Direct Research Journal of Agriculture and Food Science

Vol.6 (9), pp. 220 –224, September 2018
ISSN 2354-4147
DOI: https://doi.org/10.26765/DRJAFS.2018.5802
Article Number: DRJA6947025802
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Direct Research Journal of Agriculture and Food Science
http://directresearchpublisher.org/journal/drjafs

Research Paper

Assessment of Cowpea (*Vigna unguiculata* (L.) Walp) Genotypes in Response to *Rhizobium* Inoculation in Makurdi, Benue State, Nigeria

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Received 13 July 2018; Accepted 17 August, 2018

Field experiment was conducted to evaluate the performance of some selected cowpea genotypes inoculated with *Rhizobium* was conducted at Teaching and Research Farm of the University of Agriculture, Makurdi, Benue State, Nigeria during the 2016 rainy season. Four varieties (UAM09-1046-6-2, UAM09-1055-6, IT99K-573-1-1 and UAM14-143-4-1) were used and laid out in a Randomized Complete Block Design (RCBD) with three replications. Each variety was shared into two portions - one inoculated while the other was not inoculated. Seeds were inoculated with *Rhizobium* (*Bradyrhizobium japonicum*) by placing seeds in a plastic bowl, adding a little water to moisten, then, and adding three spoonful of sugar as adhesive. Five grams inoculant (*Bradyrhizobium japonicum*) was weighed and added to 500 g of cowpea seeds, stirred and spread on aclean surface under a shade to air-dry for one hour. Seeds (inoculated and non-inoculated) were then sowed on prepared ridges at three seeds/hole at 40 cm apart. All agronomic practices were carried out. Data collected were on plant height, number of branches, days to 50% flowering, number of pods per plant, number of seeds per pod, number of nodules, and grain yield per plot. The results showed significant effect of *Rhizobium* inoculation on grain yield, while inoculated cowpea variety UAM09 1046-6-2 had the highest yield.

Keywords: Cowpea, *Rhizobium*, inoculation

INTRODUCTION

Cowpea (*Vigna unguiculata* (L.) Walp) is one of the most important food and forage legumes in the semi-arid tropics that includes parts of Asia, Africa, Southern Europe, Southern United States, and Central and South America (Singh 2005;Timko *et al*., 2007). As a leguminous crop, cowpea improves soil fertility by fixing atmospheric nitrogen through its root nodules (Sanginga, 2003). Cowpea is well adapted to a wide range of environmental conditions and cropping systems in West Africa (Duke, 1990). Most cowpeas are grown on the African continent, particularly in Nigeria and Niger which account for 66% of world cowpea production (FAO, 2012). Cowpea crop played a vital role in providing nutritional security to many people in Africa as it is a source of food that combines essential minerals and high quality protein (Yewande and Thomas, 2015). Young and immature whole pods of cowpea are eaten while the grain and leaves are source of carbohydrates, proteins, fats, β-carotene and vitamins B and C which are necessary for good health maintenance (Boukar, *et al*. 2011). Poor soils have become a problem as a result of poor land management which leads to continuous loss of soil nutrients through the activities of soil erosion, leaching and crop removal (Aminu, 2003). Natural reserves of soil N are normally low in many African soils and phosphorus needed by legumes are also deficient (Ohyama and Kawai, 1983; Ochigbo, 2008). Measures must be taken to improve yield, and enable leguminous plants to convert atmospheric N into absorbable forms of NH_4^+ and NO_3^- to be used by plants. The acute deficiency of phosphorus can prevent nodulation in legumes. Phosphorus is required for nodule metabolism and tends to be concentrated in the nodules when the plant is deficient in these nutrients (Casman *et al.,* 1981). For this reason, the application of phosphorus fertilizer and Rhizobia inoculation play a significant role in increasing nodulation. The total world production of cowpea is estimated at 6.99 million metric tons (FAO, 2018) of dry grains, of which 64% is produced in Africa. Conservative estimate suggested that 12.30 million hectares are planted annually to cowpea around the world; of this area, about 10.48 million hectares are planted in West Africa, making the region the largest producer and consumer of cowpea in the world. Nigeria produces about 3.02 million tons of cowpea ((FAOSAT, 2018). Farmers in many parts of the world have observed dramatic increases in yields due to inoculating their legumes (Cigdem and Merih, 2008). Inoculation of seeds by *Rhizobium* species prior to planting has also been reported to be a key factor in enhancing nodulation, early emergence, crop vigour and high grain yield (Figueiredo *et al.,* 2008; Otieno *et al.,* 2009). The study conducted by Mbugua *et al.* (2009) on effects of commercial *Rhizobium* strain inoculants and triple superphosphate fertilizer on yield of new dry bean lines in central Kenya showed that bean seeds inoculated with *Rhizobium* strain had higher daily germination count, crop vigour, number of seeds per pod and grain yield as compared with those of non-inoculated crops. Furthermore, comparable results were obtained by Bambara and Ndakidemi (2010), who reported high dry bean seed yield of 1679 kg/ha with inoculated crop compared to 758 kg/ha from the control. They noted that higher yields obtained with inoculation confirm that the *Rhizobium* technology is efficient in supplying nitrogen to legumes. However, the findings of these two studies were contrary to those of Musandu and Ogendo (2001), who stated that there was no significant difference observed in yield and yield components of dry bean between inoculated and non-inoculated crops. Since the crop has importance in Africa and the world at large, this study was designed to assess the performance of selected cowpea genotypes under inoculated and non-inoculated conditions as there is increase need to develop cowpea that would be prolific in nodule production.

MATERIALS AND METHODS

The experiment was conducted at Teaching and Research Farm of the University of Agriculture, Makurdi, Benue State, Nigeria during the 2016 cropping season. Makurdi is situated in the Southern Guinea Savannah Ecological zone of Nigeria and located on latitude 7°41'N and longitude 8°37'E with an elevation of 97 m above sea level. Makurdi is characterized by a tropical climate with two distinct seasons, the wet or rainy season and the dry season. The wet season starts from April and ends in October with an annual rainfall in the range of 1500 mm to 1800 mm. The dry season begins in November and ends in March (Ochigbo, 2017). Four cowpea genotypes obtained from the Seed Technology Centre, University of Agriculture, Makurdi, Benue State, Nigeria was used for this study. These include UAM09-1046-6-2, UAM09-1055-6, IT99k-573-1-1 and UAM14-143-4-1. The *Rhizobium* used for this experiment was sourced from an agro commercial store in Jos, Plateau State, Nigeria. The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. A total area measuring 32 m x 9 m was used for the experiment. The plot was ploughed and ridges made. Three seeds were planted per hill at an inter-row spacing of 40 cm and intra-row spacing of 30cm on the 5th of August 2016.The seedlings were thinned to two plants per stand at 10 days after planting. Insects and pests were controlled by applying “Best" (cypermethrin) pesticide at the rate of 40 ml in 10 litres of water. The pesticide was sprayed on the plants with the use of knapsack sprayer starting from 14 days after planting and subsequently 16 days interval until pods were matured. Weeds were controlled manually 21 days after planting and subsequently as the need arose. Phosphorus fertilizer was applied in the form of Single Super Phosphate (SSP) as a single dose at 7 days after planting at the rate of 30 kg/ha. Application was done using the band placement method (BNARDA, 2000).

Administration of the treatment

For the treatment, each of the varieties was divided into two equal halves so as to inoculate one and leave the other un-inoculated. Inoculation was done as described by Ahiabor *et al.* (2014). The cowpea seeds were put in a plastic bowl and moistened with water, three spoonful of sugar solution was added as an adhesive and 5 g of inoculants was weighed and added to the 500 g of cowpea seeds as the sachet of inoculants used was 100g meant for 10-15kg seeds. It was then stirred with a spoon onto a clean surface and air-dried under a shade for about an hour. The sowing was done early in the morning to avoid exposing the inoculants to the direct rays of the sun which might affect the quality of the inoculants. Sowing was done on ridges at three seeds per hill at an

Table 1. Mean square estimates for yield and yield attributes of cowpea evaluated in Makurdi.

Source of variation	Df	Plt. Ht 8WAP	NOB 8WAP	Days to 1st flowering	D50%F	NOD	NOP/P	NOS/P	100SWT	YIELD
Rep	2	107.10	0.02	9.54	23.79	1.10	2.52	11.56	5.06	988
Variety(V)	3	71.80	0.06	19.15*	37.50*	3.04	0.29	2.69	3.75	17901*
Treatment(T)	1	1612.40*	0.02NS	234.38**	160.17**	72.42**	53.70**	73.50**	29.70*	28770**
V x T	3	176.70	0.04	79.26*	133.94**	2.71	1.08	1.40	1.82	140
Residual	14	144.33	0.30	6.73	7.84	1.15	0.99	1.86	4.69	1055
Total	23									
CV%		15.8	11.3	5.9	5.6	6.3	8.8	14.4	12.2	16.9

*, ** = Significant and highly significant at 5% level of probability; NS= Not Significant.
Df = Degree of freedom; Plt.Ht= Plant height; NOB= Number of branches; D50%F= Days to 50% flowering; NOD = Number of nodules; NOP/P=Number of pods/plant; NOS/P=Number of seeds/plant; SWT= Seed weight; WAP = Weeks after planting; CV = Coefficient of variation.

Table 2. Effect of inoculation on yield and yield components of cowpea in Makurdi

Variety	Trt	Plt Ht 8WAP (cm)	NOB 8WAP	NOL 8WAP	NOD	D50%F	NOP/P	NOS/P	YIELD (Kg/ha)
	IN	92.7	4.87	67.80	19.69	55.00	12.87	10.33	300.60
UAM09 1046-6-2	NO	67.4	4.67	57.30	14.42	49.00	9.67	7.20	239.40
UAM09 1055-6	IN	89.9	5.07	59.30	18.30	48.33	12.87	11.60	181.60
	NO	64.0	4.95	62.20	15.44	49.00	9.80	7.80	118.80
IT99K-573-1-1	IN	76.9	4.93	63.30	17.55	45.67	12.37	11.47	223.20
	NO	66.6	4.89	54.60	15.42	58.33	10.53	9.07	152.50
UAM14-143-4-1	IN	77.6	4.80	71.80	19.96	40.33	12.87	11.40	199.90
	NO	73.4	4.96	50.70	16.33	53.67	9.00	6.73	117.600
MEAN	IN	84.30	4.92	65.50	18.88	47.33	12.74	11.20	226.30
	NO	67.90	4.87	56.20	18.40	52.50	9.75	7.70	157.10
LSD(0.05) Variety		14.87	0.68	9.80	1.33	3.47	1.23	1.69	40.22
LSD(0.05) Treat		10.52	0.48	6.93	0.94	2.45	0.87	1.19	28.44

Plt.Ht= Plant height; D50%F= Days to 50% flowering; NOB= Number of branches; NOL= Number of Leaves; NOD = Number of nodules; NOP/P=Number of pods/plant; NOS/P=Number of seeds/plant; SWT= Seed weight; WAP = Weeks after planting; Trt = Treatment; IN= Inoculated; NO= Not inoculated.

inter and intra-row spacing of 40 x 30 cm giving a plant population of 80,000 plants per hectare. In order to avoid contamination of the un-inoculated treatments with the inoculants that might get stuck to the hand during sowing, the un-inoculated seeds were sown before the inoculated ones. The plants were allowed to grow to maturity under rain-fed conditions and the necessary management practices like weeding were observed. The living cells of *rhizobium* in inoculants was one billion per gram and the sachet of Brady*rhizobium* japonicum used was 100 g meant to treat 10-15 kg cowpea seeds.

Data collection

Data were collected from plants on each replication and observations were recorded on ten different parameters as follows: Plant height, number of leaves per plant, number of branches per plant, days to first flowering, days to 50% flowering, number of seeds per pod, number of pods per plant, number of nodules per plant, hundred (100)-seed weight (g) and grain yield (kg/ha).

Data analysis

All the data collected were subjected to analysis of variance (ANOVA) test using GenStat Release (Vers.7.22, 2009) and significant means were separated using the Least Significant Difference (LSD) at 5% level of probability.

RESULTS AND DISCUSSION

Mean square estimates for yield and other vegetative and phenological traits for cowpea genotypes evaluated in Makurdi, Benue State, Nigeria in 2016 are presented in (Table 1). There was significance at 5% level of probability for days to first flowering and days to 50% flowering for the interaction between variety and treatment. All the traits examined also showed significance for treatment given to the genotypes used in this study except for number of branches at eight weeks after planting (8WAP) which showed non-significance to the treatment. The coefficient of variation (CV) also was lowest for the traits that showed significance for interaction between variety and treatment being 5.6 and 5.9 for days to 50% flowering and days to first flowering respectively. As for the varieties, there was significance in days to first flowering, days to 50% flowering and seed yield while other traits did not show significance at P<0.05. The effect of inoculation on cowpea variety is presented in (Table 2). For all the traits investigated, there

Table 3. Performance of cowpea variety in response to inoculation in Makurdi.

Traits	Plt Ht 8WAP (cm)	NOB 8WAP	NOD	DFF	D50%F	NOP/P	NOS/P	100SWT (g)	YIELD (Kg/ha)
UAM09 1046-6-2	80.1	4.77	17.06	44.00	52.00	62.6	8.77	17.50	270.0
UAM09 1055-6	77.0	5.01	16.87	43.67	48.67	60.7	9.70	18.82	150.2
IT99K-573-1-1	71.7	4.91	16.48	46.83	52.00	58.9	10.27	17.83	187.9
UAM14-143-4-1	7.55	4.88	18.14	42.67	47.00	61.20	9.07	16.93	158.80
MEAN	76.1	4.89	17.14	44.29	49.92	60.9	9.45	17.77	191.73
LSD(0.05)	14.87	0.68	1.32	3.21	3.46	9.80	1.68	2.68	40.22

Plt Ht= Plant height; DFF= Days to first flowering; D50%F= Days to 50% flowering; NOB= Number of branches; NOD = Number of nodules; NOP/P=Number of pods/plant; NOS/P=Number of seeds/plant; SWT= Seed weight; WAP = Weeks after planting.

was no significant difference in variety for vegetative and phenological characters except in days to 50% flowering and yield. Inoculated seeds from this study performed significantly better than un-inoculated ones for all the traits except in number of branches produced eight weeks after planting. Inoculated plants compared to non-inoculated plants were taller, had more leaves, flowered earlier, produced more pods and had more seeds, culminating to higher yield as seen in (Table 2). This could mean that inoculation promoted nodulation which in turn gave the plants comparative advantage in sourcing for more nutrients for the plants during seed formation. This confirms the study by Cigdem and Merih (2008) stated that farmers in many parts of the World have received dramatic increases in yields due to inoculating their legumes. In (Table 3), the performance of cowpea in this study with response to *Rhizobium* inoculation is presented. Though there was no significant varietal influence observed on the cowpea varieties used, UAM09-1046-6-2 had the highest plant height of 80.10 cm followed by UAM09-1055-6 with 77.00 cm. The latter also had more branches (5.01) and recorded highest weight for 100 seeds (18.82g) than all the other varieties. Though UAM14-143-4-1 possessed more nodules (18.14) than all the other varieties, this did not reflect in its production of pods and eventual seed yield as it produced almost the least seed yield (158.80 kg/ha). This was also the case in its flowering as it flowered much earlier than all the other varieties, flowering about 42 days after, while variety IT99K-573-1-1 which flowered latest (46.83 days), produced highest number of pods per plant (10.27) and its yield was 187.9 kg/ha. UAM09-1046-6-2 took longer days for half the plants in the plot to flower, it produced highest number of pods per plant (62.6) and highest yield of 270 kg/ha followed by IT99k-573-1-1 with significant varietal effect. Similar results were obtained by Bambara and Ndakidemi (2010), who reported high dry bean seed yield of 1679 kg/ha with inoculated crop compared to 758 kg/ha from the control; and Mbugua *et al*. (2009) whose study on effect of commercial *Rhizobium* strain inoculants on yield of new dry bean lines showed that inoculated bean had higher germination count, crop vigour, number of seeds per pod and grain yield as compared to crops from non-inoculated crops. This result indicates that inoculation with *Rhizobium* is an efficient technology in supplying nitrogen to legumes and is a good option for resource poor farmers who cannot afford expensive inputs during production. Inoculation of cowpea is recommended as a good practice as this could help improve soil fertility for higher cowpea productivity. Also, inoculation could discourage excessive use of inorganic fertilizer and encourage biological nitrogen fixation. Inoculating cowpea before planting will go a long way in combating the problem of low yield in cowpea production associated with decline in soil fertility.

Conclusion

The study conducted to evaluate some cowpea genotypes inoculated with *Rhizobium* was carried out in the teaching and research farm of the University of Agriculture, Makurdi, Benue State, Nigeria. Inoculated seeds were planted along un-inoculated seeds and the former performed much better than the latter as plants from inoculated seeds were significantly taller, with more leaves, nodules and yielded more. The result clearly suggests that inoculation of cowpea with *Rhizobium* could enhance productivity. This could also help improve soil fertility as nitrogen fixation is greatly enhanced. Based on the result, genotype UAM09-1046-6-2 out of the four varieties used could be recommended for adoption by cowpea farmers in Makurdi, Benue State, Nigeria. Also it could be used for further breeding programmes.

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