SUITABILITY ASSESMENT OF SOME SOILSFOR CULTIVATION OF MAIZE (Zea mays) ALONG A TOPOSEQUENCE IN COLLEGE OF AGRICULTURE MOKWA TEACHING AND RESEARCH FARM NIGER STATE NIGERIA

[a]MOHAMMED, T, [2]WAPA, J, M, [c]LAWAL, B.A AND [a]MOHAMMED, A

[a]Department of Crop production Technology, College of Agriculture Mokwa, Niger State, Nigeria
[b]Department of Soil Science University of Abuja
[c]Department of Soil Science and Land Management, Federal University of Technology Minna
Corresponding Author and email: tetengi4me@gmail.com

ABSTRACT

The establishment of an institution of higher learning and related infrastructures in Mokwa community has resulted in the influx of human beings leading to serious pressure on soil and land resources. An experiment was conducted in 2017 to investigate the suitability of some soils along a toposequence for the cultivation of Maize (Zea mays) in College of Agriculture Mokwa teaching and research farm. Maize is a major crop cultivated in this farming community. Three sites were chosen along a toposequence for this study and they were the crest (CS) middle slope (SM) and valley bottom (VB). A four hectare plot was demarcated for CS and MS respectively while three hectares were for VB. At the Centre of each plot soil samples were obtained with aid of an auger from 0-120cm depth at intervals of 15cm. They were bagged separately, labeled and taken to the laboratory for routine analysis. At the laboratory samples were treated and analyzed for the following physical and chemical properties, particle size, bulk density, percentage moisture content, pH, percentage organic matter, organic carbon, total N, Available P, exchangeable bases (K, C, A, Mg and Na) CEC andECEC. Soil depth,slope, and drainage were assessed in the field while climatic data were obtained from the meteorological station of the college. Using the parametric and limitation approach, all land features were highly suitable except slope which was a limitation. The low values of physical and chemical properties make these soils currently not suitable for the cultivation of maize. However amendment with organic and mineral fertilizer is recommended for continuous cultivation of maize on these soils along with agronomic practices that will reduce run off to some certain level.

Keyword; Mokwa, suitability assessment, soils, Maize

INTRODUCTION

Mokwa is located in the Southern guinea savanna belt of Nigeria. It is a fast growing metropolitan. This is a result of three factors. It is a gate way town between North and South. It is head quarter of Mokwa Local government area. This growth is reflected in the continuous influx of human beings to the city and the surrounding communities. This is therefore continued to mount pressure on the fixed land and soil resources. This is evidenced in the drastic alteration of the general landscape as well as socio-cultural and economic life of the people. The original forest vegetation has completely disappeared. Bush fallow period meant for the restoration of soil fertility has plummeted fifteen years to three or five years. Erosion and flooding is now common feature during the rainy season. It is obvious that land and soil resources, cannot be indiscriminately used as before. There must be a conscious effort to see that

land and soil resources are allocated to use for which they best suited.

Oko*et al*., (2017) were of the view that a piece of land without determination of its suitability has a serious consequences and that inadequate soil information of the degree extent of its suitability constitute a set back to the achievement of global security particularly in developing economies such as Nigeria. Solteni, *et al*. (2013) defined land suitability as the suitability of a given type of land to support a defined land use either in its current state or after improvement.

Maize is a member of the grass family (poaceae) with the botanical name Zea mays. It is the most common and often cultivated plant globally, occurring in Africa, America, Australia, China, New Guinea and South Asia. Mokwa is a major Maize producing community in Niger State. It is an important crop in the farming activities of the people as it features prominently in most of the festival and other ceremonies in the area. Maize production in Mokwa account for about 45% of the total Maize production in Niger state (Benjamin. *et al.,* 2017). Omofowma and Kadir (2017) noted that the crop majorly serve as a staple food to the people of the area, as well as a means for income generation. Despite the important role the crop plays in the cultural and the socioeconomic life of citizens, there is no detail information on the suitability of the soils for this crop. The study was therefore undertaken to generate information on the suitability of selected soils a long a toposequence for the cultivation of Maize in Mokwa and its surrounding communities.

Material and methods

Location

Experimental site was the Teaching and Research farm, College of Agriculture, Mokwa. It is located at Latitude 6.14^{o}E and longitude 6.74^{o}N. The climate is dominated by the humid tropical type. Temperature is high throughout the year with an average of 27^{o}C. Rainfall last for between six to seven months of the year, while the annual rainfall range is between 1,000 mm-1500mm. (Remison, 1998). Humidity is high during the rainy season and could be as high as 80%.

The cold and dry hamattan wind which was a seasonal climatic event, has been reduced to just a spell of about two to three months. The terrain is dominated by what Segynola (2011) referred to as Plateaus elevation which is above its surrounding environment.). These valley bottom soils contrasts those of the nearby basement complex of Northern Nigeria that have seasonal flowing streams and hydromorphic characteristics.

Soil sample collection/Soil Analyses

Three sites were chosen for soil sample collection. These were the crest middle slope and valley bottom.A land measuring 10 hectares was used for this study. A rigid grid soil survey method was employed and the transverses were cut along the transect and auger at each point of intersection. Soil profile pit were excavated at each identified soil units. A modal profile measuring 2 x 2 (width)

and 1.5 (depth) were sunk and soil samples were collected from each genetic horizon, and pedons were described following the guidelines outline in soil survey staff (2010) and FAO (2006). At each site auger borings were made at the depth of 0-15cm from the surface and at the interval of 50m apart. Soil samples were bagged separately labeled and taken to laboratory for analysis. The following physical and chemical properties were assessed according to the method described by Udo *et al* (2009). The pH was determined by using glass electrode in a 1:1 soil water suspension. Organic carbon was determined byWalkley- Black method, and pH was determined by wet oxidation method as described by Udo*et al*., (2009).Exchangeable bases and exchangeable acidity were determined by titration method of mccleanas described by Udo*et a*l. (2009). The effective cation exchange capacity. (ECEC) was determined as total exchangeable bases plus exchangeable acidity.The percentage base saturation was calculated as the percentages of exchangeable bases divided by effective cation exchange capacity. Total nitrogen (N) was determined using Kjedahl distillation methods of Bremner as modified by Udo*et al.* (2009). Land features which include, current land utilization types, soil surface colour, slope, and drainage were assessed in the field, while climatic data for rainfall, humidity and temperature were obtained at the Meterological Station, College of Agriculture,Mokwa.

RESULTS AND DISICUSSION

The results of the selected morphological and physical properties of the study area are presented in table1. The textural class for surface soil (0-15cm) were all sandy loam for all the sites, while sub-surface soil were loamy sand. At a depth greater then 180cm the texture was sandy clay loam for all the sites, the sandy loamy nature of surface soil which cut across all the sites, was due to clay loss or illuviation or the nature of parent materials. There was an increasing clay content with increase in depth for all the sites and this agrees with the findings, of Nsor and Adesemuyi (2016). This is an indication of the movement of clay (illuviation) from upper horizons to lower horizons. The range of values for bulk density were 0.85 $gm^{-3}$for

valley bottom soils to 1.39gm $^{-3}$for middle slope, in table 2,this is expected since valley bottom soils recorded the highest value for percentage organic matter (2.326) compared to the other sites table 3. The value recorded for all the sites were lower than the critical value (1.345-1.85[3]) in which root restriction can occur (Soil survey of Staff, 1996) therefore, bulk density was not the limitation. All silt/ clay ratio values were values below unitary, indicating highly weathered soils. The mean values for percentage organic matter were 1.613, 1.803 and 2.326, for the crest middle slope and valley bottom respectively/. The crest always witnesses material loss including plant and animal litters due to gravity or run off. Materials that are lost from the crest and middle slope end up as sediment in valley bottom soils hence this is shown in table 4 and they were 6.2, 5.1 and 4.4 for crest, middle slope and valley bottom

respectively, indicating strongly acidic for crest. The concentration of H was highest for valley bottom (table 4) compare to the rest, which must have accounted for the observed pH status of valley bottom soils. Mineralization of organic matter is said to produce weak acid (Brady and Weil, 2002). This in turn releases H ions into the soil solution environment there by accelerating the acidity of the soil. Valley bottom soils recorded highest value of percentage organic matter increases soil buffering capacity Ahukaemene*et al.*,(2016) pointed out that soils of southern Nigeria are generally classified as acidic soil. They recorded low pH value, which consequently lead to unavailability of some certain nutrient for plant uptake. However, Maize plant has been shown to tolerate a pH range that is as low as the value recorded for valley bottom soils (Isitekhale, *et al*, 2014). The observed values for chemical properties were low for all the sites. Udo,*et al*, (2011) reported that the soils of Northern Nigeria are generally low in nutrients especially, P, N, O,M, and K. this could be attributed to their status as highly weathered soils.

Table 6: Some soil physical properties of the study sites

	meg/100g)				
Sites	**Clay (%) Total**	**Silt**	**Sand (%)**	**Silt/Clay ratio**	**Bulk density porosity (%)**
Crest					
0-15cm	12 59	3	86	0.035	1.08
15-30cm	13 50	3	84	0.035	1.32
30-45cm	15 59	2	83	0.024	1,08
45-90cm	29 53	1	70	0.014	1.24
90-180cm	34 50	1	65	0.015	1.32
Middle					
Slope					

0-15cm	15 62	1	84	0.012	1.01
15-30cm	24 48	1	75	0.013	1.39
30-60cm	32 59	2.6	65.4	0.040	1.08
60-85cm	33 56	1	66	0.015	1.16
85-120cm	34.8 53	1.6	63.6	0.025	1.24
120-180cm	34.6 56	1.4	64	0.022	1.16
Valley Bottom					
0-15cm	15 68	1	84	0.012	0.85
15-25cm	16.4 59	1.6	82	0.020	1.08
25-40cm	15.2 62	1.8	83	0.022	1.01
40-80cm	16.4 53	1.6	82	0.020	1.24
80-180cm	16 65	1	83	0.012	0.93

(4) SUITABILITY ASSESSMENT

The Procedure that was adopted for this work was according to Sys (1985) Here the properties of the soil in each site was matched with the requirements of the land utilization type, represent here by maize (zea mays), to assign a suitability class to it. The result of the suitability class of the site for utilization is the class indicated by the characteristics with lowest rating. In this approach, if a soil properties or land characteristics has no any limitation, the soil is said to be ideal or optimum for crop production, on the other hand if characteristics is unfavorable for the crop, there is said to be a limitation. Land characteristics and qualities of the study sites are shown on table 5 while the assessment rating resulting from the matching of land qualities and the requirements of the crop

(Maize) under consideration is shown in table 6.All the land qualities that is, annual rainfall, mean annual temperatures, humidity, drainage and soil depth were all favorable for the cultivation of the crop and fall under suitability class S1. Remission (1998) also reported that climatic condition (rainfall, temperature and % humidity) to be favorable for the establishment of rainfed agriculture for most crops in this region. It should also be noted that our findings reveal thatthese valley bottom soils in the region to be well drained. These are incised valleys on an undulating plateau (Sogynola,2011)created the existence of double slopes i.e.The wall of valley, and valley floor which also dips towards to head streams whose originated in the plateau. The only limitation was slope, where the value for crest was 11% while middle slope and valley bottom have 6% and 3% respectively. This value put the soil of crest and middle slope in suitability class (S3) while for valley bottom it was class (S1). Slope is therefore a limitation for the soils of crestand middle slope.

When considering soil depth, all the sites were highly suitable (S1) as no impediment was encountered during profile pit excavation from the surface to 120cm. With regards to chemical properties, the soils of crest and middle slope were not suitable (NS) but marginally suitable for valley bottom. Low values of exchangeable bases, K, Ca, Mg and Na for all the sites places these soils not suitable (NS) for the cultivation of the crop. Values for percentage Nitrogen and Available Phosphorus were also low for all the sites, making the soils of all the sites to fall under suitability class (NS). Olaleye, *et al.* (2002) also reported that the major limitation to Maize cultivation on rain fed soils to be low exchangeable cation, available P and organic carbon.

SUMMARY AND CONCLUSION

In this investigation some soils along a toposequence in College of Agriculture teaching and research farm (CAM), were assessed for their suitability for the cultivation of Maize (Zea mays). The crop is a major arable crop and a staple food crop for the majority of the inhabitants of Mokwa and beyond. Our findings revealed that all land characteristics such as soil depth and drainage were favourable and highly suitable, while slope was a major hindrance. The levels of all chemical properties were found to be low and are unsuitable for the cultivation of the crop. The sandy nature of the soils coupled with high degree of slopes will expose these soils except valley bottom, to high incidence of erosion and soil loss except agronomic practices that will reduce runoff to be put in place. Levels of percentage organic matter were found to be adequate for continuous cultivation of these soils to Maize, amendment with mineral is recommended.

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