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Impact of *Azadirachta indica* Plantation on Soil Physical Properties in Northern Katsina State, Nigeria

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ABSTRACT
Soil quality improvement is among the important strategy used in restoration or rehabilitation of degraded ecosystem of semi arid environment. This study investigates the impact of *Azadirachta indica* plantation on soil physical properties. Soil samples were taken at 0 to 15cm and 15 to 30cm, 10 samples each were collected from the plantation site and the control plot, 30metres away from the plantation. It was found that generally, *Azadirachta. indica* plantation does not have impact statistically on sand, silt and clay both at 0-15 and 15 to 30cm depth, this could be attributed to the nature of the land where the plantation is located, in an area very susceptible to wind and water erosion. The plantation is being disturbed by livestock and the nearby villagers who cut the branches of the trees for fuel wood and houses construction. Public participation was recommended in pursuing similar projects in the future by considering the community preference of species to be used in environmental restoration and rehabilitation and enlighten the public to protect the plantation.
Keywords: Impact, Soil, Physical Properties, Plantation, *Azadirachta. Indica*

1.0 Introduction

Land Degradation in semi arid areas of Nigeria is a major challenge which continuo to threaten the livelihood of many people. This problem have been largely attributed to lose of vegetation cover, inappropriate cultivation practices which lead to soil organic matter depletion and reduction in the number and stability of soil aggregate (Dregne, 2002; Abuhussain. 2002) The increasing demand for fuel wood, timber, pasture, shelter and the clearance and conversion of area covered by forest to crop land contributed to severe loss of vegetation and accelerated the desertification problem. According to the "World Resources Institute 2000-2005" report, cited in Medugu (2011) indicated that the rate of deforestation in Nigeria between 1990 to 2005 was about some 6.1 million hectares or 35.7 percent of its forest cover, while reforestation was a mere 32,000 hectares.

It has been widely reported that desertification is by far the most pressing environmental problem in the dry-lands parts of Nigeria (Adegbehin, 1990; Abubakar, 2006). The visible sign of this phenomenon is the gradual shift in vegetation from grasses, bushes and occasional trees, to grass and bushes; and in the final stages, expansive areas of desert-like sand. It has been estimated that between 50 and 75 percent of some states in northern Nigeria including Katsina state are being affected by desertification (Medugu, 2011).

Rapid population and increasing demand for wood product and productive land to support the need of growing population necessitate the rehabilitation and restoration of degraded land. Fast growing trees species with high productivity and good adaptation have widely been used in many parts of the world for reforestation project. To combat the problem of desertification in Nigeria, planting of exotic tree species commenced in the late 1950s in the savanna region of Nigeria (Adegbehin, 1990). Apart from the provision of fuel wood, pole and other products, the other objectives of planting the exotic trees were to increase vegetation cover, identify suitable trees species for wind break and shelterbelt in order to protect the environment, increase yield of crops and reduce the effect of desertification in the northern part of the

country. The trees species commonly used to combat the desertification i different part of the third world such as India, Pakistan, China as reported by Syed et al., 2006; Oguwole et al., 2008; Ambachew et al., 2012; Wu et al., 2013 include *Eucalylptus camaldulansis* and *Azadirachta indica*. In Katsina state, one of the most important afforestation programme executed in the state in the 1980s was financed by the European Union and Federal government. Under the programme 85 blocks of shelter belt of *Azadirachta indica* (each block being made up of 6 hectares i.e. 30meters by 2000meters) which were planned to protect about 3,400 hectares was established between 1987-1992 (Adeghbehin, 1999). Many studies have (e.g. Syed et al., 2006; Oguwole et al., 2008; Ambachew et al., 2012; Wu et al., 2013) reported the impact of restoration of vegetation through plantation in improving the condition of semi arid environment in general and specifically enhancing the soil physical and chemical properties . The aim of this study is to investigate the effects of *Azadirachta indica* plantation on soil physical properties in Daddara village in northern Katsina state, one of the areas benefited by the afforestation programme .

2.0 MATERIALS AND METHOD

2.1 The Study Area

Daddara *Azadrichata 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 way for *Azadrichata 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 harmattan periods which stretch from November to February when the dry northeast trade wind start 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).

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.

Katsina State showing Jibia L.G.A. and Study Location.
Source:- NASA/NOAA Spot Image 2016.

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 before going to the field, the coordinates of the points were downloaded into the GPS unit and then the researcher used the GPS to navigate to the selected locations 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 *Azadrichta. Indica* tree roots can spread up to 18meters from the tree trunk.

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 105^0c and reweighed then passed through 2mm sieve. Soil textures were determined by hydrometer method, while color is determined using Munsell color chart.

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

3.1 Physical Properties of Soil under *Azadrichta indica* Plantation

Sand composition at 0 to 15cm depth of 81% was higher in plantation compared to 76% in the control as indicated in the result. The t-value of the sand was 1.110 and the correlation value was 0.103 which indicates that *A. indica* plantation does not have impact statistically on sand in the study area. At 15 to 30cm depth the sand composition was 80% in the sample and 77% in the control. The t-value at this depth was 0.515 and the correlation value was 0.287 which means there was no significant difference between the sample and the control.

Table 1: Soil Texture at 0 to 15cm depth

	Sample		**Control**		**T Value**	**Correlation Value**
	Mean	SD	Mean	SD		
Sandy	81	9.666	76	15.943	1.110	0.103
Silt	10	6.533	12	9.083	-1.27	0.079
Clay	9	4.498	12	7.905	-0.976	0.276
TOTAL	100%		100%			

Means are significant at <0.05.Source; Laboratory Analysis (2017)

Silt was 10% in sample soil compared to 12% in control soil at 0 to 15cm depth. The t-value of the silt was -1.027 and the correlation value was 0.079 which indicates that *Azadirachta. indica* plantation does not have impact statistically on silt in soil in the study area. At 15 to 30cm depth silt was 8% in the sample and 11% in the control. The t-value at that depth was -1.246 and the correlation value was 0.675 which means there was no significant difference statistically between the sample and the control

Table 2: Soil Texture at 15 to 30cm depth

	Sample		**Control**		**T Value**	**Correlation Value**
	Mean	SD	Mean	SD		
Sandy	80	10.416	77	9.935	0.515	0.287
Silt	8	3.873	11	7.176	-1.246	0.675
Clay	12	6.911	12	3.670	-0.157	0.996
TOTAL	100%		100%			

Means are significant at <0.05. Source; Laboratory analysis, (2017)

Clay content was 10% in sample soil and 12% in control soil at 0 to 15cm depth as indicated by the result. The t value of the clay was -0.976 and correlation value was 0.276 which indicates that *Azadirachta. indica* plantation does not have impact. At 15 to 30cm depth the clay composition was 12% both in the sample and the control. The t-value here was -0.157 and the correlation value were 0.996 which means there was no significant difference between the control and the sample.

4.0 CONCLUSION

There is slight difference between the texture of the sample and the control sites, the sample sites have more sand content. The sandy nature of the plantation soil indicated that they were prone to excessive leaching and loss of nutrient due to their loose texture. It also indicated that the soils may not provide mechanical supports for the trees (Attoe and Amalu, 2005). Improvement in clay and silt in the plantation

sites is not significant as shown in table 1 and 2. Clay is involved in almost every reaction in soils which affects plant growth. In a soil where sand or silt dominates, most of the pores will be large and continuous so that water and air may move freely. The relevance of clay on the availability of nutrients in a soil has been acknowledge by researchers, for example, Aweto (1981, 2005 and 2010) opined that clay proportion in a soil strongly affects tree regeneration since clay enhances soil water-retaining and nutrient-holding capacities. The color of the soil sample and the control site are both yellow-red from the Munsell color system chart.

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