Available online at www.worldscientificnews.com

World Scientific News

WSN 83 (2017) 92-118 EISSN 2392-2192

Performance of some forage rass species in the Southern Guinea Savannah agro-ecological zone in Nasarawa State of Nigeria

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ABSTRACT

The absence of improved forage grass species in Nasarawa ecological zone has prompted a study to identify improved species for use. A potted screen house study was therfore conducted using four improved forage grass species obtained from the National Animal Production Research Institute (NAPRI) Shika near Zaria, Nigeria. The four forage species were thus sown into four soil types obtained from four locations in Nasarawa State arranged in a randomized complete block design. Records were taken for percent emergence, weekly growth rate and dry matter yields. The results indicated that there was significant differences in the percent emergence, weekly growth rate and dry matter yield.

***Keywords*:** Performance, Forage species, Southern Guinea Savanna, Nasarawa State

1. INTRODUCTION

Grassland farming is increasingly recognized as a centerpiece of agricultural sustainability. Perennial grasses play an essential role in animal production, soil and water conservation, and offer opportunities for agricultural income from soils unsuited to annual cropping (Griggs and Kingery, 1995). Many perennial grasses are adapted to Guinea savannah agro-ecological zone of Nigeria. These follow a similar pattern of growth and development, but vary in productivity, seasonal growth, distribution and suitability to environmental conditions and management schemes. Precipitation and temperature patterns determine periods of growth and timing of hay, silage, or pasture utilization. Animals' performance depends on the amount and quality of green fodder and its availability within the different months during the year (Hatam *et al*., 2001). Grasses, due to adaptation and acclimatization to climate and soil, are advantageous than other plant species due to their surface rooting system (February and Higgins, 2010).

Grass morphology can be conceptualized as a hierarchical arrangement of structural modules also called tiller (Briske, 1991) which is group of phytomers (Robson *et al*., 1988) consisting of leaf blade, sheath, internodes, node and associated auxiliary bud (Moore and Moser, 1995). The ability of bud allows grass to re-generate (Krishna *et al*., 1984). Tiller initiation and development is basic unit of production and can correlate well to the vegetative period of grass in agro-climatic condition to extend its multi-cut and perennially in the area as efficient biomass producer. Experiments need to be conducted for green fodder improvement through identifying potential species, appropriate variety selection with performance on marginal land under drought as perennial fodder that is effective in resource conservation i.e. solar light and natural precipitation with minimal nutrients at relatively poor fertile soils. The crop height and structure influence both forage quality and feed intake while crop growth represents plant morphology i.e. leaf to stem ratio. The stage at which the plants are harvested is very critical in determining the forage yield and quality.

Forages when harvested at early stages of their development have relatively higher crude protein content, other extract and ash content, but crude fiber, acid detergent lignin, hemicellulose and cellulose increase with later harvesting resulting in decreased dry matter digestibility (Mirza *et al.*, 2002). Higher dry matter intake is associated with the better nutritive quality of early rather than late cut forage, exemplifying the appropriate harvest treatment. In cereals forages, it has been established that dough stage is the most appropriate stage to make a compromise between dry matter yields and forage quality (Qamar *et al.*, 1997). In many countries, improved ecotypes of forage grasses have increased the range productivity of the native and naturalized grass lands (Walmsley *et al.*, 1978). Keeping in view the prevailing circumstances of the rangelands, it is the need of the time that conduction should be removed to increase forage productivity of the degraded rangelands. It is the paramount importance that high yielding and palatable grass species should be established in their suitable eco-sites (Muhammad and Naqvi, 1987).Therefore, the present study will be conducted to determine the performance of some introduced grass species.

The use of grasses in forage mixtures will improve forage and animal production in the area with subsequent improvement in soil fertility. Therefore, results from this study will help to provide valuable information on the performance of the introduced grass species on their adaptability to the environment and dry matter yield capacity.

The main objectives of this study were to identify suitable forage grass species that can adapt to the environment in terms of dry matter accumulation and yield, determine the abilityfsomeintroducedgrasses, andtoestablishsuccessfullyand to evaluate the dry matter production capacity of some grasses grown in plastic pots.

2. REVIEW OF RELEVANT LITERATURES

Forage evaluation and pasture improvement

Pasture improvement and development programmes may be initiated through a number of different approaches. The first approach is based on improved management and utilization of existing natural pasture resources. The second approach is to replace existing natural vegetation with introduced pasture species, while a third approach is a combination of methods in which an introduced species may be over-sown into existing native pasture (Whiteman, 1980).

The improved management and utilization of natural pastures finds particular application in the extensive rangeland grazing areas, usually in the drier regions. The basic philosophy is that the existing species in the region are well adapted to the environment and management seeks to increase or at least maintain the most productive species for animal production. According to McIlvain and Shoop (1971), forage resources may be improved by grazing animal management practices such as control of stocking rate and hence grazing pressure, rotational grazing systems aimed at allowing valuable species to set seed and regenerate, improved distribution of animals by fencing and placement of water points and shelter. A major increase in forage resources is achieved by clearing or thinning standing trees (Beale, 1973).

Pasture establishment

Livestock production in Nigeria is still dominated by the traditional. Under the existing extensive livestock production system, land areas for grazing and feeds availability are limiting factors in the area with high population of livestock in Nigeria (Muhammad and Abubakar, 2004). Therefore There is need to increase fodder production to accommodate the feed requfdirements of Nigeria's livestock. With the present trend of competitive land /. = se, increase in forage production through expansion of land area of natural grassland is hardly feasible as a result of the demographic changes. The newly established pastures must be protected from grazing during the year of establishment. Light grazing or mowing can be allowed during the second growing season up to the end of mid vegetative growth stage. Thereafter the field should be closed for herbage accumulation (Muhammad and Abubakar, 2004). Top dressing with appropriate fertilizer formulation is recommended for enhanced tiller production. Grasses should not be grazed until the plants have flowered. Where the stands are poor, seeds must be allowed to ripen and drop before grazing in order to encourage re-seeding and increase ground cover. On the other hand, where established pastures have good vegetative cover, the grasses could be lightly grazed before flowering. However, dry matter yield increases as the grasses approaches physiological maturity.For instance, the overall increases during the period of growth for *sorghum almum* from the full vegetative to soft dough stage was 66%, with 18% increases when delayed from boot to soft dough and 8% from flower to soft dough stage (Muhammad *et al*., 1999). Cutting at the early vegetative stages of growth resulted in lower dry matter yields compare with cutting at later stages of maturity (Muhammad *et al.*, 1999).

Fertilizer requirement

Pasture grass species respond positive to nitrogen application depending on soil fertility. Nitrogen increases the yield of forage grass by 50-60%. The application of fertilizer ensures successful pasture establishment. Soil nutrient deficiency should be identified and corrected with a balance fertilizer calendar. This is essential to ensure the successful establishment of pasture species on the soil with low fertility, or depleted of nutrient due to intensive cropping. Nitrogen (N), phosphorus (p) potassium (k) or compound fertilizer (NPK) fertilizers are necessary for grasses; Phosphorus should be applied for legumes in the savanna zone of Nigeria. High forage yield have been obtained with the application of 100-150 kgN/ha and 20-30 kgP/ha for grasses and 18-30 kgK/ha for legumes (Agishi, 1983).

Herbage yields

Grasses are generally established with legumes and their dry matter in such an association depends to a large extent on the system of management applied. The addition of high levels of nitrogen fertilizer may suppress the legume in favour of grasses. Also the addition of phosphate is more beneficial to legume growth (Omokanye, 2001). Dry matter yield from legumes and legume/grass pastures and dry matter yield of some forage legumes under irrigation improved significantly after about four 4 months of growth (Akinola, 1975).

Animal Production

A number of grazing trials carried out in Ibadan and Fashola, Oyo State, on legume/grass mixtures demonstrated the benefits of inclusion of legumes to the growth of livestock.

Overview of livestock production

Livestock are domesticated animals reared in an agricultural setting for the production of food, fiber, traction or a combination of purposes. The rearing may be set for subsistence or for profit as a component of agriculture. It has been practiced in many societies, since the transition to farming from hunter-gatherer lifestyle. Since prehistoric times, majority of Africans have been farmers and herders who raised crops and livestock for subsistence. In many cases, livestock provide the only means of survival in a harsh environment not suitable for other type of agricultural use. In addition, livestock constitute an investment unaffected by inflation that pays a significant dividend not only in terms of low cost production but also in terms of growth (Newman *et al*., 2007). The main categories of domestic livestock of the world are cattle, goats, sheep, camels, poultry, pigs and equines.According to available estimates, livestock furnish between 25-50% of the world's total value of agricultural products (Brumby, 1987). Livestock probably constitute the most valuable asset of the rural population in Tropical Africa apart from land (Jahnke, 1982). The role of livestock in the developing countries extends beyond their traditional uses of supplying meat and milk as found in the industrialized countries (Sansoucy, 1994). Livestock is an important sector of the economy through the production of food (meat and milk), provision of security, enhancement of crop production and generation of cash incomes for rural and urban populations; provision of fuel and transport and production of value added goods which have multiplier effects and create a need for services. Livestock diversify production and income, provide year-round employment, spread risk and form a major capital reserve for farming households (Jahnke, 1982). On the other hand, for the transhumant grazer, livestock may be the most valuable resource for capital or credit. Thus developing or improving production systems must take these varied roles into account and adapt them to fit into specific local situations (Preston, 1995). Livestock production in tropical countries has, as in the past, been one of the important economic and social activities of human culture. In these regions, hundreds of millions of people depend directly or indirectly on livestock-based activities (Preston, 1995).

Role of rangeland in livestock production

Rangelands are used for the production of livestock and variety of wildlife. They serve as source of high quality clean water, clean air and open spaces which benefit people as a setting for recreation and economic activities of agriculture, mining and others. They produce forage for cattle, sheep and goat flocks, horses, water buffalo and numerous wildlife species. The harvesting of range forages, produced almost totally from solar energy, remains the best way to convert sunshine to feed (Ruyle, 2003). The development and application of the art and science of range management is a necessary requisite for long term stability of the range livestock industry as an economic base (Ruyle, 2003). The productivity and efficiency of livestock production per animal unit are the key issues. Feed production, feed utilization, animal fertility, production and survival of offspring, calf survival and other productive traits need to be recorded systematically to monitor and evaluate productivity. The biomass availability and the potential to produce more biomass in the tropical countries are many times higher than in the industrialized countries which are exclusively situated in the temperate zones. However, the potential of tropical feed resources has just begun to be recognized. Therefore, there is need to devise ways of exploiting them on a sustainable basis (Preston, 1995). This underscores the need for application of range management principles which focus on the integration of the soils, feed resources base and animal interfaces for animal production on a sustainable basis.

Effects of grazing on rangelands productivity

Sustainable grazing management or land resource use is a key issue of concern in most arid and semi-arid regions of the world. Many complexities are involved in assessing the sustainable use of tropical rangelands. At government level, decision makers face a problem of inadequate and inappropriate data. In many cases the data regarding the interactions of the different components of natural rangeland ecosystems may not be available due to deficiency in technical expertise (Umrani, 1998). This is one of the greatest limitations in rangeland development of the Sub-saharan Africa. Plants vary greatly in palatability to livestock, and the preferred species tend to get grazed heavily, especially when animals are allowed to graze year round (Reynolds and Martin, 1968). Grazing can influence vegetation of the range, primarily through selective herbivory on plant species over time and space. General impacts of open range grazing and unrestricted livestock numbers were well documented in temperate regions at the turn of the century. We could learn and borrow from such data. These included loss of forage productivity and increases in plant species less palatable to livestock, bare ground, soil erosion and general land degradation. Overgrazing may arise from large herds of cattle grazing forages beyond the production capacity of the vegetation. The consequences of land degradation translate into soil compaction, broken soil crust and erosion as well as reduced species diversity and density (Chamshama and Nduwayezu, 2002). The compaction of soil by animals and the removal of vegetation through defoliation may decrease water infiltration, increase soil erosion and decrease plant growth. In permanent grazing systems, there is little opportunity to ameliorate compacted soil through tillage

Assessment of range condition

Range condition is generally defined as departures from some conceived potential for a particular site (Holechek *et al.,* 2004). The assessment of range condition is a necessary prerequisite for determination of whether to embark on range improvement or not. There are number of methods developed for assessing range condition and classification (West *et al*., 1994), but the one most commonly used is that developed by Dyksterhuis (1983). In this approach, range condition is measured in degrees of departure from climax. Generally, four condition classes are recognized: excellent (76 - 100% of climax), good (50 - 75% of climax), fair (26 - 49 % of climax) and poor (0 - 25% of climax). The classification provides an indication of management inputs necessary. Ehlert (1990) following similar classifications differed in terms of the degrees of departure from climax and proposed some indicators that can be used for assessing the range condition with recommendations.Understanding the condition will determine the option for improvement either by introduction of new forage species and/or adjustment of management systems. However, while most of the rangelands in Nigeria can generally be classified as fair or poor, there are no empirical data to verify that because there has been no long term monitoring of the rangelands to record definite changes over time.

Range rehabilitation methods

The potential for range improvement will depend on factors related to edaphic and other natural environmental conditions, vegetation composition, location of the site, choice of technique employed, water availability and socio-economic condition of the developing institution (Ayuko, 1975). The main approach to development and improvement of natural grasslands may involve improvement of their management and utilization and/or introduction of suitable improved pasture species into the natural pasture. However, in developing overgrazed degraded rangeland, rehabilitation and reseeding is to trigger a biological revival and a plant re-colonization process. The rehabilitation process is of various forms depending on the range condition class in respect of the degree of range deterioration.

Complete renovation

One of the most effective ways of improving forage production is the complete cultivation or renovation of the existing pasture to establish a new forage stand by sowing seeds or transplanting of vegetative splits. This is usually an expensive option and in some soils, where erosion or other environmental stresses are of concern, may have to be approached with caution. It is usually the accepted method where forages are used in a crop rotation (Ayuko, 1975).

Use of companion crops

Companion crops are also known as cover crops or nurse crops. The practice involves the establishment of pastures with short-term crops usually in alternating rows. This has been practiced for a long time (Skerman *et al*., 1988). In this practice, annual crops are inter-seeded with perennial pasture plantings to prevent soil erosion, suppress weeds and for the production of useable crop in the year of establishment of the forages (Manitoba Forage Council, 2006). The practice is more successful in areas that have adequate growing season precipitation. Generally, the best companion crops are small grain crops seeded at half or less than half the normal seeding rate. Companion crops that are competitive for nutrients and moisture are not recommended on sandy soils or under dry land conditions.

Sole crop seeding

Sole cropping or monocropping is the production of a single crop without mixture of any other crop. In sown pastures, sole cropping is mostly seen as sole grass or sole legume pastures. This is mostly found where seed production is the motive for establishment of the sward; otherwise, a combination of different species is more often used in grazing, hay or silage crop production.

Grass-legume mixtures

Grasses are usually the predominant species in sown pastures and grazing lands because of their greater aggressiveness, stronger competition for nutrients and higher resistance to intensive grazing, trampling by animals and burning as compared to legumes. Tropical grasses which form the main forage resource in tropical rangelands are noted to be inherently low in crude protein concentration and high in crude fibre content. In agricultural ecosystems, the integration of legume species can produce synergistic effects and minimize external inputs, especially nitrogen fertilizers (Peters et al., 2001).

Biological N fixation may be regarded as one means of increased net primary productivity directed to increasing carbon sequestration. Thus legumes may also contribute in mitigating global warming through increased net primary productivity, improved diet quality, and reduction of methane emissions from cattle. Legumes are important in the maintenance of the nutritive value of forage, both when they are ingested directly or where they contribute N to minimize the expected reduction in leaf:stem ratio and the protein dilution in the associated grass as CO_2 level increases (Valentim and de Andrade, 2004).

Over sowing

Over sowing involves the broadcasting of seed into natural or native grasslands. The cost of this process is usually quite low, but due to lower seed germination and establishment, the amount of improvement achieved may be quite limited, in comparison to other options. However, this method of range improvement or rehabilitation has been used with some levels of success in Nigeria (Gillard; 1977; McKeague *et al*., 1978).

Livestock Seeding

The method involves feeding forage seed to the animals with expectations that the seed is deposited on the pasture through the manure. Crowder and Chheda (1982) considered this as an extravagant use of seed with uneven distribution. There are obvious limitations with the method which are:

That the animals may digest the seed while passing through the gut so that the amount live seed in the manure may be very low. The ammonia in the manure can also have an effect on the germination and. There is minimal control of where the cows will deposit the manure and hence the seeds.

Grass-legume rotations

Including forages in crop rotations is one of the alternative means of improving soil quality. Crop rotations, in general, reduce input costs and lower financial risk, of fundamental importance in crop rotation is the enhancement of soil organic matter and soil structure. The root structure of forages is finer, so they break down more easily allowing air and water to enter the soil with ease. Also as forages break down, they produce binding products that act like glue to hold the soil together. The net result is larger and more stable soil aggregates that are better able to resist wind and water erosion (Sullivan, 2003).

Under-sowing or sod seeding

This is a practice used to introduce a more productive forage species into an existing forage stand. It is also known as sod seeding (Barnhart, 2004). It is often used especially on sites having limitations to cultivation by stones, brush or soil erosion problems. Legumes have generally been most successful for sod seeding although there are a number of grass species that will establish reasonably well. Legumes are usually preferred as they reduce the need for nitrogen application and will improve the quality of the forage (Nazarko and Winnipeg, 2008). In most cases equipment used for sod seeding must be able to penetrate the sod layer (thatch layer) and place the seed into the mineral soil.

Spot seeding

Spot seeding is simply dropping a predetermined number of seeds on a small spot by hand in a lightly cultivated spot (Morgan and Rickson, 1995; Barnett and Baker, 1991) as opposed to cultivating the whole area to be planted. The method is widely used for filling patches of bare ground in larger pasture fields. It is very slow and labour intensive. The seeds will usually germinate in clusters and therefore should be thinned to the recommended stands per spot to reduce competition. Seed spots can also be successfully used to introduce new species into an established vegetation cover, such as a sward (Morgan and Rickson, 1995).

Strip seeding

The planting or sowing of forage and fodder crops in narrow belts or strips in active grazing lands have been suggested as a means of improving the pasture and providing supplemental feed for grazing animals (Crowder and Chheda, 1982). This method has been tested at Runka Grazing Reserve in Kastina State with *Andropogon gayanus, Pennisetum pedicellatum* and *Stylosanthes hamata* strips under the National Livestock Projects Department (NLPD) model Grazing Reserve development (Kallah, 2009 Unpublished).

Roles of pastures in rangeland

Tropical pastures generally have high photosynthetic capacity and thus have the potential to produce large quantities of biomass. However, both the quantity and quality of the biomass changes during the year and over time, depending on the length of the dry season and soil fertility of the location. In areas of long dry season, live weight gain and milk yield can be severely depressed on pastures based on grass alone. An alternative to minimize declines in quantity and quality of forage biomass and thus increase livestock production is to utilize legumes in pastures (Lascano, 2000). The establishment and maintenance of persistent grass-legume pastures is one of the options to increase productivity, profitability and also to ensure long-term sustainability of cattle production systems in the tropics (Valentim and de Andrade, 2004).

Soil fertility management

Low soil fertility is one of the most critical limiting factors for agricultural production in the tropics with nitrogen being the most limiting nutrient in many agricultural ecosystems (Wedin, 1996; Humphreys, 1997). The use of legumes in a forage mixture will improve the soil fertility and the productivity of most forage fields. Grass/legume pasture mixtures that have at least 50% legume content are usually fertilized with phosphate fertilizer as this nutrient encourages the growth of the legume. The main reason for this is that, even though the nitrogen (N) pool is the largest, it is available to plants only through highly endergonic biological processes mediated by free-living or plant-associated bacteria that require between 25 to 30 moles of ATP per mole of N_2 fixed (Marschner, 1995).

Forage production

The presence of productive forage species in pasture ecosystem is a significant factor in determining the productivity of the forage field. Forage production requires land which continues to be the limiting factor to livestock sector's expansion. In the developed economy, most beef cattle are raised on large rangelands, but following weaning, the young animals to be used for meat may be fattened in feedlots, while dairy cattle are managed in relatively large herds under intensive conditions near centers of dense population (Robinson *et al*., 2011). Choice of species and combination need critical consideration. In grass-legume mixed pastures, dry matter yields quite often are higher per unit area than either sole grass or sole legume pasture (Asare, 1974; Skerman, 1977). Yields vary widely, depending on such factors as species of grasses and legumes, inherent soil fertility, fertilization (amount and time of application), percentage of legume, available soil moisture, intensity of defoliation, light intensity and temperature (Crowder and Chheda, 1982). The productivity and efficiency of livestock production per animal unit are the key issues. Forage production, forage utilization, animal fertility, production and calf survival and other productive traits need to be recorded systematically to monitor and evaluate productivity. The biomass availability and the potential to produce more biomass in the tropical countries are many times higher than in the industrialized countries which are exclusively situated in temperate zones. However, the potential of tropical forage resources has just begun to be recognized. There is need to devise ways of exploiting them on a sustainable basis (Preston, 1995). The biomass availability and the potential to produce more biomass are quite often high in the tropics (Preston, 1995).

Nutritive or feeding value

An outstanding feature of the herbage available for grazing in a legume-grass mixture is the increase in N content as compared to grass alone and the constancy of N found in the legume component. Legumes contain higher amounts of N than grasses whether grown alone or in mixture (Crowder and Chheda, 1982). Tanko (1994) in Nigeria found N content of grass falling from 1.5% in the early rainy season herbage to 0.7% in the early dry season herbage. Consequently, livestock performance is greater on pastures containing forage legumes than all grass. Over seeding legumes on perennial grasses results in extension of the grazing season thereby reducing costs and labor associated with dry season feeding.

Rhodes grass (*Chloris gayana* kunth.)

Rhodes grass *Chloris gayana* is a perennial grass of tropical and subtropical Africa where it remained one of the main C4 forage grasses. Rhodes grass can be used as pasture, hay and ley crop. It is also can be used to stabilize disturbed sites. It is found in open grassland, or in grassland with scattered bush and trees, lake margins or seasonally waterlogged plains up to 2000 m altitude, rarely higher (Bogdan, 1969; Bogdan, 1977). The natural distribution of Rhodes grass through much of Africa and the extensive sowing and naturalized stands elsewhere demonstrate the wide environmental adaptation of the species as a whole. It also reflects the tremendous intra-specific variation, such that different forms that can exploit different environments (Loch *et al*., 2004). Rhodes grass is a spring and summer-growing grass found in open woodlands and grasslands, in road margins, disturbed sites and river banks. It is cultivated in sown pastures in irrigated terraces (Heuze *et al.*, 2014). It is latitudinal range is between 18-33°N and S and it grows from sea level up to 2000-2400 m in equatorial areas and up to 1000 m in subtropical areas. *Chloris gayana* thrives in places where annual temperatures range from 16.5 °C to above 26 °C, with maximum growth at 30 °C/25 °C (day/night temperature). Optimal annual rainfall is about 600-750 mm with a summer-rainfall period (Cook *et al*., 2005). Rhodes grass can survive in areas where annual rainfall range is between 310 mm and 4030 mm and where temperature extremes are 5 °C and 50 °C (Cook *et al*., 2005). Due to its deep roots, Rhodes grass can withstand long dry periods (over 6 months) and up to 15 days of flooding (Cook *et al*., 2005). Seasonal waterlogging over 30 cm kills the plant (FAO, 2014). Some cultivars are tolerant of frost. Rhodes grass grows on a wide range of soils from poor sandy soils to heavy clayey alkaline and saline soils. This salt tolerance is particularly valuable in irrigated pastures where it can be cultivated without problem. Rhodes grass does better on fertile, well-structured soils and it prefers soil pH between 5.5 and 7.5. Establishment on acidic soils is difficult. It is tolerant of Li but not of Mn and Mg (Cook *et al*., 2005). *Chloris gayana* is a full sunlight species which does not grow well under shade (FAO, 2014; Cook *et al*., 2005).

Ruzi grass (*Brachiaria ruziziensis*.)

Brachiaria ruziziensis spreading perennial with short rhizomes, similar in habit to Para grass. The inflorescence consists of dense and spikelike racemes. The spikelets are all sessile and close together, the rachis of the racemes winged broad and over 3 mm wide. The spikelets are hairy and thelower glume under half the length of the spikelet. It has softer leaves than *B. brizantha*. A tufted, creeping perennial with short rhizomes forming a dense leafy cover. Culms arise from many-nodes creeping shoots and shortrhizomes, growing to a height of 1.5 m when flowering (Hare and Chaisang Phaikew, 1997). Leaves are softbut hairy, up to 25 cm long and 15 mm wide. Inflorescence consists of 3–9 relatively long racemes (4–10 cm), bearing spikelets in 1 or 2 rowson one side of a broad, flattened and winged rachis, spikelets hairy, 5 mm long. The plants are bisexual and the flowers are fleshy, with 3 anthers. Some species have a prominent vein in the center of the leaf. *Brachiaria* are C_4 species and can tolerate drier conditions and more light exposure than some other plants. *Brachiaria* can grow in many environments, from swamps to shady forest to semi-desert, but generally do best in savannas and other open tropical ecosystems (Torres-González and Morton, 2005). *Brachiaria* is the single most important genus of forage grass for pastures in the tropics. *Brachiaria* cultivars can grow in infertile and acidic soils.

Gamba grass (*Andropogon gayanus* Kunth.)

This is a tall perennial tufted grass up to 2-3 meters tall often with leaves that are up to 2 cm wide. The culms bear racemes which are hairy with 2 cm long awns (Siegfried, 1990). It is distributed in Africa, north and south of the equator, including places with up to seven months of dry season. It has been introduced into tropical South America, Australia and South-East Asia. It is adapted to a variety of soils ranging from sand to heavy black clays and also to soils high in magnesium. It is highly tolerant to drought conditions and stays green well into the dry season. It produces an abundance of new shoots soon after burning. It can be established vegetatively through planting crown splits or by seed after the establishment of rains using 5 kg/ha or 30-60 kg/ha of clean and unclean seeds, respectively. It grows well in mixture with the following forage legumes: *Clitoria ternatea, Stylosanthes guianensis* and *Crotalaria juncea* (Siegfried, 1990). It produces good quality forage and is also one of the higher yielding grasses in West Africa. Annual dry matter yields of up to 2 t/ha have been obtained from unfertilized natural grassland and up to 10 t/ha from a fertilized plot. *Andropogon gayanus* is good for grazing and can be used as pasture, hay or green fodder. It is very palatable and nutritious when young. Other tropical species of the genus available in West Africa include *A. schirensis* and *A. tectorum* (FAO, 1981; Siegfried, 1990).

***Panicum maximum* (Guinea grass)**

Panicum maximum is a perennial, tufted grass with a short, creeping rhizome. The stems of this robust grass can reach a height of up to 2 m. As the stems bend and nodes touch the ground, roots and new plants are formed. The leaf sheaths are found at the bases of the stems and are covered in fine hairs. It remains green until late into winter. The leaf blades are up to 35 mm wide and taper to a long fine point. The inflorescence is a large multi-branched, open panicle with loose, flexuous branches. The lower branches of the inflorescence are arranged in a whorl. The lower floret is usually male with a well-developed palea (upper bract enclosing flower) (Gibbs Russell *et al.*, 1991). The fertile (female) upper lemma is pale. Spikelets are green to purple and flowering occurs from November to July. This species varies in size and hairiness and may also vary to a lesser extent in growth habit. There are distinct forms of *Panicum* in South Africa, but the transversely wrinkled upper floret or seed of *P. maximum*, distinguishes it from all other *Panicum* species. It is considered to be the most valuable fodder plant in the area where it is distributed. It has a high leaf and seed production and is very palatable to game and livestock. It is widely cultivated as pasture and is especially used to make good quality hay. If it receives adequate water, it grows rapidly and occurs in abundance in veld that is in a good condition.

Forages when harvested at early stages of their development have relatively higher crude protein content, other extract and ash content, but crude fiber, acid detergent lignin, hemicellulose and cellulose increase with later harvesting resulting in decreased dry matter digestibility (Mirza *et al.*, 2002). Higher dry matter intake is associated with the better nutritive quality of early rather than late cut forage, exemplifying the appropriate harvest treatment. In cereals forages, it has been established that dough stage is the most appropriate stage to make a compromise between dry matter yields and forage quality (Qamar *et al.*, 1997). In many countries, improved ecotypes of forage grasses have increased the range productivity of the native and naturalized grass lands (Walmsley *et al.*, 1978). Keeping in view the prevailing circumstances of the rangelands, it is the need of the time that conduction should be removed to increase forage productivity of the degraded rangelands. It is the paramount importance that high yielding and palatable grass species should be established in their suitable eco-sites (Muhammad and Naqvi, 1987).Therefore, the present study will be conducted to determine the performance of some introduced grass species.

The use of grasses in forage mixtures will improve forage and animal production in the area with subsequent improvement in soil fertility. Therefore, results from this study will help to provide valuable information on the performance of the introduced grass species on their adaptability to the environment and dry matter yield capacity. The main objectives of this study were to identify suitable forage grass species that can adapt to the environment in terms of dry matter accumulation and yield, determine the ability of some introduced grasses, to establish successfully and evaluate the dry matter production capacity of some grasses grown in plastic pots.

3. MATERIALS AND METHODS

The study was conducted at the Screen House of the Faculty of Agriculture, Nasarawa State University, Shabu-Lafia Campus (Lafia North) which is located in the Southern Guinea Savannah zone of Nasarawa State, Nigeria and on Latitude 08°35N and longitude 08°33E. It has an average annual temperature range of 26.8-31.5 °C, while annual rainfall varies from 1,373 mm to 1,445 mm (Nasarawa State Ministry of Information, 2006).

Sources of experimental materials

Seeds of the improved grass species used for the trial were obtained from the National Animal Production Research Institute (NAPRI) Shika, Zaria in Kaduna State. Plastic pots for the trial were purchased from the Lafia main market. Forty eight plastic pots were perforated at the base (to facilitate drainage) and were filled with soil samples obtained from four different locations (i.e. Akwanga, Keffi, Lafia and Nasarawa Eggon) in Nasarawa State. The soil was put in to the pots and watered to create a suitable environment for the seeds. The initial nutrient status of the composite soil samples was determined in the Laboratory. Thereafter, the seeds were sown at suitable depths for each forage grass species to facilitate germination.

Experimental design

The experimental design adopted was Randomized Complete Block Design (RCBD) with three replicates.

Data Collection

Date of germination, Percentage germination, weekly growth rate, date of flowering, date of seed set, dry matter yield at maturity, soil analysis before and after the trail.

Statistical Analysis

Data collected were processed and subjected to Analysis of Variance (ANOVA). Significant treatment means were subjected to mean separation using Duncan's Multiple Range Test.

4. RESULTS AND DISCUSSION

Soil chemical and physical characteristics before commencement and after the trail, percentage germination, growth rate and dry matter yield of *Brachiaria ruziziensis*, *Chloris gayana, Andropogon gayanus and Sorghum almum* sown in potted experiment in Akwanga, Keffi, Lafia and Nasarawa Eggon soils were measured in the study (Tables 1, 2, 3, 4 and 5).

The chemical and physical characteristics of the soil before commencement of the trial are shown in Table 1. The soil chemical properties after the trial are shown in Table 2.

The soil pH in water of the four soil types after the trail viz Akwanga, Keffi, Lafia and Nasarawa Eggon are presented in Table 2. The soil pH of the above named soil types varied from 7.29 in the Lafia soil to 8.10 in Keffi soil. Keffi soil recorded the highest soil pH in water which was significantly ($P<0.05$) different from the value obtained from the remaining soil types (i.e. Akwanga, Lafia and Nasarawa Eggon with 7.95, 7.29 and 7.91, respectively). The Akwanga soil type recorded the second highest pH value (7.95) which was not significantly ($P>0.05$) different from soil pH in Nasarawa Eggon soil (7.91). The Lafia soil recorded numerically the lowest pH value (7.29) among the four soil types which was significantly ($P<0.05$) different from the other soils. It can be seen from (Table 1) that 7.16, 8.46, 7.05 and 7.90 soil pH were obtained in Akwanga, Keffi, Lafia and Nasarawa Eggon respectively. Highest soil pH was obtained in Keffi soil (8.46), while the lowest soil pH (7.05) was recorded in Lafia soil of the four soil types.

Table 1. Chemical and Physical characteristic of the soil before the commencement of the trial.

Parameters	Akwanga	Keffi	Lafia	N. Eggon
pH - H_20	7.16	8.46	7.05	7.90
pH - $CaCl_2$	6.77	7.50	7.00	7.26
% O.C	1.64	1.62	1.54	1.56
% O.M	2.28	2.79	2.65	2.68
N (mg/l)	0.0499	0.1222	0.0386	0.0408
P (mg/l)	0.0005	0.0014	0.0004	0.0013
K (mg/kg)	231	332	211	283
Mg (ppm)	0.36	0.35	0.28	0.25
Na (ppm)	0.15	0.14	0.16	0.18
Ca (mg/kg)	3.62	4.20	3.89	3.92
E.A (mg/100g)	0.67	0.67	1.00	1.00
E.C.E.C	523.80	337.36	315.33	288.35
% B.S	99.71	99.94	99.68	99.65
E.C	120	540	90	430

Particle size distribution				
% Sand	84.8	80.8	82.8	80.8
% Slit	3.4	5.4	5.8	5.4
% Clay	11.8	13.8	11.4	13.8
Texture	SL	SL	SL	SL

pH - H_2O = pH of soil in water, pH - $CaCl_2$ = pH of soil in calcium chloride, % O.C = Percentage of Organic Carbon, % O.M = Percentage of Organic Matter, N = Nitrogen, P = Phosphorus, K = Potassium, Mg = Magnesium, Na = Sodium, Ca = Calcium, E,A = Exchangeable Acidity, E.C.E.C = Effective Cation Exchange Capacity, % B.S = Percentage Base Saturation, E.C = Electrical Conductivity.

Table 2. Changes in soil chemical properties after the trail in the four soil types.

Parameter	Akwanga	Keffi	Lafia	N.Eggon	
pH - H_2O	7.95^b	8.10^a	7.29^c	7.91^b	
pH - $CaCl_2$	7.38^a	7.42^a	7.10^b	7.37^a	
% O.C	1.45^b	1.68^a	0.93^b	1.67^b	
% O.M	2.49^b	2.89^a	1.60^c	2.83^a	
N (mg/l)	0.016^a	0.007^c	0.017^b	0.113^a	
P (mg/l)	0.55^d	0.86^b	0.63^c	1.16^a	
K (mg/kg)	0.011^b	0.003^d	0.073^a	0.009^c	
Mg (ppm)	0.37	0.37	0.37	0.38	ns
Na (ppm)	0.19^b	0.18^b	0.22^a	0.23^a	
Ca (mg/kg)	4.235	4.240	4.260	4.237	ns
E.A (mg/100g)	0.350^a	0.265^c	0.330^{ab}	0.308^b	
E.C.E.C	5.250	5.058	5.253	5.187	
% B.S	93.00	95.00	93.00	94.00	
E.C					
Particle size distribution					
% Sand	85.4	73.9	89.9	85.9	
% Slit	5.8	8.8	5.4	5.3	
% Clay	8.8	17.3	9.3	8.8	
Texture	LS	SL	LS	LS	

$^{a, b, c}$ Means in row with the same superscript are not significantly different at the 5% level by Duncan's Multiple Range Test. ns = Not significant

The pH value in Keffi soil after the trail decreased and that of the remaining three soils (i.e. Akwanga, Lafia and Nasarawa Eggon) increased which as the result of this may cause decreases in dry matter yield.

The soil pH in ($CaCl_2$) after the trail ranged from 7.10 in the Lafia soil to 7.42 in Keffi soil. The Keffi soil recorded the highest soil pH (7.42) among the four soil types, which was not significantly ($P>0.05$) different from the soil pH for the Akwanga and Nasarawa Eggon soils with (7.38 and 7.37 respectively). The Lafia soil recorded the lowest soil pH in $CaCl_2$ (7.10) which was significantly ($P<0.05$) different from all other soil types. In Table 4.1 (6.77, 7.50, 7.00 and 7.26), it can be seen that the highest soil pH was recorded in Keffi soil (7.50) while the lowest soil pH was observed in Akwanga soil (6.77) before the trail. The soil pH were increased in the Akwanga, Lafia and Nasarawa Eggon soils from (7.38, 7.10 and 7.32 respectively) while that of Keffi soils was decreased (7.42) after the trial.

The percentage Organic Carbon (% O.C) of the soil after the trail varied from 0.93 in Lafia soil to 1.68 in the Keffi soil. The Keffi soil recorded the highest % O.C (0.93) among the soil types which was significantly (P<0.05) different from the remaining soil types (i.e. Akwanga, Lafia and Nasarawa Eggon with 1.45, 0.93 and 1.67, respectively). The remaining three soil types were not significantly (P>0.05) different from each other. The Lafia soil recorded numerically the lowest % O.C. Looking at Table 4.1 (1.64, 1.62, 1.54 and 1.56) the highest percentage % O.C was observed in Keffi soil (1.64) and the lowest % O.C was observed in Lafia soil (1.54) before the trail. After the trail the % O.C content were increased in the Keffi and Nasarawa Eggon soils (1.68 and 1,67)while that of Akwanga and Lafia soils was increased after the trial. The decreased or increased beyond normal in percentage organic carbon affect the activities of soil microbes.

The percentage Organic Matter (% O.M) of the four soil types after the trail ranged from 1.60 to 2.89. Keffi soil recorded the highest % O.M (2.89) among the four soil types which was not significantly (P>0.05) different from the % O.M in the Nasarawa Eggon soil (2.83) which recorded the second highest % O.M among the soil types (2.83). The Akwanga soil recorded the third highest % O.M among the soil types (2.49) which was significantly (P<0.05) different from Lafia soil which recorded numerically the lowest % O.M among the soil types (1.60). It can be seen from Table 1 that the percentage organic matter of the soil after the trail was increased in Akwanga, Keffi and Nasarawa Eggon soils while that of Lafia soil was decreased. The increase % O M was due to deposition of dead plant material decaying processes that have been going over time.

The Nitrogen content (N) of the soil when trail was terminated varied from 0.007 in the Keffi soil to 0.113 mg/l in Nasarawa Eggon soil types. The soil from Nasarawa Eggon soil recorded the highest N content which was significantly (P<0.05) different from the remaining three soil types (i.e. Akwanga, Keffi and Lafia with 0.016, 0.007, 0.017 mg/l respectively). The Lafia soil recorded the second highest N content (0.017 mg/l) in the soil which was not significantly (P>0.05) higher than the N content in the Akwanga soil (0.016 mg/l). The Keffi soil recorded the lowest N content in the (0.007mg/l) which was significantly (P <0.05) different from all other soil types. It was observed in Table 1 that the N content of the soils after trail in the Akwanga, Keffi and Lafia (0.0499, 0.1222, 0.0586 mg/l) was decreased which could show up sing of deficiency on older parts (leaves and stem) of the plant and extends to the younger portion of plants while the soil from Nasarawa Eggon soil N content was increased (0.113 mg/l).

The Phosphorus (P) content in the soil after the trail in the above named soil types, the P value varied from 0.55 to 1.16 mg/l. The Nasarawa Eggon soil recorded the highest P value (1.16 mg/l) which was significantly (P<0.05) different from the P value in the remaining soil types (i.e. Akwanga, Keffi and Lafia with 0.55, 0.86 and 0.63 mg/l respectively). The Keffi soil recorded the second highest P value (0.86 mg/l) which was significantly (P<0.05) higher, than the remaining two soil types (Akwanga and Lafia). The Lafia soil recorded the third highest P value (0.63 mg/l) in the four soil types which was significantly (P<0.05) higher from that recorded by the Akwanga soil which was numerically the lowest P value (0.55 mg/l) in the four soil types. It can be seen from Table 1 that in all the soil types the P value in increased, but it is high Keffi and Nasarawa Eggon soils (0.0014 and 0.0013 mg/l) while moderate, in Lafia and low in Akwanga soils (0.0004 and 0.0005 mg/l respectively).

The Potassium (K) content in the soil after the pulmonary study for the four soil types, the K content ranged from 0.003 in the Keffi soil to 0.073 mg/kg in the Lafia soil. The Lafia soil types recorded the highest K content (0.073 mg/kg) which was significantly ($P<0.05$) higher from the other three soil types (i.e. Akwanga, Keffi and Nasarawa Eggon with 0.011, 0.003 and 0.009 mg/kg respectively). The soil from the Akwanga location recorded the second highest K content in the soil (0.011 mg/kg) which was significantly ($p<0.05$) different form the Nasarawa Eggon soil. The Nasarawa Eggon soil recorded third highest K content in the soil (0.009 mg/kg) which was significantly ($P<0.05$) different from the K content in Keffi soil (0.003 mg/kg) which recorded numerically the lowest k content in the four soil types. It can be seen when compare the K content of the soil after the trail with the value obtained before the trail in Table 1, the value of K in all the soil types decreased. Potassium accounts for between 1 and 3% of plant tissue (dry weight) on the average but could reach up to 12% in young tissue. The amount taken up annually by a good cereal crop yielding 5 to 10 t/ha grain is between 200-300 $kg \cdot K \cdot ha^{-1}$ while a good crop of potato could be very up to 300 kg K ha^{-1}, potassium uptake by grass sward could be as vary much higher than the figures quoted for common arable crops reported by Agbede, (1984).

The Magnesium (Mg) content after the trail varied from 0.370 to 0.383 (ppm). The Nasarawa Eggon soil recorded the highest (0.383 ppm) which was not significantly ($P>0.05$) different from the value of the remaining soil types (i.e. Akwanga, Keffi and Lafia with 0.373, 0.373 and 0.370 ppm respectively). It can be seen from Table 1 that values of Mg in soil after the trail increases in all the soils. Mg performs structural role in plant linking together the subunits of ribosomes.

The Sodium (Na) content after the trail ranged from 0.185 in the Keffi soil to 0.232 ppm in the Nasarawa Eggon soil. Nasarawa Eggon soil recorded the highest the highest Na content which was not significantly ($P >0.05$) different from the value for the Lafia soil. These two (i.e. Nasarawa Eggon and Lafia soils with 0.232 and 0.223 ppm respectively) were however, significantly ($P<0.05$) different from the Na contents of the remaining soil types viz. Akwanga and Keffi soils with 0.198 and 0.185 (ppm) respectively. The Keffi soil recorded the lowest Na value (0.185 ppm) which was the lowest among the four soil types which not significantly ($P>0.05$) different from that of the Akwanga soil. From the Na obtained in Table 1 it can be seen that the Na value in all the soil increases but Nasarawa Eggon and Lafia recorded the highest Na value in soils after trail with lowest in Keffi soil.

The Calcium (Ca) content of these soil ranged from 4.235 to 4.26 (mg/kg). The Lafia soil recorded the highest Ca value which was not significantly ($P>0.05$) different from all the other soil types. The Akwanga soil recorded numerically the lowest Ca content. After trail in Table 1 it can be observed that Ca content increased in all soils from Akwanga to Nasarawa Eggon, they were ranged from 4.23 to 4.260 mg/kg respectively after the trail.

The Exchangeable Acidity (E.A) of the soil after the trail varied from 0.265 to 0.350 (mg/100g) in the four soil types. The Akwanga soil recorded the highest (0.350 mg/100g) E.A in the soil types which was not significantly ($P>0.05$) different form the E.A value obtained in the Lafia soil. Lafia soil recorded the second highest E.A value (0.330 mg/100g) which was not significantly ($P>0.05$) different from the E.A value recorded in Nasarawa Eggon soil (0.308 mg/100g). The Keffi soil recorded the lowest E.A value (0.265 mg/100g) in the four soil types. which was significantly ($P<0.05$) different from Akwanga, Lafia and Nasarawa

Eggon soil types. The E.A value in the four soils after trail when compared with the E.A value in Table 1 it was observed that the exchangeable acidity decreased in all the soils after trail.

The Effective Cation Exchange Capacity ranged from 5.058 to 5.253 in the above named soils after the trail when compared with E.CE.C in Table 1 it can be seen that the E.C.E.C values in all the soils after the trail decreased..

The Percentage Base Saturation in the all the soil types varied from 93.00 to 95.00 after the trail from Akwanga to Nasarawa Eggon soils. The % B.S before the trail in Table 1 (99.71, 99.94, 99.68, and 99.65 respectively) in all the soils before the trail, after trail all E.C.E.C of the four soils were all decreased.

The Electrical Conductivity of the soil before the trail varied from 90 to 540 in Table 1, Keffi soil recorded the highest while Lafia soil recoded the lowest when compared with E.C value after the trial.The Particle size distribution of the four soil types viz. Akwanga, Keffi, Lafia and Nasarawa Eggon are presented before and after the trail below.

The percentage of sand, slit and clay in Akwanga soil was 84.8% sand, 3.4% slit, 11.8% clay and the texture was sandy loam before the trail in Table 1 when compared with the % of sand, slit and clay after the trail the percentage of sand increase to 85.4, that of slit increase to 5.8, the percentage of clay decrease to 8.8 and texture was loam sandy.

The Keffi soil percentage was 80.8% sand, 5.4% slit, and 13.8% clay, the soil texture was sandy loam before the commencement of the trail in Table 1. It can be seen when compared with the % of sand slit and clay after the trail which recorded (73.9 sand, 8.8 slit and 17.3 clay respectively) the percentage of sand decrease, that of slit and clay increases the texture of the soil after the trail was sandy loam.

The percentage of sand, slit and clay in Lafia soil was 82.8% sand, 5.8% slit, 11.4% clay and the texture was sandy loam before the trail in Table 1 when compared with the % of sand, slit and clay after the trail the percentage of sand increase to 89.9, that of slit and clay decrease to 5.4 and 9.3 respectively the texture after the trail was loam sandy.

The percentage of soil in Nasarawa Eggon was 80.8% sand, 5.4% slit, and 13.8% clay, the soil texture was sandy loam before the commencement of the trail in Table 1. After the trail when compared with the % of sand slit and clay which recorded (85.9 sand, 5.3 slit and 8.8clay respectively) the percentage of sand increase, that of slit and clay decreases the texture of the soil after the was loam sandy

Percent emergence, flowering and seed set date in the four soil types.

The percent emergence of the sown seeds of the forage grass species is presented in Table 3.

Weekly growth rate

The forage weekly growth rate on the four soil types viz Akwanga, Keffi, Lafia and Nasarawa Eggon are presented in Table 4. *Brachiaria ruziziensis* recorded the highest growth rate in the Keffi soil (43.80 cm) which was significantly ($P<0.05$) different from the remaining three soil types (i.e. Akwanga, Lafia, and Nasarawa Eggon with 34.26, 31.94 and 38.59 cm respectively). The soil from Nasarawa Eggon location recorded the second highest weekly growth rate for this forage (*Brachiaria ruziziensis*) (38.59 cm) which was significantly ($P<0.05$) higher than the remaining two soil types (i.e. Akwanga and Lafia). The Akwanga soil recorded the third highest weekly rate for *Brachiaria ruziziensis* which was not significantly (P>0.05) different from that recorded by the Lafia soil (31.94 cm) which recorded the lowest weekly growth rate for this forage grass. These results obtained from this trail was in contrary with the previous findings by Hare and Chaisang Phaikew (1997) reported that A tufted, creeping perennial with short rhizomes forming a dense leafy cover. Culms arise from many-nodes creeping shoots and short rhizomes, growing to a height of 1.5 m when flowering.

Chloris gayana recorded the highest growth rate in the Keffi soil (34.08 cm) which was not significantly (P>0.05) different form that recorded by the Akwanga and Nasarawa Eggon soil types (27.62 and 30.80cm). The soil from Nasarawa Eggon location recorded the second highest weekly growth rate for the forage grass (*Chloris gayana*) (30.08) which was not significantly (P>0.05) different from the Akwanga soil types. The Akwanga soil recorded the third highest weekly growth rate (27.62 cm) which was significantly (P<0.05) different from that recoded by the Lafia soil (19.00 cm) which recorded the lowest weekly growth rate for this forage grass.

Table 3. Percent emergence of sown seeds in the four soil types

Soil type	*B. ruziziensis*	*C. gayana*	*A. gayanus*	*S. almum*
Akwanga	63^{a}	76^{b}	47^{c}	5^{b}
Keffi	54^{b}	91^{a}	42^{c}	94^{a}
Lafia	33^{c}	58^{c}	71^{a}	64^{c}
N. Eggon	63^{a}	86^{a}	53^{b}	90^{a}

$^{a, b, c}$ – Means in the column with similar letter are not significantly different at the 5% level by Duncan's Multiple Range Test Test

Table 4. Weekly growth rate (cm) of four grass species on four soil types

Location	*Brachiaria ruziziensis*	*Chloris gayana*	*Andrpogon gayanus*	*Sorghum almum*
Akwanga	$34.26^{c} \pm 3.15$	$27.62^{a} \pm 5.77$	$27.47^{b} \pm 4.82$	$22.71^{b} \pm 1.13$
Keffi	$43.80^{a} \pm 3.70$	$34.08^{a} \pm 8.97$	$36.05^{a} \pm 3.30$	$36.02^{a} \pm 3.00$
Lafia	$31.94^{c} \pm 4.83$	$19.00^{b} \pm 8.34$	$18.08^{c} \pm 2.70$	$23.25^{b} \pm 1.33$
N.Eggon	$38.59^{b} \pm 2.45$	$30.48^{a} \pm 8.56$	$30.70^{b} \pm 2.48$	$32.80^{a} \pm 5.90$

$^{a, b, c.}$ - Means in the column with the same superscript are not significantly different at the 5% level of probability by Duncan's Multiple Range Test. ns = Not significant. Cm = Centimeter. Spp = Species. N. Eggon = Nasarawa Eggon

The growth rate in this study ranged from 19.00 to 30.08 cm which is lower than the 1.4 and 38 dS m^{-1} reported by (Deifel et al., 2006) for *Chloris gayana* found salt-tolerant grasses species in both saline and non-saline soil respectively. The variation in the result for the previous findings and this study is that, this was a pulmonary trail and the size of the pot used contributed to the yield of this trail.

The growth rate for *Andropogon gayanus* varied from (18.00 to 36.70 cm) in four soil types, Keffi soil recorded the highest growth rate which was significantly(P<0.05) different from the remaining three soil types. The Nasarawa Eggon soil gives the second highest growth rate for this forage grass (*Andropogon gayanus*) (30.70 cm) which was not significantly (P>0.05) different from that recorded by the Akwanga soil type which recorded the third highest growth rate for *Andropogon* gayanus which was significantly (P<0.05) different from that recorded by the Lafia soil (18.05 cm) which recorded the lowest growth rate for this forage grass. The growth rate (18.00 to 36.6 cm) obtained in this trail were lower than the 1.94 m^{-1} reported by Asiegbu and Onyeonagu (2008) also not in agreement with the values 2.5 to 3.0 m^{-1} reported by Adams et al (1991) that mature plant grow up to above height with tussock up to 40 cm in diameter. The in growth in this trail are lower these because it was carried out during dry season and the trail was potted experiment.

Sorghum almum recorded the highest in growth rate in the Keffi soil (36.02 cm) which was not significantly (P>0.05) different from that recorded by the Nasarawa Eggon soil (32.80 cm) which recorded the second highest weekly growth rate for this forage grass (*Sorghum almum).* The Lafia soil recorded the third highest growth for sorghum almum which was not significantly (P>0.05) different form that recorded by the Akwanga soil type (22.71 cm) which recorded the lowest weekly growth rate for this forage grass. The highest growth rate 36.02 cm was recorded in this trail while the lowest growth rate 22.71 cm was obtained in the four soils. The figures reported here (1.1 to 1.5 m^{-1}) for sorghum almum were higher than the value that was obtained in this trail, the previous findings reported by Asiegbu and Onyeonagu (2008) was in contrary with value obtained in this trail, also not in agreement with this value 1.1 to 1.2 m^{-1} obtained by Amanullah *et al*., (2004). The variation in the growth of this forage grass may be as result unfertilized soil used and the size of the pot that was used contributed to the yield of this trail.

Dry matter yield

The forage dry matter yield on the four soil types viz Akwanga, Keffi, Lafia and Nasarawa Eggon are presented in Table 5.

Brachiaria ruziziensis recorded the highest dry matter yield in the Lafia soil (89.04kg/ha) which was significantly (P<0.05) different from the remaining three soil types (i.e. Akwanga, Keffi, and Nasarawa Eggon with 81.91, 68 26 and 72.87kg/ha respectively). The soil from the Akwanga location recorded the second highest dry matter yield for this forage (*Brachiaria ruziziensis*) (81.91kg/ha) which was significantly (P<0.05) higher than the remaining two soil types (i.e. Keffi and Nasarawa Eggon). The Nasarawa Eggon soil recorded the third highest dry matter yield for *Brachiaria ruziziensis* which was not significantly (P>0.05) different from that recorded by the Keffi soil (68.26 kg/ha) which recorded the lowest dry matter yield for the forage grass. The dry matter yield in this trial showed that *Brachiaria ruziziensis* recorded the highest dry matter yield of 89.04 kg/ha was recorded in Lafia soil with, the lowest dry matter yield of 68.26 kg/ha in Keffi soil in the four soil types.

The dry matter yield ranged from (62.26 to 89.04 kg/ha) obtained in this trail were lower than 19,500 kg DM/ha for *Brachiaria ruziziesis* reported by Grof and Harding (1970).

Chloris gayana recorded the highest dry matter yield in the Lafia soil (86 .83 cm) which was not significantly (P>0.05) different from the remaining three soil types (i.e. Akwanga, Keffi and Nasarawa Eggon with 80.77, 80.60, 84.97 kg/ha respectively). The Nasarawa Eggon soil recorded the second highest dry matter yield for this forage (*chloris gayana*) (84 .97 kg/ha) which was not significantly (P>0, 05) higher than the remaining two soil types (i.e. Akwanga and Keffi).

Table 5. Dry matter yield (kg/ha) of four grass species on four soil types

Soil type	*Brachiaria ruziziensis*	*Chloris gayana*	*Andropogon gayanus*	*Sorghum almum*
Akwanga	81.91^{b}	80.77	91.50^{b}	95.29^{a}
Keffi	68.26^{c}	80.60	89.12^{b}	76.45^{b}
Lafia	89.04^{a}	86.83	104.79^{a}	97.75^{a}
N. Eggon	72.85^{c}	84.97 ns	90.70^{b}	79.73^{b}

a, b, c. Means in the same column with similar superscript are not significantly different at the 5% level of probability by Duncan's Multiple Range Test. ns = Not significant. Kg/ha = kilogram per hectare N. Eggon = Nasarawa Eggon.

The soil from Akwanga location recorded third highest dry matter yield for this forage grass which was not significantly (P>0.05) different from that recorded by the Keffi soil (80.60 kg/ha) which recorded the lowest dry matter yield for this forage grass. The dry matter yield for *Chloris gayana* ranged from 80.60 to 86.83 kg/ha obtained in this trial for the four soil types. The dry matter yields in this trial showed dry matter yield across treatments compares was in contrary with what Gonzelez and Heliman (1977) reported that the dry matter yield for chloris gayana have found as 16.3 and 13.5tDM/ha in non-saline and saline soil respectively, also do not agree with the value 19 to 38 tDM/ha for *Chloris gayana* at kadawa in Sudan savanna of Nigeria reported by Ariba (1987). The dry matter yield in this tail was lower from the values obtained in previous findings because this was a pulmonary trial in potted experiment and the yield in this trail not an annual yield.

Andropogon gayanus recorded the highest dry matter yield in the Lafia soil (104.79 kg/ha) which was significantly (P<0.05) different from the remaining three soil types (i.e. Akwanga, Keffi and Nasarawa Eggon with 91.49, 89.12, 90.70kg/ha respectively). The Akwanga soil recorded the second highest dry matter yield for the forage (*Andropogon gayanus*) (91.49 kg/ha) which was not significantly (P>0.05) higher than the remaining two soil types (i.e. Keffi and Nasarawa Eggon). The Nasarawa Eggon location recorded the third highest dry matter yield for *Andropogon gayanus* which was not significantly (P<0.05) different from that recorded by the Keffi soil (89.12 kg/ha) which recorded the lowest dry matter yield for this forage grass. The dry matter yield in this trial showed that *Andropogon* *gayanus* recorded the highest dry matter yield of 104.79 kg/ha was recorded in Lafia soil with, the lowest dry matter yield of 89.12 kg/ha in Keffi soil in the four soil types. The dry matter yield ranged from (89.12 to 104.79 kg/ha) obtained in this trail were lower than 14.3 to 37.0 tDM/ha for *Andropogon gayanus* reported by Ariba (1987) also not in agreement with the value 11.4 tDM/ha obtained by kallah and Nzamane (1984).

Sorghum almum recorded the highest dry matter yield in the Lafia soil (97.75 kg/ha) which was not significantly ($P<0.05$) different from that of the Akwanga soil types, the soil from Akwanga location recorded the second highest dry matter for the (sorghum almum) (95.24 kg) which was significantly ($P<0.05$) higher than the remaining two soil types (i.e. Keffi and Nasarawa Eggon). The Nasarawa Eggon soil recorded the third highest dry matter yield for sorghum almum which was not significant ($P>0.05$) different form that recorded by the Keffi soil (76.45 kg/ha) which recorded the lowest dry matter yield for the forage grass. The dry matter yield (76.45 to 97.75 kg/ha) obtained in this trail were lower than 17 to 19tDM/ha reported by Muhammad (2004). The variation in the dry matter in this trail when compared with previous findings is that this trail was carried out during the dry season, and the yield was one time harvest in a potted experiment.

5. CONCLUSIONS AND RECOMMENDATIONS

Conclusions

The trail on performance of some forage grass species in the southern guinea savannah agro-ecological of Nasarawa State was conducted with aim of identifying suitable forage grass species that can adapt to the southern guinea savannah agro-ecological zone of Nasarawa State viz Akwanga, Keffi, Lafia and Nasarawa Eggon in terms of dry matter yield accumulation and yield. The finding show that four forage grass species tested were adapted to the environment with Brachiaria ruziziensis having maximum weekly growth rate followed by Andropogon gayanus recorded the second highest growth rate, Sorghum almum recorded the third highest weekly growth rate and Chloris gayana falling in to the fourth position with the lowest weekly growth rate. The finding also show that Andropogon gayanus having the maximum dry matter yield followed by Sorghum almum recorded the second highest dry matter yield, Brachiaria ruziziensis falling in to the third position for dry matter yield and Chloris gayana has the lowest dry matter yield which fall in fourth position for this forage grass species. The soil physico-chemical properties were analyzed before and after the trail.

The result obtained from this trail showed that the four grasses tested, could be grown in the environments the soil samples were taken. They established well in Keffi soil type, having the highest plant stands, followed by Nasarawa Eggon soil type having second highest plant stands, the Akwanga soil type recorded the third and Lafia soil type falling in the fourth position with lowest plant stands.

Recommendations

The results presented in this study were obtained under irrigation in the dry season and in pots.Further study on same forage species is recommended in the rainy season and under field conditions in the various locations from where these soil samples were obtained.

ACKNOWLEDGEMENT

The efforts of Professor J.T. Amodu, for the supply of the forage seeds from the National Animal Production Research Institute (NAPRI) is highly appreciated

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(Received 29 July 2017; accepted 18 August 2017)