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RESPONSE OF MAIZE *(Zea mays L.)* TO GREEN MANURE FROM VARYING POPULATIONS OF COWPEA IN A DERIVED SAVANNAH OF NIGERIA

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ABSTRACT

A field experiment was carried out at the Teaching and Research farm of the University of Agriculture, Abeokuta, located between longitude $7^{0}15^{'}$N and latitude $3^{0}25^{'}$E, a derived savannah in south western Nigeria. The study was carried out between April to September 2009 and March to August 2010 to investigate the effect of varying populations of two local cowpea varieties of contrasting growth habits on green manure production, using maize as test crop. Three population densities each of cowpea varieties Oloyin and Drum, and the control plots were arranged in a Randomized Complete Block Design and replicated three times. Six weeks after planting, the green manure was uprooted and incorporated in situ. The incorporated green manure was left for a week after which maize variety- SUWAN-IY was planted on all plots. All populations of cowpea variety Oloyin gave significantly higher biomass than all the populations of Drum in 2009; the highest significant fresh biomass was produced at 111,111 plants/ha. In 2010, Drum at 160,000 plants/ha and Oloyin at 111,111 plants/ha produced similar plant biomass ($p>0.05$) and were significantly higher than all other treatments. However, cowpea variety Drum at 80,000 plants/ha and Oloyin at 55,555 appeared to be more economical relative to other treatments in terms of seed requirements for optimum biomass production and maize grain yield. In 2009 maize grain yield was not significantly different between treatments. In 2010 however, both maize grain yield and cob girth were significantly increased ($p<0.05$) on green manure plots. Maize grain yield increased by 37-98% and 89-147% on green manure plots in 2009 and 2010**,** respectively relative to the control plots. In maize production systems in the derived savannah of Nigeria, 55,555 plants/ha of Oloyin and 80,000 plants/ha of Drum could be recommended for green manuring. This will be of immense benefit to the resource- poor farmers in this ecological zone.

Key words: cowpea population, green manure, maize

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INTRODUCTION

Maize (*Zea mays*) is the most important cereal crop in sub-Saharan Africa (SSA) and an important staple food for more than 1.2 billion people in SSA and Latin America. It is largely used as livestock feed and as a raw material for industrial products in industrialized countries [1]. Worldwide production of maize is 785 million tons, with the largest producer, the United States, producing 42%. Africa produces 6.5% and the largest African producer is Nigeria with nearly 8 million tons, followed by South Africa. Africa imports 28% of the required maize from countries outside the continent [1]. In 2010, Nigeria produced 7,305,530 tons of the total 844,405, 181 tons world production [2]. It is a major food crop in Nigeria where it is used as feed and remains an important crop for rural food security [3]. It is grown widely across the country and provides staple food for millions of Nigerians.

Constraints to maize production include climatic problems, weed infestation, pests, diseases, improper variety selection, poor performance of agricultural sector and declining soil fertility [4]. Efforts directed towards ameliorating soil fertility problems include use of land fallow and mineral fertilizer application [5]. Shortened fallow has been unable to sustain crop yields, while inorganic fertilizers are often scarce and expensive [5]. In Nigeria, both the Federal Government and the World Bank have identified high scarcity and low usage rates of mineral fertilizer as part of the major causes of the food problems in the country [6]. A major way of enhancing soil fertility is green manuring. This is the practice of incorporating *in situ*, easily decomposable plant material, either from crops grown specifically for organic fertilizer, or plant materials brought from outside the field [7]. It has also been defined simply as growing a crop and intentionally ploughing it under in order to improve the soil [8]. Research has shown almost universal beneficial effects of green manuring on rice yields and that green manure can substitute for up to 60-100 kg fertilizer nitrogen (N)/ha and many studies have shown that it can enhance the availability of native or applied phosphorus (P) and of micronutrients[7]. During the decomposition of the green manure crop carbon (IV) oxide (CO_2) production is increased. This enhances the solubility of lime and thus hastens the reclamation of alkali soil [7, 9]. A major benefit obtained from green manures is the addition of organic matter to the soil and about 40- 60% of the total amount of nitrogen contained in the green manure is available to the following crop [10]. It has also been reported that there is great potential in using green manure legumes to sustain maize yields for resource-poor farmers in Kenya [11]. In addition, maize yield response to green manure legumes was positive and higher than unfertilized maize and from natural vegetation fallow [12].

In spite of the enormous beneficial effects of green manuring, it is not a common practice among peasant farmers, who contribute up to 98% of the food consumed in Nigeria [13]. Challenges militating against the use of green manure include the fact that farmers are often reluctant to sacrifice time for food or cash crops production for improving the soil fertility only. Growing green manure results in direct costs of seed, and increase field work necessary for preparing the seedbed, incorporating the residues and possibly for mowing [14].A green manuring package that will be an acceptable technology to

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Nigerian farmers must therefore be simple and concise. One of the criteria for choice of green manure crop is that the seed of such crop must be readily available.

Cowpea (*Vignaunquiculata* L. Walp) is a common legume in Nigeria. African cowpea cultivars are mostly promiscuous and nodulate with indigenous Rhizobium strain present in the soil. Cowpea has a high potential as green manure and can provide the equivalent of 80 kg/ha of inorganic N to a subsequent crop when incorporated 8-10 weeks after planting [15]. Specific knowledge of appropriate population densities of cowpea for green manuring in the derived savannah ecological zone of Nigeria is imperative. This is because much of the work carried on earlier with respect to planting densities of cowpea in Nigeria focused much on grain production. When grain cowpea was intercropped with cassava, 80,000 plants/ha was reported to have given a higher monetary return when compared with 20, 50 or 75% of this population [16]. Similarly, spacing of 20 cm x75 cm and 50 cm x 75 cm for erect and spreading types respectively, had been recommended for grain production in Nigeria [17]. In spite of abundance of recommendations on adequate spacing/plant populations for both erect and spreading varieties of cowpea for grain production, information on optimum plant populations of the crop for the purpose of green manuring is scarce in Nigeria. The objectives of this study, therefore, were:

1. To evaluate the effect of varying populations of two local cowpea varieties of contrasting growth habits on green manure production
2. To evaluate the response of maize grain yield to cowpea green manure application in a derived savannah of Nigeria
3. To determine and prescribe an optimum cowpea population for green manuring in maize production systems in the derived savannah ecological zone of Nigeria.

MATERIALS AND METHODS

The study was carried out at the Teaching and Research farm of the University of Agriculture, Abeokuta, Ogun State, Nigeria; located between longitude $7^{0}15^{'}$N and latitude $3^{0}25^{'}$E in the derived savannah of south western Nigeria, between the months of April to September 2009 and March to August 2010. The pre-planting composite sample of the soil was taken and the results of the analysis are presented in Table 1; the same site was used in both years. There were seven treatments in the trial, laid out in a Randomized Complete Block Design and replicated three times. Two popular local varieties of cowpea (Oloyin and Drum) were planted at three different planting densities each, on six plots. The control plot did not receive any type of fertilizer but the inherent soil nutrient and this represented the local farmers' practice especially where there is no access to mineral fertilizer. The population densities of Drum in 2009 were 26,666, 40,000 and 80,000 per ha. This was doubled in 2010 by reducing the intra row spacing. The increase in population was conducted based on the low total biomass produced in the previous year and spaces left uncovered at incorporation. It was thought originally that being a spreading type, it will require wider spacing as practised for grain production, but this was found contrary at the time of incorporation in 2009. Thus, the planting densities in 2010 for Drum were 53,333(75cm x 25cm), 80,000(50cm x 25cm), and 160,000 (25cm x 25cm). Population densities for Oloyin were kept constant for both years at 55,555 (60cm x 30cm), 111,111 (30cm x 30cm) and 222,222 (30cm x 15cm).

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Spacing for grain production varies for the two varieties due to differences in growth habit where Oloyin grows erect, while Drum is the creeping type. After six weeks of planting, the green manure was uprooted and incorporated *in situ*; this was manually undertaken with the aid of a hand hoe. One week after the incorporation, maize (variety SUWAN-IY) was planted on the six green manure treated plots as well as the control plots at a planting spacing of 75cm x 50cm. Three seeds were sown per hole and then thinned to two seedlings per stand one week after emergence. Biomass yield from 2m x 2m ($4m^2$) as well as the dry weight of the green manure crop were recorded at 6 weeks after planting (WAP) in both years while additional information on plant height of the same, at 2 and 6 WAP were taken in 2010. The information on the plant height of cowpea was recorded in 2010 to complement the data collected on plant biomass. Maize plant height, 100 grain weight and grain yield were taken in both years while additional information on leaf chlorophyll content (using Minolta chlorophyll meter: model SPAD 502), canopy width, cob length, as well as cob girth were recorded in 2010. Five plants were measured per plot for plant height, canopy width and leaf chlorophyll content of maize while grain yield was measured from 2.25m X 2m ($4.5m^2$). The data collected were subjected to analysis of variance (ANOVA) and means were separated using the least significance difference (LSD) with GenStat discovery edition 3 [18].

RESULTS

Effect of plant population and varieties on plant height and biomass production of cowpea used as green manure

Plant heights for both cowpea varieties used as green manure in this study showed no significant ($p<0.05$) response to varying population densities at 2 and 6 WAP in 2010 (Table 3). There was, however, a slight increase in plant height as the population was increased from 53,333 to 160,000 plants/ha in variety Drum while variety Oloyin did not show any increase in plant height beyond population of 111,111 plant/ha. Plant biomass of both cowpea varieties showed significant response ($p<0.05$) to varying planting populations as revealed by both the fresh and dry weight in both years (Table 3). All populations of Oloyin gave significantly higher biomass than all the populations of drum in 2009, and of the three populations of Oloyin planted, the highest significant fresh biomass was produced at the 111,111 plants/ha. In 2010, however, Drum at 160,000 plants/ha and Oloyin at 111,111 plants/ha produced similar plant biomass and were significantly higher than all other treatments including Oloyin at 222,222 plants/ha. The superiority of the two varieties at the specified population was observed in both years.

Effect of varying population and varieties of preceding cowpea green manure on growth of succeeding maize

The plant height of succeeding maize was significantly different at 2, 8 and 10 WAP in 2009 (Table 4). At 8 and 10 WAP all green manure plots had taller ($p<0.05$) maize plants than the control plot, apart from maize on a preceding plot of cowpea grown at 55,555 plants /ha at 8 WAP. In 2010 there was no significant difference between the plant heights of maize across all treatments; however, all green manure treated plots produced taller plants than the control (Table 4). Similarly, canopy width of maize taken in 2010 also showed no difference ($p>0.05$) between all green manure and control plots.

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Nevertheless, the general trend showed that at 4, 6, 8 and 10 WAP, all green manure treated plots produced maize with wider canopy width (Table 5).

Effect of varying population and varieties of preceding cowpea green manure crop on the leaf chlorophyll content of succeeding maize

The leaf chlorophyll content of succeeding maize was not significantly affected by both variety and population of preceding cowpea green manure crop. However, all green manure treated plots produced maize with higher leaf chlorophyll content than the control plot (Figure1). The increase in chlorophyll content of maize was almost linear across all the treatments from 3-9 WAP.

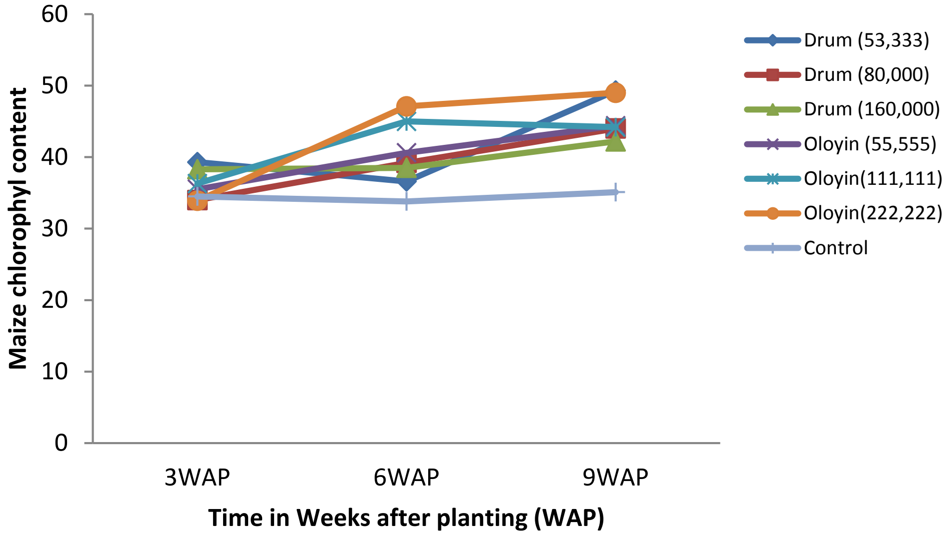

Figure1: Leaf chlorophyll content of maize as influenced by green manure application of varied population of two cowpea varieties

Effect of varying population and varieties of preceding cowpea green manure on the grain yield and yield components of succeeding maize

Maize grain yield and 100 grain weight showed no significant response to green manure treatment in 2009. However, both grain yield and 100 grain weight of maize on green manure treated plots were higher than the control plots (Table 6). In 2010 on the other hand, both maize grain yield and cob girth were significantly increased on green manure treated plots (Table 6). There was no significant difference between the grain yields of maize grown on different green manure plots; however, the highest grain yields in 2010 was from the plot preceded by Drum grown at 160,000, followed by the plot preceded by Drum at 80,000, Oloyin at 222,222 plants /ha and the least was from the control plot

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(Table 6). Maize grain yield was generally higher in 2010 relative to 2009 across all treatments. Percentage increase of maize grain yield over the control plots across the treatments for the two years were 37.1- 64.9 and 89.1 – 146.9 in 2009 and 2010, respectively for green manure from Drum; while 80.5 -97.7 and 92.5 – 135.4 in 2009 and 2010, respectively for variety Oloyin (Table 6).

DISCUSSION

The response of plant height of cowpea varieties to planting densities showed that increase in plant densities may have led to some degree of competition for light thereby causing slight elongation in the plant height. The wide margin observed between the fresh weight of the cowpea variety-Drum in 2009 as compared to 2010, as well as the differences in the dry weight between the two years was as a result of 100 % increase in population densities in 2010 for each Drum treatment relative to that used in 2009. The lower populations were adopted in 2009 because of the spreading habit of the variety Drum, however, Oloyin was observed to flower much earlier than Drum variety. Subsequently, Oloyin attained its maximum biomass accumulation within the six weeks before incorporation in contrast to Drum which did not flower until incorporation. Results obtained in both 2009 and 2010 suggest that planting at populations as high as 160,000 and 111,111 plants/ha of cowpea varieties Drum and Oloyin, respectively for the purpose of green manuring was superior in terms of total biomass produced to planting at lower or even at higher populations of each variety used in this study. This is because dry matter production changes little with the increase in plant population once most of the radiation has been intercepted [19]. The present finding for variety Oloyin is similar to the recommended 30-60 cm between rows and 10-15 cm between plants of cowpea, which translates to between 111,111- 333,333 plants/ha for fodder and green manuring in Australia [15]. The relatively higher plant height and wider canopy of maize on green manure treated plots relative to the control plots could be attributed to better nutrient availability to the maize in the green manure treated plots. Green manure generally increases soil nitrogen, soil organic matter and enhances availability of phosphorus [7, 10]. Overall, chlorophyll content in maize for all treatments increased with time. However, plants from the control plots generally registered lower chlorophyll content than those from the green manure treated plots. The increased chlorophyll content in turn reflects the nitrogen content of the plant and enhances photosynthetic capacity of the canopy. The linear increase in the chlorophyll content on the green manure treated plots could be due to gradual mineralization and release of nutrient from the incorporated green manure. Timely applications of organic materials with low Carbon to Nitrogen (C: N) ratio, such as green manure, could synchronize nutrient release with plant demand for short cycle crops with high demand such as maize [20, 21, 22]. Nutrients absorbed by green manure crops are gradually released or mineralized when the crop is incorporated into the soil and subsequently decomposes [9].

The general significant increase in grain yield of maize in green manure treated plots over the control plots especially in 2010, across both varieties and all the populations can be attributed to the positive contribution of the cowpea green manure to the fertility of the soil. Cowpea green manure increased grain yield of rice by 0.7 Mg/ha and incorporation of cowpea green manure led to a 30% higher grain yield of maize

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compared to plots that received 80 kg/ha inorganic nitrogen [13, 23]. The ear yields following green manure legumes have also been reported to be 33-39% higher than from fallow under unfertilized condition [24]. Similarly, cowpea green manure gave a grain yield increase of 77% (3.48 Mg/ha) above the control in South Africa [25]. In 2010, the manure in treated plots enhanced the performance of the crop leading to production of cobs that were longer and fatter than those from the control plots. The residual effect of the previous year trial could also have contributed to the grain yield increase. About 30-50 % of nitrogen fixed by legumes is available to the next crop while much of the remainder is incorporated into the soil organic matter and is gradually released to crops in succeeding years [9]. It has also been reported that although lesser amounts of nitrogen in the tissue of previous legumes is available for the second and third crop following a legume, increase in yields is apparent for two to three growing seasons [10]. Likely variations in elements of weather, particularly rainfall, during the growth and development of maize in the two years could have as well contributed to the differences in the maize grain yield. There was a marked decline in rainfall occasioned by August break in 2009 and this would have affected the filling of the grains, while in 2010 rainfall was abundant during the critical stage of the crop. Although the highest biomass was obtained from 160,000 plants/ha of variety Drum and 111,111 plants/ha of Oloyin, maize grain yield from 80,000 plants/ha of Drum and 55,555 plants/ha of Oloyin resulted in a similar grain yield increase above the control plot.

CONCLUSION

The results of this study showed that the highest biomass for green manuring using the two popular local cowpea varieties Drum(creeping type) and Oloyin(erect type) were 160,000 and 111,111 plants/ha, respectively. However, since the purpose of green manure is for enhanced crop production, growing cowpea variety Drum at 80,000 plants/ha and Oloyin at 55,555 appeared to be more economical relative to all other treatments in terms of seed requirements for optimum biomass production and maize grain yield.

RECOMMENDATION

For green manuring in maize production systems, 55,555 plants/ha of Oloyin and 80,000 plants/ha of Drum could therefore be recommended. This will be of prime importance to the resource-poor farmers who would want to minimize the cost of building and maintaining the fertility of the soil for crop production.

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Table 1: Chemical properties of the soil of the experimental site in Nigeria before planting

Soil Characteristics	Measured value
Soil pH(H_2O)	6.5
Available phosphorus	16.1 mg/kg
Organic carbon	14.0 g/kg
Total Nitrogen	1.5 g/kg
Exchangeable calcium	1.89 cmol/kg
Exchangeable potassium	0.40 cmol/kg
Exchangeable magnesium	0.66 cmol/kg

Table 2: Rainfall (mm) for 2009 and 2010

Month	2009	2010
January	0.0	4.4
February	59.1	41.2
March	67.3	58.9
April	273.5	112.7
May	286.8	169.6
June	258.0	100.8
July	221.5	322.4
August	56.8	266.6
September	337.3	257.6
October	141.4	172.3
November	55.8	94.7
December	0.0	0.0

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Table 3: The growth response of two cowpea varieties at different plant population densities in 2009 and 2010

Treatment Cowpea variety population/ha	Plant height (cm)		Fresh weight of Biomass(t/ha)		Dry weight of biomass (t/ha)	
	2WAP	6WAP	6WAP		6WAP	
	2010	2010	2009	2010	2009	2010
*Drum (53,333)	17.2	45.2	8.28	11.3	1.86	1.89
Drum (80,000)	17.3	48.8	6.91	15.1	1.49	2.49
Drum (160,000)	19.3	49.1	9.40	23.9	2.64	3.73
Oloyin (55,555)	18.5	47.1	17.55	16.1	3.84	2.67
Oloyin(111,111)	20.4	47.6	30.40	22.9	5.17	4.63
Oloyin(222,222)	17.5	47.1	25.88	17.2	5.50	3.18
LSD	NS	NS	2.485	4.80	0.552	1.11
SE $\pm$			1.131	2.19	0.251	0.51

WAP= week after planting NS= Non significant * All population of Drum was half of these values in 2009

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Table 4: Effect of varying population and varieties of preceding cowpea green manure on the height of the succeeding maize

Cowpea population/ha	Plant height of maize (cm)									
	2WAP		4WAP		6WAP		8WAP		10WAP	
	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010
*Drum (53,333)	12.93	15.9	47.7	53.8	122.13	130.1	173.5	177.3	174.5	185.7
Drum (80,000)	11.53	15.9	42.3	61.9	100.0	135.1	158.5	177.0	189.3	187.3
Drum (160,000)	9.66	18.3	42.4	50.9	108.2	124.2	162.8	163.7	175.6	182.2
Oloyin (55,555)	18.76	16.9	46.3	53.6	108.8	141.1	122.4	171.7	141.5	173.5
Oloyin(111,111)	17.83	16.9	49.3	49.3	122.5	124.7	143.9	168.3	158.3	176.9
Oloyin(222,222)	16.84	16.5	39.3	56.1	112.6	145.7	134.1	172.7	143.1	189.9
Control	13.60	14.5	42.7	37.9	65.1	113.3	94.7	130.5	118.3	136.5
LSD	5.097	NS	NS	NS	NS	NS	33.08	NS	21.87	NS
SE±	2.320						15.06		9.95	

WAP= week after planting NS= Not significant * All population of Drum was half of these values in 2009

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Table 5: Effect of varying population and varieties of preceding cowpea green manure on the canopy width of the succeeding maize plant in 2010

Cowpea population/ha	Canopy width(cm)				
	2WAP	4WAP	6WAP	8WAP	10WAP
*Drum (53,333)	26.2	69.9	90.0	86.7	103.3
Drum (80,000)	26.7	81.7	88.4	94.3	98.0
Drum (160,000)	29.6	69.7	91.5	86.7	105.7
Oloyin (55,555)	27.7	69.7	89.5	82.0	98.7
Oloyin(111,111)	26.8	66.2	90.1	90.3	97.0
Oloyin(222,222)	28.1	70.8	88.1	86.7	101.3
Control	22.7	53.8	72.0	72.3	82.3
LSD	NS	NS	NS	NS	NS

WAP= week after planting   NS= Non significant

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Table 6: Effect of varying population and varieties of preceding cowpea green manure on the yield parameters of the succeeding maize

Treatments Cowpea population/ha	100 grain weight (g)		Grain yield (t/ha)		Percentage increase of grain yield over the control plot		Cob girth(cm)		Cob length(cm)	
	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010
*Drum (53,333)	18.59	17.89	1.031	2.78	37.1	89.1	-	13.78	-	12.28
Drum (80,000)	19.74	19.19	1.240	3.59	64.9	144.2	-	14.37	-	12.70
Drum (160,000)	19.84	18.75	1.075	3.63	43.0	146.9	-	14.26	-	12.50
Oloyin (55,555)	20.79	18.58	1.487	2.98	97.7	102.7	-	13.75	-	11.40
Oloyin(111,111)	20.30	17.25	1.370	2.83	82.2	92.5	-	13.88	-	12.25
Oloyin(222,222)	21.28	18.98	1.357	3.46	80.5	135.4	-	14.06	-	11.73
Control	18.48	16.35	0.752	1.47	-	-	-	10.98	-	11.40
LSD	NS	NS	NS	1.078	-	-	-	1.939	-	NS
SE±				0.491				0.883		

NS= Non significant * All population of Drum was half of these values in 2009

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REFERENCES

1. **IITA.** International Institute of Tropical Agriculture *Maize programme*: *News and events* www.iita.org2012.

2. **GeoHive**- Maize (Corn) Production. http://www.geohive.com/Charts/org_maize.aspx. Accessed 14/12/2012.

3. **Kudi TM, Bolaji M, Akinola MO and DH Nasa'l** Analysis of adoption of improved maize varieties among farmers in Kwara State, Nigeria. *Int. J. Peace and Dev. Stud.* 2011; **1(3):** 8-12.

4. **Ismaila U, Gana AS, Tswanya NM and D Dogara** Cereals production in Nigeria: Problems, constraints and opportunities for betterment *African J. Agric. Res.*2010; **5(12)**: 1341-1350.

5. **Hossner LR and SRO Juo** Soil nutrient management for sustained food crop production in upland farming systems in the tropics. *Food and fertilizer technology centre publication*, 1999.1-17.

6. **Omotesho AO, Fakayode SB and Y Tariya** Curtailing fertilizer scarcity and climate change; an appraisal of factors affecting organic materials. *Ethiop. J. of Environ. Stud. and Mgt.* 2012; **5(3).**

7. **Abrol IP and SP Palaniappan** Green manure crops in irrigated and rain fed lowland rice-based cropping systems in south Asia. In: Proc. of a Symposium on Sustainable Agriculture, IRRI, Philippines 1988: 72-82.

8. **Chait J** Green manure. http://organic.about.com/od/organic_definition/Greenmanure.htm. Accessed 17/12/2012.

9. **COG.** Canadian organic growers Green manures *Field crop handbook*: 1.5. info@eap.mcgill.ca 1992.

10. **Squire GR** The Physiology of Tropical Crop Production. CAB International, Wallingford, Oxon. 1990: 197-199.

11. **Onyango RMA, Mwangi TK, N'geny JM, Lunzalu E and JK Barkutwo** Effect of relaying green manure legumes on yields of intercropped maize in smallholder farms of Trans Nzoia district, Kenya. Seventh Eastern and Southern African Regional Maize conference 11th -15th February, 2001.330-334.

12. **Sileshi G, Akinnifesi FK, Ajayi OC and F Place** Evidence for impact of green fertilizers on maize production in sub-Saharan Africa: a meta analysis. ICRAF occasional paper. Nairobi: World Agroforesty Center. http://ww.worldagroforestry.org 2009: 10 Accessed 14/12/2012.

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13. **Ozowa VN** Information needs of small scale farmers in Africa: The Nigerian example. *Quarterly Bulletin of the Int'l assoc. of agric. information specialist,* IAALD/CABI 1995; **40**:1.

14. **Peter K, Rayns F and A Rosenfeld** Green manures: A review conducted by HDRA as part of HDC Project FV 299.An investigation into the adoption of green manures in both organic and conventional rotations to aid nitrogen management and maintain soil structure 2008: 37.

15. **Whitbread A and J Lawrence** Cowpea fact sheet for Grain and Graze. *CSIRO Sustainable Ecosystems*, 2006; 1- 4.

16. **Njoku DN and CO Muoneke** Effect of cowpea planting density on growth, yield and productivity of component crop in Cowpea/Cassava intercropping system. *J. Trop. Agric. Food Env.and Ext.* 2008; **7(2):** 106-113.

17. **ICS-Nigeria** Information and communication support for agricultural growth in Nigeria Growing cowpea in Nigeria: *Commercial crop production guide series.* www.ics-nigeria.org. 2011: 1-7. Accessed 05/2011.

18. **GenStat discovery edition 3** www.vsni.co.uk. May 2011. Accessed 05/2011.

19. **Sullivan P** Overview of cover crops and green manures: Fundamentals of sustainable agriculture *ATTRA publication,* 2003: 1- 16.

20. **Burie ML** Legume green manure: Dry season survival and the effect on succeeding maize crops. *Soil management CRSP Tech. Bulletin 1992.*

21. **Lathwell DJ** Legume green manure: Principles of management based on recent research. *Trop. soils Tech. Bulletin.*1990.

22. **Sanchez PA, Palm CA, Szott LT, Curvas E and R Lal** Organic input management in tropical agro ecosystems, In: Dynamics of soil organic matter in tropical ecosystems. D.C.Coleman *et al*. (Eds), NIfTAL Project, Univ. of Hawaii, Honolulu. 1989:125-152.

23. **John PS, Pandey RK, Buresh RJ and R Prasad** Nitrogen contribution of cowpea green manure and residue to upland rice. *Plant and soil* 1992; **142(1):** 53-61.

24. **Turget I, Ahmet-Duman U and E Acikgoz** Effect of green manuring on the yield of sweet corn. *Agron.Sustain. Dev.*2005; **25**:4

25. **Odhiambo JJO, John BOO and M Thendo** Effect of green manure legume - maize rotation on maize grain yield and weed infestation levels. *African J. Agric.* 2010; **5(8):** 618-625.

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