Effect of Different Rates of Single Super Phosphate and Frequency of Megagreen on Nodulation, Nitrogen Fixation and Yield of Cowpea

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Abstract: Megagreen is a bio-stimulant, containing micronized calcite whose particles act quickly on the vegetal metabolism via foliar surface. Therefore experiment was carried out at the screen- house of the College of Plant Science and Crop Production at the Federal University of Agriculture, Abeokuta, Ogun State, Southwestern Nigeria to investigate the effect of different rates of single super phosphate and frequency of megagreen on nodulation, nitrogen fixation and yield of cowpea (*Vigna unguiculata* L). The experiment was a Complete Randomized Design (CRD) arranged in split-split plot with application of megagreen at the rates of 1.5 and 3 (kg/ha per 500 litres of water) used and applied at two frequencies and application of SSP (0 kg/ha P_2O_5) and recommended rate (40 kg/ha P_2O_5) applied at planting. Plant growth and reproductive parameters were measured. The soil physical and chemical properties; and analysis of ureides-N and nitrates-N were determined. The results showed that cowpea gave no significant response to the two treatments of SSP and megagreen in terms of the growth parameters, yield obtained, level of nitrogen retained in the soil and the ammonium nitrate in the plant sap and plant tissue. However, application of SSP and megagreen at the rate of 3 kg/ha per 500 litres of water at 2, and 3 WAP (S_1 M_2 R_1) also recorded more than 200 % increase in yield. The findings indicate that application of SSP and megagreen at the rate of 3 kg/ha are the preferred option to improve soil fertility and quality, and increase cowpea yield.

Key word: Cowpea yield, megagreen, nitrogen fixation, nodulation, single superphosphate

INTRODUCTION

Cowpea, *Vigna unguiculata* (L) Walp, also known as black eye pea or southern pea, is a grain crop cultivated in a range of ecologies especially in the Savanna regions and in the tropics and subtopics (Singh *et al*., 1990; Anonymous, 2008). It is the most important grain legume crop throughout the tropical belt which covers Asia, Far East, Africa, Central and South America. Although, the crop is cultivated in America and Asia, it originated in West Africa, where many wild types are still found (Timko, 2002). The primary cowpea-producing countries in West Africa are Nigeria, Niger, Mali, Senegal, Burkina Faso and Ghana. Cowpea is very important and widely cultivated in Nigeria, constituting a major source of vegetable protein in the diet. Cowpea is a major food crop and is widely grown in Adamawa state, however, with increasing population over the years, the demand for the crop had gone up but the production has not been increased significantly (Agwu, 2001). Increased cowpea production from intensified cropping system can play a key role in income generation in West Africa because of the multiple uses of cowpea grain and fodder in human and animal diet (Rachie, 1985).

Cowpea grain contains about 22% protein and constitutes a major source of protein for resource-poor rural and urban people. It is estimated that cowpea supplies about 40% of the daily protein requirements to most of the people in Nigeria (Muleba *et al*., 1997). Worldwide production of cowpea is put at 6 million tonnes from 7.7 million hectares of land (Singh, 2007). However, the domestic production of cowpea is in the hands of small scale farmers who obtain yield of 200-250 kg/ha and in some cases zero yield due to lack of improved technologies (Chambers, 1992). Similarly, Agboola (1979) reported an average yield of 271.5 kg/ha from the vast area of 3.8 million hectares cultivated to

cowpea in Nigeria. It was also reported that with the use of improved technologies in cowpea production yield of 1,500-2000 kg/ha can be obtained on sole cropping system (Chambers, 1992).

From an agronomic perspective, cowpea is well suited to the agro-climatic-edaphic and socio-economic situations in Sub-Saharan Africa. The traits that distinguish cowpea from many other crops currently grown in Africa include: substantial adaptation to drought; high potential to biologically fix nitrogen in marginal soils with low organic matter. However, cowpea production is generally low as a result of some factor such as diseases and pest, drought, insect pest and weeds (Gungula and Garjila, 2005). Therefore, to increase yield of cowpea additional soil enhancer must be used. Megagreen is a bio-stimulant, containing micronized calcite containing calcium, silicon, magnesium and trace elements whose particles act quickly on the vegetal metabolism via foliar surface (Majkowska-Gadomska *et al*., 2017). It act on the plant increasing the photosynthetic capability through the production of more chloroplast. Studies on megagreen properties also gave a report on better root development in treated plant, increase in protein content in treated leaves among others (Nabti *et al*., 2017). Since the plant general physiological processes follows after the rate of assimilate manufactured by the foliage, the rate of nodules formation and hence nitrogen fixation by legumes could be enhance by megagreen application. This study focused on different rates of SSP and frequency of megagreen on nodulation, nitrogen fixation and yield of cowpea.

MATERIALS AND METHODS

The site of the experiment was the screen-house of the College of Plant Science and Crop Production at the Federal University of Agriculture, Abeokuta, Ogun State, Southwestern Nigeria (Agboola, 1979). Surface soils of 1-20 cm depth, was collected at the upland part of FADAMA in the research field of University. A Complete Randomized Design (CRD) arranged in split-split plot was used for the experiment with four replicates. Each pot was labeled accordingly and seeds were sown. Application of Megagreen at rates of 1.5 kg/ha per 500 litres of water used and applied at two frequencies: 2 and 3; 2, 3 and 4 (WAP). Application of SSP at zero (0 kg/ha P_2O_5) and recommended rate (40 kg/ha P_2O_5) applied at planting.

Data collection: Plant growth parameters which include, plant height, number of leaves, number of seeds, number of pods per pot; reproductive parameters were also measured: days to flowering, and number of pods per pot. In addition, at harvest number of pods, number of seeds and weight per plant were measured while nodules were counted at 4 and 7 WAP. The soil organic carbon, total nitrogen, available phosphorus, exchangeable Ca, Mg, Na, K; Soil pH and analysis of ureides-N and nitrates-N were determined (Herridge, 1982).

Statistical analysis: Data generated were subjected to Analysis of variance test where the F test was significant at $P<0.05$ and the means were separated using F-$LSD_{0.05}$.

RESULTS

Table 1 shows the physicochemical characteristics of soil used. The soil was sandy, neutral in reaction, low in organic carbon, nitrogen, phosphorus with moderate level of cation exchange capacity. There was no significant difference between the treatment means at $P\leq0.05$. However from Table 2, the findings showed that SSP gave a numerically higher plant height, number of leaves and longer days to flowering than the non-application of SSP. However, non-application produces higher number of nodules at 4 and 7 WAP. There was no significant difference between the treatment means at $P\leq0.05$. However, from Table 3 the findings showed that application of SSP at recommended rate of 40 % P_2O_5/ha gave a higher yield of cowpea in terms of number

of pod produced, number of seeds, weight of the seeds, shoot biomass and dry matter produced at 7 WAP. There was no significant difference between the means at P≤0.05. However, from Table 4 it was observed that application of SSP retained more phosphorus and nitrogen in the soil after the termination of the experiment. This suggests that the application of SSP assist in nitrogen fixation of cowpea. Table 5 shows that, application of megagreen at the rate of 1.5 kg/ha per 500 litres of water for 2 and 3 WAP (M_1 R_1) produce a higher growth of cowpea in terms of plant height, number of leaves, number of branches and flower early compare to other applications and frequencies. Table 6 showed that application of megagreen at the rate of 1.5 kg/ha per 500 litres of water for 2 and 3 WAP (M_1 R_1) produced a highest yield of cowpea in terms of number of pod,, number of seeds, and weight of seeds. This was followed by application at the rate of 3 kg/ha per 500 litres of water, for 2 and 3 WAP (M_1 R_1) which produced higher number of pod, number of seeds and weight of seeds.

Table 1: Physical and chemical components of the soil (0-20 cm)

Particulars	Values
Sand (%)	92.8
Silt (%)	5.40
Clay (%)	1.80
Textural Class	Sandy
pH (Soil:H_2O)	7.00
Organic Carbon (g kg^{-1})	3.39
Organic Matter (g kg^{-1})	5.90
Exchangeable Cation (cmol kg^{-1})	
Ca (cmol kg^{-1})	0.83
Mg (cmol kg^{-1})	1.58
Na (cmol kg^{-1})	3.45
K (cmol kg^{-1})	1.58
CEC (cmol kg^{-1})	7.44
Available phosphorus (mg kg^{-1})	0.98
Total nitrogen, %	0.09

Table 2: Effect of single supper phosphate on growth parameters of cowpea cultivar

Treatments	PHT 6WAP	NLF 6WAP	NBR 6WAP	FW NOD	NF NOD 4WAP	NF NOD 7WAP	DTF
SSP_0	61.75	21.64	7.44	0.01	3.20	15.90	48.45
SSP_1	70.64	24.12	8.48	0.03	2.55	10.40	52.10
$LSD_{0.05}$	NS	NS	NS	NS	NS	NS	NS

TRT:Treatments; SSP_0:Single Superphosphate at 0 % P_2O_5/ha; SSP_1:Single Superphosphate at 40 % P_2O_5/ha; FW NOD:Fresh Weight of Nodules per plant; NF NOD:Number of Nodules per plant; PHT:Plant Height at 6 weeks after planting; NLF:Number of leaves per plant at 6 weeks after planting; NBR:Number of branches per plant at 6 weeks after planting; DTF: Days to flowering; WAP:Weeks after planting.

Table 3: Effect of single superphosphate on yield parameters of cowpea cultivar

Treatments	Pod NO	NO of Seed	WT of Seed	Shoot BIOMASS(g)	Dry MATTER(g)
SSP_0	3.60	23.89	4.20	40.69	4.72
SSP_1	4.05	29.89	5.564	43.50	4.89
$LSD_{0.05}$	NS	NS	NS	NS	NS

Table 5: Effect of different rates and frequencies of megagreen on growth parameters

Rate	PHT 6WAP	NLF 6WAP	NBR 6WAP	FW nod	DTF	NF nod 4WAP	NF nod 7WAP
M_0 R_0	65.01	22.73	8.00	0.02	46.75	2.63	8.88
M_1 R_1	83.93	25.79	9.03	0.01	47.52	3.13	12.31
M_1 R_2	71.41	23.79	7.98	0.02	55.63	2.25	12.88
M_2 R_1	59.04	20.38	7.43	0.02	50.50	2.88	17.88
M_2 R_2	51.58	21.73	7.38	0.037	51.25	3.50	13.81
$LSD_{0.05}$	NS	NS	NS	NS	NS	NS	NS

Key: NS=not significant, M=megagreen, R=rate; M_1: Application of megagreen at the rate of 1.5 kg/ha per 500 litres of water; M_2: Application of megagreen at the rate of 3 kg/ha per 500 litres of water; R_0:Application of megagreen at no frequency; R_1:Application of megagreen at 2 and 3 weeks after planting; R_2: Application of megagreen at 2, 3 and 4 weeks after planting.

Table 6: Effects of different rates of megagreen and frequencies on cowpea yield

Rate	Pod No	No of Seed	WT of Seed (g)	Shoot Biomass (g)	Dry Matter (g)
M_0 R_0	2.91	20.29	3.55	48.36	5.18
M_1 R_1	5.43	43.06	7.63	38.52	4.57
M_1 R_2	3.96	25.29	4.64	39.70	4.32
M_2 R_1	4.19	28.96	5.19	41.10	4.81
M_2 R_2	2.63	17.06	3.20	42.82	5.17
$LSD_{0.05}$	NS	NS	NS	NS	NS

Key: No=number, WT=weight, NS=not significant, M=megagreen, R=rate

Table 7: Effects of different rates of megagreen and frequencies on soil phosphorus and nitrogen after the experiment

Rate	Available P (mg/kg)	% nitrogen
M_0 R_O	0.94	0.07
M_1 R_1	0.97	0.08
M_1 R_2	1.42	0.10
M_2 R_1	1.00	0.03
M_2 R_2	1.18	0.09
$LSD_{0.05}$	NS	NS

Key: NS=not significant, M=megagreen, R=rate

Table 8: Effect of treatment interaction on phosphorus and ammonium nitrate in sap samples and plant tissues

Treatments	Available P (mg/kg)	% nitrogen
S_0 M_0 R_0	0.057	0.070
S_0 M_1 R_1	0.051	0.092
S_0 M_1 R_2	0.045	0.095
S_0 M_2 R_1	0.045	0.059
S_0 M_2 R_2	0.040	0.104
S_1 M_2 R_2	0.027	0.043
S_1 M_2 R_1	0.029	0.107
S_1 M_1 R_2	0.045	0.100
S_1 M_1 R_1	0.043	0.120
S_1 M_0 R_0	0.033	0.094
$LSD_{0.05}$	0.58	NS

Key: NS=not significant, M=megagreen, R=rate, S=ssp

Table 7 showed that application of megagreen at the rate of 1.5 kg/ha per 500 litres of water for 2, 3 and 4 WAP respectively (M_1 R_2) retained more phosphorus and nitrogen in the soil after the experiment. This treatment, (M_1 R_2) supports an enhanced nitrogen fixation ability of the cowpea followed by application of megagreen at the rate of 3 kg/ha per 500 litres of water for 2, 3 and 4 WAP (M_2 R_2).

Table 8 shows that, there was no significant difference in the level of ammonium nitrate retained in the plant tissues and in the plant sap. However, application of SSP and megagreen at the rate of 1.5 kg/ha per 500 litres of water at 2and 3 WAP (S_1 M_1 R_1) gave the highest level of ammonium nitrate concentration in the plant sap.

DISCUSSION

A number of studies have shown positive effect of megagreen fertilizer on the yield and product quality of different crop species, such as tomato (Stojanova *et al*., 2012), sugar beet (Artyszak, 2015) and lettuce (Dudaš *et al*., 2016). From the findings of the analysis presented it was observed that cowpea gave no significant response to the two treatments of SSP (0 kg/ha P_2O_5 and application at recommended rate of 40 kg/ha P_2O_5) and megagreen; in terms of the growth parameters, yield obtained, level of nitrogen retained in the soil and the ammonium nitrate in the plant sap and plant tissue. However, application of SSP, gave numerically higher plant height, number of leaves and number of branches yield compare to the control (Sanginga *et al*., 2000; Osunde *et al*., 2007; Ayodele and Oso, 2014). Application of SSP and megagreen at the rate of 3 kg/ha per 500 litres of water at 2, and 3 WAP (S_1 M_2 R_1) also recorded more than 200 % increase in yield. In addition, the interactive effect of SSP and megagreen at the rate of 1.5 kg/ha per 500 litres of water at 2, and 3 WAP (S_1 M_1 R_1) gave numerically higher level of ammonium nitrate concentration in the plant sap (about 70 % difference compared to the control). This results are in accordance with the studies of Buri *et al*., 2000; Qui-jano-Guerta *et al*., 2002; Asten *et al*., 2004; Kumar and Yadav, 2005; Shah *et al*., 2008; Sharma *et al*., 2010.

CONCLUSION

The treatment of cowpea with megagreen and SSP had a significant effect on the number of leaves, plant height, fresh weight of nodules, number of nodules and shorter days to flowering, resulting in increased branches and high yield.

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