

**RESEARCH TITLE**

**EFFECT OF INTERCROPPING (SORGHUM/COWPEA),  
*BRADYRHIZOBIUM*, NITROGEN AND PHOSPHORUS FERTILIZERS ON  
GROWTH OF COWPEA UNDER RAINFED CONDITIONS**

**Ekhlas Mohamedzein Musa Mohamedzein<sup>1</sup>**

<sup>1</sup> Faculty of Agriculture, University of Sinnar, Sudan.

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**Abstract**

A field experiment was carried out at the experimental field of Faculty of Agriculture (Abu Naama) - University of Sinnar for two successive seasons to study the effect of intercropping, *Bradyrhizobium*, N and P fertilizers on growth of cowpea. The experimental layout was arranged in split-split plot design with six replicates. Parameters studied are nodule numbers, nodules dry weight, plant height and shoot and root dry weight. The results showed that intercropping significantly increased number and dry weight of nodules; *Bradyrhizobium* inoculation, N and P fertilizers significantly increased number and dry weight of nodules, plant height, shoot and root dry weight in two seasons compared with the control.

**Key Words:** *Bradyrhizobium*; Nitrogen; Phosphorus; intercropping; cowpea; rainfed.

## تأثير الزراعة البينية والتلقيح ببكتيريا العقد الجذرية (*Bradyrhizoiium*) والتسميد النتروجيني والفسفوري علي نمو اللوبيا حلو

اخلاص محمد زين موسى محمد زين<sup>1</sup>

<sup>1</sup> كلية الزراعة، جامعة سنار، السودان.

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### المستخلص

أجريت تجربة حقلية بالمزرعة التجريبية لكلية الزراعة (أبونعامة) – جامعة سنار لموسمين متتالين لدراسة تأثير الزراعة البينية والتلقيح ببكتيريا العقد الجذرية (*Bradyrhizoiium*) والتسميد النتروجيني والفسفوري علي نمو اللوبيا حلو. أظهرت نتائج الدراسة أن الزراعة البينية أدت إلي زيادة معنوية في عدد العقد الجذرية ووزنها الجاف في الموسمين، كما أن التلقيح ببكتيريا العقد الجذرية (*Bradyrhizoiium*) والتسميد النتروجيني والفسفوري أدي إلي زيادة معنوية في عدد العقد الجذرية ووزنها الجاف وطول النبات والوزن الجاف للساق والجذور في الموسمين مقارنة بالشاهد.

## Introduction

Intercropping legumes and non legumes is an agriculture practice of cultivating two or more crops on the same place of land at the same time. It is commonly practiced in many parts of the world in order to increase the productivity per unit area of the land (Bhupinder *et al.*, 2003).

Cowpea (*Vigna unguiculata* L. Walps) is an important grain legume throughout the tropics and subtropics, covering Africa, Asia and Central and South America. It provides a cheap source of plant protein for the poor people in the third world. In Sudan cowpea is grown widely as a subsistence crop in Kordofan, Darfur and Central and Southern regions as a rainfed crop. In addition to the value of cowpea, as a leguminous plant, that can fixing atmospheric nitrogen and improving soil nitrogen, cowpea is also drought and shade tolerant, therefore, it compatible as an intercrop with many crops (IITA, 1997).

The inoculation the inoculums to the seedling) enhance nodule numbers, their effectiveness, the growth and yield of soybean (Salih, 2002), hyacinth bean (Obied, 2003), fenugreek (Abdelgani, 1997) and groundnut (Mohamedzein, 1996).

Application of nitrogen fertilizer as a starter dose enhanced the nodulation then the growth and yield of legumes (Abu Naib, 1982; Mahdi *et al.*, 1983; Karrar, 1984), also phosphate is known to improve rhizobial growth and vigor resulting in greater colonization, root infection and nodulation (Mahdi and Mustafa, 2005). The main objective of this study is to determine the effect of inoculation with *Bradyrhizobium* strain, intercropping, nitrogen of legumes by locally or introduced *Bradyrhizobium* or *Rhizobium* strains (either by dressing the seeds at sowing or by adding

and phosphorus fertilizers on growth of cowpea under rainfed conditions.

## Materials and Methods:

Afield experiment was carried out at the experimental field of Faculty of Agriculture (Abu Naama)- University of Sinnar (Latitude 12° 44 N and Longitude 34° 7 E) for two successive seasons (2014and 2015). The soil of the experimental site is characterized by 11.5% sand, 19.6% silt. 68.9% clay, pH=8.1, Ece= 0.9, N= 0.06% and P=5.3%.

Sorghum (*Sorghum biocolor* L. Monech) seed of variety tabat were obtained from the Sudanese Arabian company, cowpea (*Vigna unguiculata* L. Walps) seeds were obtained from the local market of Abu Naama, and *Bradyrhizobium* strain was obtained from Environment and Natural Resources Research Institute, National Centre for Research.

The experimental site was prepared by ploughing, harrowing, then leveling and ridging. The land was divided into plots, each of 4X6 m, 70 cm between ridges, and six north- south ridges per plot. P and N fertilizers were added at sowing. The experiment was arranged in split split plot design with six replicates. The following treatments were assigned to main plots:

- 1- Uninoculated (Control)
- 2- Inoculated with *Bradyrhizobium* strain.

The following cropping systems were assigned to the sub plots:

- 1- Cowpea (monocropping system)
- 2- Cowpea/sorghum (intercropping system)
- 3- Sorghum (monocropping system)

The following fertilizers were assigned to the sub sub plots:

- 1- No fertilizers (control)
- 2- 20 Kg N/ha
- 3- 50 Kg P/ha

At sowing seeds of cowpea were wetted using 40% gum Arabic solution and mixed thoroughly with the charcoal based inoculums of *Bradyrhizobium*, inoculated seeds were left to dry for few minutes in shade. Five seeds of inoculated or uninoculated cowpea in conjunction with sorghum were sown by hand on the ridges in holes 30 cm apart, which were later thinned to three plants per hole for both crops. The crops were grown in alternate, single rows. The plots were irrigated immediately after sowing. There after rainfall was the main source of irrigation.

Three samples from each plot were taken at 4, 6, 8 and 10 weeks after sowing. The parameters which were measured are nodules number, plant height, dry weight of nodules, shoot and root (determined after drying in an oven at 70°C for 48 hours).

Each sample was analyzed in triplicate. The data were subjected to analysis of variance and means were separated by the Duncan's multiple range test with probability of  $P \leq 0.05$ .

## Results:

Nodules number, nodules dry weight and plant height of cowpea significantly ( $p \leq 0.05$ ) increases by *Bradyrhizobium* inoculation and intercropping compared to control in two seasons, also significantly ( $p \leq 0.05$ ) increased by application of nitrogen or phosphorus fertilizers compared with control or with *Bradyrhizobium* inoculation alone in two seasons (Tables 1 & 2; 3&4 and 5&6).

Shoot dry weight and root dry weight significantly ( $p \leq 0.05$ ) increased by *Bradyrhizobium* inoculation, nitrogen and phosphorus fertilizers compared with control (Tables 7&8 and 9&10).

Table 1: Effect of intercropping (sorghum/cowpea), inoculation, N and P on nodules number of cowpea (nodule/plant) in season 2014

Treatment	Time (weeks after sowing)			
	4	6	8	10
Monocropping system				
Control	10.6 <sup>a</sup>	14.3 <sup>a</sup>	21.7 <sup>a</sup>	11.5 <sup>a</sup>
20 Kg N/ha	21.7 <sup>b</sup>	30.8 <sup>c</sup>	48.7 <sup>cd</sup>	20.7 <sup>c</sup>
50 Kg P/ha	20.8 <sup>b</sup>	31.1 <sup>cd</sup>	49.2 <sup>cd</sup>	21.2 <sup>c</sup>
TAL 169	21.3 <sup>b</sup>	30.6 <sup>c</sup>	45.3 <sup>cd</sup>	20.6 <sup>c</sup>
TAL 169+ 20 Kg N/ha	21.8 <sup>b</sup>	33.7 <sup>cde</sup>	52.3 <sup>de</sup>	21.3 <sup>c</sup>
TAL 169+ 50 Kg P/ha	22.1 <sup>b</sup>	33.8 <sup>cde</sup>	54.0 <sup>de</sup>	21.0 <sup>c</sup>
Mean	19.7	29.1	45.2	19.3
Intercropping system				
Control	11.2 <sup>a</sup>	17.8 <sup>b</sup>	27.2 <sup>b</sup>	16.1 <sup>b</sup>
20 Kg N/ha	21.4 <sup>b</sup>	31.0 <sup>cd</sup>	50.6 <sup>d</sup>	20.7 <sup>c</sup>
50 Kg P/ha	22.8 <sup>b</sup>	31.4 <sup>cd</sup>	51.8 <sup>cd</sup>	21.3 <sup>c</sup>
TAL 169	22.3 <sup>b</sup>	31.0 <sup>cd</sup>	47.8 <sup>cd</sup>	20.9 <sup>c</sup>
TAL 169+ 20 Kg N/ha	22.5 <sup>b</sup>	35.1 <sup>e</sup>	57.3 <sup>e</sup>	21.7 <sup>c</sup>
TAL 169+ 50 Kg P/ha	22.8 <sup>b</sup>	34.9 <sup>de</sup>	58.7 <sup>e</sup>	22.6 <sup>c</sup>
Mean	20.5	30.2	48.9	20.6

LSD (5%) treatments	2.6	3.2	4.1	3.1
LSD (5%) means	0.4	0.5	0.7	0.5

Table 2: Effect of intercropping (sorghum/cowpea), inoculation, N and P on nodules number of cowpea (nodule/plant) in season 2015

Treatment	Time (weeks after sowing)			
	4	6	8	10
Monocropping system				
Control	10.7 <sup>a</sup>	17.3 <sup>a</sup>	25.7 <sup>a</sup>	9.8 <sup>a</sup>
20 Kg N/ha	21.3 <sup>bc</sup>	31.3 <sup>c</sup>	40.2 <sup>b</sup>	17.8 <sup>bc</sup>
50 Kg P/ha	21.1 <sup>bc</sup>	31.6 <sup>cd</sup>	41.3 <sup>bc</sup>	19.4 <sup>c</sup>
TAL 169	19.7 <sup>b</sup>	30.1 <sup>cd</sup>	42.2 <sup>bc</sup>	19.4 <sup>c</sup>
TAL 169+ 20 Kg N/ha	21.7 <sup>bc</sup>	41.7 <sup>d</sup>	54.3 <sup>d</sup>	20.5 <sup>c</sup>
TAL 169+ 50 Kg P/ha	21.5 <sup>bc</sup>	41.2 <sup>d</sup>	49.0 <sup>cd</sup>	19.2 <sup>c</sup>
Mean	19.3	32.4	42.1	17.7
Intercropping system				
Control	11.7 <sup>a</sup>	22.3 <sup>b</sup>	29.7 <sup>a</sup>	15.3 <sup>b</sup>
20 Kg N/ha	23.2 <sup>c</sup>	32.6 <sup>cd</sup>	40.3 <sup>bc</sup>	20.5 <sup>c</sup>
50 Kg P/ha	23.6 <sup>cd</sup>	32.7 <sup>cd</sup>	47.2 <sup>cd</sup>	20.7 <sup>c</sup>
TAL 169	22.3 <sup>bc</sup>	32.6 <sup>cd</sup>	45.5 <sup>c</sup>	20.1 <sup>c</sup>
TAL 169+ 20 Kg N/ha	29.4 <sup>d</sup>	43.2 <sup>d</sup>	53.8 <sup>d</sup>	21.1 <sup>c</sup>
TAL 169+ 50 Kg P/ha	28.3 <sup>d</sup>	43.4 <sup>d</sup>	54.7 <sup>d</sup>	20.8 <sup>c</sup>
Mean	23.1	34.5	45.2	19.8
LSD (5%) treatments	3.0	2.7	4.2	3.6
LSD (5%) means	0.5	0.5	0.7	0.6

Table 3: Effect of intercropping (sorghum/cowpea), inoculation, N and P on nodules dry weight of cowpea (g/plant) in season 2014

Treatment	Time (weeks after sowing)			
	4	6	8	10
Monocropping system				
Control	15.22 <sup>a</sup>	36.11 <sup>a</sup>	88.89 <sup>a</sup>	47.17 <sup>ab</sup>
20 Kg N/ha	66.67 <sup>ef</sup>	112.22 <sup>c</sup>	507.68 <sup>bc</sup>	97.11 <sup>c</sup>
50 Kg P/ha	62.61 <sup>e</sup>	148.89 <sup>d</sup>	570.22 <sup>c</sup>	108.33 <sup>cd</sup>
TAL 169	50.39 <sup>d</sup>	131.67 <sup>cd</sup>	491.06 <sup>bc</sup>	117.56 <sup>de</sup>
TAL 169+ 20 Kg N/ha	50.56 <sup>cd</sup>	316.50 <sup>h</sup>	707.10 <sup>d</sup>	193.28 <sup>f</sup>
TAL 169+ 50 Kg P/ha	99.39 <sup>g</sup>	340.00 <sup>h</sup>	746.11 <sup>d</sup>	238.55 <sup>g</sup>
Mean	57.47	180.90	518.51	133.67
Intercropping system				
Control	22.28 <sup>ab</sup>	38.89 <sup>ab</sup>	155.22 <sup>ab</sup>	41.72 <sup>a</sup>
20 Kg N/ha	28.22 <sup>b</sup>	128.89 <sup>cd</sup>	414.00 <sup>b</sup>	75.06 <sup>b</sup>
50 Kg P/ha	71.67 <sup>ef</sup>	182.22 <sup>e</sup>	493.17 <sup>bc</sup>	85.72 <sup>bc</sup>
TAL 169	39.17 <sup>c</sup>	77.82 <sup>b</sup>	493.17 <sup>bc</sup>	115.61 <sup>d</sup>
TAL 169+ 20 Kg N/ha	46.94 <sup>cd</sup>	221.67 <sup>f</sup>	593.67 <sup>cd</sup>	122.22 <sup>de</sup>
TAL 169+ 50 Kg P/ha	85.56 <sup>f</sup>	246.06 <sup>g</sup>	617.89 <sup>cd</sup>	132.45 <sup>e</sup>
Mean	48.97	149.26	461.19	95.46
LSD (5%) treatments	8.70	23.92	87.12	14.37
LSD (5%) means	1.45	3.99	14.52	2.40

Table 4: Effect of intercropping (sorghum/cowpea), inoculation, N and P on nodules dry weight of cowpea (g/plant) in season 2015

Treatment	Time (weeks after sowing)			
	4	6	8	10
Monocropping system				
Control	21.36 <sup>a</sup>	14.56 <sup>a</sup>	127.05 <sup>a</sup>	57.21 <sup>a</sup>
20 Kg N/ha	53.69 <sup>cd</sup>	158.35 <sup>c</sup>	503.32 <sup>de</sup>	348.52 <sup>g</sup>
50 Kg P/ha	62.25 <sup>d</sup>	167.31 <sup>cd</sup>	593.60 <sup>e</sup>	117.60 <sup>bc</sup>
TAL 169	40.33 <sup>b</sup>	239.59 <sup>d</sup>	763.94 <sup>f</sup>	172.10 <sup>cd</sup>
TAL 169+ 20 Kg N/ha	76.74 <sup>e</sup>	337.48 <sup>e</sup>	684.32 <sup>f</sup>	299.79 <sup>f</sup>
TAL 169+ 50 Kg P/ha	104.37 <sup>f</sup>	368.00 <sup>f</sup>	648.36 <sup>ef</sup>	237.89 <sup>e</sup>
Mean	56.96	218.38	553.52	205.52
Intercropping system				
Control	24.64 <sup>ab</sup>	44.00 <sup>a</sup>	268.33 <sup>b</sup>	69.55 <sup>ab</sup>
20 Kg N/ha	50.55 <sup>c</sup>	143.15 <sup>bc</sup>	386.19 <sup>cd</sup>	100.00 <sup>b</sup>
50 Kg P/ha	62.46 <sup>de</sup>	174.92 <sup>cd</sup>	437.45 <sup>cd</sup>	110.25 <sup>bc</sup>
TAL 169	40.95 <sup>bc</sup>	134.14 <sup>b</sup>	491.40 <sup>d</sup>	206.70 <sup>de</sup>
TAL 169+ 20 Kg N/ha	46.56 <sup>bc</sup>	179.96 <sup>cd</sup>	361.10 <sup>c</sup>	184.50 <sup>d</sup>
TAL 169+ 50 Kg P/ha	85.13 <sup>ef</sup>	240.09 <sup>de</sup>	543.17 <sup>de</sup>	150.15 <sup>c</sup>
Mean	47.55	151.21	455.57	136.86
LSD (5%) treatments	6.94	20.27	83.13	30.42
LSD (5%) means	1.16	3.38	13.86	5.07



Table 5: Effect of intercropping (sorghum/cowpea), inoculation, N and P on plant height of cowpea (cm/plant) in season 2014

Treatment	Time (weeks after sowing)			
	4	6	8	10
Monocropping system				
Control	21.28 <sup>a</sup>	35.88 <sup>a</sup>	53.72 <sup>a</sup>	90.93 <sup>a</sup>
20 Kg N/ha	27.06 <sup>bcd</sup>	49.17 <sup>bc</sup>	59.22 <sup>bc</sup>	105.67 <sup>b</sup>
50 Kg P/ha	28.38 <sup>bcd</sup>	52.14 <sup>bcd</sup>	70.00 <sup>d</sup>	121.95 <sup>d</sup>
TAL 169	25.75 <sup>b</sup>	50.64 <sup>bcd</sup>	68.00 <sup>cd</sup>	106.33 <sup>bc</sup>
TAL 169+ 20 Kg N/ha	28.09 <sup>bcd</sup>	52.08 <sup>bcd</sup>	59.22 <sup>bc</sup>	114.78 <sup>cd</sup>
TAL 169+ 50 Kg P/ha	29.92 <sup>bcd</sup>	55.83 <sup>d</sup>	78.89 <sup>e</sup>	124.72 <sup>d</sup>
Mean	29.92	49.29	65.03	110.73
Intercropping system				
Control	26.70 <sup>bc</sup>	53.30 <sup>de</sup>	60.17 <sup>bc</sup>	98.06 <sup>ab</sup>
20 Kg N/ha	27.31 <sup>bcd</sup>	55.58 <sup>ef</sup>	59.00 <sup>b</sup>	111.28 <sup>bcd</sup>
50 Kg P/ha	30.53 <sup>cd</sup>	56.77 <sup>f</sup>	70.39 <sup>de</sup>	116.39 <sup>cd</sup>
TAL 169	27.42 <sup>bcd</sup>	48.55 <sup>b</sup>	54.84 <sup>ab</sup>	110.00 <sup>bcd</sup>
TAL 169+ 20 Kg N/ha	27.61 <sup>bcd</sup>	51.23 <sup>bcd</sup>	59.89 <sup>bc</sup>	115.06 <sup>cd</sup>
TAL 169+ 50 Kg P/ha	32.00 <sup>d</sup>	52.82 <sup>cde</sup>	67.47 <sup>c</sup>	124.11 <sup>d</sup>
Mean	28.59	53.05	61.21	112.48
LSD (5%) treatments	3.90	3.54	2.40	13.74
LSD (5%) means	0.65	0.59	3.40	2.29

Table 6: Effect of intercropping (sorghum/cowpea), inoculation, N and P on plant height of cowpea (cm/plant) in season 2015

Treatment	Time (weeks after sowing)			
	4	6	8	10
Monocropping system				
Control	22.56 <sup>a</sup>	37.00 <sup>a</sup>	62.25 <sup>a</sup>	95.89 <sup>a</sup>
20 Kg N/ha	24.17 <sup>ab</sup>	53.39 <sup>bcd</sup>	66.61 <sup>ab</sup>	112.84 <sup>bc</sup>
50 Kg P/ha	27.14 <sup>cd</sup>	56.00 <sup>bcd</sup>	90.45 <sup>cdef</sup>	128.61 <sup>cd</sup>
TAL 169	25.64 <sup>bc</sup>	55.67 <sup>bcd</sup>	82.94 <sup>cd</sup>	112.94 <sup>bc</sup>
TAL 169+ 20 Kg N/ha	27.08 <sup>cd</sup>	57.72 <sup>cde</sup>	94.55 <sup>defg</sup>	119.61 <sup>cd</sup>
TAL 169+ 50 Kg P/ha	30.38 <sup>e</sup>	63.06 <sup>d</sup>	105.28 <sup>g</sup>	131.39 <sup>d</sup>
Mean	26.24	53.81	84.18	116.88
Intercropping system				
Control	23.30 <sup>a</sup>	47.83 <sup>bc</sup>	77.95 <sup>bc</sup>	103.33 <sup>ab</sup>
20 Kg N/ha	27.25 <sup>cd</sup>	59.00 <sup>de</sup>	86.72 <sup>cde</sup>	116.95 <sup>bcd</sup>
50 Kg P/ha	26.78 <sup>cd</sup>	68.67 <sup>e</sup>	97.50 <sup>defg</sup>	121.33 <sup>cd</sup>
TAL 169	23.55 <sup>a</sup>	47.22 <sup>b</sup>	94.44 <sup>defg</sup>	115.84 <sup>bcd</sup>
TAL 169+ 20 Kg N/ha	26.28 <sup>cd</sup>	54.89 <sup>bcd</sup>	101.71 <sup>efg</sup>	121.06 <sup>cd</sup>
TAL 169+ 50 Kg P/ha	27.83 <sup>d</sup>	63.28 <sup>de</sup>	103.72 <sup>fg</sup>	129.94 <sup>d</sup>
Mean	25.38	57.07	93.58	118.08
LSD (5%) treatments	1.80	8.90	13.78	15.82
LSD (5%) means	0.30	1.48	2.30	2.64

Table 7: Effect of intercropping (sorghum/cowpea), inoculation, N and P on shoot dry weight of cowpea (g/plant) in season 2014

Treatment	Time (weeks after sowing)			
	4	6	8	10
Monocropping system				
Control	1.28 <sup>a</sup>	5.78 <sup>a</sup>	9.08 <sup>a</sup>	29.09 <sup>a</sup>
20 Kg N/ha	1.63 <sup>bc</sup>	7.03 <sup>ab</sup>	12.61 <sup>ab</sup>	52.29 <sup>b</sup>
50 Kg P/ha	1.93 <sup>d</sup>	10.82 <sup>d</sup>	16.92 <sup>c</sup>	62.08 <sup>cd</sup>
TAL 169	1.34 <sup>ab</sup>	6.75 <sup>ab</sup>	14.09 <sup>bc</sup>	57.31 <sup>bc</sup>
TAL 169+ 20 Kg N/ha	1.73 <sup>bc</sup>	7.90 <sup>abc</sup>	15.47 <sup>bc</sup>	63.26 <sup>cd</sup>
TAL 169+ 50 Kg P/ha	1.61 <sup>b</sup>	9.60 <sup>cd</sup>	17.27 <sup>e</sup>	62.94 <sup>cd</sup>
Mean	1.59	7.98	14.24	54.49
Intercropping system				
Control	1.34 <sup>ab</sup>	5.89 <sup>a</sup>	9.99 <sup>a</sup>	32.07 <sup>a</sup>
20 Kg N/ha	1.87 <sup>cd</sup>	6.12 <sup>ab</sup>	12.16 <sup>ab</sup>	64.32 <sup>d</sup>
50 Kg P/ha	1.95 <sup>d</sup>	7.27 <sup>abc</sup>	15.21 <sup>bc</sup>	65.01 <sup>d</sup>
TAL 169	1.40 <sup>ab</sup>	7.04 <sup>ab</sup>	14.05 <sup>abc</sup>	61.01 <sup>cd</sup>
TAL 169+ 20 Kg N/ha	1.85 <sup>cd</sup>	7.90 <sup>abc</sup>	16.32 <sup>c</sup>	66.03 <sup>d</sup>
TAL 169+ 50 Kg P/ha	1.86 <sup>cd</sup>	8.31 <sup>bc</sup>	17.20 <sup>c</sup>	66.25 <sup>d</sup>
Mean	1.17	7.17	14.15	59.11
LSD (5%) treatments	0.16	2.04	3.20	6.16
LSD (5%) means	0.03	0.34	0.53	1.03

Table 8: Effect of intercropping (sorghum/cowpea), inoculation, N and P on shoot dry weight of cowpea (nodule/plant) in season 2015

Treatment	Time (weeks after sowing)			
	4	6	8	10
Monocropping system				
Control	1.44 <sup>a</sup>	5.67 <sup>ab</sup>	8.36 <sup>a</sup>	30.07 <sup>a</sup>
20 Kg N/ha	2.10 <sup>b</sup>	6.35 <sup>abc</sup>	9.19 <sup>b</sup>	57.31 <sup>bcd</sup>
50 Kg P/ha	2.94 <sup>cd</sup>	9.95 <sup>d</sup>	9.55 <sup>bcd</sup>	67.00 <sup>d</sup>
TAL 169	2.50 <sup>bc</sup>	5.74 <sup>abc</sup>	9.57 <sup>bcd</sup>	52.41 <sup>bc</sup>
TAL 169+ 20 Kg N/ha	2.88 <sup>cd</sup>	7.47 <sup>bcd</sup>	9.98 <sup>de</sup>	66.36 <sup>d</sup>
TAL 169+ 50 Kg P/ha	3.12 <sup>cd</sup>	8.73 <sup>cd</sup>	10.16 <sup>e</sup>	66.11 <sup>d</sup>
Mean	2.49	7.32	9.47	57.21
Intercropping system				
Control	1.58 <sup>ab</sup>	4.30 <sup>abc</sup>	8.56 <sup>a</sup>	38.70 <sup>a</sup>
20 Kg N/ha	2.33 <sup>bc</sup>	5.09 <sup>ab</sup>	9.40 <sup>bc</sup>	54.08 <sup>bcd</sup>
50 Kg P/ha	2.40 <sup>bc</sup>	6.09 <sup>abc</sup>	9.75 <sup>cde</sup>	57.18 <sup>bcd</sup>
TAL 169	2.57 <sup>bc</sup>	4.01 <sup>a</sup>	9.80 <sup>cde</sup>	51.11 <sup>b</sup>
TAL 169+ 20 Kg N/ha	3.27 <sup>d</sup>	4.93 <sup>abc</sup>	10.12 <sup>e</sup>	62.70 <sup>bcd</sup>
TAL 169+ 50 Kg P/ha	3.52 <sup>e</sup>	5.93 <sup>abc</sup>	10.19 <sup>e</sup>	63.02 <sup>cd</sup>
Mean	2.61	5.06	9.64	54.46
LSD (5%) treatments	0.56	2.38	0.42	10.30
LSD (5%) means	0.09	0.40	0.07	1.72

Table 9: Effect of intercropping (sorghum/cowpea), inoculation, N and P on root dry weight of cowpea (g/plant) in season 2014

Treatment	Time (weeks after sowing)			
	4	6	8	10
Monocropping system				
Control	0.23 <sup>a</sup>	0.93 <sup>a</sup>	1.16 <sup>a</sup>	2.44 <sup>a</sup>
20 Kg N/ha	0.33 <sup>cde</sup>	1.10 <sup>abc</sup>	1.87 <sup>bcd</sup>	3.95 <sup>b</sup>
50 Kg P/ha	0.34 <sup>de</sup>	1.39 <sup>de</sup>	2.01 <sup>bcde</sup>	4.03 <sup>b</sup>
TAL 169	0.26 <sup>ab</sup>	1.20 <sup>bcde</sup>	1.74 <sup>bc</sup>	3.81 <sup>b</sup>
TAL 169+ 20 Kg N/ha	0.32 <sup>cde</sup>	1.27 <sup>bcde</sup>	1.94 <sup>bcd</sup>	3.84 <sup>b</sup>
TAL 169+ 50 Kg P/ha	0.31 <sup>cd</sup>	1.32 <sup>cde</sup>	2.08 <sup>bcd</sup>	3.90 <sup>b</sup>
Mean	0.30	1.20	1.80	3.66 <sup>b</sup>
Intercropping system				
Control	0.25 <sup>ab</sup>	0.94 <sup>ab</sup>	1.69 <sup>b</sup>	2.68 <sup>a</sup>
20 Kg N/ha	0.31 <sup>cd</sup>	1.04 <sup>ab</sup>	1.89 <sup>bcd</sup>	3.82 <sup>b</sup>
50 Kg P/ha	0.35 <sup>e</sup>	1.12 <sup>abcd</sup>	1.95 <sup>bcd</sup>	3.76 <sup>b</sup>
TAL 169	0.27 <sup>b</sup>	1.19 <sup>bcde</sup>	1.84 <sup>bcd</sup>	3.70 <sup>b</sup>
TAL 169+ 20 Kg N/ha	0.30 <sup>bc</sup>	1.33 <sup>cde</sup>	2.12 <sup>cd</sup>	3.88 <sup>b</sup>
TAL 169+ 50 Kg P/ha	0.34 <sup>de</sup>	1.46 <sup>e</sup>	2.21 <sup>d</sup>	3.92 <sup>b</sup>
Mean	0.30	1.18	1.95	3.63
LSD (5%) treatments	0.04	0.22	0.30	0.44
LSD (5%) means	0.01	0.04	0.05	0.07

Table 10: Effect of intercropping (sorghum/cowpea), inoculation, N and P on root dry weight of cowpea (nodule/plant) in season 2015

Treatment	Time (weeks after sowing)			
	4	6	8	10
Monocropping system				
Control	0.40 <sup>a</sup>	0.98 <sup>a</sup>	1.57 <sup>a</sup>	2.57 <sup>a</sup>
20 Kg N/ha	0.60 <sup>bc</sup>	1.15 <sup>abc</sup>	1.69 <sup>ab</sup>	4.00 <sup>b</sup>
50 Kg P/ha	0.74 <sup>c</sup>	1.45 <sup>de</sup>	2.13 <sup>abcd</sup>	4.08 <sup>b</sup>
TAL 169	0.60 <sup>bc</sup>	1.25 <sup>bcde</sup>	2.23 <sup>cd</sup>	3.86 <sup>b</sup>
TAL 169+ 20 Kg N/ha	0.59 <sup>bc</sup>	1.33 <sup>bcde</sup>	2.40 <sup>cd</sup>	3.90 <sup>b</sup>
TAL 169+ 50 Kg P/ha	0.69 <sup>bc</sup>	1.37 <sup>cde</sup>	2.41 <sup>cd</sup>	3.95 <sup>b</sup>
Mean	0.60 <sup>bc</sup>	1.26	2.07	3.95
Intercropping system				
Control	0.56 <sup>abc</sup>	0.99 <sup>a</sup>	1.59 <sup>a</sup>	2.73 <sup>a</sup>
20 Kg N/ha	0.57 <sup>bc</sup>	1.09 <sup>ab</sup>	1.81 <sup>abc</sup>	3.87 <sup>b</sup>
50 Kg P/ha	0.66 <sup>bc</sup>	1.16 <sup>abcd</sup>	2.21 <sup>bcd</sup>	3.81 <sup>b</sup>
TAL 169	0.55 <sup>ab</sup>	1.24 <sup>bcde</sup>	2.32 <sup>cd</sup>	3.75 <sup>b</sup>
TAL 169+ 20 Kg N/ha	0.59 <sup>bc</sup>	1.38 <sup>cde</sup>	2.41 <sup>cd</sup>	3.95 <sup>b</sup>
TAL 169+ 50 Kg P/ha	0.66 <sup>bc</sup>	1.50 <sup>e</sup>	2.62 <sup>d</sup>	3.97 <sup>b</sup>
Mean	0.60	1.23	2.16	3.68
LSD (5%) treatments	0.16	0.22	0.56	0.44
LSD (5%) means	0.03	0.04	0.09	0.07

### Discussion:

Nodules number of cowpea significantly increased by *Bradyrhizobium* inoculation (Pahwa and Yadava, 2002; Kishan *et al.*, 2001; Fenning and Danso, 2001), by *Bradyrhizobium* inoculation and starter dose of nitrogen (Babo and Mishra, 2001) and by *Bradyrhizobium* inoculation and phosphorus fertilizer application (Mand *et al.*, 1991).

The increment of nodules dry weight by *Bradyrhizobium* inoculation was reported for soybean and hyacinth bean (Obied, 2003), soybean (Salih, 2002), faba bean (Ahmed, 2000) and fenugreek (Abdelgani, 1997), and by *Bradyrhizobium* inoculation and application of nitrogen and phosphorus fertilizers for groundnut (Mohamedzein, 1996).

The increment of nodules number and nodules dry weight by intercropping may be due to excretion of organic compounds by companion cereals e.g. carbohydrates needed by bacteria.

The increment of plant height, shoot dry weight and root dry weight by *Bradyrhizobium* inoculation were for soybean and hyacinth bean (Obied, 2003), soybean (Salih, 2002), by *Bradyrhizobium* inoculation nitrogen and phosphorus fertilizers for cowpea (Babo and Mishra, 2001), for groundnut (Mohamedzein, 1996).

Inoculation, nitrogen and phosphorus fertilizers increased the fixation, which in turn enhances growth and consequently plant height, shoot dry weight and root dry weight of cowpea.

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