**Growth of Cowpea (*Vigna unguiculata* (*L.*) Walp.) and Weed Infestation as Affected by Cultivar and N-Sources in Minna, Niger State.**

M.A. Yusuf1, A.O. Uzoma2, A.Y. Mamudu1 and M. T Salaudeen1

*1. Department of crop production, Federal university of technology, Minna.*

*Email:* *yusuf.pg813287@st.futminna.edu.ng*

*Phone No: +2348140001799*

*2. Department of Soil Science and Land Management, Federal University of Technology, Minna.*

*Email:* *uzo\_ozo@yahoo.com*

*Phone No: +2347060915615*

**Abstract**

*A screen house experiment was conducted early in 2019 at the screen house of the Department of Soil Science and Land Management, School of Agriculture and Agricultural Technology, Federal University of Technology, Gidan-kwano campus, Minna, Niger State, to investigate the response of some selected cowpea cultivars to three sources of Nitrogen. Three cowpea cultivars (SamPea 15, SamPea 16 and Kananado white) were tested against three Nitrogen sources in sole and combined form (Control, 30kg urea N, 30kg urea N + Agrolyzer, Gw5 inoculant, 30kg urea N + Agrolyzer + Gw5 inoculant). The experiment was laid out in a Completely Randomized Design (CRD) replicated three times. The outcome of the experiment showed that SamPea 16 significantly increased the plant height, lowered weed density, lowered weed dry weight, increased branches, number of leaves, leaf area, as well as shoot and root biomass compared to SamPea 15. On the other hand, 30kg urea N + Agrolyzer + Gw5 inoculant significantly produced tallest plant, lowest weed density, lowest weed dry weight, more branches, leaves, leaf area, more shoot and root biomass, though statistically similar to the use of urea or Gw5 inoculant alone. Gw5 inoculant alone also improved nodule number and nodule dry weight. SamPea 16 can therefore inoculated with Gw5 inoculant to supplement the nitrogen supplied in cowpea production and curb the menace of the abuse of inorganic fertilizer in the advent of global warming.*

***Keywords****: Cowpea, Cultivars, Growth, Infestation, N-Source and Weed*

**1.0 INTRODUCTION**

Nitrogen is an essential nutrient for plant growth, development and reproduction. Despite nitrogen being one of the most abundant elements in the atmosphere, it is still the most limiting nutrient controlling the primary production of agricultural systems (Fagodiya *et al.,* 2017), leading to a steady decline in food production system. Inspite of the low soil fertility, application of mineral fertilizer to leguminous crop such as cowpea in tropical Africa is not a common practice due to the crop’s ability to fix atmospheric nitrogen with rhizobia (Kan`ankuk`a, 1999). Regardless of this N fixing ability, a positive response of cowpea to the application of organic and inorganic fertilizer has been reported by several authors from various cowpea grown areas (Madukwe *et al.,* 2008; Singh *et al.,* 2011a) especially when they used nitrogen (Amujoyegbe and Alofe, 2003; Singh *et al.,* 2007; Daramy *et al.,* 2016). This has prompted farmers to amend soil with different N-sources, both organic and inorganic in order to enhance growth and increase yield. However, to avoid long-term negative cumulative effects of inorganic fertilizer on the soil, the use of organic fertilizer is usually suggested (Abayomi *et al.,* 2008). However, organic manure is usually required in large quantity to sustain crop production and may eventually not available, hence the need for rhizobia inoculation.

Weed is however another factor constraining the productivity of agricultural crops, when not properly managed in a famers field, it could reduce cowpea yield by 82 % whereas significant increase in pod yield could be recorded when weeds were controlled up to 45 days of sowing (Tripathi and Singh, 2001). Various approaches could be employed in controlling weeds. Presently, the most commonly employed method in cowpea weed control are manual, mechanical or the use of chemicals. All these approaches have certain limitation such as non-availability of labor at right time and financial instability of the peasant farmer (Taramani *et al.,* 2017) or contamination of the natural ecosystem by the use of chemicals. Contrary to these, cultural method of weed control such as choice of crop species, crop cultivars, planting density, crop geometry, inter cropping, crop rotation, time of sowing; crop rotation, fertilizers and irrigation practices have profound effect on weed suppression (Taramani *et al.,* 2017).

In view of this, a study was conducted to evaluate the growth of cowpea and weed infestation as affected by cultivar and N-sources in Minna.

**2.0 MATERIALS AND METHODS**

*2.1 Study Area*

This study was conducted early in 2019 at the screen house of the Department of Soil Science and Land Management, School of Agriculture and Agricultural Technology, Federal University of Technology, Gidan-kwano campus, Minna, Niger State. Minna stands on the geographical coordinate of 0060 27` 240`` E and 090 31` 735`` N, which is 208 m above an average sea level. It has a sub-humid climate with a mean annual rainfall of 1284 mm (90 %of which falls between the month of June and August). The mean maximum temperature remains high throughout at about 33.5 oC particularly in March and June (Ojanuga, 2006).

*2.2 Soil Sampling and Analysis*

The soil used for this experiment was gotten from the Experimental Research Farm of the School of Agriculture and Agricultural Technology, Federal University of Technology, Minna. Prior to pot filling, soil samples were collected from ten points within the plot marked for field experiment at the depth of 0-15cm using soil auger. Soil collected was bulked to form a composite. A substantial portion was used to fill the pots with 2 kg soil per pot while about 125 g of soil was passed through 0.5 mm and 2 mm sieve in preparation for physical and chemical analysis as described by ISRIC/FAO (2002). Indigenous rhizobia population of the soil sample was enumerated by MPN count.

*2.3 Treatments and Experimental Designs*

Treatment consisted of three cowpea cultivars (*SamPea* 15, *SamPea* 16 and *Kananado* white) receiving 2 N-sources in sole and combined form (Control, 30kg urea N, 30 kg urea N + Agrolyzer, Gw5 inoculant, 30 kg urea N + Agrolyzer + Gw5 inoculant), arranged in a 3 by 5 factorial layout fitted to a Completely Randomized Design (CRD) replicated three times.

*2.4 Planting and Crop Management*

Two kilograms of the sieved soil were measured into poly pots, and thoroughly mixed with basal dose of phosphate fertilizer at the rate of 30 kg P per hectare which is equivalent to 0.27 g per pot prior to planting of four seeds per pot and later thinning to two seedling per pot. Thereafter, the seedlings received basal applications of 20 kg N ha-1 as 0.05 g pot urea followed by the application of various fertilizer treatments earlier mentioned. Inoculant used (Gw5) was obtained from the Laboratory of the Department of Soil Science and Land Management, Federal University of Technology, Main Campus, Gidan-kwano, Minna. Rhizobium isolate GW5, is an indigenous rhizobium isolate that has about 96.32 % similarity with BGC8 rhizobium strain that infect cowpea in Bangladesh. GW5 has percentage symbiotic effectiveness that is greater than 120 % i.e., the amount of N-fixed by GW5 is higher than 100 kg N ha-1.

*2.4.1 Weed and Pest Control*

Weeding was done manually by hand picking while the pests were control by the application of organophosphate insecticides as the plants attained 4 weeks after sowing at five days interval at the rate of 1.5 litres per hectare. The active ingredients contained in the organophosphate insecticides are lambda-cyhalothrim 2.5% E.C. and dimethoate at the rate of 15g/l and 300g/l respectively.

*2.5 Weed Species Assessment*

Weed species were assessed at 3 and 6 weeks after sowing. Weeds observed in each pot were cut at soil level, identified, and counted to obtain the weed density in number per meter square after which they were bulked into one sample and oven dried to a constant weight at the temperature of 65oC. Plant data collection were growth parameters which include the plant height, number of leaves per plant, number of branches per plant and leaf area at 3 and 6, while nodule assessment, shoot and root biomass were collected at harvest.

*2.7 Harvesting and Data Collection*

At harvest (6WAS), the plant shoots were cut at soil level using a clean pair of shears. The shoots from each treatment plots were packed separately into paper envelopes, while the plant roots were carefully dug out and the soil gently washed with water from the roots over a metal sieve. Nodules were detached from the roots gently, counted and packed separately in paper envelopes per treatment plots. All the enveloped plant materials (shoots and nodules) were then taken to the laboratory, oven dried at 65 oC to constant weight for 72 hours. Thereafter, the shoot and nodule dry biomass were determined and recorded.

*2.8 Statistical Analysis*

All data collected and variables calculated were subjected to two-way Analysis of Variance (ANOVA) using the GLM procedure of SAS package version 9.0 (SAS Institute, 2002) and where the F-values were found to be significant, the treatment means were separated by Least Significant Difference (LSD) at 5% probability level.

**RESULTS AND DISCUSSION**

Table 1. Shows the result for the soil physical and chemical properties of the experimental field. According to Esu (1991), the loam soil was revealed to be slightly acidic, very low in organic carbon and total nitrogen.

The available phosphorous of 6.33 mg kg-1 was less than the soil critical available P level of 7.0 mg kg-1 required for proper growth and development of cowpea (Aune and Lai, 1995). This necessitated the application of SSP fertilizer at the rate of 30kg ha-1 as recommended by Haruna and Usman (2013) as a basal dose for enhancing N2 fixation in cowpea. On the other hand, the low soil total nitrogen indicate the need for external N input to compliment Biological Nitrogen Fixation (BNF).

Organic carbon content of the soil was low according to Esu rating (1991) and this may be due to low organic inputs. This may also be responsible for the low level of soil nutrients observed. This is consistent with the report of Ayodele and Oso (2014) who reported that soil organic matter influenced nutrient retention and should be managed to prevent rapid depletion of soil nutrients.

**Table 1: Initial physical and chemical properties of the soil in the experimental field.**

|  |  |  |
| --- | --- | --- |
| Parameters | Values | Rating |
| Sand (g kg-1) | 429 |  |
| Silt (g kg-1) | 488 |  |
| Clay (g kg-1) | 83 |  |
| Textural class | Loam  |  |
| pH (H2O) | 6.47 | Slightly acidic |
| pH (CaCl2) | 5.39 |  acidic |
| Total Nitrogen (g kg-1) | 0.19 | Medium  |
| Available P (mg kg-1) | 6.33 | Low  |
| Organic Carbon (g kg-1) | 0.68 | Very low |
| Exchangeable Bases (cmol kg-1) |  |  |
| Ca2+ | 1.57 | Low  |
| Mg2+ | 0.48 | Medium |
| K+ | 0.10 | Low |
| Na+ | 0.61 | High |
| Exchangeable Acidity (cmol kg-1) | 0.60 |  |
| ECEC (cmol kg-1) | 3.36 | Low  |

Rating adopted from Esu (1991)

The results of the effect of cultivars and N-sources on weed parameters are represented in Table 2. These results has indicated that the weed density was significantly (P ≤ 0.05) affected by crop varieties and N-sources. *SamPea* 16 produced the lowest weed density throughout the sampling period, though it was not statistically different from the local check (*Kananado* White) especially at 3 WAS compared to *SamPea* 15 which had the highest weed infestation. The lowest weed density observed under *SamPea* 16 compared to *SamPea* 15 could be attributed to differences in their anatomy, morphology and physiology which differentiated their ability to absorb nutrients and water from the soil and carry out effective photosynthetic process to form wider canopies. This observation supports the report of Aaron (2009) who stated that crop varieties can vary substantially in response to weed competition, with those that form canopy earlier and provide more shading being the most competitive.

Similarly, the combination of the 2 N-sources + Agrolyzer produced the lowest weed density and weed dry weight though weed density was not significantly different from that obtained as a result of the use of Gw5 inoculant alone. The lowest weed dry weight observed when Urea + Agrolyzer + Gw5 inoculant were used could be related to the presence of micronutrient in the combination which enhanced nutrient uptake and assimilation in favour of the crop. This finding is in line with the work of Uzoma *et al.* (2013b) who maintained that inclusion of micronutrient improved the nutrients uptake and translocation of assimilates.

The interaction between crop varieties and nutrient combination did not significantly (p>0.05) affect weed density and weed dry weight across sampling period. This further supports the fact that with or without addition of nutrients, there will be a significant reduction of weed density by *SamPea* 16 and *Kananado* white over *SamPea* 15.

Height performance of the various cultivars of cowpea receiving different N-sources are presented in Table 3. The result of this experiment shows that cultivar significantly (P ≤ 0.05) affected plant height in the sense that *SamPea* 16 produced the tallest height which was statistically similar to the height produced by the local check but significantly different from the height of *SamPea* 15 at 6 WAS. The differences in plant height could be attributed to phenotypic as well as genetic make-up of the varieties (Magani and Kuchinda, 2009). The tallest plant height recorded with the application of Urea alone could be related to the effect of readily available inorganic Nitrogen which plays a vital role as a constituent of protein, nucleic acid

**Table 2: Effect of the Cultivar and N-sources on Weed Density and Weed Dry Weight**

|  |  |  |  |
| --- | --- | --- | --- |
|  | Weed Density (per unit area |  | Weed Dry Weight (g plant-1) |
| 3 WAS | 6 WAS | 3 WAS | 6 WAS |
| Varieties (V) |  |  |  |  |  |
| Kananado white | 4ab | 5 a |  | 1.58 a | 1.58 a |
| SamPea 15 | 5a | 6 a |  | 1.68 a | 1.68 a |
| SamPea 16 | 3b | 4 b |  | 1.27 a | 1.27 a |
| SE± | 0.45 | 0.57 |  | 0.26 | 0.28 |
| Nitrogen sources (N) |  |  |  |  |  |
| Control | 8a | 9 a |  | 2.30 a | 2.96 a |
| Urea | 6b | 6 b |  | 2.01 a | 3.08 a |
| Urea + Agrolyzer | 4c | 6 b |  | 1.79 a | 2.47 a |
| Gw5 inoculant | 2cd | 3 c |  | 0.69 b | 1.11 b |
| Urea + Agrolyzer + Gw5 inoculant | 1d | 2 c |  | 0.63 b | 0.94 b |
| SE± | 0.58 | 0.74 |  | 0.33 | 0.37 |
| Interaction |  |  |  |  |  |
| V \* N | NS | NS |  | NS | NS |

Means with the same letter(s) are not significantly different at 5 % level of probability.

WAS = Week After Sowing NS = not significant

and chlorophyll which is essential for building up protoplasm and protein when optimally applied (Rizvi and Khan., 2018). This corroborate with the result reported by Abayomi *et al.* (2008) who stated that plants given inorganic nitrogen during vegetative period were much larger by the onset of flowering than those dependent on symbiotic N fixation. The effect of interaction between cowpea cultivar and N-source on plant height were recorded in Table 4. The result revealed that planting *SamPea* 16 without any fertilizer input produced the tallest plant height at 3 WAS suggesting that *SamPea* 16 could probably be nutrient efficient. Inoculation with Gw5 also produced the tallest plant height at 3 WAS compared to plants without any fertilizer input (Table 5). This suggests that nitrogen fixing ability of the inoculant used could be comparable to that of indigenous rhizobia. This can however be confirmed only when the shoot biomass accumulations are comparable. The tallest plant height obtained by *SamPea* 16 at 6 WAS when treated with urea alone is an indication that nitrogen enhances vegetative growth. The extent of enhancement will however depend on crop variety.

**Table 3: Cowpea Growth as Affected by Cultivar and N-Sources**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | Plant Height (cm) |  | Number of Branches |  | Number of Leaves |  | Leaf Area (cm2) |
|  | 3 WAS | 6 WAS |  | 3 WAS | 6 WAS |  | 3 WAS | 6 WAS |  | 3 WAS | 6 WAS |
| Varieties (V) |  |  |  |  |  |  |  |  |  |  |  |
| Kananado white | 14.3 a | 27.2ab |  | 2a | 8a |  | 9 a | 42 a |  | 18.52 a | 38.06 a |
| SamPea 15 | 15.8 a | 26.4 b |  | 2a | 6b |  | 8 a | 34 b |  | 19.36 a | 33.79 b |
| SamPea 16 | 15.6 a | 29.4 a |  | 2a | 8a |  | 8 a | 40ab |  | 17.80 a | 37.41ab |
| LSD (0.05) | 0.51 | 0.87 |  | 0.18 | 0.46 |  | 0.50 | 2.14 |  | 1.27 | 1.27 |
| N-sources (N) |   |   |  |   |   |  |   |   |  |   |   |
| Control | 15.2ab | 22.61 d |  | 2b | 6b |  | 8ab | 33 b |  | 19.65 a | 29.74 c |
| Urea | 13.6 b | 32.41 a |  | 3a | 9a |  | 10 a | 36ab |  | 19.17 a | 44.99 a |
| Urea + Agrolyzer | 15.3ab | 24.8cd |  | 2b | 7b |  | 9ab | 44 a |  | 17.53 a | 39.23 b |
| Gw5 inoculant | 16.5 a | 28.0bc |  | 2b | 7b |  | 7 b | 41ab |  | 18.60 a | 36.76 b |
| Urea + Agrolyzer + Gw5 inoculant | 15.4ab | 31.2ab |  | 2b | 9a |  | 9ab | 38ab |  | 17.90 a | 30.35 c |
| LSD (0.05) | 0.66 | 1.12 |  | 0.22 | 0.58 |  | 0.65 | 2.76 |  | 1.64 | 1.64 |
| Interaction |   |   |  |   |   |  |   |   |  |   |   |
| V \* INM | \* | \*\* |  | NS | NS |  | NS | NS |  | NS | NS |

Means with the same letter(s) are not significantly different at 5 % level of probability.

WAS = Week After Sowing NS = not significant \* = significant \*\* = highly significant

**Table 4: Effect of Interaction between Cowpea Varieties and N- sources on Plant Height.**

|  |  |  |  |
| --- | --- | --- | --- |
|  | Plant Height at 3 WAS |  | Plant Height at 6 WAS |
|  | Kananado white | SamPea 15 | SamPea 16 |  | Kananado white | SamPea15 | SamPea 16 |
| Nitrogen sources |  |  |  |  |  |  |  |
| Control | 13.0d | 14.93bc | 17.57 a |  | 23.01gh | 23.33gh | 21.50h |
| Urea | 16.0ab | 14.00cd | 10.93e |  | 34.77b | 24.43fg | 38.03 a |
| Urea + Agrolyzer | 14.25cd | 16.37ab | 15.63bc |  | 23.13gh | 26.60ef | 25.38efg |
| Gw5 inoculant | 14.87bc | 17.37 a | 17.40 a |  | 26.41ef | 27.47de | 30.22cd |
| Urea + Agrolyzer + Gw5 inoculant | 13.05d | 16.13ab | 16.27ab |  | 31.45c | 30.17cd | 31.97bc |
| SE± | 1.14 |  | 1.94 |

Means with the same letter(s) are not significantly different at 5 % level of probability

This is consistent with the work of Uzoma *et al*. (2013a) who reported that inclusion of nitrogen increases dry matter accumulation of soybean. Rizvi and Khan (2018) also reported that adequate supply of nitrogen is essential for vegetative growth of legumes.

The effect of cowpea varieties and N-sources on number of branches, number leaves and leaf area were shown in Table 3. The observed significant performance of *Kananado* white and *SamPea* 16 in terms of number of branches, number leaves and leaf area show variation in the anatomical, morphological and physiological structures of these crop varieties which made them readily able to absorb nutrients and water from the soil, carry out effective photosynthetic process and store more photosynthates than *SamPea* 15. This finding supports the earlier reports of Agbogidi and Ofuoku (2005), Alhaji (2008), Futuless and Bake (2010), Agbogidi and Egho (2012) who opined that response of plants to environmental factors differ based on their genetic makeup and their adaptation capability indicating variability among species. On the other hand, N-sources produced significant (P ≤ 0.05) effect on number of branches, number of leaves and leaf area. The increase in number of branches, leaves and wider leaf area recorded when 30 kg Urea was used buttressed the fact that inorganic nitrogen promotes heavy and luxurious vegetative growth. Similar response was reported by Abayomi *et al.* (2008) who concluded that inorganic nitrogen promote vegetative growth in plants even in cowpea.

*SamPea* 16 produced the heaviest shoot and root biomass that is statistically similar to the *Kananado* white but different from *SamPea* 15 (Table 6). The varietal difference observed in the cowpea cultivar in response to shoot and root biomass could be as a result of a positive correlation that exist between shoot and root biomass and other growth parameters such as height, branches, leaves and leaf area or an improvement in hybrid vigour of the cultivar which translated to its ability to convert nutrients more efficiently and effectively to cellular materials for cell division and elongation as reported by Abukutsa (2011).

Variation in N-sources also produced a significant effect on shoot and root biomass (Table 6). Pots treated with urea alone had the heaviest shoot and root biomass, confirming the fact that urea is essential for vegetative growth and plays important role in various metabolic process of the plant including being an essential constituent of protein and chlorophyll (Meena *et al.,* 2014). Although, cowpea is known to obtain most of its nitrogen requirements through symbiotic fixation of the atmospheric nitrogen, the importance of externally applied N has been

**Table 5: Cowpea Shoot Weight, Root Weight and Nodule Production as Affected by Cultivar and N-Sources**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  |  | DSW | DRW | DNW | NNPP |
| Varieties (V) |  |  |  |  |
| Kananado white | 29.36 a | 5.78 a | 1.75 a | 38 a |
| SamPea 15 | 25.16 b | 4.54 b | 1.15 a | 25 b |
| SamPea 16 | 30.14 a | 4.95ab | 1.08 a | 35ab |
| SE± | 1.09 | 0.32 | 0.27 | 4.21 |
| Nitrogen sources (N) |  |  |  |  |
| Control | 24.18c | 3.61 b | 1.37ab | 30a**b** |
| Urea | 33.79 a | 6.22 a | 0.62 b | 30ab |
| Urea + Agrolyzer | 25.14bc | 3.98 b | 1.43ab | 32ab |
| Gw5 inoculant | 29.15 b | 6.00 a | 1.80 a | 45 a |
| Urea + Agrolyzer + Gw5 inoculant | 29.30 b | 5.84 a | 1.40ab | 25 b |
| SE± | 1.40 | 0.42 | 0.37 | 5.44 |
| Interaction |  |  |  |  |
| V \* N | NS | NS | NS | NS |

Means with the same letter(s) are not significantly different at 5 % level of probability. WAS = Week After Sowing NS = not significant DSW= Dry Shoot Weight DRW = Dry Root Weight

DNW = Dry Nodule Weight NNPP = Number of Nodule Per Plant

documented by several workers (Abayomi *et al.,* 2008) including Dart *et al*. (1977) who further stress that application of a small quantity of inorganic nitrogen (20 kg N ha‑1) enhanced early vegetative growth as obtained in the present study. There is no significant interaction effect between the cultivar and N-sources on shoot and root biomass.

Nodulation response of the cowpea cultivars to N-sources was presented on Table 6. The local check produced the heaviest nodule weight and highest effective nodule number followed by *SamPea* 16. The significant variation in nodulation amongst varieties could be attributed to the superiority in genetic constituents of individual varieties (Ayodele and Oso, 2014). Although, the Gw5 inoculant produced superior nodule weight of 1.8 g per plant, it was only significantly higher than nodule weight of plants treated with urea. This suggests that application of urea at 30 kg N depressed nodulation. This is contrary to the reports of so many authors and may be a reflection of poor soil management. A poorly drained soil may accumulate by-products of N that may depress nodulation (Wanek and Arndt, 2002). More nodules were produced when cowpea cultivars were treated with Gw5 inoculant.

**CONCLUSION**

This study was carried out to investigate the response of some selected cowpea cultivars to three sources of nitrogen in sole and combined form. The outcome of the experiment showed that *SamPea* 16 significantly (P<0.05) increased the plant height, lowered weed density, lowered weed dry weight, increased branches, leaves, leaf area, as well as shoot and root biomass compared to *SamPea* 15. on the other hand, 30kg urea N + Agrolyzer + Gw5 inoculant significantly produced tallest plant, lowest weed density, lowest weed dry weight, more branches, leaves, leaf area, more shoot and root biomass, than the use of urea of Gw5 inoculant alone. Gw5 inoculant alone also improved the nodule number and nodule dry weight. in most cases these improvements were not statistically different from the use of other N-sources

**RECOMMENDATION**

*SamPea* 16 can therefore be inoculated with Gw5 inoculant to supplement the nitrogen supplied in cowpea production and curb the menace of the abuse of inorganic fertilizer in the advent of global warming.

**REFERENCES**

Aaron (2009) Weed management. Illinios Agronomy Handbook 24th edition Chapter 12. Cooerative Extension Service pp 153 – 177

Abayomi YA, Ajibade TV, Samuel OF, & Sa’adudeen BF (2008) Growth and yield responses of cowpea (*Vigna unguiculata* (L.) Walp) genotypes to nitrogen fertilizer (N.P.K.) application in the Southern Guinea Savanna zone of Nigeria. *Asian Journal of Plant Sciences* 7(2): 170-176. DOI: 10.3923/ajps.2008.170.176.

Abukutsa-Onyango M. O. A., (2011). The Diversity of Cultivated African Leafy Vegetables in Three communities in Western Kenya. *African crop science journal.* 7:1.

Agbogidi, O. M. & Egho, E. O. (2012). Evaluation of eight varieties of cowpea (*Vigna unguiculata* (L.) Walp) in Asaba agro-ecological environment, Delta State, Nigeria. *European Journal of Sustainable Development* 1(2): 303-314.

Agbogidi, O.M. & Ofuoku, A.U. (2005). Response of sour sop (*Annona muricata* Linn) to crude oil levels. *Journal of Sustainable Tropical Agricultural Research*. 16:98-102.

Alhaji, I. H. (2008). Yield performance of some Cowpea varieties under sole and intercropping with Maize at Bauchi, Nigeria*. An International Multidisciplinary Journal of Ethiopia.* 2(3): 278-291.

Amujoyegbe BJ & Alofe CO (2003) Influence of poultry manure and inorganic nitrogen fertilizer on grain yield and proximate component of two cultivars of cowpea (*Vigna unguiculata* L. Walps). Moor Journal of Agricultural Research 4: 37-45. DOI: 10.4314/mjar.v4i1.31750.

Aune, J.B. & R. Lai, (1995). The Tropical Soil Productivity Calculator-a Model for Assessing Effects of Soil Management Ion Productivity. In: Soil Management Experimental Basis for Sustainability and Environmental Quality, Lai, R. and B.A. Stewart (Eds.). Chapter 17, Lewis Publishers, Boca Raton, FL., USA., ISBN-13: 9781566700764, pp: 499-520.

Ayodele, O.J. & A.A. Oso, (2014). Cowpea responses to phosphorus fertilizer application at Ado-Ekiti, South-West *Nigeria Journal of Applied Science and Agriculture*, 9: 485-489.

Daramy MA, Sarkodie-Addo J & Dumbuya G (2016) The effects of nitrogen and phosphorus fertilizer application on crude protein, nutrient concentration and nodulation of cowpea in Ghana. ARPN Journal of Agricultural and Biological Science vol. 11, No. 12, pp 470-480.

Dart, P., Day, J., Islam R.A. & Dobereiner, J. (1997). Some effects of temperature and composition of the rooting medium in symbiotic nitrogen fixation in plants synthesis. In: tropical grain Legume, Nutman, R.S> (Ed.). Cambridge univ. Press, pp: 361-383.

Esu, I.E. (1991). Detailed Soil Survey of NIHORT Farm at Bunkure, Kano State, Nigeria. Institute for Agricultural Research, Ahmadu Bello University, Zaria.

Fagodiya, R.K. Pathak, H., Kumar, A., Bhatia, A., & Jain, N. (2017). Global temperature change potential of nitrogen use in agriculture: A 50-year assessment. Scientific reports, 7(1), 1-8.

Futuless, K. N. & Bake, I. D. (2010). Evaluation of yield and yield attributes of some cowpea (*Vigna unguiculata* (L) Walp) varieties in Northern Guinea Savanna. *Journal of American Science* 6(8): 508-511.

Haruna, I. M. & Usman, A. (2013). Agronomic efficiency of cowpea varieties (*Vigna unguiculata* ( L.) Walp) under varying phosphorus rates in Lafia, Nasarawa State, Nigeria. *Asian Journal of Crop Science,* 5: 209-215. DOI: 10.3923/ajcs.2013.209.215 (<http://dx.doi.org/10.3923/ajcs.2013.209.215>)

ISRIC/FAO, (2002). Procedures for soil analysis. Sixth edition, L.P. Van Reeuwijk (ed). Institutional Soil Reference and Information Centre / Food and Agricultural Organization, pp 119.

Kan’ankuk’a CN (1999) Effect of lime, nitrogen and phosphorus on growth, yield and yield components of cowpea (*Vigna unguiculata* (L.) Walp.). Thesis submitted to the Postgraduate school, Ahmadu Bello University, Zaria. 110pp.

Madukwe DK, Christo IE & Onuh MO (2008) Effects of organic manure and cowpea (*Vigna unguiculata* (L.) Walp) varieties on the chemical properties of the soil and root nodulation. Science world Journal 3:43-46.

Magani, I.E. & C. Kuchinda, (2009). Effect of phosphorus fertilizer on growth, yield and crude protein content of cowpea (*Vigna unguiculata* [L.] Walp) in Nigeria. J. Applied Biosci., 23: 1387-1393.

Meena, J. S.; Verma, H. P. & Picholi, P. (2014). Effect of fertility levels and biofertilizers on yield, quality and economic of cowpea. *Agricultural Sustainability Development* 2(2): 162–164.

Ojanuga A. G. (2006). *Agroecological Zones of Nigeria Manual*. FAO/NSPFS, Federal Ministry of Agriculture and Rural Development, Abuja, Nigeria, 124 pp.

Rizvi, A., & Khan, M. S. (2018). Heavy metal induced oxidative damage and root morphology alterations of maize (Zea mays L.) plants and stress mitigation by metal tolerant nitrogen fixing Azotobacter chroococum. *Ecotoxicology and environmental safety*, *157*, 9-20.

Singh A, Baoule AL, Ahmed HG, Dikko AU, Aliyu U, Sokoto MB, Alhasan J & Musa M, Haliru (2011a) Influence of phosphorus on the performance of cowpea (*Vigna unguiculata* [L] Walp) varieties in Sudan savanna of Nigeria. *Journal of Agriculture Sciences* 2: 313-317.

Singh, A.K., Tripathi, P.N. & Room, S. (2007) Effect of Rhizobium inoculation, nitrogen and phosphorus levels on growth, yield and quality of kharif cowpea (*Vigna unguiculata* L. Walp). *Crop Research* Hisar 33:71-73.

Taramani Yadav, N. K., Chopra, N.K. Chopra, M.R. Yadav, Rakesh Kumar, D.K. Rathore, P.G. Soni, G. Makarana, A. Tamta, M. Kushwah, H. Ram, R.K. Meena & M. Singh. (2017). Weed management in cowpea– A Review. *International Journal of Current Microbiology and Applied Science,* 6(2): 1373-1385. doi: <http://dx.doi.org/10.20546/ijcmas.2017.602.156>

Tripathi S.S & Singh, G (2001) Critical period of weed competition in summer cowpea (*Vigna unguiculata* (L.) Walp.) *India Journal of Weed science*, 33: 67-68.

Uzoma, A.O., Jemiyo, C.A., Bala, A., Adeboye, M.K.A. & Osunde, A.O. (2013a). The growth and yield performance of groundnut (*Arachis hypogeal*) cultivated under various fertilizer inputs on an alfisols in the Southern Guinea Savanna zone of Nigeria. *Nigeria journal of soil science*, 23(2): 146-156.

Uzoma, A.O., Okoh, J., Bala, A., Adeboye, M.K.A. & Osunde, A.O. (2013b). The impact of various fertilizer inputs on the growth, nodulation and yield of soybean (*Glycine max*) cultivated on an alfisols in Minna, Southern Guinea Savanna of Nigeria. *Nigeria journal of soil science*, 23(2): 157-167.

Wanek W. & Arndt S. K. (2002) the N variation between nodulated roots and shoots of soybean reflects the relative contribution of symbiotic N2 fixation to plant N acquisition. *Journal of Experimental Botany.* 53, pp 1109 – 1118.