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Effects of Sowing Methods, Cutting Age on Growth Components, Forage Yields and Chemical Composition of White Mucuna (*mucunapruriens*) Forage

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Abstract

The study was carried out at the Pasture Experimental Unit of the Livestock Teaching and Research Farm of the Department of Animal Science, University of Maiduguri to investigate the effect of sowing methods and cutting age on growth components, forage yields and chemical composition of White Mucuna (Mucuna pruriens). The treatment was laid down in a split-plot design with sowing method (dibbling, drilling and broadcasting) as the main plot and cutting age (4, 6, 8 and 10 weeks after sowing) as the sub-plot. There was significant (P<0.05) difference across sowing method on plant height, leaf number, leaf length, leaf width and number of branches of White mucuna. In this study, it was observed that at the early stage of growth there was no significance (P<0.05) difference on growth components at all the sowing method but from 6WAS to 10WAS there was significant (P<0.05) difference among sowing methods on plant height and number of branches where dibbling recorded highest plant height and number of branches at 10WAS over drilling and broadcasting. Taller (P<0.05) plant height, more number of leaf and more number of branches were recorded at 10WAS by dibbling while shorter (P<0.05) plant height, and less number of leaf were recorded by broadcasting method of sowing. There was significant (P<0.05) effect of cutting age on plant height, leaf length, number of leaf and number of branches with increasing number of days. The result obtained from chemical composition has dry matter (90.80%), organic matter (84.91%), ether extract (0.97%) and nitrogen free extract (52.43%) has the highest value at drilling method. the crude protein (17.72%), crude fibre (15.09%), neutral detergent fibre (16.77%) and acid detergent fibre (15.02%) showed the highest value at dibbling method, also, ash content (5.95%) and hemicellulose (1.75%) were obtained highest at broadcasting method. However, the cutting age significantly (p< 0.05) affected the chemical composition of white Mucuna forage at 6, 8, and 10 weeks after sowing. The result for dry matter (91.06%), *OM (85.94%) and nitrogen free extract (55.17%) were recorded highest at 8 weeks. The AC (5.97%), EE (1.05%), CF (14.86%), NDF (15.86%), ADF (15.78%) and hemicellulose (1.84%) were higher at 10 weeks after harvest. Similarly, crude protein (14.86%) had higher value at 6 weeks after harvest, respectively. Similarly, the result of this experiment shows that both fresh forage yield ranged from (4000 to 14000 kg/ha) and dry forage yield ranged from (968 to 3505 kg/ha) of white Mucuna. It was concluded that dibbling method of sowing and cutting age of 10 weeks after sowing gave better growth components, forage yields and optimum nutrient composition for White Mucuna that can meet the nutrients requirements of ruminants' animals.*

Keywords: *White Mucuna, Dibbling, Drilling and Broadcasting*

Description of problem

The attainment of sustainable livestock production largely depends on the availability of sufficient quality feed. Due to seasonal fluctuations in Nigeria, scarcity of forage is the major factor limiting the productivity of ruminants as they experience the stop and grow (staircase) growth and even death thus resulting in a great economic loss to the farmer. (1) reported that various efforts are being made by researchers in mitigating these adverse effects by integrating feeding of forage legumes into their feeding scheme.

White Mucuna holds significant importance as a forage crop for ruminants due to its high protein content, palatability, and potential nitrogen-fixing ability. According to (2), White Mucuna provides valuable protein to the ruminants, which is essential for their growth, milk production and reproduction. Furthermore, the ability of white Mucuna to fix atmospheric nitrogen through its symbiotic relationship with rhizobia bacteria enhances soil fertility and reduces the need of nitrogenous fertilizers in livestock farming systems (3). *Mucuna* has been compared to *Gliricidia sepium* (a recommended legume for supplementation of grass-base diet) in dairy livestock feeding (4).

The growth of white mucuna (*Mucuna pruriens,* or *velvet bean*) in semi-arid zone of Nigeria is influenced by various factors such as adequate soil moisture, limited water availability, variation in rainfall patterns and the ability of the soil to retain moisture (5). High temperature can also increase the stress of the plant, affecting its growth components (6). Therefore this study was designed to investigate the effects of sowing method on growth components, yield and chemical composition of White Mucuna forage.

Materials and Methods

Experimental Site

The experiment was carried out at the Pasture Experimental Field of the Livestock Teaching and Research Farm of the Department of Animal Science, Faculty of Agriculture, University of Maiduguri, Borno state during 2023 raining season (July - September). Maiduguri is situated at latitude 11^0 5' North, longitude 30^0 0' East and an altitude of 354m above sea level (7). Maiduguri falls within the Sehelian Region (Semi-Arid Zone) of West Africa which is characterized by short duration of rainfall varying from 2-4 months (June-September). The rainfall varies from 300-500mm per annum and the ambient temperature rises from 25^0 C-28^0 C in December to January and higher in April and May which range from 39^0 C-40^0 C (8, 9).

Experimental Layout and Design

The experiment was laid in a Split-Plot Designwith methods of sowing(dibbling, drilling and broadcasting) as the main plot and cutting age (4, 6, 8 and 10 weeks after sowing (WAS) as the sub-plot which was replicated three times.

Source of Mucuna Seed and Land preparation

White Mucuna seeds were obtained from the Pasture Experimental Unit of the Livestock Teaching and Research Farm of the Department of Animal Science, University of Maiduguri. The soil type is sandy loam, the soil were generally well-drained and appeared to be fairly homogenous. The soil is attributed to reduction in organic matter content and moisture holding capacity. The land was cleared with hoe to provide a clean seedbed and to enhance early seed germination. Land preparation techniques, including ploughing, harrowing, and leveling was adopted for this experiment.

Sowing Methods and Depth: Sowing methods include dibbling, drilling and broadcasting. Dibbling is the process of placing seeds in holes made in the seedbed and closing the seed with soil using a *dibbler*. Drilling consists of dropping the seeds in furrow lines in a continuous stream and covering them with soil. The spacing between the seeds is not uniform. Broadcasting is the method of random scattering of seeds on the surface of seedbed. For dibbling and drilling, 50cm inter-row spacing was used. The seeds were sown at the depth of 3cm.

Germination Percentage: Germination percentage was estimated to know the viability of seeds planted using the formula by (10):

$$GP = \frac{\text{Seed germinated x 100}}{\text{Total number of seed planted}}$$

Weeding: Weeding of the experimental plots was carried out at two weeks interval using hoe.

Fertilizer application: Manure (cow dung) fertilizer was sourced from the Livestock Teaching and Research Farm, University of Maiduguri, and applied at 100kg/ha to the soil to improve the fertility of the soil and to enhance the growth of the plant.

Harvesting: The plant was harvested or cut at the interval of 2, 4, 6, 8, and 10 weeks after sowing.

Data Collection on Plant Growth Parameters

Data on growth components was measured at 2, 4, 6, 8 and 10 weeks after sowing (WAS) on primary growth. Three plants were randomly sampled per plot and tagged for measurements of agronomic parameters using the standard procedure as reported by (10).

Fresh Forage yield: This was determined directly by harvesting the fresh forage within each plot. The total fresh forage of samples was weighed and shade dried at room temperature for 48 hours and reweighed to estimate dry matter yield. The samples were collected by cutting directly, the forage at 4 weeks after sowing within each plot at 2cm above the ground using hand sickle. The total fresh forage samples were dried at room temperature for 48 hours and weighed to estimate dry matter yield (10).

Chemical Analysis

Forage samples were collected and analyzed for proximate according to (11) while neutral detergent fibre (NDF), acid detergent fibre (ADF) and hemicellulose were determined by the method (12) in the Biochemical Laboratory of the Department of Animal Science, University of Maiduguri.

Statistical Analysis

All data generated were subjected to Analysis of Variance (ANOVA) using (13). Significant differences between treatments means were separated using Duncan Multiple Range Test (DMRT), (14).

Results and Discussion

Effect of Sowing Methods on Growth Components of White *Mucuna*

The effect of sowing method on growth components of *White mucuna* was presented in Table1. There was significant ($P<0.05$) difference on plant height and number of branches of *WhiteMucuna*. Dibbling method recorded the highest plant height (85.53 cm) while broadcasting recorded the least (68.91 cm) so also the branch number 3.75 and 1.69 in dibbling and broadcasting, respectively, result from this study concurred with (15) who suggested that dibbling method of sowing helps reduced weed competition which improve management of weed growth by creating more space for crop growth. The lower growth components recorded in this study by broadcasting method might be attributed to the fact that lack of seed-soil contact; since the seeds were scattered on the soil surface, they may not have consistent depth or contact with the soil, leading to uneven germination and plant growth as stated by (15).

There was a significant ($P<0.05$) difference across the sowing methods on number of leaf, leaf length and leaf width of *White Mucuna* also presented in Table 1. Number of leaf was more ($P<0.05$) in dibbling (67.45) followed by (48.09) in drilling while broadcasting recorded the least (27.87).Longer ($P<0.05$) leaf length (10.07 cm) was recorded at dibbling while the shorter leaf length (7.21 cm) was recorded at broadcasting method of sowing. Longer ($P<0.05$) leaf width (6.52 cm) was recorded in drilling while shorter leaf width was recorded (4.87 cm) in broadcasting. This shows that sowing methods have significant ($P<0.05$) effect on growth components of *White Mucuna* at 10WAS, where dibbling appeared to have longer leaf length, leaf width and number of leaf over drilling which have moderate and broadcasting have least leaf length, leaf width and number of leaf.

These findings is slightly in line with (16) who assessed plant height, leaf length, leaf number, and leaf width and branch number at different stage of growth and reported that at 70-75 days after sowing, the plant exhibited maximum leaf length, leaf number, leaf width. However, at 100-105 days resulted in longer and wider leaves.

Effect of Cutting Age on Growth Components and Forage Yield of White Mucuna (*Mucuna pruriens*)

There was significant ($P<0.05$) effect of cutting age on plant height and branch number of White Mucuna as presented in Table 2.Taller plant height (128.56 cm) was recorded at 10WAS while shorter plant height (10.04 cm) was observed at 4WAS. More branch number (5.52) was recorded at 10 WAS followed by 8WAS (3.25) while few number of branches (1.52) was recorded at 6WAS. This is in line with the findings of (17) who reported that younger plants cut at 55-60 days after sowing, had the highest plant height and number of branch. However, cutting the plant at a more advanced stage, around 85-90 days (10-12 weeks after sowing) resulted in younger and wider branches. This study agrees with (18) who examined the effect of cutting age on growth components of *White Mucuna* and reported that cutting the plant at an early stage around 40-45 days (7-8WAS) resulted in shorter plants with fewer branches. However, cutting the plant at a later stage, around 80-85 days (10-12WAS) led to increased plant height and more number of branches.

Results obtained from this study showed significant ($P<0.05$) effect with higher leaf number (115.88) at 10 WAS, (42.93) 8 WAS while (11.07) 4 WAS recorded the least (Table 2). This shows that number of leaves increased with increasing plant height. Leaf length also showed significant increase across the number of days with increasing plant height(11.04 cm) recorded at 10 WAS, (8.25 cm) at 8 WAS, (6.64 cm) 6WAS while shorter leaf length was recorded at 4WAS, respectively. Similar trend was observed for leaf width in which higher ($P<0.05$) leaf width (7.04 cm) at 10WAS which was at par with that of 8WAS (6.78 cm) while the lower leaf width (4.73cm) at 4WAS recorded the least. These findings were in line with Shankar *et al.* (16) who investigated the impact of forage cutting on the growth parameters of *White Mucuna* cut at 70-75 days after sowing. However, cutting the plant at 100-105 days resulted in longer and wider leaves, leaf length, and leaf width and plant height. Similarly, another study conducted by Singh *et al.*(19) reported that cutting the plant at an earlier stage promotes greater plant height and leaf number, while cutting at more advanced stage enhances leaf length and leaf width. The optimum cutting age may vary depending on specific objectives, such as maximizing biomass production or nutrient content (20).

Result for the fresh and dry forage of *White Mucuna* was as well presented in Table 2. This study indicated that there were no significant ($P>0.05$) difference among the treatments. However, highest value was obtained (14,000 kg/ha) at dibbling for fresh forage yield with values (3,505 kg/ha) dry forage yield, respectively. Drilling recorded lower value (12,000 kg/ha) fresh forage yield, and dry forage yield (2,752 kg/ha) and the least forage yield at broadcasting (4,000 kg/ha) for fresh forage yield with (969) dry forage yield, respectively. The values of fresh and dry forage yields obtained in this study are higher than the values recorded by (21), who reported that the average forage yield of Mucuna in Nigeria was observed to be (1.5-2.0tons/ha) that is between (1500-2000kg/ha). Higher values recorded for dibbling agreed with (22) who report that dibbling is associated with potentially higher fresh forage yield compared to others methods. The lower yields obtained at broadcasting (4,000 kg/ha) fresh and (969 kg/ha) for dry forage yields disagreed with what was reported by (22) who reported that drilling has been associated with potentially lower fresh forage yield compared to dibbling and broadcasting, primarily due to reduced seed-to-soil contact and increased competition among plot. The result from this study agrees with (22) who reported that drilling yield gives comparable or slightly higher fresh forage compared to broadcasting.

Table 1: Effects of sowing methods on growth components of White Mucuna

Sowing Methods	Plant Height (cm)	Branch No.	Leaf No.	Leaf Length (cm)	Leaf Width (cm)
Dibbling	85.53^a	3.75^a	67.45^a	10.7^a	6.52^a
Drilling	68.91^a	2.78^b	48.09^b	7.92^b	5.84^a
Broadcasting	40.46^b	1.69^c	27.87^c	7.21^b	4.87^b
SEM	10.87^*	0.41^*	9.15^*	1.06*	0.49^*

^{abc}=Means with different superscript within rows differed significantly (P<0.05), SEM = Standard error of mean

Table 2: Effects of cutting age on growth components and forage yields of White Mucuna

Cutting Age	Plant Height (cm)	Branch No.	Leaf No.	Leaf length (cm)	Leaf width (cm)	Fresh forage (kg/ha)	Dry forage (kg/ha)
Week 4	10.04^d	0.00^d	11.07^c	6.64^c	4.73^b	14,000	3,505
Week 6	43.11^c	1.52^c	21.33^c	7.67^{bc}	5.43^b	12,000	2,752
Week 8	78.16^b	3.25^b	42.93^b	8.25^b	6.78^a	4,000	969
Week 10	128.56^a	5.52^a	115.88^a	11.04^a	7.04^a	$2,063.80^{NS}$	512.737^{NS}
SEM	8.15^*	0.30^*	6.86^*	0.80*	0.37^*		

^{abc}=Means with different superscript within rows differed significantly (P<0.05), SEM = Standard error of mean

Chemical Composition of White Mucuna Forage as Influence by Sowing Method and Cutting Age

The result of chemical composition of *White Mucuna* forage were significantly (P<0.05) affected by sowing method and cutting age. The result obtained for dry matter content in this experiment showed that there was significant (P<0.05) difference among the treatments. The result for crude protein in this study shows that there was a significant (P<0.05) difference between the treatments. The highest value was recorded at Dibbling (17.72%). The high protein content coupled with moderate fibre levels makes Mucuna forage suitable for ruminants' diets, supporting their growth and production .The crude fibre (CF) content in this study showed significant (P <0.05) difference among the treatments. The highest result was recorded at dibbling (15.09%). This result is higher than the study conducted by (23, 24, 25) who reported low CF (2.80 – 4.90 %). Similarly, the dietary fibre range from 6.70 – 19.50% as reported by (26, 27) .The result of organic matter showed significant (P< 0.05) difference among the treatments. The highest value was obtained in drilling (84.91%). The ether extract (EE) was significantly (P< 0.05) different among the treatments. The highest value was obtained at drilling (1.02%). The result of ash content showed significant (P<0.05) difference between the treatments. The highest value was obtained at broadcasting (5.95%) . Ash content range from 2.90 – 5.50% in a study conducted by (23) and also slightly lower than the values 3.50 – 4.90%as reported by (30).The nitrogen free extract significantly (P<0.05) differs between treatments. The highest value was recorded at drilling (52.43%). The result is lower than the experiment conducted by (28) who reported 59.20 – 64.88% range. The NFE content is slightly lower in this experiment compared with 53.73% by (1). This implies that White Mucuna forage can adequately meet the nutrients requirements of ruminants' animals.

The neutral detergent fibre showed significant (P<0.05) different among the treatment. This result recorded highest at dibbling (16.77%). This result is lower than the research conducted by (19) who revealed that Mucuna forage has (26.90%) NDF. Similarly, the result for acid detergent fibre shows significant (P<0.05) difference between the treatments. The result obtained highest at dibbling (15.02%) in this study. However, this result is slightly lower compared to (17.10%) obtained by (30). Similarly, research conducted by (29) reported that white Mucuna had NDF ranging from 30% to 40% and ADF 20% to 30% making it valuable source of protein for ruminant. Similarly, this result is in line with the NDF and ADF ranged between 10.30 – 29.90% and 9.30 – 20.40% reported by (31), respectively. The result of hemicellulose in this study showed that there was significant (P<0.05) difference between the treatment means. The highest result value was recorded in broadcasting (1.75%). This result is within the range reported by (28) 1.51 to 3.90% range.

However, cutting age showed significant (P<0.05) effect on the chemical composition of *White Mucuna* forage at 6,8 and 10 ,weeks after sowing. Dry matter content was recorded highest at 8 weeks (91.06%). The crude protein recorded highest value at 6 weeks (16.89%); the crude fibre was higher at 10 weeks (14.86%). The organic matter was recorded highest at 8 weeks (85.94%). Similarly, the ether extract obtained highest value at 10 weeks (1.05%) and the ash content recorded higher value at 6 weeks (6.57%). However, the nitrogen free extract recorded highest at 8 weeks (55.17%) whereas the neutral detergent fibre and acid detergent fibre obtained highest at 10 weeks (15.86%) and (15.78%), and also the hemicellulose recorded highest value at 6 weeks (1.72%) after sowing , respectively. The optimum cutting age may vary

Table 3 : Chemical composition of White Mucuna forage as influence by sowing method and cutting age

Treatment	DM	CP	CF	OM	EE	Ash	NFE	NDF	ADF	HEM
Sowing Methods										
Dibbling	89.83^{c}	17.72^{a}	15.09^{a}	84.02^{c}	1.02^{a}	5.81^{c}	51.20^{c}	16.77^{a}	15.02^{a}	1.75^{a}
Drilling	90.8^{a}	17.48^{c}	14.99^{c}	84.91^{a}	0.97^{c}	5.89^{b}	52.43^{a}	16.66^{c}	14.92^{c}	1.74^{c}
Broadcasting	90.74^{b}	17.59^{b}	15.04^{b}	84.78^{b}	0.97^{b}	5.95^{a}	52.16^{b}	16.71^{b}	14.96^{b}	1.75^{b}
SEM	0.01*	0.01*	0.05*	0.01*	0.01*	0.02*	0.03*	0.02*	0.01*	0.01*
Cutting Age (WAS)										
6	90.77^{b}	16.89^{b}	14.76^{b}	84.20^{b}	0.97^{b}	6.57^{a}	52.55^{b}	14.76^{b}	14.68^{b}	1.72^{b}
8	91.06^{a}	16.25^{c}	14.51^{c}	85.94^{a}	0.94^{c}	5.11^{c}	55.17^{a}	14.51^{c}	14.44^{c}	1.68^{c}
10	89.55^{c}	16.65^{a}	14.86^{a}	83.57^{c}	1.05^{a}	5.97^{b}	48.06^{c}	15.86^{a}	15.78^{a}	1.84^{a}
SEM	0.01*	0.01*	0.05*	0.01*	0.01*	0.02*	0.03*	0.02*	0.01*	0.01*
Interactions										
S x W	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

Mean within the same column with different superscripts not follow the same letter differ at (P< 0.05), *= significance difference (P< 0.05). SEM= standard error of mean, DM= dry matter, MC= moisture content, OM= organic matter, EE= ether extract, CP= crude protein, CF= crude fibre, NDF= neutral detergent fibre, ADF= acid detergent fibre, NFE=nitrogen free extract, HEM= hemicellulose.

depending on specific objective which could be to maximize biomass production or nutrient content as reported by (20). It can be deduced that White Mucuna contains nutrients that could meet the nutrient requirements of ruminants.

Conclusion

It was concluded that dibbling method of sowing and cutting age of 10 weeks after sowing gave better growth components, forage yields and optimum nutrient composition for White Mucuna that can meet the nutrients requirements of ruminants' animals.

Recommendation

It is recommended that dibbling sowing method should be adopted by farmers when planting White Mucuna and should be harvested at 10 weeks after sowing for feeding ruminants and other Animals with high quality forage.

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