Gashua Journal of Irrigation and Desertification Studies
Available online at www.gjidsfugashua.org.ng
Volume 2, Issue 2

GROWTH COMPONENTS, FORAGE AND SEED YIELD OF VELVET BEAN *(Mucuna pruriens)* AS AFFECTED BY PIG MANURE RATES AND IRRIGATION INTERVALS IN NIGERIAN SAVANNA

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Abstract

A study was conducted to determine the effects of graded levels of pig manure rates and irrigation frequency on growth components, forage and seed yield of Velvet bean (*Mucuna pruriens).* The experimental design was a split plot fitted into a Randomized Complete Block Design (RCBD), replicated three times. Treatments consisted of graded levels of pig manure application rates (0, 9 and 18 t / ha) and three irrigation frequencies (2,4 and 6 days intervals). Results indicated that tallest plant, (112.44cm) ($P<0.05$), more leaves (107.75) were obtained when pig manure was applied at 18 t / ha and irrigated at 6 days irrigation interval, which was at per with result applied 9 t / ha at 4 days irrigation interval. However, the leaf area index (LAI) did not differ ($P>0.05$) with increase in irrigation interval. Also, the heaviest ($P<0.05$) fresh and dry forage yields (9.22t/ha vs. 6.66t/ha) were observed when pig manure was applied at 18 t / ha, at irrigation interval of 6 days, which was at per with applied 9 t /ha and 2 days irrigation interval. For seed production, irrigation interval of 2 days produced the highest ($P<0.05$) yield (2.98t/ha), when pig manure was applied at the rate of 9 t / ha. It was therefore concluded that pig manure could be applied to *Mucuna pruriens* forage at 9 t / ha at irrigation interval of 4 days, for better growth components. However, for forage yield and seed production, 9t/ha of pig manure and 2 days irrigation interval produced the best result in Northern Guinea savannah of Nigeria.

Key words: Dry matter, irrigation, Nigeria, nutrients, soil, velvet bean.

INTRODUCTION

Mucuna (*Mucuna pruriens* L.), is a popular leguminous forage that is used for different purposes in tropical countries (Kevin *et al.*, 2008; Anastasia and Joseph, 2003). It belongs to the family Fabaceae (*leguminoceae*) and subfamily *Faboideae* (USFS, 2011). There are many species of Mucuna which are characterized by remarkable physical and physiological

variations (Pengelly *et al.,* 2004). The black seeded *Mucuna pruriens*has superior quality than others, especially in early seed ripening and vegetative growth (Onoma and Asongwed, 2002). Mucuna is believed to have originated from Eastern India, Malaysia, and southern parts of China (Janardhanan and Lakshaman, 1985; FAO, 2011).

Mucuna is cherished by farmers as a leguminous forage crop used for livestock feeding and green manuring in different parts of the tropics (Mbuthia and Gachuiri, 2003) that is compartible with other pasture species (Whitbread *et al.,* 2004). It also has the ability to smoother weeds with less problem of insect attack (FAO, 2011, Agyenim, 2006). Many cultivars of Mucuna are suitable for humid regions of the tropics, while others are suitable for dry land farming (Anastasia and Joseph, 2003). Mucuna can be grown successfully on soils unsuitable for cowpeas, and therefore helps to protects the soil from environmental hazards. However, it has the disadvantage of a longer growth period and the seeds are more difficult to thresh. Moreover, the seedsare not highly valued for human consumption or animal feeding, because of the prolonged soaking and, or boiling required before it can be cooked for safety consumption (Ross, 1999). The leaves and vines make an excellent fodder for livestock (Westphal, 1974).

In developing countries such as Nigeria, Mucuna is produced by smallholder farmers for soil fertility improvement and livestock production (Ngosong *et al.,* 2015). However, the major challenges include drought (Gabrielle, 2016), scarcity and cost of initial fertilizer doses to be applied for proper vegetative growth and seed yield (Odedina *et al.,* 2011). The use of animal manure such as cattle, sheep, poultry and pig manure in crop production with the aim of reducing production costs and environmental damages has been reported (Odedina *et al.,* 2011; Obi and Ebo, 1995; Ojeniyi, 2002). Despite its ability to grow on soils with low available soil phosphorus, Mucuna has been reported to respond to phosphorus and lime applications on acid soils, either from amelioration of pH or from Mg and Ca applications (Maasdorp *et al,,* 2004). The use of Mucuna seeds to supplement poor quality grasses in small ruminant diet has been reported in Zimbabwe (Matenga *et al.,*2003).

Pig manure is a very good source of organic matter which plays a vital role in improving the physical, chemical and biological properties of the soil, which activate the activities of soil microorganism, and enhance slow release of plant nutrients (macro and micro) with resultant environmental harmony (Sharma and Mitta, 1991). Efficient and effective use of pig manure ensure sustainable crop productivity, because soil organic matter is maintained, nutrients are released more slowly, stored for a longer time in the soil, improved root development and high crop yield (Sharma and Mitta,1991).

Global climate change (GCC) has led to an increasing instability differences in the rainfall distribution pattern for crop cultivation. This leads to developing methods of irrigation that will minimize the impact of drought, thereby maximizing the crop water use efficiency (Salah *et al.,* 1995). Irrigation is an important component of the farming system in Nigeria. It helps to supply enough moisture to crops for better performance. Similarly, irrigation fetches

more income to farmers than rainfed farming. In Nigeria, smallholder farmers hardly utilize pig manure as a source of fertilizer for their crops, despite its availability and low cost. Therefore, it was hypothesized that utilization of pig manure by smallholder farmers, with appropriate agronomic practices, will help to provide cheap and sustainable option for forage crop production under irrigation in Nigeria. This will lead to improvement in productivity of livestock and economic status of farmers thereby preventing further environmental degradation, due to indiscriminate use of chemical fertilizers by the farmers. Hence, this study was conducted to evaluate the effect of single application of graded levels of pig manure on growth components, forage and seed yield of *Mucuna pruriens* under different irrigation frequencies in Northern Guinea savannah of Nigeria.

MATERIALS AND METHOD

The study was carried out at Samaru located between latitude $11^0$11'N and longitude $7^0$38'E, on altitude of 686 m above sea level. The area falls within the Northern Guinea Savannah zone with an average rainfall of 1100mm. The maximum temperature varies from 26^0C to 35^0C depending on the season, while the mean relative humidity during harmattan period and the wet season are 21% and 72%, respectively (Ovimaps, 2016).Seeds of *Mucuna pruriens* used for the study were obtained from the Feeds and Nutrition Research Programme at the National Animal Production Research Institute (NAPRI) Shika, Zaria. The soil at the experimental site was taken prior to land preparation using soil auger at 0-15cm depth for routine analysis, which was conducted in the Department of Soil Science, Faculty of Agriculture, Ahmadu Bello University, Zaria. Table 1 shows the physical and chemical properties of the soil at the experimental site.

Treatments, Experimental Design, and Data Collection

The treatments consist of graded levels of pig manure application (0, 9 and 18 t/ha) and three irrigation intervals (2, 4 and 6 days intervals).The experimental design was a split plot fitted into a Randomized Complete Block Design (RCBD), replicated three times.The land was cleared, prepared and irrigated for 7days during the 2014/2015 dry season to attain field capacity. Net plots measuring 1.5m by 1.5m were prepared using hoes. Seeds of Mucuna (black) were treated with Apron star, which is a fungicide at the rate of 4 kg/ sachet and then sown using dibbling method at inter and intra row spacing of 25cm, respectively. All plots were fertilized with a basal NPK fertilizer at the rate of 60kg/ha.

Data were collected for agronomic indices at 12 weeks after sowing on plant height, number of leaves, leaf length, leaf breadth, number of branches, number of nodes and fresh forage yield/ha. Plant height, leaf length and breadth were measured using a meter rule. Fresh forage yield was estimated using a 0.5 m by 0.5 m quadrant in each plot. The forage material was cut using a hand sickle at 10cm height, bulked and weighed immediately using a hanging scale before sub-sampling 300g per plot for the determination of proximate composition of the forage. Forage samples were oven dried at 60^oC for 72 hours until they attained constant weight. The dried samples were

milled to pass 1mm mesh using an electric miller. Milled samples of *Mucuna pruriens* forage were analyzed for proximate composition: dry matter(DM), crude fibre(CF), crude protein(CP% =N×6.25), nitrogen free extract (NFE), ether extract(EE) and ash content, respectively at the Biochemistry Laboratory of the Department of Animal Science, Ahmadu Bello University, Zaria, using the method described by A O A C. (2005). All data collected were subjected to analysis of variance (ANOVA) using 'F' test as the Statistical Analysis System (2002) computer software package. Means were compared by a Post-hoc Tukey's HSD test ($P<0.05$). Since there were significant interactions, only main effects of factors were considered in the results.

RESULTS AND DISCUSSION

The result of the soil analysis shows that the soil was a sandy-loam under the soil textural classification (Table 1).

The pH was 5.60 which indicated that the soil was slightly acidic. The result shows that the total nitrogen and organic carbon contents of the experimental site were low. This showed that there was need for the application of nutrients to support full establishment and seed production of *Mucuna pruriens*.The chemical composition of pig manure showed that the manure was rich in essential nutrients (Table 2).

Many studies reported positive improvements in growth performance of different crops fertilized with pig manure (Ojeniyi and Akanni, 2008; Olomilua *et al.*, 2007). Findings ofSanni and Okeowo (2016) confirmed the superiority of using pig manure on eggplant compared to other manure sources. Table 3 shows the results of interaction effect of levels of pig manure application and irrigation frequency.

The tallest plants (112cm) and more of leaves per plant (108) were observed at combination levels of 18 t / ha pig manure rate and 4 days irrigation interval and 18 t / ha and 6 days irrigation interval, respectively. This result is similar to the findings of Sanni and Okeowo (2016) in eggplant. These authors found that plots treated with pig manure at the rate of 7.5 t / ha produced the highest mean height of eggplant.Results obtained in this study might be related to the high nutrient content of pig manure, especially calcium and phosphorus, which are necessary for plant growth (Odedina*et al.,* 2011; Adeniyan and Ojeniyi, 2003). It was also reported that pig manure could increase the contents of soil macro and micro nutrients and yield of different crops (Awodun and Alafusi, 2007; Olomilua *et al.*, 2007; Ayeni *et al.,* 2009). Results of Okonmah (2011) on okra plants showed that plants that received pig manure at the rate of 15t/ha, produced the best growth parameters, which is supported by the findings of Giwa and Ojeniyi (2004) and Christo *et al.* (2011), proving the efficiency of pig manure in supporting plant growth. The highest number of leaves of Mucuna recorded in this study (108) obtained at treatment combination of 18 t / ha pig manure rate and 6 days irrigation interval was significantly lower than the value reported in eggplant (239) at lower rate of pig manure application (7.5t/ha). This result can be explained by the excessive leaf shading effect of Mucuna forage at maturity period, due to rapid formation of new dark green leaves (Zsolany and Gorlitz, 1994).

Similarly, the highest quantity of pig manure applied in this study might have led to higher accumulation of nitrogen in the soil. However, the rate of nitrogen uptake from the soil by Mucuna forage is minimum compared to non-nitrogen fixing plants such as okro plant, since it has been reported that the rate of nitrogen uptake by plants is proportional to the quantity of nitrogen in the soil (Madukwe *et al.,* 2008). Irrigation interval of 4 or 6 days in combination with pig manure rate of 18 t / ha showed the tallest plants and number of leaves of Mucuna forage, respectively (Table 3). This indicated that Mucuna forage could survive dry spell condition, which further shows that it can be successfully produced in areas with less rainfall in Nigeria. Salah *et al.* (1995) reported a similar effect of irrigation interval on agronomic and quality indices of alfalfa forage in Riyadh, Saudi Arabia. The leaf area index of Mucuna forage in this study was however statistically similar across the treatments. This result might be related to the rapid canopy development and short photoperiod in legumes. Lawson et al. (2013) reported reduced leaf area index in cowpea intercropped with cereal in Ghana. However, the result obtained in this study is contrary to the findings of Nweke *et al.* (2008) who reported an effect of different nutrient sources on the leaf area index of maize crop. These authors showed that combination of pig manure and urea fertilizer produced the best leaf area index. Table 4 shows the results of combined effect of pig manure application and irrigation frequency on forage yield of *Mucuna pruriens.*

Results obtained indicated that the highest fresh (9.22t/ha) and dry forage yields (6.66t/ha) were recorded in all applied manure rates at 6 days irrigation interval, which was also at per with applied 9 t / ha of pig manure at 2 days interval, except on dry forage yield were depression was observed with applied 9 t / ha at 6 days irrigation interval. This suggests that Mucuna forage can also survive short term water logging, in soils with low nutrient status in Northern Guinea savannah of Nigeria. The values obtained in this study fall within the range of 5-12t/ha previously reported (Maasdorp *et al.,* 2004). The Mucuna forage in this study was cut once at maturity stage of growth (16 weeks), which could explain the reason for the general low forage yield obtained in this study. Ross (1999) reported that when Mucuna plant is intended for forage, it can be harvested at the period of 90-120 days. Increasing the irrigation interval from 2 to 6 days in this study led to progressive increase in both fresh and dry forage yields. This result could be related to the fact that Mucuna plant has the ability to tap adequate soil moisture through its long tap root system in addition to unintercepted sunlight received. However, Salah *et al.* (1995) reported dramatic decreases in forage yields of alfalfa in Rhiyad in fresh (97.3 vs. 91.7t/ha/yr) and dry forms (25.3 vs 23.1t/ha/yr), when irrigation interval was increased from 5 to 10 days interval, respectively. Donovan and Meek (Donovan and Meek, 1983), reported that proper irrigation of legumes such as alfalfa is a critical factor in the success of the crop. Also, research has shown that water stress condition has a remarkable decrease in top and root growth of legumes and grass species (Stevensonand Laidlaw, 1985). Maasdrop *et al.* (2004) suggested that

growth of Mucuna is affected by continuous moisture supply in the soil, especially when they are defoliated before flowering.

Table 5 presents the result of seed yield of *Mucuna pruriens* as influenced by level of pig manure application and irrigation interval. The highest ($P<0.05$) seed yield (2.89t/ha) was produced at 9 t / ha of pig manure application at 2 days irrigation interval. However, increasing the level of pig manure application rate and irrigation interval to 18t/ha and 4 days irrigation interval, led to 13% decrease ($P<0.05$) in the quantity of seeds produced by Mucuna. This indicates that for seed production, farmers in the study area should irrigate Mucuna forage at 2 days interval with 9t/ha of pig manure as a source of nutrients, for proper flowering and seed production. Although the results obtained showed that both seed yields at 9 and 18 t / ha at irrigation intervals of 2 and 4 days are at par, but using lower rate of pig manure might be more economical to farmers in Nigeria. Similar findings were reported by Eilittä and Carsky (2003), Omokanye (2001) and Lal (2015).

This supports the fact that higher rates of pig manure application on crops might results in highest seed yield, although Ojeniyi and Olamilua (2006) observed the highest yield of okro pods at 10t/ha pig manure application rate. Work by Christo *et al.* (2011) on fruit production by eggplant supported that pig manure can serve as good substitute to poultry manure.

CONCLUSION

The results of this study showed that for production of fresh forage and dry matter yields as well as seed yield of *Mucunapruriens*, farmers in the study area should apply pig manure at the rate of 9t/ha and irrigate at 2 days interval for better yield.

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Table 1: Physical and chemical properties of the soil at the experimental site

Properties	Value
Physical (%)	
Clay	14
Silt	26
Sand	60
Textural class	Sandy-loam
Chemical:	
pH (H_2O)	5.60
pH ($CaCl_2$)	5.00
Exchange cations (Cmol/kg):	
Na	0.27
K	0.33
Ca	4.36
Mg	0.84
Total N (%)	0.28
Available P (ppm)	33.25
Organic carbon (%)	0.40
Cation Exchange Capacity (Meq/100g)	8.20
Exchangeable acidity (Cmol/kg):	
$H+Al^{3+}$	0.40

Table 2: Chemical composition of pig manure applied to *Mucuna pruriens* forage

Parameter	Value
N total (%)	2.66
P (%)	0.23
K (%)	0.11
P/N	0.09
K/N	0.04

Tabl 3: Effect of pig manure application and irrigation frequency on growth components of *of m mucuna pruriens*

	Levels of pig manure applied (t/ha)		
Irrigation interval (days)	0	9	18
	Plant height (cm)		
2	84.21[a]	75.88[b]	76.67[b]
4	69.33 [b]	83.33[a]	112.44[a]
6	68.47 [b]	60.94[c]	110.10[a]
Overall mean (cm)	74.03	73.39	99.92
SEM	2.87	2.86	3.33
LOS	*	*	*
T×I	*	*	*
	Number of leaves (no.)		
2	69.00[b]	76.88[b]	80.00[c]
4	60.38[c]	85.50[a]	97.29[b]
6	76.38[a]	64.67[c]	107.75[a]
Overall mean (no.)	68.58	75.68	95.01
SEM	2.76	2.89	3.25
LOS	*	*	*
T×I	*	*	*
	Leaf Area Index (LAI)		
2	0.15	0.17	0.18
4	0.13	0.16	0.20
6	0.13	0.15	0.21
Overall mean	0.14	0.16	0.19
SEM	0.12	0.13	0.15
LOS	NS	NS	NS
T×I	NS	NS	NS

[abc] Means with different superscripts along the column differed significantly ($P<0.05$); LOS = Level of significant; SEM = Standard error of the mean, T×I = Interaction between pig manure application rate and irrigation interval.

Table 4: Effect of pig manure application and irrigation frequency on forage yield of *Mucuna pruriens.*

	Level of pig manure application (t/ha)		
Irrigation interval (days)	0	9	18
	Fresh forage (t/ha)		
2	5.12[c]	7.74 [a]	8.49[b]
4	6.33[b]	6.15[b]	8.42[b]
6	7.00[a]	7.56 [a]	9.22 [a]
Overall mean (t/ha)	6.15	7.15	8.71
SEM	0.11	0.13	0.15
LOS	*	*	*
T×I	*	*	*
	Dry forage yield (t/ha)		
2	2.98[c]	4.11 [a]	5.38[b]
4	3.10[b]	3.77[c]	5.00[c]
6	4.57[a]	3.99[b]	6.66 [a]
Overall mean (t/ha)	3.55	3.96	5.68
SEM	0.03	0.01	0.02
LOS	*	*	*
T×I	*	*	*

[abc] Means with different superscripts along the column differed significantly (P<0.05); LOS = Level of significant; SEM = Standard error of the mean, T×I = Interaction between pig manure application rate and irrigation interval.

Table 5: Effect pig manure application and irrigation frequency on seed yield of *Mucuna pruriens*

	Level of pig manure application (t/ha)		
Irrigation interval (days)	0	9	18
	Seed yield (t/ha)		
2	2.04[a]	2.89[a]	1.33[c]
4	1.29[b]	2.00[b]	2.55[a]
6	0.49[c]	0.36[c]	1.61[b]
Overall mean (t/ha)	1.27	1.75	1.83
SEM	0.02	0.04	0.01
LOS	*	*	*
T×I	*	*	*

[abc] Means with different superscripts along the column differed significantly (P<0.05); LOS = Level of significant; SEM = Standard error of the mean, T×I = Interaction between pig manure application rate and irrigation interval.