World Journal of Agricultural Sciences 2 (1): 105-108, 2006
ISSN 1817-3047

Phosphorus Level Affects Brown Blotch Disease, Development and Yield of Cowpea

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Abstract: Application of Phosphorus in adequate concentrations could directly or indirectly reduce disease incidence and severity of cowpea brown blotch and improve the forage and grain yield. A field experiment was conducted to investigate the effects of level of phosphorus application on Brown Blotch disease of cowpea (*Vigna unguiculata* [L.] Walp), caused by *Colletotrichum capsici* during 2003, 2004 and 2005 planting seasons. Application of phosphorus was at 30, 60, 90 and 120 kg ha^{-1} of P_2O_5. As P level increased numbers of petioles, pods, nodules, seed/pod, leaf area and yield significantly increased. Disease incidence and severity of Brown Blotch were significantly reduced at 90 and 120 kg ha^{-1} of P_2O_5 was not affected irrespective of the method of application. Application method did not affect yield. Reduction in brown blotch disease at higher levels of P was recorded.

Key words: Cowpea · disease · methods · phosphorus · rate

INTRODUCTION

Cowpea (*Vigna unguiculata* [L.] Walp) is an important grain legume in drier regions and marginal areas of the tropics and subtropics. It is particularly important in West Africa with over 9.3 million metric tons of annual production [1]. The grain is a good source of human protein, while the haulms are valuable source of livestock protein [2]. Diseases of cowpea, induced by species of pathogens, constitute one of the most important constraints to profitable cowpea production wherever it is cultivated. Among the fungal diseases, brown blotch, caused by *Colletotrichum capsici*, is the most devastating with yield loss between 46 and 85% in Nigeria [3, 4].

Phosphorus fertilizer application has been observed to reduce rice blast disease [5]. He stated that repeated application of phosphorus fertilizers delays the onset and lessens the severity of take-all disease of barley just as potassium application reduces the disease incidence in many cases probably by increasing phenolics synthesis in plants Calcium application also reduces bean root rot caused by *Rhizoctonia solani* probably by altering pectin metabolism of the host [5]. Therefore, application of mineral elements in adequate concentrations could directly or indirectly reduce disease incidence and severity of crops.

Phosphorus, although not required in large quantities is critical to cowpea yield because of its multiple effects on nutrition and nitrogen fixation [6]. It also influences the content of other nutrients in cowpea leaves [7] and seed [8]. Agboola and Obigbesan [9] reported that P concentration in plant was highest with the use of single super phosphate, as opposed to rock phosphate. The present study was undertaken to determine effects of level and method of application of phosphorus on development, yield and severity of brown blotch disease in cowpea.

MATERIALS AND METHODS

Field operation: Brown blotch infected seeds of Ife brown variety of cowpea were collected from seed stored at the Institute of Agricultural and Training, Ibadan. Nigeria. Field experiments were conducted during 2003, 2004 and 2005 at the Institute of Agricultural and Training. The site is located at Latitude 7°31'N and longitude 3°45'E and 210 m above sea level in the forest-savanna transition agro-ecological zone of Nigeria. The field was laid out in a Randomized Complete Block Design. The treatments consisted of four levels phosphorus (0, 30, 60, 90 and 120 kg ha^{-1} of P_2O_5) and two methods of application (at planting or as a foliar spray).

Three years before the experiment started, the plot had been cropped continuously to maize with no fertilizer. The physicochemical properties of the field were analyzed before cultivation in each of the three years, with P level determined by the procedure of Leverty [10] (Table 1). The land was plowed and harrowed twice. There were 27 plots (nine treatments replicated three times) of 25 m^2

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Table 1: Mean values of analyzed physicochemical properties of the soil of the experimental site at Ibadan, Nigeria in years 2003, 2004 and 2005

Soil characteristics	0-15 cm soil depth
Percent clay	5.2
Percent silt	9.8
Percent sand	85.0
Soil Texture	Sand loam
pH (H_2O)	5.500
Organic carbon (%)	0.063
Total nitrogen (%)	0.070
Available phosphorus mg kg^{-1}	0.870
CEC (meq/100 g soil)	3.390
Ex changeable bases (meq/100 g soil)	
Ca^{2+}	2.040
Mg^{2+}	0.500
K^{+}	0.140
Na^{+}	0.350

each, with 1 m paths across the rows and along the rows. Four seed/hole were planted on 4 Sept. in each year were planted at a spacing of 75 X 30 cm and thinned two-weeks later to two plants/hole. At planting fertilizer was applied to the side of the cowpea hill and foliar application was done four weeks after planting. Weeds were controlled with a mix of Gramozone® (paraquat dichloride: Jubaili Agrotect Nigeria Limited) and Galex 500E® (metolachor + metobromuron) (Novartis Nigeria Limited, Mushin, Lagos, Nigeria) as a pre-emergent treatment at 2.5 L ha^{-1} with two hoe weeding at three and six weeks after planting (WAP).The herbicides were applied at rate of 3 L ha^{-1} each using the Knapsack sprayer. The interior four of seven rows per plot were used for data collection. The insecticide Nuvacron® (Monocrotophos: Afcott Nigeria Plc, Lagos, Nigeria) at the rate of 2 L ha^{-1} using the Knapsack sprayer.

Numbers of petioles were counted and leaf area measured at 50% pod formation, using a destructive procedure from the plants in the rows next to the border rows after the four interior rows, while numbers of pods, nodules, seed/pod, 100-seed weight and yield were assessed at maturity. Disease incidence was calculated from the number of infected plants in the population. The severity of brown blotch disease on pods on all plants in the four interior rows was determined using the visual assessment scale according to Alabi [3] and modified: 0: no symptoms, 1: up to 20%; 2: 1-40%; 3: 41-60%; 4: 61-80% and 5: over 80% pods covered with brown blotch.

Statistical analysis: The data were analyzed using the general linear model (GLM) Statistical Analysis System (SAS Inc., Cary, NC) at the 5% probability and means separated using the Fishers Protected LSD test.

RESULTS AND DISCUSSION

The soil was very low in available P (0.87 mg kg^{-1}). Table 2 shows the analysis of variance of the effect of the different levels and method of application of P on yield parameters and brown blotch disease of cowpea. The results show that significant differences occurred among the treatments irrespective of the parameters ($p<0.05$). The influence of the environment was significant only on the number of nodules per plant (Table 1). The number of petioles per plant (Table 2) as well as the number of pod per plant (Table 3) was not significantly different among the three growing seasons irrespective of the level and method of application. However, the environment significant influence the number of nodules when plants

Table 2: ANOVA table of the influence of levels and method of P application on yield components and brown blotch disease of Brown of cowpea

	Per plant						Disease		
Sources	Petioles	Pods	Nodules	Seed/ pod	1000 seed wt.	Leaf area	Incidence	Severity	Yield
Application									
method (A)	0.20	6.12*	4.56**	2.54	3.42	0.99	29.22*	1.98	17.23
P rate (P)	3.44**	13.22**	1.10	10.23**	6.56*	3.41*	52.35**	5.25**	65.33**
Year (Y)	0.43	0.89	0.82	2.58	3.33	1.20	16.25	1.88	17.52
Interaction									
A X P	2.33**	7.18*	13.77*	29.43**	3.86**	68.92**	18.16*	1.78**	47.98*
A X Y	0.01	0.05	0.55	2.75	1.45	1.47	3.89	0.36	6.20
P X Y	0.13	1.03	0.96	2.66	4.33	1.39	17.70	0.25	18.71
A X P X Y	0.19	0.71	0.88	0.86	1.93	0.05	6.90	2.05	13.25
Error	0.30	0.70	0.66	2.33	2.78	0.89	15.43	1.52	16.48

*, ** significant at $p < 0.05$ or $p < 0.01$, ANOVA

Table 3: Effect of levels and method of P application on yield components and brown blotch disease of Ife-Brown variety of cowpea

Application method	Phosphorus level (kg ha^{-1})	Petioles/ plant	Pod/ plant	Nodule/ plant	Seed/pod	100-seed wt.	Leaf area	Disease incidence	Disease severity	Yield (kg ha^{-1})
Broadcasting										
	30	29.22[a]	50.23d	25.89d	12.82d	102.3b	20.56[a]	66.33b	3.50b	993.85b
	60	24.78[a]	60.32c	36.00c	14.23bc	103.9b	24.11[a]	26.11de	2.78b	1454.58a
	90	26.67[a]	69.67a	42.67b	16.78a	128.4a	26.33[a]	24.89de	1.00c	1450.96a
	120	27.44[a]	75.12a	46.78a	16.88a	129.9a	27.67[a]	21.67cd	1.00c	1482.11a
Foliage Spray										
	30	27.89[a]	50.87d	26.33d	15.22b	105.4b	23.89[a]	48.00c	2.00c	983.07b
	60	24.44[a]	58.22b	39.55c	15.34b	120.8a	26.88[a]	30.33e	2.00c	1431.96a
	90	26.56[a]	69.00a	42.21b	17.12a	130.5a	26.77[a]	29.11d	1.00b	1462.50a
	120	32.66[a]	73.78a	47.56a	17.22a	137.1a	26.78[a]	25.44de	1.00b	1498.08a
control	0	12.44[b]	25.22e	19.44e	12.56d	85.5c	18.88[b]	80.11a	4.2a	647.74c

Values followed by the same letters are not significantly different Fishers Protected LSD test ($p<0.05$)

were sprayed with 30 kg ha^{-1} and 120 kg ha^{-1} with both application methods. There were also no significant variations in the effect of the phosphorus fertilizer among the three growing seasons on the number of seeds per pod leaf area (cm^3) 100-seed weight and yield kg ha^{-1}. The application method by phosphorus rate interaction (A x P) were significant for all the growth parameters ($p<0.05$) just as it influenced significantly ($p<0.05$) the incidence and severity of brown blotch of cowpea. The application method by year interaction (A x Y) just as phosphorus rate by year interaction was not significant for all the parameters as well as for disease incidence and severity (Table 2). The results in Table 2 also showed that the application by phosphorus rate by year interactions (A x P x Y) was not significant The results in Table 3 show that significant differences did not occur among the levels P irrespective of the method of application on the number of petioles. However, the number of petioles in these treatments was significantly higher than in the control. The maximum number of petioles 32.66 was recorded when the plant was sprayed with 120 kg ha^{-1} of P. Application of higher doses of P significantly increased the number of pods/plants and nodules/plant irrespective of method of application. The highest number of pods (75.12) was obtained when the crop received 120 kg ha^{-1} of P fertilizer applied basally while, the maximum number of nodules of 47.56 was recorded when the same quantity of P was sprayed on cowpea. Application of higher doses P increased the leaf area compared to the control but all the treatment were statistically at par with each other. The number of seeds per pod increase significantly with increase in the levels of P fertilizer. There were however, no significant differences in the number of seed per pod between the control and basal application of 30 kg ha^{-1} of *P. Foliar* spray of P at 120 ka ha^{-1} gave the highest number of seed per pod (17.22), while the control experiment gave the lowest seed/pod of 12.56. The data in Table 3 revealed a significant increase in 1000-grain weight with increase in the concentration of P irrespective of method of application. However, foliar application of 120 kg ha^{-1} of P gave the maximum 1000-grain weight (137.10 g), while the control gave the lowest 1000-grain weight of 85.5 g. The results indicated that all the fertilizer treatments gave significantly higher yield as compared to control. Table 3 also showed that P application significantly increased the grain yield of Ife-Brown cowpea variety compared with the recommended 30 kg ha^{-1} and the control. However, among the fertilizer treatments, foliar application of 120 kg ha^{-1} of P produced the highest grain yield (1493.07 kg ha^{-1}). The results in Table 3 also show that application of P at 90 and 120 kg ha^{-1} irrespective of method of application reduced the incidence and severity of brown blotch disease significantly. The highest disease incidence and severity were observed with control.

The significant response of cowpea variety to P application in terms of growth parameters, grain yield and reduction in the incidence and severity of brown blotch disease is an indication that P is an important nutrient element influencing the performance of cowpea plant on the field. Tenebe *et al*. [11], Ankomah *et al.* [12], just as Okeleye and Okelana [13], observed significant increase in nodulation, grain yield, total dry matter, numbers of flower, pods and seed per plant for cowpea varieties in response to P application. The increase in nodulation observed in this study contradicts the findings of Kolawole *et al*. [14], which reported a decrease in number of nodules due to increase in P application, but agrees with the results of Luse *et al.* [15], Agboola and Obisesan [9] and Ankomah *et al*. [12]. The observed increase in cowpea grain yield due to increase in level of P in the present study is in consonance with the results reported by Tenebe *et al*. [11], Ankomah *et al.* [12] and Kolawole *et al.* [14], but disagrees with the results obtained by Agboola and Obigbesan [9] and Osiname [16], who did not observe significant effect of on the yield of cowpea with increased levels of P at Ibadan, but rather enhanced nodulation and P content of leaf and stem. The results of the present study also show that application of P significantly reduced the incidence and severity of brown blotch disease of cowpea. The response of Ife-Brown variety of cowpea to this disease could be as a result of enhanced root growth and development, consequently improved nutrient uptake for vigorous vegetative growth that could have resulted in disease escape. The results aggress with the report of Tenebe *et al*. [11] that increase in height and vegetative growth of cowpea lines with an increase in P application. This investigation also observed that significant differences did not occur between the two application methods except for the fact that 120 kg ha^{-1} P applied by foliar spray gave the highest yield. However, it was observed that cowpea plants that received foliar spray of P had their leaves more greener (dark green) and healthier those with basal application Moreover, the time and amount of energy expended on foliar application is less than in application. Thus, foliar application of 120 kg ha^{-1} of phosphorus from SSP ensures the high yield and reduction in incidence and severity brown blotch disease of Ife-Brown variety of cowpea, but 60 kg ha^{-1} of phosphorus basal application gave an optimal yield of the cowpea variety.

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