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EFFECT OF FERTILIZER LEVELS AND PLANT SPACING ON THE PERFORMANCE OF *Mucuna prureins* (VELVET BEAN) IN THE NORTHERN GUINEA SAVANNA OF NIGERIA

Bature, M.S., Hassan, A.H., Jantar, H.J and Shu'aibu, A.S
College of Agriculture and Animal Science, Division of Agricultural Colleges, Ahmadu Bello University, Mando-Road, Kaduna
Department of Agronomy, Institute of Agricultural Research, Ahmadu Bello University, Zaria
Corresponding Author (salisumusabature@gmail.com,GSM: 08065549941)

ABSTRACT
Fertilizer recommendation for crop and plant spacing is dynamic process in view of the generation of new knowledge with management practices. Information such as (phosphorus levels and plant spacing) on maintaining adequate soil fertility is very much important for producing better forages for livestock. Leguminous crop such as Velvet bean (Mucuna pruriens) can alleviate some of these problems. Field experiment was conducted to access the effect of phosphorus fertilizer application level at 0, 80 and 120kg/ha and plant spacing interval of 30, 60 and 90cm of Velvet bean. Application of 80kg/ha of phosphorus fertilizer significantly influenced the performance of Mucuna plant such as plant height, number of branches and forage yield. Plant spacing interval of 30cm resulted in better stand count, taller plant, higher number of branches and forage yield per plant. Famers in Northern Guinea Savanna of Nigeria can adopt the application of phosphorus fertilizer at 80kg/ha and using narrower spacing (25cm by 30cm) for better yield of Mucana, thereby increasing farm output and animal performance.
Key words: phosphorus level, plant spacing, Mucuna pruriens, Velvet bean

INTRODUCTION

Velvet bean (*Mucuna pruriens*), is probably a native to tropical southern or southeastern Asia (Houngnandan *et al.*, 2012). It is naturalized in tropical and subtropical areas around the world including the West Indies, Mexico and South America (Diollo and Berhe, 2003). Humphres and Riveros (1986), suggest that the species was probably introduced into Mesoamerica in the 1920s by the United Fruit Company as a forage crop for the company's mules on banana plantations. Houngnandan *et al.*(2012) had previously listed the species as 'probably native' in Puerto Rico and the Virgin Islands, but later became convinced that the species is likely "exotic and naturalized" in Puerto Rico as well as the Virgin Islands, Lesser Antilles, the US, Mexico, and South America. *Mucuna pruriens* seeds are dispersed by water and in soil. The species was introduced outside of its native range both intentionally in agricultural settings, and unintentionally. It became invasive in many of its introduced places including the Mariana Islands, Fiji and New Guinea and West Africa (Kavitha and Vadivel, 2008). As a tropical legume plant, Velvet bean (*M. pruriens*) has potential of energy and protein supplement in livestock feeds. The foliage is frequently fed to grazing animals and the beans are sometimes eaten by humans and animals (Kavitha and Vadivel, 2006b). The whole plant can be fed to animals as silage, dried hay or dried seeds. *M. pruriens* silage contains 11-23% crude protein, 35-40% crude fiber, and the dried beans 20-35% crude protein. The objectives of the study were:

To determine the effect of phosphorus levels (0, 80 and 120Kg/ha) on fresh and dry matter yield of Velvet bean (*Mucuna pruriens*). To determine the effect of plant spacing (25cm by 30cm,25cm by 60cm,and 25cm by 90cm) on growth components of Velvet bean (*Mucuna pruriens)*.

MATERIALS AND METHODS

The study was conducted at the pasture and range unit of teaching and research farm, College of Agriculture and Animal Science, Ahmadu Bello university, Mando Road- Kaduna (latitude 10^0 20′ N and longitude 07^0 45′ E with an elevation of 632 meters sea level), in the northern guinea savanna ecological zone of Nigeria.The zone is characterized by a rainy season that starts in April/May, stabilize in June and end in early October. The mean annual rainfall is 1,100 mm, maximum temperature varies between 27^0C to 35^0C, depending on the season. The relative humidity is about 72%. The dry season begins with a period of dry cool weather called harmattan that last from October to January. The harmattan is followed by a dry hot weather from February to April (Nimet, 2017).

Soil Sampling

A composite soil sample was obtained from the experimental plots using a soil auger at a depth of 15cm-30cm before establishing the plots at the beginning of the experiment. The soil sample was analyzed for physical and chemical properties such as Clay, Silt, Sand, pH, total N, available P, organic C, exchangeable bases, Ca^{2+}, Mg+, K^+, Na^+, cation exchange capacity and exchangeable acidity, using standard procedure as described by Black (1968), to determine the pre-planting nutrient status of the soil at the Department of Soil Science, Ahmadu Bello University, Zaria.

Source of mucuna seeds and NPK Fertilizer

Two kilograms (2kg) of *Mucuna pruriens* seeds and 25kg of phosphorus and NPK fertilizer were obtained from Feed and Nutrition Research Program of National Animal Production Research Institute (NAPRI) Shika, Nigeria. The source of phosphorus was single super phosphate (18%P) which was broadcast on the day of sowing.

Treatments and Experimental Design

The treatments consisted of combination of three phosphorus rates (0, 80, 120kg/ha) and three plant spacing (25cm×30cm, 25cm×60cm and 25cm×90cm). The experiment was laid out in a 3×3 factorial arrangement in a randomized complete block design (RCBD) with three replications. There were total of 27 net plots, inform of basins measuring $4m^2$ with 1m inter-row path and watering channels.

Forage Establishment and Management

The field was ploughed, harrowed to a fine tilth manually using a hand hoe before planting. There were total of 27 net plots inform of basins measuring $4m^2$ with 1m inter-row path and watering channels. All experimental plots received 40kgNPK/ha as uniform dressing by incorporating it into the soil before sowing. Two mucuna seeds were sown manually per hole, while the field was maintained weed free throughout the trial period, using hoe weeding at 3 and 6 WAS.

Observation and Data Collection

Stand Count

Stand count was recorded at 4 weeks after sowing by counting the number of stands in each plot.

Plant Height: The heights of 3 tagged plants in each plot were measured from the ground level to the tip of the plant using a meter rule.

Number of Leaves: These were obtained by counting the number of leaves and recording the average of 3 tagged plants in each plot.

Number of Branches: Number of branches were counted and recorded the average of 3 tagged plants in each plot.

Fresh and Dry Forage Yield: The fresh forage material cut 5cm above the ground level were weighed immediately using a hanging scale to determine the fresh forage yield. A sample of 150-200g fresh material was weighed, oven dried at 65°C for 48hrs and reweighed to give an estimate of the percent (%) dry matter, while the dry matter production was obtained using the formula below:

Dry matter (kg/ha) =Total fresh weight in Kg × % Dry matter

Statistical Analysis

Data collected for the experiment were subjected to analysis of variance (ANOVA) by using procedure of Statistical Analysis System (SAS, 2003). Probability level of significance at 5% ($\leq$ 0.05) to separate treatment means was adopted using Duncan's Multiple Range Test (Duncan, 1955).

RESULTS

Table 1 shows the effect of phosphorus level and plant spacing on stand count of *Mucuna* at 3 weeks after sowing (WAS). Phosphorus application show no significant ($p>0.05$) on stand count of *Mucuna* plant. Differences among spacing were significant ($p<0.05$), whereas plant spacing (25cm×30cm) produced more number of stands than both (25cm×60cm and 25cm×90cm) plant spacing.

Table 2shows the effect of phosphorus levels and plant spacing on plant height of *Mucuna* at 3, 6 and 9 WAS. Phosphorus application levels, showed an increasing trend ($p<0.05$) in the height of plant with 120>80>0 kgP/ha across the treatments at 3 and 6 WAS. But at 9WAS, the means with phosphorus application were significantly similar compared to the control. There was a significant ($p<0.05$) increase in the height of *Mucuna* plant both at 3 and 6WAS with (25cm×30cm and 25cm×60cm) plant spacing compared to (25cm ×90cm) plant spacing. But at 9WAS, there was no significant increase ($p>0.05$) in height of plant across all the spacing treatments.

Table 3 shows the effect phosphorus level and plant spacing on number of branches of *Mucuna* at 3, 6 and 9 WAS. Application of phosphorus rates show an increasing trend ($p<0.05$) in number of branches with 120>80>0 kg/ha at 3 WAS. But it does not show a significant difference ($p>0.05$) in the number of branches at 6WAS. At 9WAS, there was a significant difference ($p<0.05$) in number of branches with phosphorus application. There was a significant increased ($p<0.05$) in number of branches with (25cm×30cm and 25cm×60cm) plant spacing compared to (25×90) plant spacing at 3WAS. At 6WAS, no significant difference was observed across all the spacing. However, the means for (25cm×30cm) and (25cm×90cm) plant spacing were significantly similar than for 25cm×60cm plant spacing at 9WAS. Plant spacing (25cm×60cm) was observed to produce the highest number of branches at 9WAS.

Table 4 shows the effect of phosphorus levels and plant spacing on fresh and dry matter yield of *Mucuna* during the harvesting period. The application of phosphorus rates produced more fresh and dry matter yield than the control level. Application of phosphorus at 80 and 120kgP/ha was significantly similar during the harvesting period. There was an increase ($p<0.05$) in fresh and dry matter yield with (25cm×30cm and 25cm×60cm) plant spacing compared to (25cm×90cm) plant spacing. Plant spacing (25cm×30cm and 25cm×60cm) were significantly similar across the treatments for fresh and dry matter yield, but (25cm×30cm) produced statistically higher fresh and dry matter yield compared to (25cm×60cm) plant spacing.

Table 1: Effect of Phosphorus Level and Plant Spacing on Stand Count of *Mucuna* at 3 WAS.

Treatments	**Stand count**
Phosphorus (kg/ha)	
0	18.11
80	21.11
120	18.22
Spacing	
25 x 30	26.22[a]
25 x 60	19.00[b]
23 x 90	12.22[c]
SEM	1.24
p-value	0.0001

Means within a column of any set of treatment group with unlike letter(s) are significantly different at ($p<0.05$)SEM = Standard Error of Mean WAS = Weeks after sowing.

Table 2: Effect of Phosphorus Level and Plant Spacing on Plant Height of *Mucuna* at 3, 6 and 9 WAS.

	Plant height		
Treatments	**3 WAS**	**6 WAS**	**9 WAS**
Phosphorus level (kg/ha)			
0	30.31a	101.91b	154.31b
80	33.64ab	114.94ab	209.56a
120	41.24a	128.26a	213.62a
Spacing			
25 x 30	38.86a	116.82b	191.60
25 x 60	39.64ab	135.03a	208.49
25 x 90	26.75b	93.26b	197.40
SEM	2.96	4.53	6.32
p-value	0.0058	0.013	0.0178

Means within a column of any set of treatment group with unlike letter(s) are significantly different at ($p<0.05$)SEM = Standard Error of Mean WAS = Weeks after sowing

Table 3: Effect of Phosphorus Level and Plant Spacing on Number of Branches of *Mucuna* at 3, 6 and 9 WAS.

	Number of branches		
Treatments	**3 WAS**	**6 WAS**	**9 WAS**
Phosphorus level (kg/ha)			
0	10.60b	24.04	45.40b
80	11.66ab	41.02	75.06a
120	12.66a	28.16	72.84a
Spacing			
25 x 30	12.57a	22.96	59.53b
25 x 60	12.08a	32.22	77.44a
25 x 90	10.26b	38.04	56.33b
SEM	1.12	4.72	2.93
p-value	0.0021	0.327	0.0001

Means within a column of any set of treatment group with unlike letter(s) are significantly different at ($p<0.05$) SEM = Standard Error of Mean WAS = Weeks after sowing.

Table 4: Effect of Plant Spacing and Phosphorus Level on Fresh and Dry Matter Yield of *Mucuna* during the harvesting period

Treatments	**Fresh Matter Yield (Kg/ha)**	**Dry Matter Yield (Kg/ha)**
Phosphorus level(kg/ha)		
0	1133.55[b]	1013.78[a]
80	1169.16[a]	1004.50[ab]
120	1174.72[a]	1014.11[a]
Spacing		
25 x 30	1118.50[a]	1024.22[a]
25 x 60	1111.38[a]	1030.58[a]
25 x 90	973.55[b]	1000.67[b]
SEM	17.28	16.003
p-value	0.331	0.236

Means within a column of any set of treatment group with unlike letter(s) are significantly different at ($p<0.05$) SEM = Standard Error of Mean WAS = Weeks after sowing.

DISCUSSION

Effects of Phosphorus Levels on the Performance and Forage Yield of (*M. pruriens).*

The application of phosphorus rates in this trial produced more growth components and forage yield than the control level. This might be related to plants having access to greater share of available nutrients (response to phosphorus) in the soil which resulted in improved growth performance. The observed increased in growth components and forage yield with phosphorus application agrees with the report of Kumwenda and Gilbert (2002) and Kavitha (2005) on mucuna plant. Application of phosphorus at 80 and 120KgP/ha was significantly similar during the harvesting period. This indicates that 80KgP/ha might be optimum phosphorus fertilization in *Mucuna pruriens.*

Effect of Plant Spacing on the Performance and Forage Yield of (*M. pruriens*)

Results of this trial had shown that there was significant response on stand count, plant height, number of branches and forage yield per plant. Spacing among plant stands influenced the degree of intra plant competition for available resources. However, the heights of the plant at spacing (25cm×30cm and 25cm×60cm) were found to be slightly higher than at wider spacing (25cm×90cm), this is because there was high competition for sunlight, hence growing taller. Kumwenda and Gilbert (2002) reported similar results. The total yield per unit land area depends on the number of plants per unit's area. Also, it had been reported that mucuna produced high forage yield at advanced stage of maturity compared to with the early stage of maturity (Farooqi *et al.,* 1999).

CONCLUSION

From the results of the trial, it is clear that *Mucuna pruriens* is influenced by phosphorus application and plant spacing. Famers in Nigeria could plant *Mucuna pruriens* at narrower spacing using 80Kg/ha phosphorus application if is to be harvested at 9WAS. This will help to famers to save extra cost of fertilizer, thereby increasing farm output and animal performance.

RECOMMENDATION

Mucuna pruriens should be allowed to reach maximum maturity (seed yielding stage) so as to see the effect of spacing. Seeds of *Mucuna* should be made available to famers to encourage its incorporation into the farming system for higher yield.

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