NIGERIAN AGRICULTURAL JOURNAL
ISSN: 0300-368X
Volume 51 Number 3, December 2020 Pg. 168-177
Available online at: http://www.ajol.info/index.php/naj

GROWTH AND NUTRIENT CONTENT OF SELECTED LEGUME SPECIES IN HUMID TROPICAL FOREST OF SOUTHEASTERN NIGERIA

Nwajiobi, B., Nzegbule, E.C., Mbakwe, R., Asawalam, D., Mejeha, R., Chukwu, G.O. and Ezenwa, L.I.

Michael Okpara University of Agriculture, Umudike Abia State, Nigeria
Corresponding Authours' email: benson.nwajiobi@gmail.com

Abstract

The growth and mineral composition of six locally available but underutilized leguminous species (*Centrosema pubescens, Mucuna pruriens, Calopogonium mucunoides, Stylosanthes capitata, Lablab purpurues,* and *Mucuna bracteata*) being considered for organic fertilizer production were investigated at Michael Okpara University of Agriculture Umudike, South-East Nigeria. The legumes which constitute the experimental treatments were raised in the nursery and transplanted to the field using RCBD design with three replicates. Vine length, number of leaves and number of branches of the species were measured weekly. Dry weights of the legumes were determined at three stages of the plants growth. Legume samples were also analyzed for nutrient elements composition at 50% flowering. Data collected were subjected to statistical analysis of variance (ANOVA) with the significant means separated using the Duncan Multiple Range Test (DMRT) at $p<0.05$.The results show significant variations in the growth parameters and nutrient elements composition among the legumes. *L. purpureus* had highest plant height (7.00±0.707cm), *M. bracteata* had greatest number of branches (14.80±2.653) and biomass (205.12±5.984g/plant), *S. capitata* had highest number of leaves (20.60±1.327), while *C. mucunoides* contains highest N (3.90 %) and organic matter (31.83%). The legumes are rich in nutrient elements and organic matter which are necessary for healthy growth of agricultural and forest crops.

Key Words: Legumes, plant growth, chemical composition, organic fertilizers, and soil fertility

Introduction

Ensuring food security has remained a major challenge for Nigerian government. A major constraint to crop production in Nigeria is related to the poor quality soils. In the South-Eastern states in particular, soil erosion and poor agricultural practices have increased the severity of poor quality soil. The soils have poor structure because low organic carbon content (0.51 t0 2.53%). The practice of shifting cultivation which helped in the past to restore soil fertility is no more a sustainable means of crop production because of population growth and increased demand for land. The approach of using inorganic fertilizers to boost agricultural production and to meet the food demand of the rapidly growing population has over-shadowed other fertilization techniques in Nigeria since early 80's because of the subsidy introduced by the government and the ready advantages associated inorganic fertilization (Adeniyan *et al.,* 2011; Uka *et al.*, 2013). Some of the advantages include; high concentration of nutrients such as Nitrogen, Phosphorous and Potassium needed by plants. The nutrients are more rapidly available for plant use, they are more convenient to use as they save time and effort associated with use of organic fertilizers, it resuscitates ailing crops faster, and it is more convenient and cheap to transport (Tisdale *et al*., 1990; Uka *et al.*, 2013). However there are serious challenges posed by the continuous application of inorganic fertilizers that cannot be overlooked. These include increasing soil acidity, eutrophication of nearby water bodies, damage to soil structure and growing unavailability and high cost of inorganic fertilizers (Tisdale *et al*., 1990;

Zublena *et al*., 1999; Ewulo, *et al*., 2007; Nwosu *et al.*, 2011; Mbah *et al*., 2011). These concerns, in addition to the environmental and biodiversity consequences of inorganic fertilizer usage, have in recent times shifted attention and interest to organic fertilization.

The use of organic fertilizers is not new in both agricultural and forestry practices of Nigeria. Even prior to the introduction of mineral fertilizer, about 80 years ago in Nigeria, soil fertility is maintained by use of manure, compost and the practice of leaving land fallow for some years (Mbah *et al*., 2011; Nwosu *et al.*, 2011). The major nutrient sources traditionally used by farmers, which includes; manure, woodland leaf litter, and terrnitarium soil, are largely derived from common pool resources (Campbell *et al.,* 1993; Mapfumo *et al*., 2001). The application of organic manure not only replenishes lost nutrients but also to improve the physical, chemical and biological properties of such ecologies (Hubbe *et al*., 2010; Mbah *et al*., 2011). However, the rising human population pressure has caused a rapid disappearance of such resources, including loss of grazing areas, as cultivated lands continue to expand (Mapfumo *et al*., 2001; Nwosu *et al.*, 2011). Although cattle manure remains the most commonly used organic fertilizer, it has a poor capacity to supply N and is only available to about 50% of the households in the smallholder farming sector (Mugwira and Murwira, 1997). As with cattle manure, key among challenges with organic manures is the difficulty of compounding all the needed nutrients in a single medium and achieving rapid release of the nutrient (Louisa and Taguiling, 2013). Thus, a method of increasing the available nutrient content of compost fertilizer have become very necessary (Louisa and Taguiling, *ibid*), and legumes could play a vital role.

Legumes, members of the large family of plants known as *Leguminosae,* are known for their high crude protein content. Among other uses such as food for humans, animal feed including grazing livestock in animal husbandry, as ground cover for protection of soil from erosion and suppression of weeds, legumes are very useful in soil nutrient and fertility management (Mapfumo *et al.*, 2001, Nwosu *et al*., 2011). Green manuring using leguminous cover crops has been a common strategy for farmers to enhance farm productivity and is currently being promoted (Rao and Mathuva, 2000; Ngome *et al.*, 2011; Nwosu *et al*., 2011). Not only do they fix highly needed nitrogen to the soil through the activities of microorganisms inhabiting their root nodules, their organic matter is rich in mineral elements such that leguminous cover crops add significant organic matter to the soil through leaf litter fall (Nwosu *et al*., 2011), It was reported that soils in which legumes are either grown or incorporated, enhanced chemical, physical and biological properties (Rao and Mathuva, 2000; Nwosu *et al.*, 2011; Ngome *et al.*, 2011). Thus, their vegetal matter is rich in mineral elements which when composted, could be used to effectively enhance the fertility of forest and agricultural soils.

Common indigenous forage legume of Nigeria include *Centrosema pubescens* Benth., *Mucuna pruriens* (Linn.) DC*, Calopogonium mucunoides* Desv.*, Stylosanthes capitata* Vogel*, Lablab purpurues* L. (Sweet)*, and Mucuna bracteater* DC. These legumes are found commonly growing in the wild, largely because much of their uses are relatively unknown (Karachi, 1997). This may also explain why some species e.g. *M. bracteata* is under threat of extinction (Chadburn, 2012). Although the above mentioned species are forage legumes well accepted as feed by animals, including chickens, ducks and pigs (Skerman, 1977), their biology and agricultural potentials have not received adequate research attention. For instance, Karachi (1997) reported that large diversity of ecotypes of *L. purpureus* still exist whose potentials for use in conjunction with native pastures has not been examined. The need to assess these legumes for production of nutrient-fortified compost towards enhancing soil fertility and boosting yield of agriculture and forest crops informed this research.

Materials and Methods

Study Area: The research was conducted in the Michael Okpara University of Agriculture Umudike (Lat. $5^0$30'N, Long.$7^0$31'E at altitude 122m). Umudike is situated within the rainforest zone where climate is essentially humid tropical. There are two distinct seasons: the rainy season covering March/April to October/November while the dry season starts in November and ends in March (Nwosu *et al*., 2011). The area has a bimodal pattern of rainfall which peaks in June and September with a short spell in August. Annual precipitation is an average 2,163mm. Maximum and minimum annual mean temperatures are 28^0C and 21^0C, and through the year insolation is high. The soil which is derived from coastal plain sediments is classified as ultisol and haplic acrisol (FDALR, 1990; 2000; Nwosu *et al*., 2011). The main occupation of the people in the region is subsistence farming. Though the vegetation is rainforest, much of forest estate have been destroyed leaving behind few patches of forest stands which are mostly protected areas (Akachuku, 2006).

Seed Collection: Seeds of the legume species (*Centrosema pubescens, Mucuna pruriens, Calopogonium mucunoides, Stylosanthes capitat, Lablab purpureum and Mucuna bracteater)* were collected by trained attendants from the parent legumes growing in the wild. A kilogram (1kg) by weight of seeds of the various species was collected.

Soil Analysis: Soil samples were collected randomly from three locations on each sub-plot using soil auger at 0cm - 20cm depth. The soil samples were bulked, mixed properly to ensure uniformity and sieved to remove large particles, roots and debris. A composite sample was then collected and analyzed for soil physicochemical properties (Table 1) at the soil laboratory of the National Root Crops Research Institute (NRCRI), Umudike, using conventional methods for soil analysis as described by Udo *et al.* (2001).

Table 1: Physico-chemical properties of soil of the experimental plot

Soil Properties	Values
Sand (%)	46.40
Silt (%)	19.40
Clay (%)	34.20
Texture	SCL
pH	4.40
P (mg/kg)	20.80
N (%)	0.156
OC (%)	1.88
OM (%)	3.25
Ca (cmol kg^{-1})	2.60
Mg (cmol kg^{-1})	1.00
K (cmol kg^{-1})	0.083
Na (cmol kg^{-1})	0.234
EA (cmol kg^{-1})	1.60
ECEC (cmol kg^{-1})	5.517
BS (%)	71.00

SCL = Sandy clay loam, CL = clay loam, SL = Sandy-loam

Planting: The seeds of the legume species were sown by direct seeding at 3cm depth and the nursery was maintained for 3 weeks after planting after which the seedlings were transplanted to the experimental plot.

Experimental plot and design: The experimental plot was established in an open space measuring 25m x 14m (350m^2) at the Nursery Unit of Department of Forestry and Environmental Management (FOREM), Michael Okpara University of Agriculture, Umudike. The site was manually cleared of existing weeds using hoes and cutlasses; and subsequently ploughed and harrowed. The plot was divided into six subplots of 4x14m (56m^2). The experiment was organized in a Randomized Complete Block Design in 3 replications, with the blocks separated by a 50cm open space boarder. The plot was maintained for eighteen (18) weeks.

Data collection: The legumes growth parameters –height (cm), number of leaves and number of branches were measured weekly. Plants height was measured using meter tape at a distance from the soil to the terminal bud. Number of leaves and number of branches were determined weekly by counting, while plants girth was determined using thread and meter rule. The dry matter (DM) weight of the legumes was determined at 4WAP, 8WAP, and 12WAP. Samples of the various legumes were carefully collected by uprooting plants from the plots. Soils were washed off uprooted plants with tap water, and the plants oven dried at 70^{0}C until a constant weight is achieved.

Plant analysis: The legumes samples were analyzed at the laboratory of the National Root Crops Research Institute (NRCRI), Umudike for mineral element composition using standard laboratory methods as described by Udo *et al.* (2001). The various legumes were analyzed for their mineral elements composition. The mineral elements composition which was determined include: N, P, K, Ca, Mg, Na, Org. C and Org. M.

Legumes harvesting: Harvest of the legumes vegetal matter was made from the experimental plots at 50% flowering of the species. The harvest consisted mainly of the leaves, vines and tendrils.

Data Analysis: Data collected were analyzed using the analyses of variance (ANOVA) statistical tool using SPSS software version 17. Significantly different means were separated using Duncan Multiple Range Test (DMIRT) at $p \leq 0.05$.

Result and Discussion

Elongation growth of the legumes (cm)

There was significant variation in the elongation growth of the various legumes across the various weeks (Table 1). At 1week after planting (WAP), *L. purpureus record a* significantly higher elongation growth (7.00±0.707) than the all the other legumes. It is followed by *M. Puriens* (4.80±0.374) and *M. Bracteata (*4.40±0.510), while *C.Mucunoides (*1.00±0.0000) recorded the least growth. At 2WAP however, *M. bracteata and M. Puriens with vine lengths of* 21.00±2.408 and 15.80±1.497 respectively have outgrown *L. purpureus (*9.40±0.510) and other legume species significantly. The findings supported Mathews (1998) who reported that *Mucuna* species are fast growing than other leguminous cover crops species. The two *Mucuna* species maintained their highest height value for each week throughout the period of the experiment. At 12WAP, *M. bracteata* has significantly higher vine length *(*477.80±29.802) than all the other legumes species followed by *M.Puriens (*303.80±107.946*) and L.purpureus (*238.40±13.537). *S. capitata* recorded significantly least vine length *(*58.20±4.521), followed by *C. Mucunoides (*108.40±8.140). All the legumes showed three distinguishable stages of growth during the experimental period: a lag phase, exponential phase, and a senescence phase. Thus, it is in agreement with Nwosu *et al.* (2011) that the legumes are short fallow species.

Number of Leaves of the Legumes

The number of leaves of the legumes varied significantly from 3 WAP, and becoming more varied with increase in time (Table 2). At 4 WAP, the Mucuna species (*M. bracteata* and *Mucuna pruriens*) had significantly highest number of leaves than all other legume species with leaf number values of 14.80±2.653 and 13.40±1.435 respectively. However, at the 12 WAP, *Stylosanthes capitata* followed by *L purpureus* had significantly highest number of leaves than other legume species, with values of 116.00±15.489 and 113.20±4.810 respectively. Tolerance of infertile soils could have conferred an advantage on *Stylosanthes capitata* resulting in the greater number of leaves over the other legume species since soils of southeast Nigeria have been reported as having poor fertility status (Nwosu *et al*., 2011, Omenihu *et al*., 2011). Thus the result will be supporting Grof *et al.* (1979) who reported that *Stylosanthes capitata* is tolerant of infertile soils. Moreso, whereas the other legumes have creeping, twinning and climbing habit, *S. capitata* is an erect perennial (Skerman, 1977). The erect habit of the species means a greater access to sunlight and consequently production of more leaves than the other legume species which only have greater opportunity to access light as a result of twinning on other nearby plants. The findings therefore support Akanvou (2001) who noted that leaves productivity of cover crop leguminious plants depends on solar radiation which provides the energy necessary for photosynthetic processes.

Number of branches of the legumes

Branch formation in the legumes started from the fifth week (Table 3). *Stylosanthes capitata* has significantly the highest number of branches (20.60±1.327) than all the other legume species at 12 WAP. It was closely followed by *L. purpureus* (113.20±4.810) while *C. mucunoides* had significantly least number of branches (42.60±2.522). Branch formation and leaf formation in plants are very similar physiological processes and are influenced by similar factors. Thus, tolerance of infertile soils by *Stylosanthes capitata* (Grof *et al.,* 1979) could have conferred an advantage of having a the greater number of branches on the species over the other legume species due to the poor fertility status of soils of southeastern Nigeria (Nwosu *et al*., 2011, Omenihu *et al.*, 2011). Again, as the only species that grows erect (Skerman, 1977) among the six legumes, *S. capitata* has a greater access to sunlight and consequently produced more branches than the other legume species. The findings therefore also support Akanvou (2001) who reported that leaves productivity of cover crop leguminious plants depends on solar radiation which provides the energy necessary for photosynthetic processes. Moreover, as branch formation from their vines is also determined by the available space around the species to get sun light and air which contribute to their biomass production (Peng and Aminah, 1997), an erect habit could also have benefitted *S capitata* to a greater number of branches than the other legumes.

Dry Weight of the legumes at various growth stages

Fig.1 shows the biomass dry matter production by the various legumes during their various stages of growth. The result shows that the pattern of growth in the legumes differed significantly. During the lag stage of the legumes development (WK 2-5), M. pruriens and M. bracteata recorded the highest dry weight values of 13.09±2.184 and 11.84±1.533 respectively. S, capitata and C. mucunoides recoreded the least dry weight values of 1.66±0.070 and 0.97±0.127 respectively. At the log/exponential stage, S.capitata recorded the highest dry weight of 143.93±30.059 indicating a rapid growthfrom its lag statge towards the mature stage. *C. mucunoides* recorded the least biomass addition of all the legumes through the periods of growth. The dry weight of the legume was the least during the lag stage (0.97±0.127), log stage (40.93±6.006), and the senescence stage (61.73±6,535) respectively. The findings did not support Skerman (1977) who reported that *C. mucunoides* establishes rapidly from seed to provide early ground cover. *M. bracteata* recorded the highest dry weight value (205.12±5.984) indicating a higher growth rate than the rest of the legumes. It is followed by *L.purpureus* with dry weight value of 176.67±31.550 and s. capitata with a dry weight value of 171.17±38.204. This could be indicative that *M. bracteata* has high capacity for Nitrogen fixation than the other legumes since it has been reported that on low-N soils, the amount of N fixed is closely correlated with legume dry-matter production (Skerman, 1977; Vallis *et al*, 1983). Similar high dry matter yield of *L.purpureus* was reported by Karachi (1997) who reported a DM leaf yield of 143.9 g/plant and stem yield of 161.2 g/plant. Similarly, Lukiwati (2007) reported a lower dry matter production of *Cenrtosema pubescens* against *Pueraria phaseoloides*. The result show that the growth pattern of the legumes differed significantly from the lag stage (2 - 5 WAG) through the log stage (5 – 10WAG) to the Senescence stage (!0WAG and above). All legumes however recorded increases in dry weight from the lag stage to the senescence stage.

Nutrient composition of the legumes

The nutrient content of the legume species did not follow any uniform pattern (Table 4). However, except in *S. capitata* with N content of 2.82%, all the legumes recorded N content of at least 3%. *C. mucunoides* has highest percentage N content of all the species with a value of 3.90%, followed by *L. purpures* (3.86%). *S. capitata* has the least N content value of 2.82%. Though N content of the legumes were significantly varied, all the legumes recorded higher value for nitrogen than other nutrient elements. McKey, (1994) similarly reported rich nitrogen content of legumes matter and noted that leguminous crops can add up to 500kg of nitrogen to the soil per ha per year. *Stylosanthes capitata* recorded highest value for P (0.868%), *L. purpurues for K* (1.600%) and Na (0.635%), *M. bracteata* for Ca (3.81%), *C. pubescens* for Mg *(1.46%), and C. mucunoides* for Organic carbon (18.46%) and organic matter (31.83%). The high organic matter content of the legumes suggests huge prospects of the legume materials for soil amendment as soil organic matter is known to perform diverse functionary roles in improving the physical, chemical and biological composition of the soil (Omotayo and Chukwuka, 2009). This is particularly essentially for soil amendment in the southeastern Nigeria where low activity clay (LAC) has made organic matter the hub around which soil fertility revolves (Omenihu *et al*., 2011). The result supported use of leguminous plants for improving soil fertility (McKey, 1994; Nwosu *et al*., 2011). According to Nwosu *et al*. (2011), besides direct fixation of nitrogen, leguminous cover crops add organic matter to the soil through leaf litter fall, which decomposes and improves soil organic matter, physical and chemical properties. Thus legume integration into farming systems have become an important component of integrated soil fertility management (ISFM) options for increasing soil fertility and agronomic efficiency of applied inputs (Vanlauwe *et al*., 2010, Mohammadi and Rokhzadi, 2012; Khaledian *et al*., 2014). The result also shows however that a legume species may not provide all the nutrient requirement by plant for healthy growth. In essence, even when cover cropping and green manuring with legumes, a mixed legume species on same farm or a rotation of legume species with farming season may result in improved output. It also confers potential benefit on compounding vegetal matter of different legumes in compost production.

Table 1: Elongation growth of legumes (cm)

SamplingWeeks	*M. Puriens*	*S.capitata*	*L.purpureus*	*C. pubescens*	*M. bracteata*	*C.Mucunoides*	F-statistic
Week 1	4.80 ± 0.37^{b}	0.80 ± 0.20^{d}	7.00 ± 0.71^{a}	3.00 ± 0.32^{c}	4.40 ± 0.51^{b}	1.00 ± 0.00^{d}	32.931***
Week 2	15.80 ± 1.50^{b}	4.40 ± 0.51^{d}	9.40 ± 0.51^{c}	4.20 ± 0.37^{d}	21.00 ± 2.41^{a}	1.00 ± 0.00^{d}	41.112***
Week 3	39.40 ± 4.68^{a}	8.40 ± 1.21^{b}	10.80 ± 0.74^{b}	8.80 ± 0.86^{b}	39.20 ± 3.25^{a}	1.49 ± 0.00^{c}	48.663***
Week 4	66.80 ± 5.81^{a}	12.00 ± 1.41^{b}	14.80 ± 0.86^{b}	15.60 ± 1.97^{b}	71.60 ± 4.52^{a}	1.82 ± 0.00^{c}	92.52***
Week 5	146.00 ± 10.0^{a}	15.40 ± 2.02^{b}	23.00 ± 5.55^{b}	23.00 ± 3.85^{b}	146.40 ± 18.20^{a}	2.40 ± 0.25^{c}	57.142***
Week 6	190.60 ± 6.43^{a}	33.00 ± 2.12^{b}	160.60 ± 10.77^{a}	68.80 ± 14.00^{b}	191.80 ± 28.32^{a}	4.40 ± 0.51^{c}	35.704***
Week 7	287.40 ± 24.99^{a}	37.60 ± 2.09^{d}	191.60 ± 6.83^{b}	96.60 ± 19.95^{c}	261.00 ± 22.57^{a}	7.80 ± 0.80^{d}	51.97***
Week 8	374.00 ± 24.43^{b}	42.60 ± 2.68^{e}	219.40 ± 8.78^{c}	112.40 ± 21.32^{d}	432.60 ± 24.69^{a}	19.40 ± 1.54^{e}	102.863***
Week 9	394.00 ± 41.91^{b}	47.00 ± 3.66^{e}	227.40 ± 10.44^{c}	118.00 ± 21.11^{d}	463.00±28.73a	41.80 ± 2.78^{e}	61.301***
Week 10	284.00 ± 105.47^{b}	50.20 ± 4.52^{d}	232.40 ± 9.08^{b}	120.00 ± 20.97^{c}	463.00 ± 28.73^{a}	65.80 ± 4.54^{d}	11.9***
Week 11	296.60 ± 107.27^{b}	55.40 ± 5.81^{d}	232.40 ± 9.08^{c}	122.00 ± 21.02^{c}	467.00 ± 29.28^{a}	97.40 ± 8.89^{d}	10.925***
Week 12	303.80 ± 107.95^{b}	58.20 ± 4.52^{e}	238.40 ± 13.54^{c}	124.00 ± 21.25^{d}	477.80 ± 29.80^{a}	108.40 ± 8.14^{d}	11.245***

Values are mean± standard error of three determinations. Value in each row followed by different superscripts is statisticall y significantly different at P=0.01 level Mean separation was done using Duncan multiple range test

Table 2: Number of leaves of legumes

SamplingWeeks	*M. Puriens*	*S.capitata*	*L.purpureus*	*C. pubescens*	*M. bracteata*	*C.Mucunoides*	F-statistic
Week 1	2.00 ± 0.00^{a}	2.00 ± 0.00^{a}	2.00 ± 0.00^{a}	2.00 ± 0.00^{a}	2.00 ± 0.00^{a}	2.00 ± 0.00^{a}	-
Week 2	2.80 ± 0.37^{c}	3.40 ± 0.25^{b}	2.20 ± 0.20^{d}	2.00 ± 0.00^{d}	4.00 ± 0.32^{a}	2.00 ± 0.0^{d}	12.047***
Week 3	6.80 ± 0.74^{b}	4.20 ± 0.37^{b}	4.40 ± 0.25^{b}	4.20 ± 0.37^{b}	11.20 ± 1.83^{a}	2.00 ± 0.0^{c}	14.506***
Week 4	13.40 ± 1.44^{a}	7.20 ± 0.58^{b}	7.40 ± 0.51^{b}	7.80 ± 1.02^{b}	14.80 ± 2.65^{a}	2.20 ± 0.20^{c}	11.826***
Week 5	24.60 ± 2.46^{a}	10.60 ± 1.12^{b}	8.80 ± 1.20^{b}	7.20 ± 1.24^{bc}	23.00 ± 1.92^{a}	3.60 ± 0.25^{c}	32.428***
Week 6	48.00 ± 2.83^{a}	49.40 ± 7.94^{a}	41.60 ± 6.62^{a}	23.60 ± 3.44^{b}	43.80 ± 2.65^{a}	4.00 ± 0.00^{c}	14.264***
Week 7	55.00 ± 2.56^{a}	73.60 ± 11.02^{a}	54.60 ± 6.39^{a}	33.40 ± 4.50^{b}	69.60 ± 7.42^{a}	5.20 ± 0.49^{c}	16.055***
Week 8	64.40 ± 4.43^{b}	98.00 ± 14.08^{a}	87.60 ± 7.43^{a}	43.40 ± 2.87^{b}	86.60 ± 7.00^{a}	9.80 ± 0.49^{c}	20.256***
Week 9	68.40 ± 1.43^{c}	106.00 ± 15.49^{a}	96.20 ± 6.60^{b}	54.00 ± 4.59^{d}	90.80 ± 7.08^{b}	15.40 ± 1.33^{e}	1.205^{ns}
Week 10	71.60 ± 3.96^{b}	108.20 ± 15.66^{a}	100.20 ± 4.81^{a}	57.20 ± 4.47^{c}	91.80 ± 7.09^{a}	19.80 ± 2.93^{d}	17.618***
Week 11	74.40 ± 3.70^{c}	110.40 ± 14.36^{a}	106.20 ± 4.81^{a}	64.20 ± 4.47^{c}	93.40 ± 7.60^{b}	28.20 ± 1.66^{d}	17.822***
Week 12	77.60 ± 3.669^{c}	116.00 ± 15.489^{a}	113.20 ± 4.810^{a}	70.20 ± 4.465^{c}	95.80 ± 3.262^{b}	42.60 ± 2.522^{d}	16.36***

Values are mean of three determinations± standard error. Value in each row followed by different superscripts is statisticall y significantly different at P=0.01 level Mean separation was done using Duncan multiple range test

Table 3: Number of branches of legumes

Week	*M. Puriens*	*S.capitata*	*L.purpureus*	*C. pubescens*	*M. bracteata*	*C. Mucunoides*	F-statistic
Week 5	3.40 ± 0.25^{ab}	3.20 ± 0.374^{ab}	3.00 ± 0.58^{ab}	2.40 ± 0.25^{b}	3.60 ± 0.40^{a}	-	14.933***
Week 6	3.60 ± 0.25^{b}	8.80 ± 1.80^{a}	5.40 ± 0.78^{b}	3.80 ± 0.37^{b}	5.20 ± 0.58^{b}	-	11.429***
Week 7	4.60 ± 0.60^{b}	13.40 ± 1.75^{a}	5.40 ± 0.25^{b}	5.40 ± 0.51^{b}	6.80 ± 0.58^{b}	-	27.663***
Week 8	6.20 ± 0.58^{c}	15.00 ± 1.87^{a}	7.40 ± 0.51^{bc}	6.00 ± 0.45^{c}	8.20 ± 0.86^{b}	2.80 ± 0.20^{d}	20.02***
Week 9	6.80 ± 0.58^{b}	16.60 ± 1.37^{a}	8.58 ± 0.37^{b}	6.80 ± 0.66^{b}	9.20 ± 0.86^{b}	3.60 ± 0.40^{c}	32.17***
Week 10	7.50 ± 0.58^{c}	17.80 ± 0.66^{a}	9.09 ± 0.37^{bc}	6.88 ± 0.66^{c}	9.51 ± 0.86^{b}	4.80 ± 0.37^{d}	56.471***
Week 11	7.80 ± 0.58^{bc}	18.60 ± 2.67^{a}	9.20 ± 0.37^{b}	7.40 ± 0.66^{bc}	9.89 ± 0.86^{b}	4.20 ± 0.49^{c}	16.63***
Week 12	8.20 ± 0.58^{b}	20.60 ± 1.37^{a}	9.74 ± 0.37^{b}	8.2 ± 0.66^{b}	9.98 ± 0.86^{b}	4.40 ± 0.40^{c}	29.247***

Values are mean± standard error of three determinations. Value in each row followed by different superscripts is statistically significantly different at P=0.01 level Mean separation was done using Duncan multiple range test

Table 4: Nutrient composition of the legumes

Legumes	Mineral elements (%)							
Species	**N**	**P**	**K**	**Ca**	**Mg**	**Na**	**Org. C**	**Org. M**
C. pubescens	3.82ab	0.412bc	1.078bc	3.41ab	1.46a	0.550b	17.54b	30.25b
M. pruriens	3.45bc	0.342c	1.520ab	3.01ab	1.16bc	0.450bc	16.52bc	29.79bc
C. mucunoides,	3.90a	0.44bc	1.140bc	2.20c	0.851c	0.160d	18.46a	31.83a
L. purpureus,	3.86a	0. 508b	1.600a	3.61a	1.22bc	0.635a	17.54b	30.25b
M. bracteata	3.28ab	0.381c	0.850c	3.81a	1.34ab	0.275cd	17.75b	30.60ab
S. capitata,	2.82c	0.868a	1.560ab	2.410bc	1.09bc	0.250d	17.50b	28.21c

Mean values followed by the same letters in the column are not significantly different ($P < 0.05$) by DMRT. Figures in parenthesis are the percentage compositions

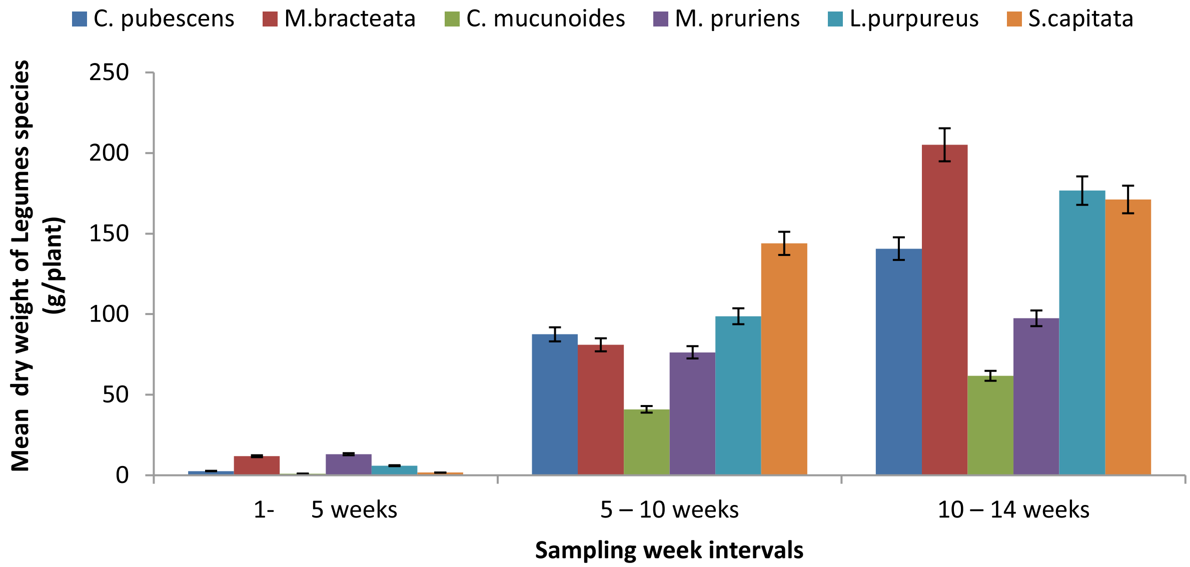

Fig. 1: Dry Weight of the legume at various growth stages

Conclusion

Legumes, known for their high crude protein content serve multiple uses to man. Some common indigenous legume species of Nigeria include *Centrosema pubescens*, *Mucuna pruriens, Calopogonium mucunoides, Stylosanthes capitata, Lablab purpurues. and Mucuna bracteater*. These legumes are commonly found growing in the wild largely because much of their uses are yet unknown, and this may be reason some are now under threat of extinction. Although the species are well accepted as feed by livestock, their biology and agricultural potentials have not received adequate research attention. Among other uses such as feed for animal including grazing livestock in animal husbandry, as ground cover for suppression of weeds and protection of soil from erosion, legumes are very useful in fertility management. Not only do they fix highly needed nitrogen to soil through the activities of microorganisms inhabiting their root nodules, their organic materials is rich in mineral elements such that leguminous cover crops add nutrients to the soil through leaf litter. However, the legumes vary in their growth characteristics, mineral element composition and biomass yield. Thus, it may be necessary to ascertain the mineral requirements of soils wherein organic fertilizers produced from the legumes is to be use so as to identify which of the legumes can best serve the soil nutrient requirements. Nevertheless, mineral composition of the legumes indicated that their vegetal materials is rich in mineral elements which should be available for crop use when composted. Thus, the legumes could compliment other organic sources of plants nutrient for the manufacture of a fortified organic fertilizer that could effectively improve the productivity of forest and agricultural soils.

Acknowledgements

The authors are grateful to the Tertiary Education Trust Fund (TETFUND) and Michael Okpara University of Agriculture, Umudike (MOUAU) for providing funding for the project on Producing Organic Fertilizers Using Locally Available Legumes for Forest Nursery Nutritional Management.

References

Adeniyan O. N., Ojo A. O., Akinbode, O. A. and Adediran J. A. (2011). Comparative study of different organic manures and NPK fertilizer for improvement of soil chemical properties and dry matter yield of maize in two different soils. *Journal of Soil Science and Environmental Management,* 2 (1) : 9 - 1 3 . http://www.academicjournals.org/JSSEM

Akachuku, A. E. (2006) Disappearing forests, the consequences and the challenges of sustainable development in Nigeria. Proceedings of 31st Annual Conference of Forestry Association of Nigeria (FAN) held in Markurdi, Benue State, Nigeria, 20th–25th November, 2006. Pp. 48 – 61.

Akanvou, R., Bastiaans, L., Kropff, M.J., Goudriaan, J., and M. Becker (2001). Characterization of Growth, Nitrogen Accumulation and Competitive Ability of Six Tropical Legumes for Potential Use in Intercropping Systems. *Journal of Agronomy and Crop Science*, 187 (2): 69--144

Campbell, B., Grundy, I. and Matose, F. (1993). Tree and woodland resources - the technical practices of small-scale farmers. In: *Living with Trees: Policies for Forestry Management in Zimbabwe.* Bradley, P.N. and McNarnara, N. (Eds.), World Bank Technical Report number 210. Washington D.C. Pp. 29-62.

Campbell, B.M. (1994). The environmental status of the Save catchment. In: Wetlands Ecology and Priorities for Conservation in Zimbabwe. Matiza, T. and Carter, S.A. (Eds.), IUCN, Gland, Switzerland. Pp. 21-24.

Chadburn, H. (2012). Mucuna bracteata. The IUCN Red List of Threatened Species 2012. e.T19891625A20113493. http://www.iucnredlist.org.details/19891625 Visited 15 February, 2018.

Chikoye, D. and F. Ekeleme (1999). Response of *Imperata cylindrica* to smothering by different Mucuna accessions. In: Cover crops for natural resources management in West Africa (Carsky, R.J., Eteka, A.C., Keatinge, J.D.H. and V.M. Manyong) (eds.). Proceedings of a workshop organized by IITA and CIEPCA, 26-29 October, 1999, Cotonou, Benin. Pp. 62-70.

Ewulo, B. S., Hassan, K. O. and Ojeniyi, S. O. (2007). Comparative effect of Cowdung manure on soil and leaf nutrient and yield of pepper. *International Journal of Agricultural Research,* 2 (12): 1043-1048.

FDALR (1990), Federal Department of Agriculture Land Resources Soil Map of Nigeria. Field soils Survey done and published by Soil survey division, Federal Department of Agriculture Land Resources (FDALR), Kaduna- Nigeria. 58pp.

Grof, B., Schultze-Kraft, R. and F. Muller (1997). *Stylosanthes capitata* VOG., Some agronomic attributes, and resistance to Anthacnose (*Colletotrichum gloeosporioides* Penz.). *Tropical Grasslands,* 13 (1): 28 -37.

Hubbe, M.A., Nazhad, M., and Sanchez, C. (2010). Composting as a way to convert cellulosic biomass and organic waste into high-value soil amendments: A review. *BioResources* 5(4):2808-2854.

Karachi, M. (1997). Growth and nutritive value of Lablab purrpureus in semi-arid Kenya. *Tropical Grasslands,* 31:214-218.

Khaledian, M.S., Mohammadi, K., and M. Javaheri (2014). Grain Yield and Yield Components of Soybean Affected by Integrated Fertilization Methods. *International Journal of Agriculture and Forestry*, 4(3A): 1-3 DOI: 10.5923/s.ijaf.201401.01

Louisa, M.A. and Taguiling, G. (2013). Quality improvement of organic compost using green biomass. *European Scientific Journal,* 9 (36): 1857 – 7881.

Lukiwati, D. R. (2007). Dry matter production and digestibility improvement of *Centrosema pubescens* and *Pueraria phaseoloides* with Rock fertilization and vam inoculation. *Jurnal Ilmu Pertanian Indonesia*, 9(1): 1-5

Mapfumo, P., Campbell1, B.M., Mpepereki, S. and Mafongoya, P. (2001). Legumes in Soil Fertility Management: The Case of Pigeonpea In Smallholder Farming Systems of Zimbabwe. *African Crop Science Journal,* 9(4):629-644.

Mathews, C. (1998). The Introduction and Establishment of a New Leguminous Cover Plant, *Mucuna bracteata* under Oil Palm in Malaysia. *The Planter,* 74 (860):: 359 - 368

Mbah, C.N., Nweke, A.I. and Njoku, C. (2011). Potentials of rice mill waste as soil amendment: Part 2: Effect on corn growth and changes in selected soil chemical properties. *Inter. Journal of Agricultural Sciences and Soil Science*, 2(2):072 – 076.

Mohammadi, K. and Rokhzadi, A. (2012). An integrated fertilization system of canola (*Brassica napus* L.) production under different crop rotations. *Industrial Crops and Products*, 37: 264-269.

Mugwira, L.M. and Murwira, H.K. (1997). *Use of Cattle Manure to Improve Soil Fertility in Zimbabwe:Past and Current Research and Future Research Needs.* Network Working Paper No. 2. Soil Fertility Network for Maize-Based Cropping Systems in Zimbabwe andMalawi. CIMMYT, Harare, Zimbabwe. 33PP.

Mulongoy, K. and Kang, B.T. (1986). The role and potential of forage legumes in alley cropping, live mulch and rotation systems in humid and subhumid tropical Africa. http://www.fao.org/Wairdocs/ILRI/x5488E/x5488e0g.htm visited again 16.02.2018

Ngome, A. F. E., Becker, M., and Mtei, K. M. (2011). Leguminous cover crops differentially affect maize yields in three contrasting soil types of Kakamega, western Kenya. *Journal of Agriculture and Rural Development in the Tropics and Subtropics,* 112 (1):1 -10.

Nwosu, P.O. and Chukwu,G.O. (2009). Liming potentials of leguminous species on a haplic acrisol in southeastern Nigeria. *Proceedings of the 33rd Annual conference of Soil Science Society of Nigeria, Ado Ekiti, Nigeria. 9-13th March, 2009*.

Nwosu, P.O., Chukwu, G.O. and Ikeorgu, J.G. (2011). Management of leguminous fallows to improve haplic acrisols of southeastern Nigeria for sustainable cocoyam production. *The Nigerian Journal of Agriculture,* 42:174-181.

Olorunfemi, I. E (2013). The Role Of Climate, Soil And Crop On SustainableAgriculture In Nigerian Ecological Zones: A Brief Overview, *Scientia Agriculturae,* 4 (1): 2013: 26-36

Omenihu, A.A., Nwaogu, E.N. and Ogumba, P.O. (2011). Effect of rice mill waste enriched with NPK fertilizer on the utilization of nitrogen in an ultisol in Umudike, Southeastern Nigeria. *ABSU Journal of Environment, Science and Technology*, 1:72-83.

Omotayo, O.E. and Chukwuka, K.S. (2009). Soil fertility restoration technique in sub-Saharan Africa using organic resources. *African Journal of Agricultural Research*, 4(3):144-150.

Peng, C. C. and Aminah, A. (1997). *Calopogonium mucunoides* Desv. Record from Proseabase. Faridah Hanum, I & van der Maesen, L.J.G. (Editors). PROSEA (Plant Resources of South-East Asia) Foundation, Bogor, Indonesia. http://www.proseanet.org/prosea/e-prosea_detail.php?frt=&id=61

Rao, M.R. and Mathuva, M.N. (2000). Legumes for improving maize yields and income in semi-arid

Kenya. *Agriculture, Ecosystems and Environment,* 78, 123-137.

Skerman, P J. (1977). *Tropical forage legumes.* FAO Plant Production and Protection Series No. 2. FAO, Rome. 609 pp.

SPSS Inc. (2008). Statistical Package for Social Sciences (SPSS) Version 17.0 for Windows. SPSS Inc., Chicago, IL, USA.

Tisdale, S.L., W.L. Nelson and J.D. Beaton, (1990). *Soil Fertility and Fertilizer: Elements Required in Plant Nutrition,* 4th Ed., Maxwell Macmillan Pub., Singapore. Op: 52–92.

Udo, E.J., Ibia, T.O., Ogunwale, J.A., Ano, A.O., and Esu, I.V. (2001). Manual of soil, plant and water analyses. Sibon books limited, Festac, Lagos.183pp.

Uka, U.N., Chukwuka, K.S. and Iwuagwu, M. (2013). Relative effect of organic and inorganic fertilizers on the growth of Okra [*Abelmoschus esculentus* (L.) MOENCH]. *Journal of Agricultural Sciences*, 58 (3): 159-166.

Vallis, I., Fergus, I. F. and Henzell, R.F. (1983). Role of legumes in soil improvement. In: Burt R L, Rotar P P. Walker J L and Silvey M W (eds). *The role of Centrosema, Desmodium, and Stylosanthes in improving tropical pastures.* Westview Tropical Agriculture Series, No. 6, Westview Press, Colorado. Pp. 231-246.

Vanlauwe, B., Bationo, A., Chianu, J., Giller, K.E., Merckx, R., Mokwunye, U., Ohiokpehai,. O, Pypers, P,, Tabo, R., Shepherd, K.D., Smaling, E.M.A., Woomer, P.L. and Sanginga, N. (2010). Integrated soil fertility management. Operational definition and consequences for implementation and dissemination. *Outlook Agric*., 39(1): 17-24

Zublena, J.P., Bird, J.V. and Lilly, J.P. (1999). Extension soil science specialist 1997 (DBL) Nutrient content of fertilizer and organic material. North Carolina Co-Operative Ext. serv. AG 439 18