. It is concluded that the use of exotic species for plantation in semi arid areas has high technical and economic potential to enhance food production and minimize ecosystem degradation.

**Keywords**: Soil chemical properties, soil quality, improvement, *Azadirachta Indica*

## 1.0 Introduction

Decline of soil fertility is a serious impediment to agricultural growth and the major cause of slow growth in food production in semiarid areas of Nigeria (Jaiyeoba, 1996). Unfortunately, population growth in this part of the country has been increasing rapidly which has accelerated the increase in demand for land for different activities. The pressure led to many problems such as overgrazing by livestock, increase cutting of trees and shrubs for fuel wood and other unsustainable land utilization. Hence, resulted in an increased lost of fragile land to desertification and severe decrease in agricultural production. Consequently, food production per capita decrease drastically. These environmental challenges necessitate the need to introduce various measures to increase food production and restore the environmental quality. Among the strategies adopted include restoration of vegetation through the use of shelter belt and plantation of fast growing trees (exotic species) with high productivity and good adaptation (Adegbehin, 1990).

A number of studies have reported the potential impact of both exotic and indigenous species in enhancing crop production and minimizing environmental degradation in semi arid areas of different parts of the world. Jaiyeoba (1996) reported studies conducted in Senegal where yield of millet and sorghum increase by 100% to 180% beneath Faidherbia alabida and in Nigeria yield of millet beneath *Azadirachta. Indica* increase by 30%. Chartterson (2009) reported the findings of the research conducted in Senegal, Sudan and Niger on the impact of the exotic and indigenous species on soil properties, it shows the level of increase of organic carbon and nitrogen by as much as 200-600%, and the also the increase of the base elements by 20% to 100% under Faidherbia alabida, compared with condition of the field outside the influence of the trees canopy. Similarly, studies conducted on the impact of Eucalyptus camadulensis plantation on soil properties of semi arid areas by Aweto and Moleele (2005) in Botsawana, Syed et al. (2005) in Pakistan, Ambashew (2013) in Ethiopia, Wu et al. (2013) in China all reported improvement of most of the soil properties. However, the impact of the plantation still need to be verified or established for other species in the local condition where such studies are yet to be conducted. The aim of this study was to investigate the effects of plantation on soil *Azadirachta Indica* chemical properties in semi arid area of Katsina State, northern Nigeria.

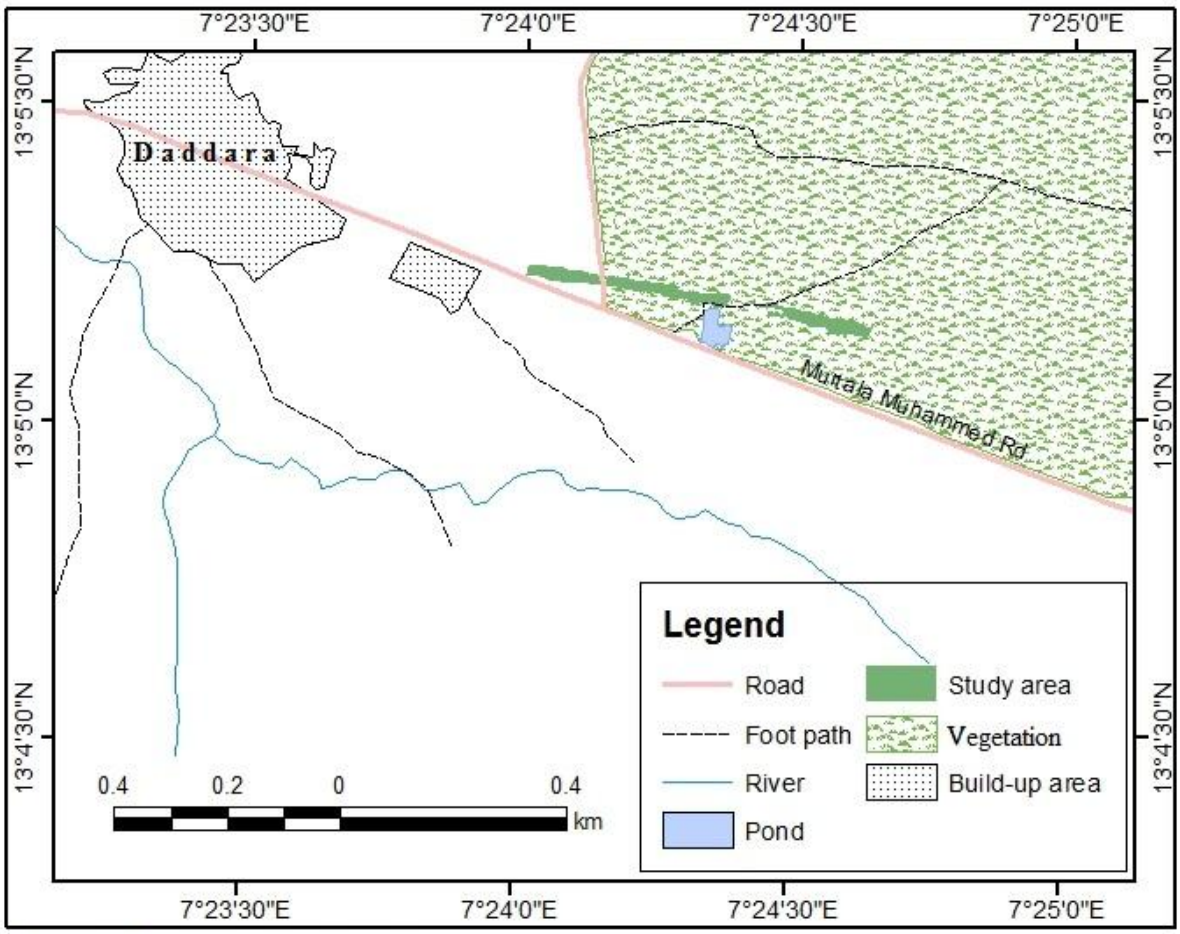
## 2.0 MATERIALS AND METHOD

### 2.1 The Study Area

Daddara *Azadirachta Indica* plantation is located in Jibia Local Government area of Katsina State along Katsina-Maradi road. The plantation is located between $13^0$ 05' 12.10'' N, $7^0$ 24' 02.17'' E and $13^0$ 05' 07.28''N, $7^0$ 24' 36.44''. The total size of the plantation is 2000m x 30m which is about 6 hectares. The dominant indigenous specie of the area was *combretum,* which was cleared in 1991 to pave for the *Azadirachta Indica* plantation. The purpose of the plantation was to combat desert encroachment which is very alarming in the area. The study area is also characterized by a humid tropical climate with a relatively long dry season and shorter rainy seasons. Rainfall starts in May and ends in September with an annual range of

between 600 to 800 mm. The monthly dry season average temperatures are above 30°C but significantly drop in harmatan periods which stretch from November to February when the dry northeast trade wind starts blowing, while the mean monthly temperature during the rainy season ranges between 22°C -28°C. Four distinct seasons are experienced in the area; these are dry and cool, dry and hot, wet and warm, and dry and warm seasons respectively (Abubakar, 2006).

The trees of this area grow long tap roots and thick barks both of which make it possible for them to withstand the long dry season and bush fires. The grass cover is mostly perennial, with durable roots, which remain underground after stalks are burnt away or wilted in the dry season. The precise mixture of the various species is determined by such factors as soil type, moisture conditions, and the degree of human disturbance (Gambo, 2016).




**Daddara Neem Plantation (Study Area )**

Source:- NASA/NOAA Spot Image 2016.

Human activities in Daddara include farming, trading and animal rearing. The farming is mostly subsistence; millet, beans and guinea corn are the most common crops. Trading is usually done in weekly markets in and around the area. For the animal rearing, sheep, goats and livestock are common.

Houses are constructed in narrow lanes and alleys. They are mostly constructed with mud blocks with corrugated roofing sheets. Few others are constructed with cement and aluminum roofing sheets.

### 2.2 Soil Sample Collection

The selection of random points in the study area was made using Global Positioning System (GPS), auto card software and Google earth map. The points to be sampled were randomly selected using the Google earth map.

Plate 1: *Azadrichata Indica* plantation near Daddara village.

Before going to the field, the coordinates of the points were downloaded into the GPS unit and then the researchers used the GPS to collect the soil sample in the field.

Soil samples were taken at 0 to 15cm and 15 to 30cm because exchangeable bases/pH measurements are of importance. To ensure a uniform volume of soil is taken through the full depth of each sampling point, samples were collected using soil probes and augers. 10 samples were collected, this is because about 1hectare of the plantation is not in existence and therefore the results will be altered if samples were collected from this location because the trees do not exist. Also 10 samples were collected from a control plot, 30metres away from the plantation; this is because *Azadirachta Indica* tree roots can spread up to 18meters from the tree trunk (Adegbehni, 1990).

### 2.3 Soil Sample Handling and Laboratory Analysis

The samples collected were stored in a polythene bag and transported to laboratory for analysis. The samples were air dried at $105^0$c and reweighed then passed through 2mm sieve. Soil pH was determined in soil water ratio of 1:2.5 using a glass electrode pH meter. Organic carbon was determined by Walkley and Black method, total nitrogen was by the Kjedahl digestion method. Available phosphorus was determined by the Bray and Kurtz method. The exchangeable bases (Ca, Mg, Na and K) were determined by ammonium acetate extraction. Potassium and sodium were determined with a flame photometer. Effective cation capacity was a summation of exchangeable bases (Ca, Mg, K and Na) and exchangeable acidity. Percent base saturation was obtained by dividing the total exchangeable bases (Ca, Mg, K and Na) by the effective cation exchange capacity (Ackley, 2012).

### 2.4 Method of Data Analysis

The results obtained from the laboratory were subjected to analysis using statistical package for social science SPSS 16.0 software. Paired t-test was used to assess whether the means of two groups are statistically different from one another, because the samples are related and observation in one sample can be paired with observation in the other sample. Differences of mean were tested at 95% confidence level and a relative error of 5%.

## 3.0 RESULTS AND DISCUSSION

Soil chemical properties are the most important among the factors that determine the nutrient supplying power of the soil to the plants and microbes. The chemical reaction that occurs in the soil affect the process leading to soil development and soil fertility build up.

**Table 1: Soil Chemical Properties at 0 to 15cm depth**

| | **Sample** | | **Control** | | **T Value** | **Correlation Value** |
|---|---|---|---|---|---|---|
| | Mean | SD | Mean | SD | | |
| pH | 6.46 | 0.406 | 6.35 | 0.408 | -0.808 | 0.442 |
| EC(ds/m) | 0.70 | 0.027 | 0.59 | 0.025 | 1.991 | 0.762 |
| N(g $g^{-1}$) | 0.58 | 0.120 | 0.29 | 0.121 | 7.844 | 0.542 |
| Av.P (mg/kg) | 10.62 | 1.176 | 8.23 | 1.010 | 9.260 | 0.728 |
| CEC (cmol/kg) | 3.63 | 0.582 | 3.47 | 0.542 | 0.820 | 0.428 |

Means are significant at <0.05 Source; Lab analysis, (2016)

Soil pH shows whether the soil is acidic, neutral or alkaline, as such, it provides useful information on the availabilities of exchange i.e cations. It controls nutrient availability and microbial reactions. At the depth of 0 to 15cm the result indicated that the mean value of the soil sample was 6.46 while that of the control was 6.35, the standard deviation of the sample was 0.406 and that of the control was 0.408. The t-value was -0.808 and the correlation value was 0.442 which shows there is no significant difference statistically between the sample and the control. At 15 to 30cm depth the result shows that the mean value of sample was 6.28 and that of the control was 6.31. The t value standard deviation of the sample was 0.470 and that of the control was 0.636. The t-value was -1.81 and the correlation value was 0.708 which indicates that there is no significant difference between the sample and the control statistically at this depth.

### 3.1 Electric Conductivity (Ec)

The result indicated that the mean Ec measured in ds/m at 0 to 15cm in the sample soil was 0.70 while the mean value of the control soil was 0.59; the standard deviation of the sample was 0.027 while that of the control was 0.025. The t-value was 1.991 and the correlation value was 0.762 which suggests that there was no significant difference statistically between the Ec of the soils in the sample site and that of the control. At 15 to 30cm depth the mean of the sample was 0.61 and that of the control was 0.46. The standard deviation of the sample was 0.026 and that of the control was 0.017. The t-value was 2.020 and the correlation value was 0.710 which also shows that there was no significant difference statistically between the sample and the control.

**Table 2; Soil Chemical Properties at 15 To 30cm depth**

| | **SAMPLE** | | **CONTROL** | | **T VALUE** | **CORRELATION VALUE** |
|---|---|---|---|---|---|---|
| | Mean | SD | Mean | SD | | |
| pH | 6.28 | 0.470 | 6.31 | 0.636 | -1.810 | 0.708 |
| EC(ds/m) | 0.61 | 0.026 | 0.46 | 0.017 | 2.020 | 0.710 |
| N(g $g^{-1}$) | 0.68 | 0.163 | 0.46 | 0.115 | 7.527 | 0.588 |
| Av.P (mg/kg) | 10.16 | 1.559 | 9.16 | 1.530 | 4.216 | 0.572 |
| CEC (cmol/kg) | 4.27 | 0.469 | 3.45 | 0.666 | 2.232 | -0.04 |

Means are significant at <0.05. Source; Laboratory analysis, (2016)

### 3.2 Nitrogen (N)

The result obtained indicated that at 0 to 15cm depth the mean value of N measured in g $g^{-1}$ of the soil sample was 0.58 and that of the soil control was 0.29, the standard deviation of the soil sample was 0.120 and that of the soil control was 0.121. The t-value was 7.884 and the correlation value was 0.542. Although the mean values positively correlate, there is no significant difference statistically between the means. At 15 to 30cm depth the mean of the sample was 0.68 and that of the control was 0.27, the standard deviation of the sample was 0.163 and that of the control was 0,115. The t-value was 7.527 and the correlation value was 0.572 which shows that there is no significant difference statistically between the sample and the control.

The lower value of the nitrogen in the control site may be attributed to water runoff. Nitrogen being a mobile element is prone to be loosed easily through leaching and percolation when there is direct rainfall on a soil surface.

### 3.3 Available Phosphorus (Av.P)

The result indicated that the mean value of Av.p at 0 to 15cm depth for soil sample was 10.62 and 8.584 for the control soil while the standard deviation was 1.176 and 1.010 respectively. The t-value was 9.260 and the correlation value was 0.728. The correlation of the means shows that there is no significant difference statistically between the Av.p of the sample and the control. At 15 to 30cm depth the mean of the sample was 10.16 and that of the control was 9.16, the standard deviation of the sample was 1.559 and that of the control was 1.530.

The t-value was 4.216 and the correlation value was 0.572 which shows there is no significant difference between the sample and the control.

The slight increase in the availability of Av. P in the sample soil can be attributed to decomposition of leaves and flowers of the neem tree at the canopy of the plantation.

### 3.4 Cation Exchange Capacity (CEC)

Cation exchange capacity is an overall assessment of the potential fertility of the soil. The result indicated that at 0 to 15cm depth the mean value of the soil sample (3.63) was higher than that of the soil control (3.47), the standard deviation of the sample was 0.582 and that of the control was 0.542. The t-value of the CEC was 0.820 and the correlation value was 0.428 which shows that there was no significant difference statistically between the sample and the control. At 15 to 30cm depth the mean of the sample 4.27 was higher than that of the control 3.45, the standard deviation of the sample was 0.469 and that of the control was 0.666. The t-value was 2.232 and the correlation value was -0.04 which shows there is significant difference statistically between the sample and the control.

### 3.5 Calcium (Ca)

The result shows that at 0 to 15cm depth the mean value for Ca in the soil sample was lower than that of the soil control, which was 2.40 and 2.44 respectively, the standard deviation for the sample was 0.359 and that of the control was 0.412. The t-value was -0.193 and the correlation value were 0.742 which shows that there was no significant difference statistically between the means of the sample and the control. At 15 to 30cm depth, the mean of the sample was 2.84 and that of the control was 2.31, the standard deviation of the sample was 0.140 and that of the control was 0.194. The t-value was 2.285 and the correlation value was 0.064 which shows there is no significant difference statistically between the sample and the control.

### 3.6 Magnesium (Mg)

The result indicated that at 0 to 15cm depth there was more Mg concentration in sample soils 0.62 than there was in control soils 0.39, the standard deviation of the sample was 0.194 and that of the control was 0.110. The t-value was 6.364 and the correlation value was 0.862 which indicates the means positively correlate but there is no significant difference statistically between them. At 15 to 30cm depth the mean of the sample was 0.66 and that of the control was 0.38, the standard deviation of the sample was 0.173 and that of the control was 0.078 the t-value was 6.538 and the correlation value was 0.937 which shows there was no significant difference statistically between the sample and the control.

### 3.7 Sodium (Na)

The result indicated that at 0 to 15cm depth there was higher concentration of Na 0.29 in sample soil than there was in the control soil 0.24, the standard deviation of the sample was 0.065 and that of the control was 0.110. The t value was 3.029 and the correlation value was 0.556 which indicates that there was no significant difference statistically between the sample

and the control. At 15 to 30cm the mean of the sample was 0.36 and that of the control was 0.23, the standard deviation of the sample was 0.067 and that of the control was 0.077. The t-value was 7.615 and the correlation value was 0.862 which shows there was no significant difference between the sample and the control.

### 3.8 Phosphorous (P)

The result shows that at 0 to 15cm the mean value of the sample 0.31 is higher than the mean value of the control 0.36 which means there was higher concentration of P in the control. The standard deviation for the sample was 0.088 and that of the control was 0.107. The t-value was -1.244 and the correlation value was 0.693 which shows there was no significant difference statistically between the sample and the control even though the correlation was negative. At 15 to 30cm depth the mean of the sample was 0.36 and that of the control was 0.34, the standard deviation of the sample was 0.074 and that of the control was 0.186. The t-value was 0.274 and the correlation value was -0.024 which shows there was significant difference between the sample and the control.

## 4.0 CONCLUSION

Generally, this study indicated that there was no significant difference in the chemical properties tested at 0 to 15cm depth, but at 15 to 30cm depth there is significant difference in CEC and P. It also revealed that *Azadirachta Indica* plantation has more positive impact on sub surface soil than on surface soil. The study shows that CEC as an important fertility indicator, it is significantly higher in sub surface than surface soil, therefore fertility improvement is more likely to be seen in sub surface soil than in surface soil under *Azadirachta indica* plantations. Many environmental scientists believed that the use of exotic species for plantation in semi arid areas has high technical and economic potential to address production and sustainability problems of the small holders that constitute most of the farming population in the Africa**.**

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