INFLUENCE OF INOCULATION ON NODULATION AND NODULE ACTIVITY OF COWPEA VARIETIES (*Vigna Unguiculata*) IN PAIKO, NIGER STATE

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Abstract

*Cowpea response to* *Bradyrhizobial inoculation has been confirmed by many researchers, but not much study has been undertaken on response of cowpea to BR 3262 and BR 3267 inoculant strains in soils of Nigerian Savanna. The objective of this study was to determine the influence of Bradyrhizobium inoculation on nodulation and nodule activities of some cowpea varieties in Paiko, Niger state. Pot experiment was carried out in the screen house of the Federal University of Technology, Minna. A 2 x 4 x 4 factorial experiment was fitted to a Completely Randomized Design (CRD) and replicated three times. The treatments consisted of proximities to homestead (< 50 m close to homestead, and > 250 m far from homestead), cowpea varieties (Kanannado, IT93K-452-1, IT97K-499-35, and IT90K-277-2), and nitrogen sources (Urea (100 kg N ha-1), inoculation with* Bradyrhizobium *sp. (strain BR 3262 or BR 3267) and control. Most Probable Number count of the soils cultivated to cowpea varieties ranged from (9.26 - 12.27 x 106) with BR 3267 having the highest effective nodules (averagely 30 %) while the least was with the N treatment (averagely 10%). The result obtained from this study shows that cowpea could respond to Bradyrhizobial inoculation. Shoot dry weight of cowpea treated with BR 3262, BR 3267, Urea or uninoculated control indicated that the inoculant strains used for this study were highly effective. Although inoculation generally increased nodule number and nodule dry weight, however there was no corresponding increase with the urea treated plant. Proximity to homestead was not significant (p > 0.05) for the growth parameters measured in this study. The main effect of varieties was significant for all the growth parameters measured, Kanannado variety gave a better yield compared to the other varieties, while the least was IT90K-277-2. Further study should however be carried out in order to affirm this study.*

**Keyword:** cowpea, rhizobia, *Bradyrhizobium* inoculants

**1.0 INTRODUCTION**

Nitrogen (N) is one of the major nutrients required for plant growth. It is often a limiting nutrient for cowpea production. This arises as a result of either inherently low level of N in the soils or depleted of nutrients through cultivation (Woldeyohannes *et al.,* 2007). Sanginga *et al*. (2001) reported that N depletion in cereal-based cropping system of Nigerian Savanna soils is estimated between 36 - 80 kg N ha-1 per year. Also, report has it that an estimated rate of 22-112 kg ha-1 N is been depleted in African soils (Stoorvogel *et al.*, 1993). Cowpea is an important grain legume crop because it fixes its own nitrogen from the atmosphere using nodules as a result, requires little amount of nitrogen fertilizer. However, its yield remains low due to the poor nutrient status of tropical soils (Sprent, 2007).

Nitrate and ammonium are necessary inputs for optimal yield of cowpea, these nutrient can be supplied through the addition of nitrogen fertilizers or Biological Nitrogen Fixation (BNF). However, inorganic nitrogen fertilizers are not readily available and/or the resource-poor farmers cannot afford them. As a result, inadequate fertilizers are applied to legumes crops. Biological Nitrogen Fixation (BNF) is an economically viable and environmentally pleasant N source some soils do not have adequate amount of native rhizobia in terms of number, quality or effectiveness to enhance biological nitrogen fixation (BNF).

Like most grain legume, cowpea forms symbiotic association with indigenous rhizobia in the soil to fix atmospheric nitrogen for use by the host plant, thus resulting in the above ground portion of the plant to be rich in nitrogen (Reamaekers, 2001). Biological fixed N via rhizobia - legumes symbiosis account for the largest amounts of nitrogen to agriculture. Herridge *et al*. (2008) reported that more than 20 million tonnes of N is fixed by grain legume to agriculture each year.

Also, report has it that some grain legume like cowpea fixes 30-125 kg N ha-1(Ennin-Kwabiah and Osei-Bonsu, 1993) moreso as much as 201 kg N ha-1 per season has been reported (Singh and Richie, 1985). BNF is more environmentally prudent and economically sustainable option in replenishing the depleted N in soil. Although cowpea can meet all or part of its N requirement through BNF (Awonaike *et al.,* 1990). Some studies have shown that the crop may benefit from rhizobial inoculation with specific strains of rhizobia (Fening and Danso, 2002). Many soils however, do not have adequate amount of native rhizobia in terms of number, quality or effectiveness to enhance biological nitrogen fixation (BNF) (FAO, 2012).

This situation may lead to the use of rhizobia inoculant. Inoculation is a technology used for the manipulation of rhizobia populations for improved nodulation and crop yield (Keyser and Li, 1992). Peoples *et al*. (1995) reported that inoculation with effective rhizobia strains can lead to the establishment of large populations of rhizobia in the root zone and improve nodulation and N2 – fixation. Inoculation of cowpea with elite rhizobia strains does not however prompt positive response. Most tropical grain legumes have rarely been found to respond to inoculation unless they are grown in a soil where the conditions are not conducive for the survival of native rhizobia (Giller, 2001). Martins *et al*. (2003) reported an increase in yield of cowpea due to inoculation with *Bradyrhizobium* strains BR3267and BR3262 in Brazil. There is a dearth of information on weather inoculation with either of the inoculant strains could exhibit similar yield response in Nigerian Savanna.

1. To evaluate the effect of proximity to homestead on the indigenous rhizobia population
2. To ascertain the response of cowpea nodulation to different N sources
3. To determine the effect of cowpea varieties (Kanannado, IT93K-452-1, IT97K-499-35, and IT90K-277-2) on nodulation
4. To investigate if there exist a relationship between cowpea varieties and nitrogen sources

2**.0 MATERIALS AND METHODS**

2.1 Experimental Site

The experiment was conducted in the greenhouse of the Federal University of Technology Minna. The study area is located in the Southern Guinea Savannah of Nigeria which lies between longitudes 90 30’ and 90 40’ E and latitudes 6° 30’ and 6° 35’ N at an elevation of about 258.5m above sea level.

The mean annual rainfall is about 1,338 mm which falls between April/May and October, November. The effective length of wet season is about 5 months. The highest mean monthly rainfall is in September with 300 mm. The temperature rarely falls below 22°C. The peaks are 40°C between February to March and 35°C between November and December (Osunde *et al.,* 2003).

2.2 Soil Sampling and Preparation

Composite soil samples were collected randomly across the field at a depth of (0-20 cm) using sterilized soil auger. The composite samples were taken to the laboratory, part of the soil samples was air dried and pass through a 2 mm mesh for routine analysis while the remaining samples was prepared moist for MPN.

2.3 Determination of soil physical and chemical properties

Physical and chemical properties of the sampled soil was determined by standard methods IITA (1989). Soil organic carbon was determination by Walkley and Black Oxidation method (Nelson and Sommers, 1982). Soil particle size w was determined by the hydrometer method (Bouyoucous, 1936). Soil pH was determine using a pH-meter in water (soil solution ratio 1:2.5). Exchangeable bases were extracted with IN ammonium acetate (NH4OAc) solution at pH 7.0 (Thomas, 1982). Potassium in the extract was measured using Gallen Kamp flame photometer Helmke and Sparks (1996), while calcium and magnesium was determined by titration. Exchangeable acidity (H+, Al3+) was determined by titrametric method after extraction with 1N KCl (Anderson and Ingram, 1993). Total nitrogen by the Kjeldahl method (Bremner, 1982). Available phosphorus by the Bray P1 method, color was developed in soil extract using ascorbic acid blue method (Murphy and Riley, 1962). Effective Cation Exchange Capacity (ECEC) was determined by summation of exchangeable bases (Ca2+, Mg2+ K+, Na+) and exchangeable acidity (H+, Al3+).

2.4 Most Probable Number (MPN) Method

The assay was conducted using modified Leonard jar method Howieson *et al*., (2014) using coarse sand as the potting medium. The coarse sand was washed several times with tap water to remove all traces of dissolved nutrients and finally rinsed with sterile distilled water before sun drying.

A 3 litre pot was filled with 2.5 kg of sand medium to which 200 ml of calcium solution was added. Cowpea seeds were sown at the rate of 3 seeds per pot and thinned to 1 per pot a week after planting. Plants were watered daily using sandsman’s nitrogen free nutrient solution (Sandsman, 1970). One week after planting, the plants were inoculated with 1 ml aliquots of the soil suspensions made from serial dilution of the soil samples. Each soil sample was initially diluted 20-fold by adding 10g of soil in 190 ml of sterile distilled water. Each dilution level was replicated four times resulting in a total of 24 pots per each soil sample.

Harvesting was done in a period of seven weeks after planting to observe the patterns of nodule appearances. The (+) sign was used to indicate presence of at least one nodule, while (–) denoted absence of nodules (Vincent, 1970).

2.5 Inoculation

Cowpea seeds were inoculated prior to planting with a peat - based inoculum of Bradyrhizobium sp. (strain BR 3262 or BR 3267)at the rate of 5 g per one kilogram of seed using the slurry method as described by Woomer *et al*. (1994).

2.6 Planting

Soil samples were added to 2.5 litre pot at 2 kg per pot. Cowpea seeds were planted at 3 per pot and thinned to two per pot one week after emergence. The plants were watered daily with sandsman’s N free nutrient solution 200 ml per pot for the first four weeks and later one quarter strength of the solution or just sterile distil water plants were harvested 7 weeks after planting.

2.7 Fertilizer Application

To each pot 372.6 mg basal application of nutrient (P, K, Mg, Zn, Mo, and B) was added and thoroughly mixed. N treated plants were supplied with nitrogen and was split applied to the N treatment at first week (81.60 mg) and second week (244.80 mg) after planting.

2.8 Treatments

The treatments used for this study were, Proximity to homestead (2), nitrogen sources (4), and varieties (4). Proximity to homestead was either close or far from the homestead. N sources were (i) plant treated with nitrogen in form of urea at the rate of 100 kg N ha-1, (ii) plant inoculated with *Bradyrhizobium* sp. strain BR 3262 or *Bradyrhizobium* sp. strain BR 3267, and control (Neither N nor inoculant rhizobia applied). The cowpea varieties were IT93K-452-1 (extra-early Maturing), IT97K-499-35 (Early Maturing), IT90K-277-2 (Medium Maturing), Kanannando (Late Maturing).

2.9 Experimental Design

The experiment was arranged in a 2 x 4 x 4 factorial combination fitted to completely randomised design (CRD) replicated four times.

2.10 Statistical Analysis

The data obtain from the trialwere subjected to statistical analysis using MINITAB 17.0. Analysis of variance (ANOVA) of the general linear model was used to check for significant effects and significant means were separated using Tukey pairwise comparisons method.

**3.0 RESULTS**

**3.1 Routine analysis and MPN count of soils cultivated to cowpea varieties**

Soils of the experimental site from both close and far proximities to homestead was slightly acidic and loamy sandy in texture (Table 1). Organic Carbon (3.60 - 4.35 g kg-1), Total nitrogen was (0.11 - 0.18 g kg-1), available P (6.00 - 7.00 mg kg-1), exchangeable cations (0.19 - 5.04 C mol kg-1), and effective cation exchange capacity (6.71- 6.76 C mol kg-1). The ECEC analysis reveals that the experimental soil is low in nutrients.

The MPN count of indigenous rhizobia population in soils using the four cowpea varieties in respect to proximities were high. Kanannado and IT93K-452-1 had similar MPN value (12.27 × 106 - 11.28 × 106 cell g-1 of soil), IT97K-499-35 (9.26 × 106 - 12.27 × 106 cell g-1 of soil), and IT90K-277-2 (10.94 × 106 cell g-1 of soil) for both close and far proximities to homestead.

**Table 1. Routine analysis and MPN count of soils cultivated to cowpea varieties in respect to proximity to homestead**

|  |  |  |
| --- | --- | --- |
| **Parameters** | **Values**  **(Close Proximity)** | **Values**  **(Far Proximity)** |
| Sand (g kg-1) | 857 | 847 |
| Silt (g kg-1) | 80 | 80 |
| Clay (g kg-1) | 63 | 73 |
| Textural Class | Loamy Sand | Loamy Sand |
| pH (CaCl) | 5.36 | 5.80 |
| Organic Carbon (g kg-1) | 3.60 | 4.35 |
| Total Nitrogen (g kg-1) | 0.11 | 0.18 |
| Available Phosphorus (mg kg-1) | 6.0 | 7.0 |
| Sodium (C mol kg-1) | 0.50 | 0.49 |
| Potassium (C mol kg-1) | 0.19 | 0.22 |
| Calcium (C mol kg-1) | 4.80 | 5.04 |
| Magnessium (C mol kg-1) | 1.12 | 0.80 |
| Exchangeable Acidity (C mol kg-1) | 0.10 | 0.21 |
| ECEC | 6.71 | 6.76 |
| MPN (Cell g-1 of soil ) |  |  |
| Kanannado | 12.27 × 106 | 11.28 × 106 |
| IT93K-452-1 | 12.27 × 106 | 11.28 × 106 |
| IT97K-499-35 | 9.26 × 106 | 12.22 × 106 |
| IT90K-277-2 | 10.94 × 106 | 10.94 × 106 |

|  |
| --- |
|  |
|  |

**3.2** **Effect of nitrogen sources, proximity to homestead and varieties on growth parameters of cowpea**

The main effect of nitrogen sources significantly (P <0.05) affected the growth parameters of cowpea (Table 2). Shoot dry weight of cowpea was enhanced with BR 3267 (2.05 g plant-1) inoculant, though similar to that produced by urea treated plant (2.01 g plant-1) and BR 3262 (1.97 g plant-1) respectively, the control treatment recorded the least dry weight of cowpea. Inoculated treatment BR 3262 produce the highest nodule number and dry weight though not significantly (P >0.05) different from BR 3267 while the urea treated plant had the least nodule number and dry weight. The use of inoculant BR 3267 gave the highest nodule activity (30 %) followed by BR 3262 (22 %), which was at par with control (20 %). Urea treatment had the lowest nodule activity (10 %). The growth parameters measured were not significant (P >0.05) affected by proximity to homestead.

The main effects of variety were however highly significantly (p <0.001) affected by the growth parameter of cowpea measured. Kanannado variety (2.22 g plant-1) resulted in the highest shoot dry weight though not significantly (P >0.05) different from the shoot gotten from IT97K-499-35 (2.07 g plant-1) which was marginally higher than IT93K-452-1 (1.86 g plant-1), the least was recorded with the un-inoculated control (1.52 g plant-1). Similarly, kanannado variety (19.71 plant-1) had the heaviest nodule number which was not significantly (P >0.05) different from IT93K-452-1 variety (15.75 plant-1) followed by IT97K-499-35 and IT90K-277-2 (13.13- 11.54 plant-1) respectively. Nodule dry weight of kanannado variety (0.10 g plant-1) was significantly higher than that of IT93K-452-1(0.08 g plant-1) followed by IT97K-499-35 variety (0.06 g plant-1) which was at par with IT90K-277-2 (0.05 g plant-1). kanannado and IT93K-452-1 variety (27- 21 %) recorded the highest percentage of nodule activity while a similar activity of nodules was observed with IT97K-499-35 (18 %) and IT90K-277-2 (15 %). The interaction of nutrient sources, proximities and varieties significantly affected (P <0.05) affected all the measured parameters but the reverse was the case for nodule activity.

**3.3** **Interactive effect of nitrogen sources, proximities and varieties on shoot dry weight of cowpea**

The highest shoot dry weight of 3.01 g plant-1 was recorded using *bradyrhizobium* strain BR 3262 with IT93K-452-1 variety, followed by IT97K-499-35 for soils of proximity away from homestead, also a similar shoot was obtained with Kanannado and IT93K-452-1 variety treated with *bradyrhizobium* strain BR 3267 proximity near homestead, urea treated plant with kanannado variety for both proximity homestead, kanannado variety with *bradyrhizobium* strain BR 3267 for soils far from homestead. Similar yield was obtained with control treatment for soils of proximity close to homestead using the four cowpea varieties except for IT93K-452-1, soils of both proximity to homestead for kanannado, Urea treated plant using cowpea variety IT93K-452-1 and IT90K-277-2 for soils of proximity away from homestead and IT97K-499-35 variety close to homestead, strain BR 3262 using kanannado variety further away from homestead and IT97K-499-35 close to homestead, strain BR 3267 for soils of both proximities to homestead with IT97K-499-35 and IT93K-452-1 away from homestead.

The least was with control treatment using IT93K-452-1 on soils away from homestead, followed by control using soils far from homestead with IT90K-277-2, soils of both proximities to homestead with strain BR 3267 using IT90K-277-2 variety and BR 3262 inoculant strain with IT93K-452-1 variety for soils close to homestead.

**Table 2. Effect of Nitrogen sources, Proximity to homestead and Varieties on growth parameters of cowpea**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Treatment** | **Shoot Dry Weight**  **(g plant-1)** | **Nodule Number**  **(plant-1)** | **Nodule dry Weight**  **(g plant-1)** | **Nodule Activity (%)** |
| **Nitrogen sources (N)** |  |  |  |  |
| Control | 1.64b | 13.08bc | 0.06bc | 19.58b |
| Urea (100 kg N ha-1) | 2.01a | 8.50c | 0.04c | 10.00c |
| BR 3262 | 1.97a | 21.25a | 0.10a | 22.08b |
| BR 3267 | 2.05a | 17.29ab | 0.08ab | 30.00a |
| Significance | **\*\*** | **\*\*** | **\*\*** | **\*\*** |
| **Proximity (P)** |  |  |  |  |
| Close | 1.91a | 14.31a | 0.07a | 21.04a |
| Far | 1.93a | 15.75a | 0.07a | 19.79a |
| Significance | NS | NS | NS | NS |
| **Varieties (V)** |  |  |  |  |
| Kanannado | 2.22a | 19.71a | 0.10a | 27.08a |
| IT93K-452-1 | 1.86b | 15.75ab | 0.08ab | 21.25ab |
| IT97K-499-35 | 2.07ab | 13.13b | 0.06bc | 18.33b |
| IT90K-277-2 | 1.52c | 11.54b | 0.05c | 15.00b |
| Significance | **\*\*** | **\*\*** | **\*\*** | **\*\*** |
| **Interaction** |  |  |  |  |
| N X P | **\*\*** | **NS** | **NS** | **NS** |
| N X V | **\*\*** | **\*\*** | **\*\*** | **\*\*** |
| P X V | **NS** | **NS** | **NS** | **NS** |
| N X P X V | **\*** | **\*\*** | **\*\*** | **NS** |

**Table 3**. **Interactive effects of nitrogen sources, proximity to homestead and varieties on shoot dry weight (g/plant) of cowpea**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Varieties | | | | | |
|  | | | | | |
|  |  |  |  |  |  |
| Nitrogen sources | Proximity | Kanannado | IT93K-452-1 | IT97K-499-35 | IT90K-277-2 |
|  |  |  |  |  |  |
|  |  |  |  |  |  |
| Control | Close | 1.93a-f | 1.44def | 2.06a-f | 1.91a-f |
|  | Far | 1.91a-f | 1.01f | 1.66c-f | 1.22ef |
|  |  |  |  |  |  |
| Urea | Close | 2.70abc | 1.62c-f | 1.86a-f | 1.78b-f |
|  | Far | 2.64a-d | 1.89a-f | 1.73c-f | 1.87a-f |
|  |  |  |  |  |  |
| BR3262 | Close | 1.69c-f | 1.35ef | 2.05a-f | 1.25ef |
|  | Far | 1.87a-f | 3.01a | 2.97ab | 1.53c-f |
|  |  |  |  |  |  |
| BR3267 | Close | 2.72abc | 2.72abc | 2.18a-f | 1.25ef |
|  | Far | 2.33a-e | 1.83a-f | 2.04a-f | 1.34ef |

**Table 4.** **Interactive effects of nitrogen sources, proximity to homestead and cowpea varieties on** **Nodule Number (plant-1)**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Varieties | | | | | |
|  | | | | | |
|  |  |  |  |  |  |
| Nitrogen sources | Proximity | Kanannado | IT93K-452-1 | IT97K-499-35 | IT90K-277-2 |
|  |  |  |  |  |  |
|  |  |  |  |  |  |
| Control | Close | 19.33a-d | 13.33bcd | 7.67cd | 9.33cd |
|  | Far | 18.33bcd | 12.67bcd | 12.00bcd | 12.00bcd |
|  |  |  |  |  |  |
| Urea | Close | 9.33cd | 7.33cd | 6.67cd | 6.33cd |
|  | Far | 12.00bcd | 6.67cd | 11.33bcd | 8.33cd |
|  |  |  |  |  |  |
| BR3262 | Close | 23.67abc | 22.33a-d | 22.00a-d | 23.00abc |
|  | Far | 17.33bcd | 22.67a-d | 18.33bcd | 20.67a-d |
|  |  |  |  |  |  |
| BR3267 | Close | 19.00bcd | 11.33bcd | 19.00bcd | 9.33cd |
|  | Far | 38.67a | 29.67ab | 8.00cd | 3.33d |

**Table 5.** **Interactive effects of nitrogen sources, proximity to homestead and varieties on** **Nodule dry weight (g/plant) of cowpea**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Varieties | | | | | |
|  | | | | | |
|  |  |  |  |  |  |
| Nitrogen sources | Proximity | Kanannado | IT93K-452-1 | IT97K-499-35 | IT90K-277-2 |
|  |  |  |  |  |  |
|  |  |  |  |  |  |
| Control | Close | 0.10a-d | 0.08bcd | 0.03cd | 0.05bcd |
|  | Far | 0.08bcd | 0.06bcd | 0.05bcd | 0.06bcd |
|  |  |  |  |  |  |
| Urea | Close | 0.05bcd | 0.06bcd | 0.04cd | 0.03cd |
|  | Far | 0.06bcd | 0.03cd | 0.04cd | 0.04cd |
|  |  |  |  |  |  |
| BR3262 | Close | 0.11abc | 0.11abc | 0.10a-d | 0.11abc |
|  | Far | 0.08bcd | 0.11abc | 0.08bcd | 0.10a-d |
|  |  |  |  |  |  |
| BR3267 | Close | 0.09a-d | 0.06bcd | 0.10a-d | 0.04cd |
|  | Far | 0.20a | 0.15abc | 0.04cd | 0.00d |

**3.4** **Interactive effect of nitrogen sources, proximities and varieties on nodule number of cowpea**

Kanannado and IT93K-452-1 varieties inoculated with BR 3267 for soils sampled away from homestead as well as kanannado and IT90K-277-2 inoculated with BR 3262 grown in soils sampled close to homestead produced the highest number of nodules. These are however at par with the yield produced by BR 3262 inoculant with IT93K-452-1 for both proximities to homestead and -499-35 variety grown in soils sampled near homestead and by kanannado plant treated with neither N nor inoculants for proximity close to homestead.or those treated with neither N nor inoculant

The smallest number of nodules was produced by IT90K-277-2 in soils sampled of both proximities that were either treated with N or BR 3267 inoculated in soils sampled close to homestead. These were however similar to the nodule gotten from N treated with kanannado and IT97K-499-35 variety in soils sampled near homestead, IT93K-452- 1 in soils sampled from both proximities or treated using BR3267 inoculant with IT97K-499-35 variety in soils sampled further away from homestead

**3.5** **Interactive effect of nitrogen sources, proximities and varieties on nodule dry weight of cowpea**

Plant grown on soils away from homestead treated with BR 3267 inoculant strain showed the highest nodule dry weight followed by that produced using the same treatment with IT93K-452 -1 variety however not different from the nodule dry weight gotten from BR3262 on soils close to homestead for Kanannado, IT90K-277-2, as well as IT93K-452-1 variety for both proximities to homestead, kanannado variety close proximity to homestead for control and BR3267, either of the inoculant strains for proximity near homestead and IT90K-277-2 inoculated with BR 3232 for soils away from homestead. The least nodule dry weight was produced by IT90K-277-2 variety in soils far from homestead which was at par with the same treatment for soils near homestead, followed by urea treatment using either soils of proximities to homestead for IT97K-499-35 and IT90K-277-2. Variety IT97K-499-35 for soils away from homestead with urea treatment and IT90K-277-2 treated with control for soils close to homestead and BR 3267 inoculant for soils further away from homestead.

**DISCUSSIONS**

It was evident from this study that high population density of native rhizobia dose not impede response to bradyrhizobia inoculation if highly effective and competitive rhizobia strains are introduced. Indigenous soil populations of rhizobia can be characterized functionally for N, fixation potential by determining their species composition, number, and ability to fix N2 (Singleton and Travers, 1986). MPN count of soils cultivated to cowpea varieties showed that the experimental soil has high (>103 cells g-1 of soil) nitrogen fixing ability for cowpea (Table 1).

Sanginga *et al*. (1996) and Houngnandan *et al.* (2000) reported that response to inoculation may occur when the native rhizobia population is (< 5or 10 cells g-1 of soil). Contrary to this findings, in spite of the high number of native rhizobia response to inoculation was observed in this study. Meaning that, the native populations may be sufficient in number but not effective enough to elicit significant response More so, other factors aside from native rhizobia population may have reduced the symbiotic performance of the native strains. Moreso, Giller (2001) report that the presence of large population density of compatible rhizobia does not, however, preclude the possibility that responses to inoculation can be obtained if competitive and highly effective strains are introduced in high quality inoculants. Which implies that either of the inoculant strains BR 3262 or BR 3267 used for this experiment are of high quality and may have perform a greater role in nodule occupancy and nitrogen fixation.

The success of Rhizobiuminoculation primarily depends on the rhizobial strain, the legume genotype, the environmental conditions, and crop management (Woomer *et al*., 2014). The control plant recorded the least dry weight of shoot, shoot dry weight of cowpea inoculated with either 3262 or BR 3267 strains had highest shoot dry weight of cowpea which was significantly (p <0.05) at par with the shoot produced by the N treatment at the rate of 100 kgNha-1; meaning that N was limiting in soils of the experimental sites. An increase in shoot dry weight of cowpea in either of the treatment may not be observed if N is not limiting in the study site. Similar findings were reported by Abayomi *et al*. (2008) that plants that receive inorganic nitrogen perform better than those dependent on biological nitrogen fixation. Subasinghe *et al*. (2001) also observed a significant increase in dry matter production of cowpea in response to increased N application. Inoculation of cowpea with both inoculant strains varied significantly (p <0.05) higher than the N and uninoculated control in nodule number of cowpea, a similar trend was also observed with nodule dry weight. These did not only show that the cowpea responded to inoculation but indicate that the introduced strains were compatible with the indigenous strains especially with BR 3262 thereby aggravated substantial level of increase in nodule number and dry weight. This result conforms to the findings of Martins *et al*. (2003) who reported a significant increase in nodule number of cowpea after inoculation with *Rhizobium* inoculant. More so, nodule dry weight is very important in strain assessment as it serves as an indicator for symbiotic proficiency (Graham *et al.,* 2004). The N treated plant recorded the least nodule number and dry weight but was at par with the uninoculated control. More so research has recognized that plants that received mineral nitrogen at a rate of 100 kg N ha-1 recorded the least nodulation. Although such results were expected because high levels of nitrogen have been affirmed to affect rhizobia activity in the soil by hindering legume host production of lectin which attracts the rhizobia to infect the roots. more so, the use of N at the rate of 100 kg N ha-1 as a control is to reveal an ideal situation when N is not a limiting factor in cowpea growth.

Research has recognized that increasing nodule weight by inoculation was generally a criterion for increasing N2 fixation. Although inoculation frequently increased nodule number, there was also a corresponding increase in nodule weight.

In this study all nodules where affirmed to have effective rhizobia ranging between (10-30 %), either of the inoculant strains had more effective nodules compared to the N treated plant and did as well as the control treatment. meaning that nodule activity of the control treatment cannot be underestimated better still either of the inoculated plant show superior nodule activity.

Proximity to homestead did not significantly affected any of the yield parameters measured in this study, this result doesnot affirmed the observation that fertile plots is often closest to homesteads, as a result of continous accumulation of organic ammendment and household waste applied directly surrounding the settlements (Zingore *et al.,* 2007).

Most of the yield parameters measured were significantly (p <0.05) affected by the cowpea varieties in this study although, in some cases there were marginal differences among the varieties used. Among the varieties, kanannando was observed with the highest yield parameters of cowpea though at par with IT93K-452-1 except for shoot dry weight of cowpea. Also the least was recorded with IT90K-277-2 though was statistically similar to IT97K-499-35 in nodule number, nodule dry weight and nodule activity the reverse was the case for shoot dry weight. The observed significant difference with plant among varieties in this study in consistent with the earlier work done by Terao *et al*., (1995) who observed that cowpea varieties with spreading growth habits collected more light than those with erect growth habit and consequently produced more leaves which resulted in larger shoot biomass. Similar observation was also obtained by (Njeru *et al*., 2013).

**CONCLUSIONS**

The use of elite inoculant strains, indeed contributed positively to the performance of cowpea in the study area, meaning that the indigenous strains where less effective hence couldn’t meet the N2 need of the plant. Therefore, symbiotic N2 requirement and optimum yield potential of cowpea varieties grown in the Southern Guinea Savanna may not always be met by high population density of native rhizobia.

However, cowpea farmers in the southern guinea savanna can derive some benefits from biological nitrogen fixation by inoculating their crops which could serve as cheaper alternative source to N2 fertilizer. The nodule activity of the control treatment cannot be underestimated, better still BR 3267 had more effective nodule these may explain attribute to the responsiveness of the elite strains.

It was also evident in this study that varieties had significant effect on cowpea yield. Kanannado variety did better in most of the parameter measured though at par with IT93K-452-1 therefore recommended for cultivation in Southern Guinea Savanna. However, further studies should be carried out to affirm this studies.

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