Effects of Phosphorus and Harvest Time on Dry Matter Yield, Nitrogen and Phosphorus Contents of Horsegram *Macrotyloma uniflorum*

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Key words: - *Macrotyloma uniflorum* - Phosphorus - Nitrogen and P contents - Stage of growth - Forage yield - Nigeria

Summary

A two year field study was conducted at Shika, Northern Nigeria to determine the effects of phosphorus levels (0, 40, 80 and 120 kgP$_2$0$_5$/ha) and harvest times (6, 9, 12 and 15 weeks after planting, WAP) on dry matter yield (DM), N and P distribution in plant parts of horsegram (Macrotyloma uniflorum).

Leaf and stem DM yields (2.8 and 2.3 t/ha) were highest (P<0.05) when 80 kgP$_2$0$_5$/ha was applied. Total DM yields ranged from 1.9 t/ha in the control to 5.1 t/ha at the 80 kgP$_2$0$_5$/ha treatment. The leaf (2.9 t/ha) and stem (2.6 t/ha) DM yields were greatest at 12 and 15 WAP respectively. The total DM yields were lowest (2.3 t/ha) and highest (5.3 t/ha) at 6 and 12 WAP respectively. The application of 80 kgP$_2$0$_5$/ha when harvested 9 WAP favoured total plant N content. The P content in the herbage increased with increase in P application, and was highest at 6 WAP.

Résumé

Les rendements en matière sèche (feuille, tige et total), la teneur des plantes en azote et phosphore à différents niveaux d'engrais phosphoré (0, 40, 80 and 120 kgP$_2$0$_5$/ha) et de temps de récolte de 6, 9, 12 et 15 semaines après semis de "horsegram" (Macrotyloma uniflorum) *ont été étudiés sur deux saisons de culture à Shika, dans le Nord du Nigéria.*

Les rendements de matière sèche des feuilles et des tiges (2, 8 et 1,3 t/ha) ont été meilleurs (P<0,05) après traitement avec 80 kgP$_2$0$_5$/ha. Le rendement total en matière sèche a été de 1,94 t/ha pour le témoin et de 5,1 t/ha après traite par 80 kgP$_2$0$_5$/ha. Les rendements en matière sèche des feuilles et des tiges ont été élevés (2,9 t/ha) et plus élevé (5,3 t/ha) respectivement à 6 et 12 semaines après semis. L'application de 80 kgP$_2$0$_5$/ha augmente la teneur en azote des plantes lorsque la récolte est précoce. La teneur en phosphore des plantes est proportionelle a l'application du phosphore et est supérieure à 6 semaines après semis.

Introduction

Several forage legumes species have been introduced into Shika, Northern Nigeria and screened or productivity and adaptability over the past years. This has been in a search for outstanding materials that could be used to partialy or completely replace the low productive native grassland species (8,19). In some of these screening trials, Agishi (1) on upland and Akinola and Olorunju (3) on lowland reported the legume, horsegram *(Macrotyloma uniflorum)* to be well adapted to the Northern Guinea savanna and to produce substantial amount of forage. Agishi (2) observed that it produced moderate quantity of seeds. However, since these screening trials no concerted effort whatever has been made to carry out further agronomy trials in this environment dispite its mentioned attributes, such as its palatability to livestock at different stages of growth (6), drought tolerance and ease of regeneration from seeds (16). Horsegram can tolerate a wide range of soil types (17).

The present experiment was therefore designed to study the effect of phosphorus fertilizer and age of growth on forage yield and quality of horsegram in a subhumid environment zone of Nigeria.

Material and Methods

The study was carried out at the National Animal Production Research Institute. Shika (Latitude 11° 12' N, Longitude 7° 33' E) in the subhumid Zone of Nigeria. Rainfall data during the experimental periods are presented in Figure 1. Shika soils have been classified by Klinkenberg and Higgins (10) and physical properties described by Kowal (11).

Prior to planting the area was ploughed and harrowed. Forty eight plots (2m x 3m each) separated by 1m pathways were laid out in a split plot design with 3 replicates to accomodate four levels of phosphorus as the main plot and four harvest times as the subplots.

The levels of phosphorus used were equivalent to 0, 40, 80 and 120 kgP$_2$0$_5$/ha. The harvest times imposed were 6, 9, 12 and 15 weeks after planting (WAP). Seeds were drilled in rows, 25 cm apart on July 11th, 1991 and July 8th 1992 at the rate of 10 kg/ha. Basal fertilizer of 10 kgN/ha was applied to all plots. Plots were hand weeded twice.

Sampling for yield estimation in each plot was done by cutting plants within a 1 m^2 quadrat with hand sick-

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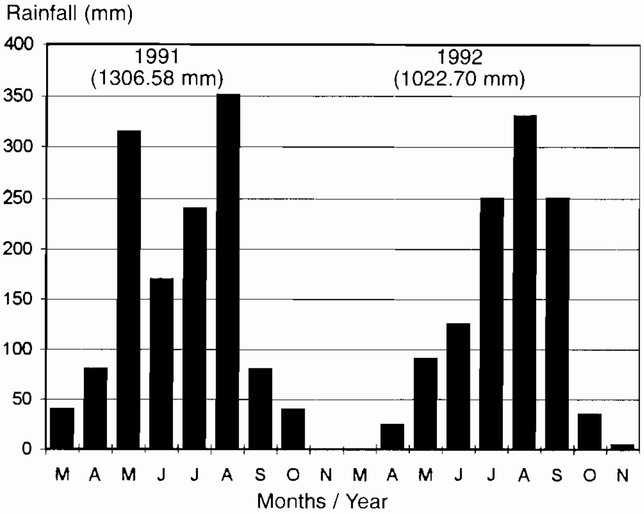

Figure 1 Annual Rainfall at Shika, Nigeria.

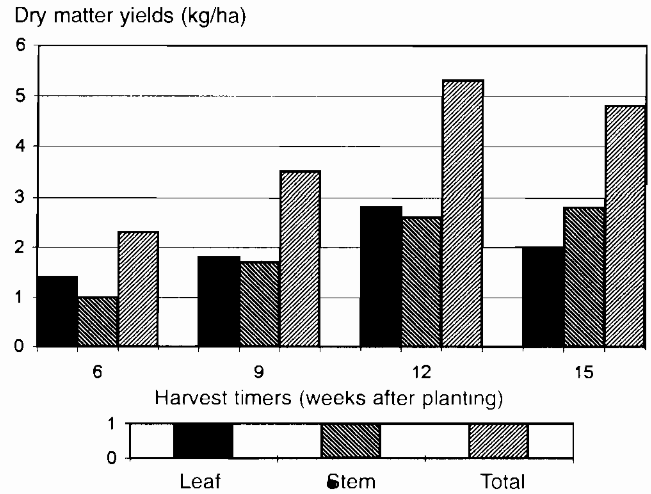

Figure 3 . Effect of harvest time on DM yields.

les to a height of 10 cm above ground level. The samples were weighed as whole plant, leaf and stem components and thereafter dried in a unitherm oven at 80°C for 48 hours and reweighed for estimation of DM yields. Whole (total) plant samples were ground and analysed for N and P contents (by percentage in DM) using methods recommended by the Association of Official Analytical Chemist (4). The N and P contents reported here were that of 1991 alone.

The data were subjected to the analysis of variance procedure and the means compared by the Duncan's Multiple Range Test as described by Steel and Torrie (18). Forage yields, N and P contents were either correlated against fertilizer P or harvest time over the two years.

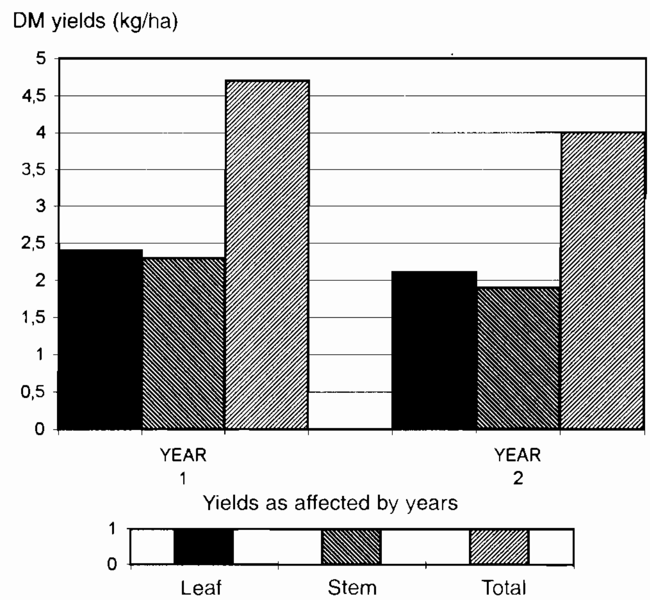

Figure 4 Effects of year on DM yields on horsegram.

Results

Herbage yield

Horsegram sown in 1991 significantly had ($P<0,05$) higher leaf, stem and total DM yields than those planted in 1992 (Figure 2).

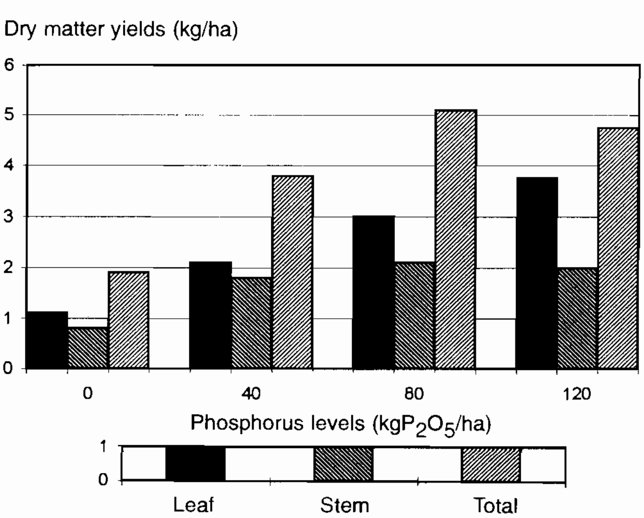

Figure 2 : Effect of P fertilizer on DM yields.

The DM yields (leaf, stem and total) increased ($P<0.05$) with higher P level up to 80 kgP_2O_5/ha before they declined (Figure 3). At all the levels of P the leaf component was higher than the stem component. The Leaf, stem and total DM yields were lowest (1.1, 0.8 and 1.9 t/ha) in the control and highest (3.0, 2.1 and 5.1 t/ha) with the application of 80 kgP_2O_5/ha. (Figure 3).

The leaf DM (r=0.425*, $P<0.05$), stem DM (r=0.509*, $P<0.05$) and total DM yields (r=0.515*, $P<0.05$) were positively and significantly correlated with the P levels applied.

The leaf, stem and total DM yields between 6 and 12 WAP ranged respectively from 1.4 -2.8, 1.0 - 2.5 and 2.4 - 5.3 t/ha (Figure 4). The stem DM yield was positively and significantly correlated (r=0.510*, r=0.381 at $P<0.05$) with P levels and harvest time. The contribution of stem yield was less than that of leaf, except at 15 WAP.

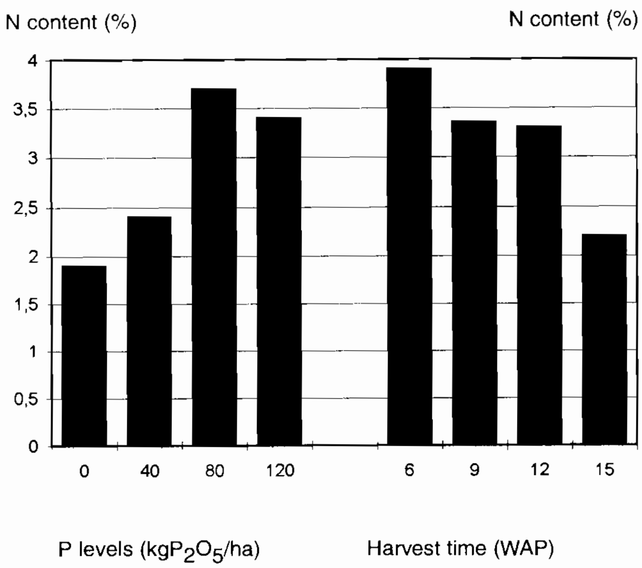

Figure 5 : Effects of P levels and harvest time on N content.

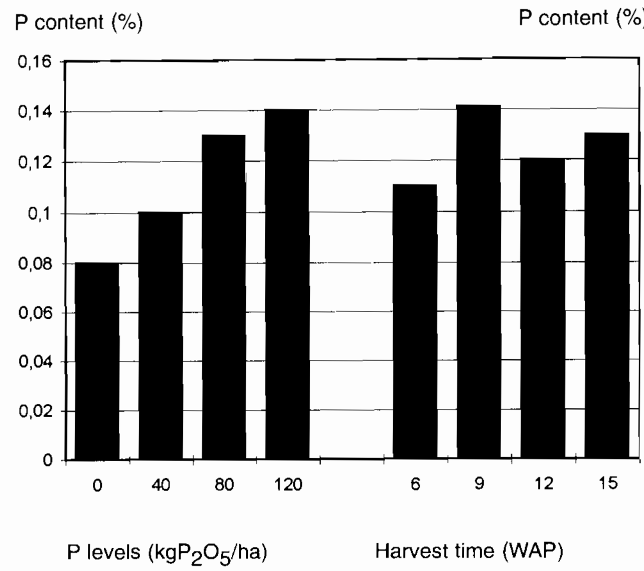

Figure 6. Effects of P levels and harvest time on P content.

N content

The N content differed significantly (P<0.05) between the different levels of fertilizer P applied. The N content 1.94% in the control, rose to 3.63% with 80 kgP_2O_5/ha. Thereafter a non-significant decline occured (Figure 5). The N content was highest (3.86%) when harvested at 9 WAP and decreased with increase in age (Figure 5).

The N content was positively and significantly correlated (r=0.514) with P levels, while a negative and significant correlation (r=0.661*, P<0.05) was recorded with harvest time.

P content

The application of fertilizer P led to increase in P content. The P content was 0.08% for the control and 0.14% for the highest level of P (Figure 6). Harvesting at 9 WAP significantly gave higher P content (0.147%) than other harvest times (Figure 6).

The correlation between P levels and P contents was positive and significant (r=0.406*, P<0.05), whereas the correlation with harvest time was significant negative correlation (r=0.706*, P<0.05).

Discussion

For optimum forage yields the application of 80 kgP_2O_5/ha appeared to be beneficial. Observation of the plots showed that the application of 80 and 120 kgP_2O_5/ha on horsegram under rainfed condition caused profuse compared to flowering and prolonged the growth period by about 30 days than did the control and 40 kgP_2O_5/ha.

The trend of the leaf and stem DM yields obtained in this study as the plant ages agrees with the earlier findings of Nkiwa *et al.* (15) on *Crotalaria ochroleuca* that with advancing plant growth the proportion of stem increases at the expense of leaf due to an increase in the proportion of lignified structural tissues.

The observation that yield declined after reaching a maximum (at 12 WAP) is common with tropical forages and may in the present instance be attributed to several factors including the onset of dry season and leaf senescence. The outstanding total dry matter yields obtained in this study at 6 to 12 WAP were higher than 1.16 to 3.33 t/ha reported by Akonola and Olorunju (3) for similar plant age on lowland in the same environment. This difference in sites of studies however favoured higher yields (5.38 t/ha) from the lowland at 15 WAP than recorded in this study.

The contribution of leaf (60%) towards the total forage yield at 80 kgP_2O_5/ha when harvested at 12 WAP is thought to be more beneficial. This in view of the fact that cattle and sheep have been shown to eat more of the leaf than the stem fraction of forages (9). The need for improved pastures characterised by higher leaf, stem ratios has been stressed (13); because leafiness is a strong determinant of forage intake (14). The dry matter yield of the leaf component in this study exceeded those of Akinola and Olorunju (3) harvested at similar growth stage. Differences in the levels of P used between Akinola and Olorunju (3) and in the present study could probably have contributed to this.

The lowest value of N content obtained for the unfertilized plots compared with those given P clearly showed P deficiency, indicating the need to apply P to horsegram. Lambert and Toussaint (12) have shown that P is needed not only for plant growth but also for rhizobia activity in nodulation and N fixation. The application of P on rhizobial activity in horsegram needs to be investigated. The N contents obtained in this study were slightly lower than those of Akinola and Olorunju (3). The application of copper sulphate, zinc sulphate, cobalt sulphate and other elements by

Akinola and Olorunju (3) probably enhanced higher N uptake.

The highest N content in horsegram obtained in this study at 6 WAP was in line with the results of Akinola and Olorunju (3) for the same species. The ARC (5) recommended the range of 1,2 to 2,7% in the diet of ruminants. This study showed that the N requirement for most classes of ruminant livestock could be met by feeding horsegram.

The lowest values of P content obtained for the control and 40 kgP_2O_5/ha as against the application of 80 and 120 kgP_2O_5/ha could be due to plant senescence and leaf-fall which limits P uptake by plant. The trend of P. content of the whole plant obtained in this study agrees with the findings of Mkiwa et. al. (15) on *C. ochroleuca* at Marogoro. Tanzania that there are no consistent effect of age of plant on its P contents. The minimum P requirement for ruminant livestock in the diet is considered to be 0.12%. (Boudet 1975). The P contents in whole plant recorded for the control and 40 kgP_2O_5/ha appeared inadequate to meet the demand of livestock.

Conclusion

From the results of this experiment, the application of 80 kgP_2O_5/ha and harvesting of horsegram at 12 WAP (corresponding to a period of greater pod filling) gave the maximum forage yield and satisfactory N and P contents of horsegram at Shika, Nigeria.

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