IDENTIFICATION OF COWPEA CULTIVARS FOR LOW PHOSPHORUS SOILS OF NIGERIA

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Abstract

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Twenty cultivars of cowpea, *Vigna unguiculata*, adapted to the Nigerian ecologies were screened to identify cultivars which can give high and sustainable yields when grown on soils with low available phosphorus in a sub-humid climate. Some cultivars including TVX3236, AFB1757, Ogunfowokan and K-28 gave three to four times higher grain yields than the other cultivars at zero phosphorus supply. While phosphorus application reduced grain yield in most of the cultivars with marked reduction in the higher yielding cultivars, low yielding cultivars tended to show some yield increase. Phosphorus use efficiency of the roots, stem or leaves was not significantly correlated with grain yield when 60 KgP/ha was applied. Reduction in yield due to phosphorus application might be due to induced Zn deficiency as Zn supply in these soils has been found to be inherently low. High grain yielding capacity without fertilizer phosphorus application was generally positively correlated with high vegetative shoot dry matter production. However, no clear relationship could be found between grain yield and root dry matter at maturity. It is concluded that selection for phosphorus efficiency in cowpea can substantially ontribute to higher cowpea productivity and the farmers income on soils low in available phosphorus in the sub-humid areas of Nigeria.

INTRODUCTION

Cowpea, *Vigna unguiculata* (L.) Walp, is a major source of cheap and good quality protein for the low income people of Nigeria. Also, for people who, for religious reasons, abstain from animal protein, cowpea remains the main source of protein. In the sub-humid zone of Nigeria, cowpea is widely grown under rainfed conditions. However, within the last few years, rainfall pattern has become quite erratic. Thus, during the cropping season in this zone, rainfall is poorly distributed and varied within seasons. Also dry spells of 7-14 days are frequent during the begiming and towards the end of the cropping season. Since phosphorus availability is drastically reduced in dry soils this amplifies the consequences of the inherent low phosphorus supply of these soils on crop yields [1]. Low phosphorus supply may result in severe seed yield losses especially during dry years. To be able to increase productivity on such soils, therefore, farmers could be advised to supplement the nutrient status with inorganic fertilizers. However, owing to the ever increasing cost and often unavailability of this comodity, most farmers find it difficult (if not impossible) to purchase adequate quantities of fertilizer.

There is, therefore, a compelling need to identify alternative ways to increase agricultural productivity without necessarily using inorganic fertilizers. Consequently, identification of cowpea cultivars that can be profitably grown on these depleted soils will be a step in the right direction. The use of nuclear and other techniques to determine the factors responsible for this important attribute will greatly assist the plant breeder to develope improved varieties of this important crop to enhance the achievement of the national objective of self-sufficiency in food production at the shortest possible time.

The major objectives of this study were: (a) identify cowpea cultivars which can give high and sustainable yields when grown under rainfed and low phosphorus conditions and (b) identify the characters responsible for the better performance observed.

MATERIALS AND METHODS

Twenty (20) cowpea cultivars (Appendix Table 21) were sown in the field at Ilora in the guinea savanna ecological zone on Nigeria under rainfed conditions in accordance with the guidelines agreed upon at the RCM. In each of the blocks the twenty cultivars were randomly distributed into plots of 10 square meters. The experimental design was a complete randomized block with two phosphorus treatments and four replications. The plot size was 4 rows 5m long with distance between and within the rows 0.5 and 0.2m respectively to give a plant population of 100,000 plants per hectare. The treatment with phosphorus received at 60 kg per hectare in the form of single super phosphate. The fertilizer was well mixed with the surface soil by hand raking before plantig. Sowing of the crop was done mid-August.

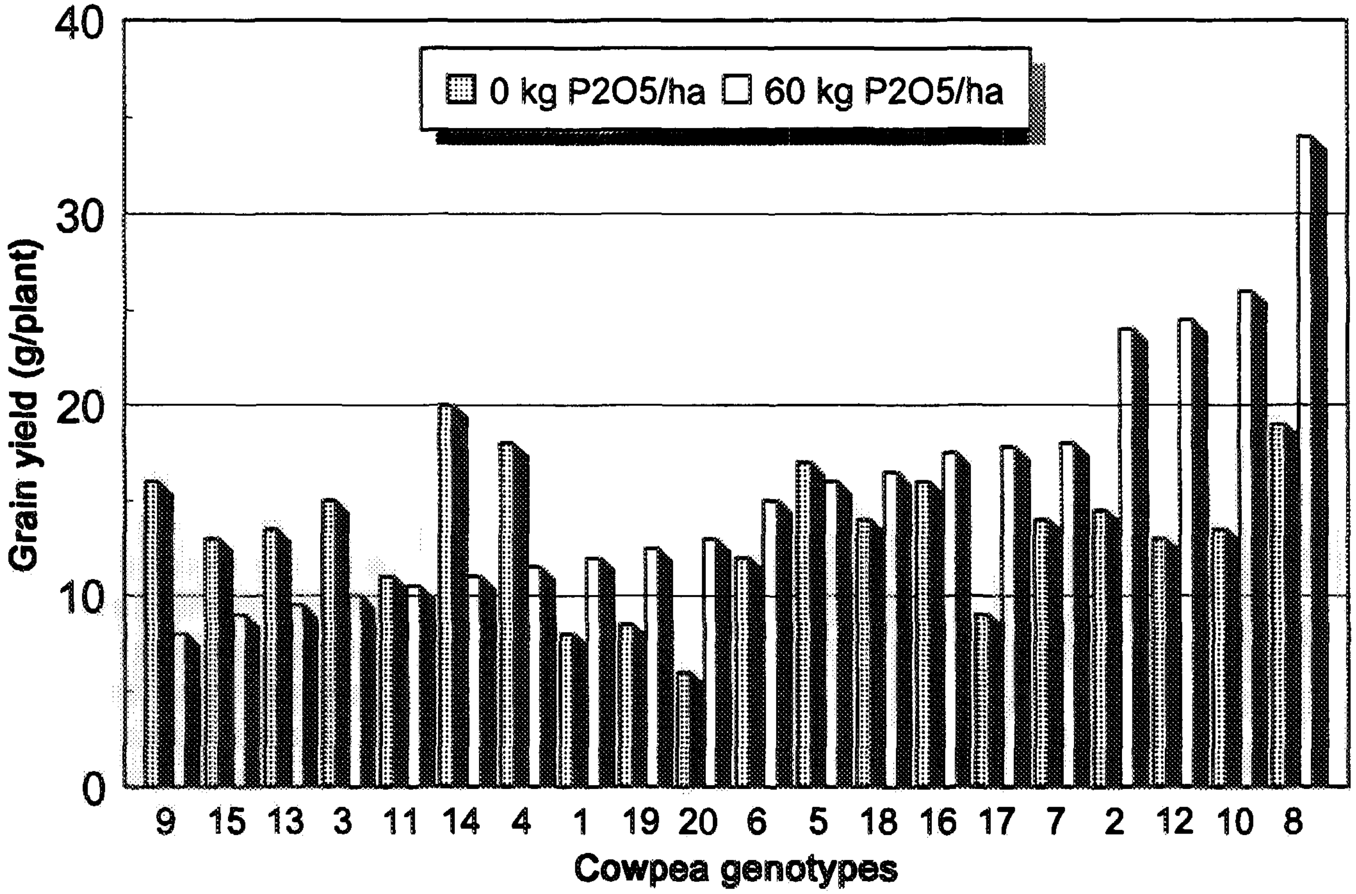
All other cultural practices including pesticide application were carried out as recommended for the zone. Climatic data such as temperature, humidity and precipitation were recorded throughout the experimental period. Some characteristics of the soil of the experimental site are given in Appendix Table 22. At flowering and physiological maturity stages, data of fresh and dry weights (48 hours at 5°C) of roots, stems and leaves were recorded. Observations were taken on five randomly picked plants in the two central rows. Means of these were used for the statistical analysis. Data were recorded on days to flowering, days to maturity, grain yield (g/plant), dry plant weight (g) number of pods per plant, 100 seed weight and threshing percentage. Phosphorus use efficiency based on dry matter yield/kg P was calculated following the procedures suggested by Siddiqi and Glass [2], and Isreal and Rufty [3].

RESULTS AND DISCUSSION

The cultivars included in the study show highly significant differences in grain yield when grown at zero P as well as when 60 kg/ha P was applied (Fig. 1). Cultivars K-28, AFB 1757 and Ogunfowokan gave three to four times higher grain yields than cultivars Ife BPC, 4113-4 and L-72 at zero phosphorus supply (Table I). The highest grain yield was however, obtained from TVX 3236 which gave up to 25-38% grain yield higher than the three high yielding cultivars. Surprisingly, phosphorus application reduced grain yield for most of the cultivars (Table I, Fig.1). The reduction was specially marked for the high yielding cultivars, whereas the low yielding cultivars tended to show some yield increase. The yield of cultivars TVX 3236 was reduced by 43% on phosphorus application, while for other promising cultivars, the yields decreased by 25-50%. However,

TABLE 1. CHARACTERISTICS OF COWPEA CULTIVARS STUDIES IN ILORA 1990-1992

Cultivar	Source of cultivar	Habit	Growth duration
Ife Brown	I.A.R.T.	Erect	Medium
Ife B P C	"	"	"
AFB 1757	"	Spreading	"
A9	"	"	"
Ogunfowokan	"	Erect	"
K-28	N.C.R.I.	"	"
K-39	"	"	"
K-59	"	"	Early
L-72	"	"	Medium
L-80	"	"	"
IAR 48	I.A.R.	"	"
IAR-11/48-2	"	"	"
IT86D-957	I.I.T.A.	"	"
IT86D-715	"	"	"
IVX 3236	"	"	"
IT86D-721	"	"	"
IT84S-224.6-4	"	"	Early
IT86D-719	"	"	Medium
H 113-4	O.A.U.	"	"
H 64-3	O.A.U.	"	"



1. Ife Brown
2. K-28
3. IT86D-715527
4. K-39
5. IT86D-957
6. IK 408
7. K-59
8. TVX 3236
9. Ife BPC
10. AFB 175
11. A9
12. OGUNFO
13. L-72
14.483 IAR 11/48
15. HK3-4
16. H64-3
17. IT845-224
18. H64-3
19. L-80
20. IT86D-719

FIG. 1. Genotypic differences in grain yield of cowpea.

phosphorus application resulted in grain yield increase by 30-80% for some medium yielding cultivars such as K-39, IAR 11/48-2, IT86D-715, Ife BPC and H113-4. Cultivars L-80, L-72, A9, Ife Brown and IT86D-719 seemed to be low yielding at zero phosphorus supply and also, these varieties showed little or no response to phosphorus application.

The highest phosphorus use efficiency (PUE) values were recorded for most of the low low yielding cultivars while the lowest values were obtained from the high yielding ones (Fig. 2). Interestingly, this supports the fact that the most most prominent cultivars at zero phosphorus application could not utilize phosphorus efficiently for grain formation when the element was supplied. This indicated that there was no close relationship between FUE and the grain produced. Correlation at 60 kg P/ha between PUE in root, shoot and grain yields were rather negative and low ($r=0.05$ and $r=0.241$, respectively. It could rather be deduced from these results that, the most efficient cultivars showed no response to phosphorus application. This indicated that such cultivars have the capacity to produce high yields under low phosphorus conditions. Also, phosphorus application to these cultivars might induce vegetative growth rather than high grain yield production.

Reduction in grain yield due to phosphorus application might be due to induced Zn deficiency as Zn supply in these soils has been found to be inherently low [4]. Since Zn requirements is much higher for higher yielding cultivars, these responded more sensitively to phosphorus induced Zn deficiency. The positive response of the low yielding cultivars to phosphorus application indicate that, at least for these cultivars, phosphorus limited growth at the zero phosphorus treatment and thus yielding capacity at zero phosphorus might indicate differences between the cultivars in phosphorus use efficiency

Grain yield at zero phosphorus supply was highly positively correlated to vegetative dry matter accumulation at maturity (Table II). Aggarwal and Halley [5] made similar observations where the total dry matter yield was significantly correlated with grain yield. These authors concluded that plants with more vigour (dry matter) are better adapted to the environment. Differences in phosphorus use efficiency could be due to differences in phosphorus uptake owing to a more extensive root system. Therefore, root growth was assessed at flowering (Table II). Obviously, root dry matter was not closely related to grain yield formation. Only two of the phosphorus efficient cultivars (Cultivars K-28 and AFB1757) also were among the two highest rooting cultivars. However, root dry weigh might not be a suitable parameter for phosphorus acquisition which is much more dependent on root surface area and thus root length.

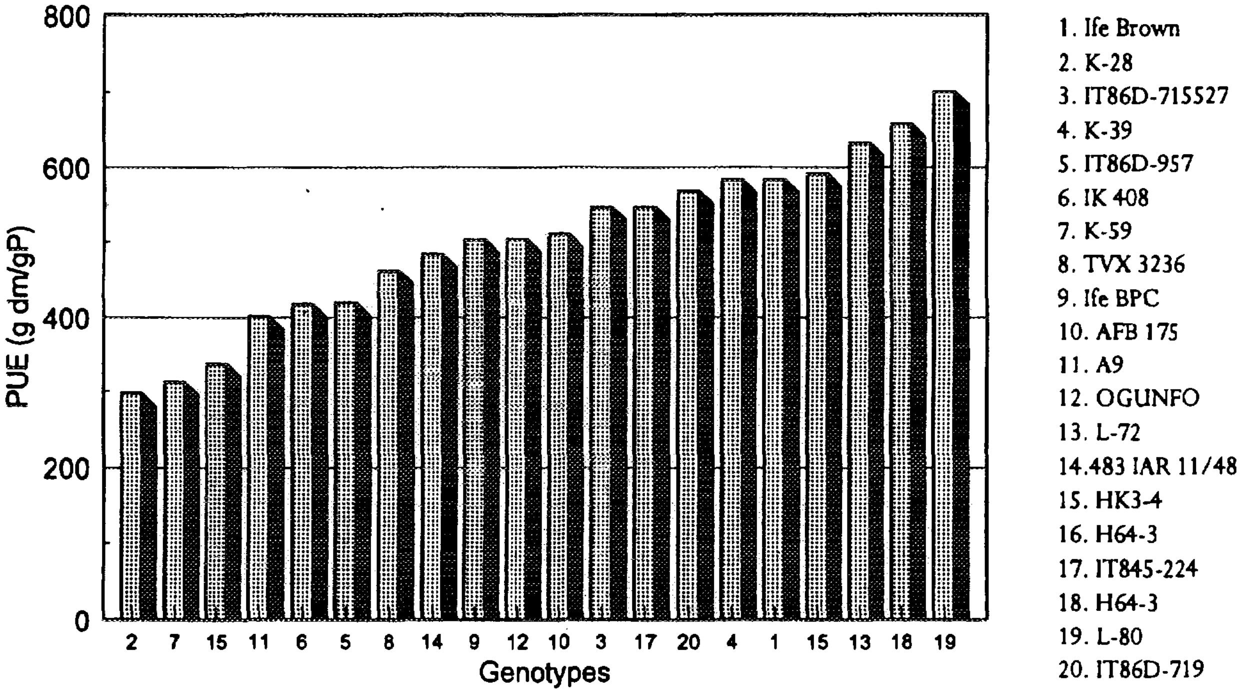


FIG. 2. Genotypic differences in phosphorus use efficiency (PUE) of cowpea.

TABLE II. SOME SOIL CHARACTERISTICS OF THE EXPERIMENTAL FIELD

Parameter	Quantity
Sand (%)	75.8
Silt (%)	12.8
Clay (%)	11.4
Ca^{2+} (meq/100g)	4.90
Mg^{2+} (meq/100g)	3.27
CEC (meq/100g)	9.15
KCl acidity (meq/100g)	0.40
Base saturation (%)	99
pH (KCl)	6.55
N (%)	0.08
P (Bray 1) mg kg^{-1}	4.95

REFERENCES

[1] Ayanduba, E.T. and J.A. Adepetu (1983). Predicting the phosphorus fertilization need of tropical soils; sigificance of the relationship between critical solution P requirement of cowpea, P sorption potential of free iron content of soil. J. Trop. Agric. Vet. Sci. 21(1):21-30. W.O. and W.A. Moore (1966). Phosphate status in some Nigerian Soils. Soils. Soil Sci. 102: 322 - 327

[2] Siddiqi, M.Y. and A.D.M. Glass (1981). Utilization index: A modified approach to the estimation and comparison of nutrient utilization efficiency in plants. J. Plant Nutr. 4: 289 - 302.

[3] Israel, D.W. and T.W. Rufty (1988). Influence of phosphorus nutrition on phosphorus and nitrogen utilization efficiencies and associated physiological responses in Soybean. Crop Sci. 28:954-960.

[4] Aggarwal, V.D., R.B. Ntare and J.B. Smithson (1982). The relationshi among yield and other characters in vegetative cowpea and effect of different trelis management systems on pod yield. Tropical Grain Legume Bulletin. 25:8-14.

[5] Aggarwal, V.D. and S.D. Halley (1985). Varietal evaluation of cowpea to determine characters associated it'. adaptation to dry areas Africa. In: S.R. Singh nd K.O. Rachie (eds.). Cowpea Research, Production and Utili.ation. John Wile and Sons, Ltd., New York.