GROWTH AND YIELD CHARACTERISTICS OF COWPEA (*VIGNA UNGUICULATA* (L.) WALP) AS INFLUENCED BY AQUEOUS EXTRACT *OF* MORINGA (*MORINGA OLEIFERA* LAM.) AND NITROGEN RATES II

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ABSTRACT

Increase in Cowpea (Vigna unguiculata (L.) Walp) production and yield becomes vital in Nigeria, because it is the major cash crop and a source of plant protein to many who cannot afford animal or fish protein. Implicit to this dictum, field experiments were conducted in 2009 and 2010 rainfed cropping seasons at the Teaching and Research Farm, Faculty of Agriculture, Bayero University, Kano, Nigeria to study the performance of cowpea with aqueous extract of moringa (Moringa oleifera Lam.) and Nitrogen rates. Moringa shoot were crushed with water and filtered out. Liquid extract were then diluted with water in the following concentrations: 0 %, 3 %, 4 % and 5 %. These treatments with 3 N rates (0, 10 and 20 kg N ha^{-1}) in a factorial combination were tested on cowpea in an experiment laid out in a Randomized Complete Block Design with three replications. Foliar spraying of aqueous extract of moringa (AEM) was done fortnightly from 2 to 8 weeks after sowing. Data were taken on leaf area per plant (LA), crop growth rate (CGR), number of pods per plant (NPP) and grain yield (GY) per hectare. Data generated were subjected to analysis of variance. Results showed highest LA (4547 cm^2) and CGR (21.58 gwk^{-1}) in the combined seasons with 20 kg Nha^{-1}, and NPP (183.47) with 10 kg N ha^{-1}. Similarly, highest LA (6058 cm^2) and CGR 21.96 (gwk^{-1}) were obtained with 3 % AEM, and NPP (188) with 5 % AEM. There was no significant effect of N on grain yield in the seasons. Significant effect of AEM was recorded on grain yield; 5% had highest yield (769.68 kg ha^{-1}) in the combined seasons. Based on the results, it was concluded that AEM can compliment N in increasing cowpea yield. Thus, 20 kg N $ha^{-1}$with 5 % AEM should be adopted.

Keywords: Aqueous extract of moringa, cowpea yield improvement, Nitrogen.

INTRODUCTION

Even though Nigeria is the largest producer and consumer of cowpea in the world (Madamba and Grubben, 2006), its production could not meet with the demand, it needs to be increased. Cowpea is the cheapest source of plant protein to many who cannot afford enough of the expensive animal protein. It is also a source of minerals, vitamins, fiber and medicine. Moringa extract were reported to enhance crop growth and yield as a plant growth regulator (PGR) (Foidl *et al*., 2001: Muhamman *et al*., 2014). However, the findings are limited to some crops and in research stations. If moringa can improve cowpea yield, it will help in meeting with its demand and improves farmer's income. It may also help in meeting up with the nitrogen fertilizer need of the crop; being the scarcest and expensive commodity among small scale farmers who constitute the bulk of cowpea producers.

This study therefore, was aimed at determining the use of moringa on the growth and yield of cowpea in Nigeria as well as its ability to compliment N fertilizer. Thus, recommends its use to improve cowpea production and yield.

MATERIALS AND METHODS

Field experiments were conducted in 2009 and 2010 rainy seasons at the Teaching and Research Farm, Faculty of Agriculture, Bayero University, Kano, Nigeria (Latitude 11^0 58' N and Longitude 8^0 25' E at an altitude of 458 m). To study the performance of cowpea with aqueous extract of moringa (AEM) and Nitrogen rates. Moringa shoots (about 40 days) were crushed with water (10 kg of fresh material in 1 litre of water) and filtered out. Liquid extract obtained were diluted with water in the following concentrations: 0%, 3%, 4% and 5% to give 4 treatments. The treatments with three N rates (0, 10, 20 kg N ha^{-1}) in a factorial combination were tested on cowpea in an experiment laid out in a Randomized Complete Block Design with 3 replications. Foliar spray of AEM started at 2 weeks after sowing (WAS) and continued fortnightly until 8 WAS. Land for the experiments were prepared by harrowing and ridging at a spacing of 0.75 m between rows, thereafter were marked into 36 plots with gross plot sizes of 13.5 m^2 and net plot sizes of 3.15 m^2. Soil samples were collected in the two seasons randomly at a depth of 0 - 15 cm and 15 – 30 cm using soil auger its physical and chemical properties determined. Sowing was at a spacing of 0.75 m x 0.25 m. Two seeds were sown per hole which was later thinned to one plant per stand at 2 WAS. Complete doses of N rates and 10 kg ha^{-1} P and K were applied at sowing. Weeds were controlled by spraying *Pendimethalin* (500 EC) at 1.5 L ha^{-1} using CP 20 knapsack sprayer and were supplemented by hoe weeding at 3 and 7 WAS. Insects pest were controlled using *Cypermethrin 30 gm/l + Dimethoate 25 gm/l* at 1L ha^{-1} at flowering and at podding using the above sprayer. Data were collected on leaf area per plant (LA) at 7 WAS and at harvest: this was determined using graphical method, leaves per plant were sketched and leaf area per plant calculated and recorded. Crop growth rate (CGR) (g wk^{-1}); this was determined as follows: CGR = $(W_2 – W_1)/ (T_2 – T_1)$. Where W_1 and W_2 are shoot dry weights taken at two consecutive harvests over time intervals T_1 and T_2. Number of pods per plant (NPP): pods of the five tagged plants were counted at harvest, means determined and recorded. Grain yield (GY) ha^{-1}: Net plot yield were harvested and grain weights were converted to yield per hectare. Data generated were subjected to analysis of variance using SAS system for windows (SAS, V8, 2000).

RESULT AND DISCUSSION

Result of the physico – chemical properties of the experimental sites in the seasons indicated that the soil textural class was silty clay, soil pH (H_2O), organic carbon (g kg^{-1}), organic matter (g kg^{-1}), Total N (g kg^{-1}), available P (mg kg^{-1}) and CEC (cmol kg^{-1}) in 2009 at 0 – 15 cm were 6.7, 3.9, 6.7, 1.0 and 5.0, respectively and at 15 – 30 cm were 6.0, 1.0, 2.0, 1.3 and 5.0, respectively. Also, in 2010 at 0 – 15 cm were 6.0, 10.0, 17.0, 2.0 and 6.0, respectively. While at 15 – 30 cm were 6.0, 9.0, 15.0, 2.0 and 6.0, respectively. The variation in the physico – chemical properties in the seasons may be due to the residual soil nutrient which made that of 2010 rainy season higher than that of 2009 rainy season. There was a highly significant effect of N rates on LA in 2009 rainy season at harvest, in 2010 rainy season at 7 WAS and at harvest (Table 1), and a significant effect in the combined at harvest. Except in 2010 rainy season at 7 WAS where 10 kg N ha^{-1} had higher LA (4720 cm^2); 20 kg N ha^{-1} had highest effect with LA's; 4505 cm^2 in 2009 rainy season at harvest, 4034 cm^2 and 4588 cm^2 in 2010 rainy season at 7 WAS and at harvest, respectively, and 4547 cm^2 in the combined at harvest. Least LA in the seasons was with 0 kg N ha^{-1}. The significant effect of N on LA might be due to the role of N in promoting vegetative production. Also in Table 1 there was a significant effect of AEM on LA in 2009 rainy season at 7 WAS, and a highly significant effect in 2010 rainy season at 7 WAS and at harvest as well as in 2009 rainy season at harvest and combined at 7 WAS and at harvest. Aqueous extract of moringa at 3 % had higher LA; 5340 cm^2 and 6447 cm^2 in 2009 rainy season at 7 WAS and at harvest, respectively, 5241 cm^2 and 5669 cm^2 in 2010 rainy season at 7 WAS and at harvest, respectively and 5291 cm^2 and 6051 cm^2 in the combined at 7 WAS and combined, respectively. Except in 2009 rainy season at harvest where lower LA was recorded with 4 %; LA was lower with 0 % AEM (Table 1). The significant effect of AEM on LA might be due to the ability of some crops to manifest response to growth hormone faster than others. Earlier, Remison and Mgbeze (2004) reported increased in the number of leaves per plant of cowpea with PGR. Increase in the number of leaves might have affected leaf area. The result of this study agreed with the earlier report of Prabhu *et al*. (2009) that leaf area of Kalmegh was increased with moringa extract. There was no interaction between N rates with AEM on LA in 2009 and 2010 rainy seasons at 5 WAS. Significant interaction was recorded in the combined at 5 WAS and in 2009 rainy season at 7 WAS. Also recorded was a highly significant interaction in 2010 rainy season at 7 WAS and at harvest; in 2009 rainy season at harvest as well as in the combined at 7 WAS and at harvest (Table 1). In Table 2 interaction that had highest LA in the combined at 5 WAS were 20 kg N ha^{-1} with 4 % AEM (5425.52 cm^2). In 2009 rainy season 0 kg N ha^{-1} with 3 % AEM had higher leaf area per plant; 7466.11 cm^2, and 7937.69 cm^2 in 2009 rainy season at 7 WAS and at harvest, respectively. Similarly, in 2010 rainy season and combined at harvest 0 kg N ha^{-1} with 3 % AEM continued to manifest highest effect on LA; 9404.36 cm^2 and 9571.03 cm^2, respectively. At 7 WAS 10 kg N ha^{-1} with 3 % AEM recorded the highest LA (7743.99 cm^2) in 2010 rainy season and (5848.01 cm^2) in the combined. Least interaction with least LA in the seasons and combined at 7 WAS was with 0 kg N ha^{-1} with 0 % AEM. At harvest least interaction with least LA in the seasons and combined was in 20 kg N ha^{-1} with 4 % AEM (Table 2). The significant interaction between N rates and AEM on LA might be due to the plant response to the individual treatments. Earlier, Vagner *et al*. (2003) reported that plant growth hormone in small amounts modify a given physiological process and rarely act alone as the action of two or more of these compounds is necessary to produce a physiological effect. The effect of N and AEM on CGR of cowpea is presented in Table 3. Highly significant effect was recorded in 2009 rainy season and combined at 7 WAS as well as significant effect in 2010 rainy season at harvest. There was no significant effect in 2010 rainy season at 7 WAS and in 2009 rainy season and combined at harvest. Nitrogen at 20 kg ha^{-1} had highest CGR; 63.55 g wk^{-1}, 52.72 g wk^{-1} and 21.58 g wk^{-1} in 2009 rainy season at 7 WAS, combined at 7 WAS and 2010 rainy season at harvest, respectively. While 10 kg N ha^{-1} had lower CGR in 2009 rainy season at 7 WAS. In the combined at 7 WAS and in 2010 rainy season at harvest 0 kg N ha^{-1} had lower CGR. The significant effect of N on CGR might be connected to the significant effect of N on LA, since CGR is the measure of the rate of dry matter production per unit time. In this study LA which is CGR determinant is significant, LA is not the only measure of the area available to intercept light for photosynthesis other structures which are not measured in this study such as stem and green pods might have contributed to the total photosynthetic area. Also in Table 3, highly significant effect of AEM was recorded on CGR in 2009 and 2010 rainy season and combined at 7 WAS; and a significant effect in 2010 rainy season at harvest. There was no significant effect in 2009 rainy season and combined season at harvest. Aqueous extract of moringa at 3% had higher CGR in 2009 rainy season (63.17 g wk^{-1}) and combined (53.83 g wk^{-1}) while 4 % AEM had highest in 2010 rainy season (56.05 g wk^{-1}). In 2010 rainy season at harvest 3 % had higher CGR (21.96 g wk^{-1}). Lowest effect was with 0 % at 7 WAS in 2009 rainy season and combined, 3 % in 2010 rainy season and at harvest least effect was with 5 %. The significant effect of AEM on CGR might be due to the reason mentioned earlier, apart from LA dry matter production can be achieved through other photosynthetic areas such as stem and green pods. Highly significant interaction between N rates with AEM on CGR in 2009 rainy season

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at 7 WAS and in 2010 rainy season at harvest was recorded. There was no interaction in 2010 rainy season at 7 WAS; in 2009 rainy season at harvest as well as in combined at 7 WAS and at harvest (Table 3). In 2009 rainy season interaction that had higher CGR (Table 4) was 20 kg N ha^{-1} with 5 % AEM (72.62 g wk^{-1}), while least interaction was in 0 kg N ha^{-1} with 0 % AEM. In 2010 rainy season 0 kg N ha^{-1} with 4 % AEM had higher CGR (34.33 g wk^{-1}). In Table 5 highly significant effect of N rates on NPP of cowpea in 2009 rainy seasons was recorded. Similarly, significant effect was recorded in 2010 rainy season and combined. In 2009 rainy season; 20 kg N ha^{-1} had higher NPP (129.53) and least number of pods was with 0 kg N ha^{-1}. In 2010 rainy season and combined; 10 kg N ha^{-1} had higher NPP; 237.75 and 183.47, respectively. Least number of pods was with 0 kg N ha^{-1} (Table 5). The significant effect of N on NPP in the seasons might be due to the ability of N to promote growth, development and yield by promoting more vegetative growth which might have increased plants ability to intercept light for photosynthesis, finally helps in producing more pods per plant. Highly significant effect of AEM on NPP was recorded in 2009 rainy season and combined. Also recorded was significant effect of AEM in 2010 rainy season. Aqueous extract of moringa at 4 % had higher effects; 136.63 in 2009 rainy season and 180.48 in the combined. In 2010 rainy season 5 % had higher number of pods (245.67). Least number of pods in the seasons was with 0 % (Table 5). The significant effect of AEM on NPP might be due to the ability of PGR to improve the effective partitioning and translocation of assimilates from source to sink in field crops (Solaimai *et al*., 2001). Highly significant interaction between N rates with AEM on NPP was recorded in 2009 rainy season. There were no interactions between N rates with AEM in 2010 rainy season and combined (Table 5). Interactions that had maximum NPP was 20 kg N ha^{-1} with 4% AEM (149.00) and least interaction was 0 kg N ha^{-1} with 0 % AEM (Table 4). Table 5 shows the effect of N rates and AEM on GY of cowpea in 2009 and 2010 rainy season and combined. There was no significant effect of N rates on cowpea GY in the seasons. The non – significant effect of N on grain yield might be due to the ability of N to promote vegetative growth at the expense of grain yield. There was a significant effect of AEM on cowpea grain yield in 2009 rainy season; and highly significant effect in the combined. There was no significant effect in 2010 rainy season. Aqueous extract of moringa at 4 % had higher grain yield in 2009 rainy season (984.8 kg ha^{-1}) and combined (791.15 kg ha^{-1}). No interaction between N rates with AEM in the seasons (Table 5). The significant effect of AEM on cowpea grain yield which might be due to the ability of AEM to promote growth and yield of crops (Foidl, *et al.*, 2001).

CONCLUSION

Based on the result of this study, cowpea responds significantly to AEM. Its effect can be alone or with N fertilizer, but preferably the combination of the two. Since PGR rarely act alone as the action of two or more is vital to produce a physiological effect. Thus, 20 kg N ha^{-1} with 5 % AEM should be adopted to improve cowpea production and yield.

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Table 1. Effect of aqueous extract of moringa and nitrogen rates on leaf area per plant (cm^2) of cowpea in 2009 and 2010 rainy seasons and combined.

Treatments	7 weeks after sowing			Harvest		
Nitrogen (kg ha^{-1})	2009	2010	Combined	2009	2010	Combined
0	4644.1a	3697.6b	4170.9	2624.0c	2207.3c	2415.6c
10	4214.5a	4720.3a	4467.4	3462.5b	3212.5b	3337.5b
20	4926.2a	4034.2b	4480.2	4505.0a	4588.3a	4546.7a
Level of significance	NS	**	NS	**	**	*
SE (±)	417.30	175.38	320.08	194.95	253.89	226.35
AEM (% concentration)						
0	3307.4b	2989.3d	3148.3c	2525.8b	2303.6b	2414.7b
3	5340.3a	5241.2a	5290.8a	6446.7a	5668.8a	6057.8a
4	4519.7ab	3747.0c	4133.3b	2389.6b	2500.7b	2445.1b
5	5212.4a	4625.3	4918.9	2760.0b	2871.1b	2815.5b
Level of significance	*	**	**	**	**	**
SE (±)	481.29	202.27	369.16	224.84	292.82	261.05
Interactions	NS	**	**	**	**	**

Means in the same column followed by the same letter (s) are not significantly different at 5 % level of probability using DMRT. *= significant at 5% level of probability using DMRT. ** = highly significant at 1 % level of probability using DMRT. NS = not significant. AEM = Aqueous extract of moringa.

Table 2. Interaction between aqueous extract of moringa and nitrogen rates on leaf area per plant of cowpea in 2009 and 2010 rainy seasons and combined

Treatments	Aqueous extract of moringa (%) Leaf area per plant							
	7WAS 2010 rainy season				Combined			
Nitrogen (kg ha^{-1})	0	3	4	5	0	3	4	5
0	677.09c	3672.89de	5140.72bc	5299.77bc	1143.03e	5569.50a	4971.72abc	4999.17abc
10	2513.39f	7743.99a	3539.43def	5084.31bc	3065.62d	5848.01a	3772.97bcd	5182.97ab
20	5777.31b	4306.85cd	2560.85ef	3591.96def	5236.30ab	4454.89abcd	3655.34cd	4574.41abc
SE (±)	350.76				640.16			
	Harvest 2009 rainy season				Harvest 2010 rainy season			
0	1707.30f	9737.69a	3131.84cde	3443.17cde	1707.30d	9404.36a	3465.17c	3776.51c
10	3692.70cd	52.87.46b	2477.60def	2392.35ef	2692.70cd	5287.46b	2477.60cd	2392.35cd
20	2177.45ef	4314.80bc	1559.26f	2444.37def	2510.78cd	2314.80cd	1559.29d	2444.37cd
SE (±)	389.89				507.79			
	Combined at harvest							
0	1707.30e	9571.03a	3298.50cd	3609.84c				
10	3192.70cd	5287.46b	2477.60de	2342.35de				
20	2344.12de	3314.80cd	1559.26e	2444.37de				
SE (±)	452.69							

Means in the same column followed by the same letter (s) are not significantly different at 5 % level of probability using DMRT. WAS = weeks after sowing

Table 3. Effect of aqueous extract of moringa and nitrogen rates on crop growth rate (g wk^{-1}) of cowpea in 2009 and 2010 rainy seasons and combined.

Treatments	Crop growth rate					
	7 weeks after sowing			Harvest		
Nitrogen (kg ha^{-1})	2009	2010	Combined	2009	2010	Combined
0	48.98b	34.38	41.68b	7.71	9.17b	8.44
10	44.85b	48.00	46.42ab	3.98	12.11b	8.05
20	63.554a	41.88	52.72a	11.20	21.58a	16.39
Level of significance	**	NS	**	NS	*	NS
SE (±)	2.17	4.36	3.44	5.67	2.97	4.53
AEM (% concentration)						
0	43.05c	31.33b	37.19b	5.32	14.11ab	9.71
3	63.17a	28.78b	45.97a	3.14	21.96a	12.55
4	51.63b	56.05a	53.84a	2.54	15.33ab	8.89
5	51.99b	49.50a	50.74a	19.60	5.74b	12.67
Level of significance	**	**	**	NS	*	NS
SE±	2.5	5.07	3.97	6.54	3.42	5.22

Interactions	**	NS	NS	NS	**	NS

Means in the same column followed by the same letter (s) are not significantly different at 5 % level of probability using DMRT. *= significant at 5% level of probability using DMRT. ** = highly significant at 1 % level of probability using DMRT. NS = not significant. AEM = Aqueous extract of moringa.

Table 4. Interaction between aqueous extract of moringa and nitrogen rates on crop growth rate (g wk^{-1}) and number of pods per plant of cowpea in 2009 and 2010 rainy seasons and combined .

Treatments	Aqueous extract of moringa (%)							
	Crop growth rate							
	7 WAS 2009 rainy season				Harvest 2010 rainy season			
Nitrogen (kg ha^{-1})	0	3	4	5	0	3	4	5
0	33.10f	69.39ab	53.30cde	40.12ef	7.78bc	34.11a	34.33a	14.11bc
10	39.90ef	58.29bc	37.97f	43.23def	34.33a	5.78c	7.45bc	0.89c
20	56.16bcd	61.83abc	63.62abc	72.62a	4.22c	26.00ab	4.22c	2.22c
SE (±)	4.34				5.94			
	Number of pods per plant 2009 rainy season							
0	116.00f	128.17de	133.67bc	126.33de				
10	129.44cd	123.67e	127.22de	136.45b				
20	118.45f	125.44de	149.00a	125.22de				
SE (±)	1.56							

Means in the same column followed by the same letter (s) are not significantly different at 5 % level of probability using DMRT. WAS = weeks after sowing

Table 5. Effect of aqueous extract of moringa and nitrogen rates on number of pods per plant and grains yield (kg ha^{-1}) of cowpea in 2009 and 2010 rainy seasons and combined.

Treatments	Number of pods plant^{1}			Grain yield		
	2009	2010	Combined	2009	2010	Combined
Nitrogen (kg ha^{-1})						
0	126.04b	186.83b	156.44b	797.14	543.81	670.48
10	129.19a	237.75a	183.47a	772.40	582.81	677.58
20	129.53a	199.42b	164.47b	852.40	615.02	733.69
Level of significance	**	*	*	NS	NS	NS
SE (±)	0.78	12.51	8.86	65.70	42.46	55.31
AEM (% concentration)						
0	121.29d	172.22c	146.76b	707.7bc	511.73	609.69b
3	125.76c	189.78bc	157.77b	633.00c	577.30	605.14b
4	136.63a	224.33ab	180.48a	984.8a	597.53	791.15a
5	129.33b	245.67a	187.5a	903.7ab	635.62	769.68a
Level of significance	**	*	**	*	NS	**
SE (±)	0.90	14.43	10.22	75.78	48.97	63.80
Interactions	**	NS	NS	NS	NS	NS

Means in the same column followed by the same letter (s) are not significantly different at 5 % level of probability using DMRT. *= significant at 5% level of probability using DMRT.
** = highly significant at 1 % level of probability using DMRT. NS = not significant.
AEM = Aqueous extract of moringa.