SOIL CHARACTERISTICS AND GERMINATION INDICES OF *Centrosema pascuorum* AND *Stylosanthes hamata* FOR ENHANCING BETTER PASTURE ESTABLISHMENT IN GOMBE STATE, NIGERIA

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ABSTRACT

The experiment was carried out in Akko local Government Area of Gombe State, located on latitude11^{o}15'North and longitude 10^{o}29'East, to evaluate germination indices and soil productivity of unimproved tropical rangeland between the months of May and Novenber, 2020. The experiment was arranged in Completely Randomized Design with four (4) replicates. Pre-treatment methods hot water at 80^{o}C and mechanical (Sand paper). Hundrend (100) seeds of Centro and stylo were kept in sterile Petri dish (9 cm diameter) lined with one layer of filter paper. The filter papers were kept saturated with addition of distilled water throughout the experimental period. The petri dishes were kept on laboratory bench at the temperature of 30 – 36^{o}C and covered to prevent the loss of moisture by evaporation. The germination period lasted for 14 days, with germination counts done at 1, 2, 3…, and 14 days. Seeds were considered germinated following the rupture of the seed coat and emergence of the radicle.The final germination was recorded and germinated seeds were discarded after counting. Soil was obtained for analysis at 0 – 15 and 15 – 30 cm for subsoil analysis using the method of NSCS 2013. The physic-chemical analysis was done using the method outlined by ISRIC/FAO 2003.The soil analysis revealed that the soil was sandy clay loam, Very strongly acidic and low in major plant nutrients, especially total nitrogen and available phosphorus and ECEC. The soil acidity ranged from 4.94 – 5.95, the pH values were within the optimal ranges required for pasture production, breaking of dormancy in seeds of Centrosema pascuorum and Stylosanthes hamata was investigated through laboratory experiment to elucidate the best method that can be used to enhance germination of the seed. The results showed that mechanical treatment (sand paper) had the highest germination percentage in Centrosema pascuorum (72 %) followed by immersion in hot water 48%. The results also showed that hot water treatment had the highest in Stylosanthes hamata 67%, followed by mechanical method with 24%. The lowest germination percentage was obtained in the control in all legumes.The study also showed that hot water treatment and sand paper significantly induced germination in seeds of Centrosema pascuorum and Stylosanthes hamata. To improve and sustain the fertility status of soils of the study area forage legumes, Manure incorporation will enhance organic matter and ECEC thereby improving soil condition and retention/release of nutrients and water. Liming and any management practice to improve the pH condition is required specifically to the fields with strongly acidic reactions.

Keywords: *Soil fertility,Forage legumes, Germination, Pasture Establishment*

1.0 INTRODUCTION

The major challenge to livestock production is ensuring adequate feed supply throughout the year in terms of quality and quantity (Kallah. *et al.,* 1997). The situation is even worsened by desertification, leaching and urbanization, the potential to increase ruminant production is constrained by the low quantity and quality of available forages in the savannah rangelands for optimum livestock production , most especially during the dry seasons (Omokanye, *et al* 2004). The inherently low livestock productivity is attributed to low quantity and quality of feed for the livestock (Nyangito, *et al* (2008). This is because native grasses are grown on low fertile soil which is not well suited for cropping (Humphreys, 1995). Seasonal variation affect the availability of nutrients from the soil to forage species (Ezenwa *et al*, 1995). The need for productive and sustainable agriculture, makes soil restoration and fertility management a priority. This implies recommendations are based on the soil characteristics and properties of some fractions of larger areas. This type of recommendations leads to inappropriate fertilizer use, thus resulting in nutrient imbalance which affects the overall fertility and

productivity of soils. To adapt better fertility management practices for increased and sustained productivity, periodic and site specific evaluation of soil fertility status is critical.*Centrosema pascuorum* common name centro , is a perennial twining, trailing and climbing legume that native to subhumid and humid regions of central and South America and now it has been naturalized in tropical Asia and Africa. *Stylosanthes hamata* it is an erect, annual to short-lived much-branched herbaceous perennial dry season legume with branching upright stem up to about 30 - 75 cm high which may become more prostrate under grazing, they had a high potential adaptation to diverse habitat such as dry and high altitude of the tropics, poorly drained and/or seasonally flooded conditions and acids, low fertility soils (Schultze-Kraft *et al.,* 1990). They are widely used as forage and source of protein, calcium and phosphorus to livestock, they can be grown for cover crops because it naturally suppressed weeds. Like other N-fixing legumes, centro and Stylo are soil improvers, their association with grasses is beneficial to grass yield making N fertilization unnecessary (Castillo *et al.,* 2003). The amount of nitrogen fixed by centro is average of 259 kg/ha with ranged of 126 – 395 kg/ha (Adegboola and Fayemi, 1972). Centro and Stylo are suitable to be used as animal feed. They have high quality forage and is recommended for pasture improvement in Indonesia. Despite the great importance and characteristics, establishment of centro and Stylo is difficult. One of the major constraints to its successful establishment is due to high proportion of hard seed (Verhoeven, 1958). Field observations have indicated that without seed treatment, germination of centro and stylo is low (Serpa and Achicar, 1970). High hard seed content in a seed lot can lead to delayed or decreased seedling emergence. As a result, plant stand becomes thin, sporadic and less competitive with weeds or undesirable species. Therefore, reduction of hard seed content in seed lot of these forages is very important. As a successful establishment of plant depends initially on high germination rate over a short period of time, Thus the need for site-specific soil fertility evaluation in the Northern Nigerian Guinea Savanna biome in order to recommend practices that will improve fertilizer use efficiency prompted this study.

therefore, this study was conducted to find suitable treatment that would increase germination as well as to improve the establishment of *Centrosema pascuorum* and *Stylosanthes hamata.*

2.0 MATERIALS AND METHODS

2.1 Study area

The experiment was conducted in Akko Local Government Area of Gombe State. Its lies on 11^{o}15'North and 10^{o}29'East. It is located in Northern guinea savannah with annual rainfall ranges between 787 and 960 mm usually between mid-May and terminating in late October with a 140 days growing period for arable crops. The annual mean temperature is 38^{0}C with maximum of 41^{0}C obtained mostly in April and minimum 5^{0}C obtained mostly in January (GSG (2021).).The vegetation is deciduous shrubs with occasional short trees. The ground cover is exclusively annual grasses, legumes with few broad leaves (Mohammed *et al.,* 2015).

2.2. Collection of Soil sampling for laboratory Analysis

Soil samples were collected per replication at random at a depth of 0-15 and 15-30cm for physical and chemical analysis (NRCS), Natural Resources Conservation Services, (2013).A stainless steel, hand shovel were used in the collection of the soil sample on the experimental site. The samples were collected into a dried polythene bags and was thoroughly mixed together. The soil sample was collected before and after the rainy season. Sample was collected in the first week in May and First week in November, 2015.

2.3. Soil Sampling Preparation

Soil were packed in well labeled polythene bags and taken to the laboratory. In the laboratory, the samples were dried at room temperature 25 – 27^{c}, gently crushed sieved through 2-mm sieve mesh preparatory for laboratory analysis. Samples for total nitrogen and organic carbon were passed through a 0.5mm sieved.

2.4. Experimental design and measurement of Germination test

The experiment was arranged in Completely Randomized Design with four (4) replicates. Pre-treatment methods hot water at 80^{o}C and mechanical (Sand paper). Seed of Legumes *Centrosema pascuorum* and *Stylosanthes hamata* were sourced from the National Animal Production Research Institute NAPRI/ABU; Shika - Zaria. (100) seeds of *Centro and stylo* were kept in sterile Petri dish (9 cm diameter) lined with one layer of filter paper. The filter papers were kept saturated with addition of distilled water throughout the experimental period. The petri dishes were kept on laboratory bench at the temperature of 30 – 36^{o}C and covered to prevent the loss of moisture by evaporation. The germination period lasted for 14 days, with germination counts done at 1, 2, 3…, and 14 days. Seeds were considered germinated following the rupture of the seed coat and emergence of the radicle. The final germination was recorded and germinated seeds were discarded after counting. Germination indices measured were: (1) Total germination (TG): number of germinated seeds/total number of seeds in petri dish x 100. (2) Mean daily germination (MDG): Total number of germinated seeds/total number of days of germination period.

2.5. Soil Analysis

Soil samples were analyzed for some physico-chemical properties following the procedure outlined by the International Soil Reference and Information

centre of food and Agricultural Organization. (ISRIC/FAO, 2002). The particle size was determined by the Bouyoucous hydrometer method using sodium hexametaphosphate as dispersing agent. Soil pH was determined using glass electron pH meter in soil water and CaCl ratio of 1.1:1.2 respectively. Organic carbon was determined by wakley-Black method of wet combustion involving oxidation of organic matter with potassium dichromate (KCrO) 2 2 7 and sulphuric Acid (HSO). Available phosphorus was determined by Bray 1 method. 2 4 Total Nitrogen was determined by microKjeldahl digestion and distillation method. 2 2- + 0Exchangeable bases (Ca, Mg , Na) extracted with 1N neural ammonium acetate (NH , 4 AC) Solution and amount of K and Na in sodium were measured using flame, photometer while Ca and Mg were measured by Atomic Absorption Spectrophotometer (AAS). Cation. Exchange Capacity (CEC), was determined by the neutral 1N NH AC saturation 4 method while ECEC was the summation of exchangeable bases and exchangeable acidity. Base saturation was been calculated (dividing the sum of exchangeable base by + 3+there CEC them multiply by 100 exchangeable acidity (H and Al) was determined by titrimetric method.

2.6. Data analysis

The data collected were analysed using the Microsoft Excel 2007 package and presented
using simple Descriptive statistics

3.0. RESULTS AND DISCUSSION

3.1 Soil Analysis Results

The soil physico-chemical properties are presented in Tables 1

The soil of the experimental site was sandy clay loam, Very strongly acidic and low in major plant nutrients, especially total nitrogen and available phosphorus these two plant nutrients are noted as limiting in tropical agricultural soils and its one of the major causes of the low DM yields and nutrients quality of natural pastures(Mohammed –saleem 1986, Olanite *et al.,* 2010. The results agree which Manu, *et al* (1991) who reported that low in organic carbon, available phosphorus and very low in total nitrogen contents obtained in the survey might be partly related to their inherent low status, such as the parent materials which are mainly of Aeolian origin, with low weatherable mineral reserve necessary for nutrient recharge for savanna soils of northern Nigeria. It is also for this reason that routine application of a compound fertilizer is generally recommended for pasture establishment in savannah zone of Nigeria (Muhammad *et al* 2005).

Table 1Physical and Chemical Properties of Soil in the Study Area

Chemical/Physical parameters	**Mean Values**	**Nutrient rating**
pHw (1:1)	5.95	Moderately acidic
pHc (1:2)	4.94	V. strongly acidic
Organic Carbon (g kg-1)	0.57	Low
Total Nitrogen (g kg-1)	0.06	V. Low
Available P (mg kg-1)	7.03	Low
Exchangeable cations (cmol kg^{-1})		
Ca	3.18	Medium
Mg	0.83	Medium
K	0.28	Medium
Na	0.11	Medium
TEB	4.35	Medium
Soil texture (g kg^{-1})		**Texture**
Sand (%) Depth (cm)	(%)	
0-15	66.24	Sandy clay loam
15-30	64.24	Sandy clay loam
Silt (%) Depth (cm)		
0-15	11.28	Sandy clay loam
15-30	9.28	Sandy clay loam
Clay (%) Depth (cm)		
0-15	22.48	Sandy clay loam
15-30	26.48	Sandy clay loam

Esu, I. E. (1991).

3.2. Breaking Dormancy *in S.hamata* and *C.pascuorum*

The results of the germination test for different methods of breaking dormancy are shown in Table 2. It was observed *S.hamata* seeds immersed in hot water had the highest total germination (TG) with mean daily germination (MDG) values (67 % and 4.78 %) and the lowest TG and MDG values were recorded in control (T3). However, that mechanical scarification (Sand paper) was a method that had higher total germination (72 %) with a mean daily germination values (5.14 %) while the control (T3) had the lowest total germination (TG) and Mean daily germination (MDG) values. Good quality seed ensures good germination, rapid emergence and vigorous growth (Santos, 2013). When seed has good physical, physiological health, and genetic qualities, farmers have greater prospects of producing a good crop (International Seed Testing Association, 2011). Seed germination is the emergence and development of the essential structures from the embryo which are indicative of the ability to produce a normal plant under favorable condition (Anonymous, 2002).In the present study, scarification with sand paper was better for breaking dormancy in *C. pascourum* as it increased seed germination compared to control. This method was in agreement with report by Duguma *et al* (1998) and Aduradola *et al* (2005) who all observed mechanical scarification was an effective way of improving seed coat permeability in *Leucaena leucocephala* and *Chrysophyllum abidum*, respectively. The breaking of lignified palisade cells permitting water and oxygen absorption into the cells Yildiztugay *et al;* 2012). The conventional treatment using hot water had a better positive effect on breaking dormancy in *S.hamata* thus, resulted in the higher germination indices,which, might be attributed to the increased penetration of water and oxygen into the seeds.

Table 2. Effect of Scarification Treatments on Germination Iindices of *S.hamata* and *C.pascourum*

Treatment	Seed rate (kg/ha)	TG%	MDG%
	S.hamata		
Sand paper (T1)	30	24	1.72
Hot water (T2)	30	67	4.78
Control (T3)	30	10	0.71
	C.pascourum		
Sand paper (T1)	15	72	5.14
Hot water (T2)	15	48	3.42
Control (T3)	15	26	1.85

T1= Sand paper, T2 = Hot water, T3 = Control, TG = Total germination, MDG = Mean daily germination

4.0 CONCLUSION AND RECOMMENDATIONS

4.1 Conclusion

The study disclosed that the study area was sandy loam, with low organic C, total N, available P and ECEC. The pH values were within the optimal ranges required for pasture production, the study also showed that hot water treatment and sand paper significantly induced germination in seeds of *Centrosema pascourum* and *Stylosanthes hamata*. The best germination value was recorded from sand paper scarification in *Centrosema pascourum* and immersion in hot water in *Stylosanthes hamata*.Therefore, sand papering and hot water treatments could be considered for substitution.

4.2 Recommendations

To improve and sustain the fertility status of these soils, current fertilizer recommendations need to be reviewed and improved to include other nutrients in addition to the primary macronutrients (N, P and K). Manure and crop residue incorporation will enhance organic matter and ECEC thereby improving soil condition and retention/release of nutrients and water. Liming and any management practice to improve the pH condition is required specifically to the fields with strongly acidic reactions

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