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Effects of Spacing, Cutting Height and Cutting Interval on Fodder Yield and Nutritional Value of *Cajanus Cajan*

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***Abstract*—** *Forage production is one of the ways of sustaining ruminant animal production in Nigeria as these animals depend largely on plant-based feed. Hence, Cajanus cajan pasture was established to evaluate the effects of planting space, cutting height and interval at harvest on fodder yield and nutritional value of C. cajan. Pre-planting operations (bush clearing, ploughing, harrowing and ridging) were carried out on a hectare of land, sectionalized into fifteen equal portions. 2 - 3 seeds of C. cajan were planted using five different planting spaces (40x60 cm, 60x60 cm, 80x30 cm, 100x30 cm and 120x30 cm) of three replicates per treatment. Post-planting operations (thinning, supplying and weeding) were done to ensure uniform plant stands, nursed to maturity and harvested at different cutting heights (50, 100 and 150 cm) with cutting intervals from 2, 3 and 4 weeks respectively for five consecutive times to calculate the initial, total and average yield per plot. Air-dried samples of harvested forages were analysed for proximate composition; and data generated were subjected to statistical analysis. Results showed that; C. cajan sown using 40x60 cm planting space, cutting height of 50 cm and cutting interval of 4 weeks had the best fodder yield both at the initial (8.95 kg) and cumulative (3.60 kg) compared to other treatments. Crude protein, crude fibre and nitrogen free extract contents were significantly ($p>0.05$) influenced; and could adequately support the growth of ruminant animals. Thus, it can be concluded that C. cajan could be established using 40x60 cm planting space, harvested at 4 weeks interval and cutting at 50 cm height for maximum fodder yield with the aim of feeding ruminant animals.*

***Keywords*— Cajanus cajan, cutting height, plant spacing, cutting interval, fodder yield.**

I. INTRODUCTION

Cajanus cajan (pigeon pea) is a perennial member of family Fabaceae and is one of the most common legumes of the tropics and sub-tropics with a wide adaptability to poor soil conditions than most tropical legumes and drought tolerant (Akinola and Oyejola, 1994; Speranza *et al*., 2007, Crop Trust, 2014). *Cajanus cajan* is a glandular-pubescent, short-lived perennial (1-5 years) shrub, usually grown as an annual plant, 0.5-4 m high, with roots up to 15 - 20cm deep; stems up to 15 cm in diameter; branches are many and slender. It is emerging as common domestic forage plants as they are raised in traditional home gardens in many parts of Nigeria. Pigeon peas are evergreen and could be used as a potential source of forage for ruminant animals year round. Pigeon pea is a multi-purpose nitrogen fixing plant that provides food, fuel wood, fodder and shelter material to subsistence farmers. The seeds can be used as animal feed and post-harvest products such as haulms, leaf and young stems have good fodder value. Pigeon pea has a prolonged cooking time and low food value for human when compared to cowpea (Amaefule and Obioha, 2001). Amaefule and Onwudike (2000) reported that pigeon pea is rich in nitrogen (21-30% CP), thus qualifies it as a suitable protein source of ruminant animal feed. These attributes have elicited interest among Animal Nutritionist on the need to explore and exploit further use of the plant/crop as an alternative source of plant protein for ruminants (Ahamefule *et al*., 2006). Seeds are sown where desired, in pure stands at about 9–22 kg/ha for rows, but sometimes it is broadcast. Seed germinates in about 2 weeks. Quite frequently (in India) pigeon pea is grown mixed with other crops are grown in alternate rows with rows of sorghum, groundnuts, sesame, cotton, pineapples, millets or maize. For pure crops pigeon pea should be sown 2.5–5 cm deep in rows 40–120 cm by 30–60 cm. When sown as a mixture, it should be sown in widely spaced rows ranging

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from 1.2–2.1 m depending on the associated crop. About 3–4 seeds may be planted in each hill, and later thinned to 2 plants per hill. Plants show little response to fertilizers, e.g., mixed plantings with millet in India showed negative responses to N. For the first month, pigeon pea shares the inter-cultivation of the main crop. In the tropics, 20–100 kg/ha phosphoric acid is recommended. S, with or without P, can significantly increase seed yield and nitrogen fixation. Early CVs start podding in 12 weeks, but maturation requires 5–6 months. Late CVs require 9–12 mos. The crop may be ratooned for forage or let persist for 3–5 years. Seed yields drop considerably after the first year, and disease build-up may reduce stand. *Cajanus cajan* is a short-lived perennial leguminous shrub that usually grows to a height of about 1-2 m, but can reach up to 2-5 m high. The stems are woody at the base, angular and branching. The leaves are alternate and trifoliate while the leaflets are oblong and lanceolate. Leaves and stems are pubescent. The flowers are papilionaceous and generally yellow in colour. They can also be striated with purple streaks. The fruit is a flat, straight and pubescent pod, 5-9 cm long x 12-13 mm wide. It contains 2-9 seeds that are brown, red or black in colour, small and sometimes hard-coated (FAO, 2016a; Bekele-Tessema, 2007). According to FAO, 2016b, World production of *C. cajan* was 4.85 million tonnes in 2014. The main producers were India (3.29 million tonnes, 65% of world production), Myanmar (0.57 million tonnes), Malawi (0.3 million tonnes), Kenya (0.28 million tonnes) and Tanzania (0.25 million tonnes). Forage yield ranges from 20-40 t DM/ha. Levels as high as 24 tonnes DM/ha of fodder and stalks have been reported from the Sahel, and it has been suggested that there should be further study on the use of pigeon pea as a forage plant in this area (FAO, 2016a). Up to 40 tonnes DM/ha could be expected under optimal conditions (ILRI, 2013). Pigeon pea is used as a contour hedge in erosion control (Bekele-Tessema, 2007). An N-fixing legume, it does not need inoculation before sowing. It was reported to fix 40-97 kg N/ha/year in Africa and up to 235 kg N/ha/year in Florida, 88% being used for pods and seed formation. Pigeon pea cultivation could provide 40-60 kg N/ha to the following crop (Valenzuela, 2011). The extensive root system of *Cajanus cajan* improves soil structure by breaking plow pans, and enhancing water holding capacity of the soil (Crop Trust, 2014; Mallikarjuna *et al*., 2011). Its deep taproot is able to extract nutrients (e.g. P) from the lower layers of the soil and deposit them in upper layers where they can benefit other crops (Valenzuela, 2011). The leaves and immature stems can be cut and used as a green manure (OAF, 2015). Fallen leaves act as a mulch and are estimated to return about 40 kg N/ha to the soil. They also return organic matter, which helps in preventing erosion due to heavy rains, and reduces soil temperature (Ecocrop, 2016). Thus, the crux of this study is to evaluate the appropriate planting space, cutting interval and height of *C. cajan* for maximum fodder yield.

II. MATERIALS AND METHODS

The study was carried out at the Crop section of the Teaching and Research Farm and laboratory analyses were carried out at the Animal Production and Health Nutrition Laboratory of the Federal University of Technology, Akure (Latitude 70 18" and Longitude 50 10" E) (Aro *et al*., 2008) between March – July, 2016. A hectare of land was acquired to establish *Cajanus cajan* pasture. The seeds were gotten from the Ministry of Agriculture, Ado-Ekiti, Ekiti state; the land was ploughed and harrowed, two to three seeds of pigeon pea were planted per hole using planting spaces of 40x60 cm, 60x60 cm, 80x30 cm, 100x30 cm and 120x30 cm. After germination, thinning and supplying were done to ensure uniform plant stand per hole; and were managed for 3-4 months prior to the flowering stage. The commencement of harvest was done using different cutting heights (50, 100 and 150 cm) and cutting intervals (2, 3 and 4 weeks) on the allotted plots for five consecutive times. The forages were weighed per plot. Sub-samples of air-dried harvested forage were bulked and taken to the Nutrition Laboratory for proximate analysis (moisture content, dry matter, crude protein, crude fibre, ash and nitrogen free extract) according to the procedures of A.O.A.C. (2002). The experimental design was 3x3 factorial arrangements in a completely randomized design and data generated were subjected to statistical analysis using SAS (2008) and the means were compared using Duncan Multiple Range Test of the same package.

III. RESULTS AND DISCUSSION

The fodder yield of *Cajanus cajan* was significantly ($p>0.05$) influenced by the planting space, cutting height and cutting interval. The initial yield ranged from 0.34 kg (120x30 cm planting space, 150 cm cutting height and 2 weeks cutting interval) to 8.95 kg (40x60 cm planting space, 50 cm cutting height and 4 weeks cutting interval). It was observed that the longer the period /interval of cutting and at a shorter cutting height, the more the biomass yield (Table 1). Hence, the same was the trend across the planting space. Though, higher yield was recorded at 40 x 60 cm planting space plot, especially at 50 cm cutting height. However, the regeneration ability of the plant is very high and could persist and rejuvenate easily if left for four (4) weeks before harvesting

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(ICRAF, 1992; Akinola and Oyejola, 1994). Yield attributes per plant were significantly lower with narrow spacing (because of the competition between plants) when compared to the yield attributes per plant recorded with wider spacing. These results were in accordance with the findings of Telgate *et al*. (2004). Pavan *et al*. (2009) and Mula *et al*. (2011). The least fodder yields (total and average yield) irrespective of cutting intervals were obtained on experimental plots of 120x30 cm planting space and cutting height of 150 cm. The initial cutting (8.95 kg), total yield (3.60 kg) and average yield (0.78 kg) per experimental plot of *C. cajan* at 40 x60 cm planting space, 50 cm cutting height and at 4 weeks interval had the highest yield compared to other experimental plots.

Table.1: Biomass yield (kg) of Cajanus cajan sown and harvested at different intervals and heights

		2 weeks cutting interval			**3weeks cutting interval**			**4weeks cutting interval**		
Planting space(cm)	Cutting height(cm)	Initial yield	Total yield	Average Yield	Initial yield	Total yield	Average yield	Initial yield	Total yield	Average Yield
	50	8.47^{a}	1.46^{a}	0.30^{a}	8.85^{a}	2.40^{a}	0.47^{a}	8.95^{a}	3.60^{a}	0.78^{a}
	100	4.48^{e}	1.02^{c}	0.21^{bc}	4.81^{f}	1.63^{c}	0.34^{c}	4.85^{h}	2.55^{b}	0.48^{c}
40 x 60	150	1.83^{k}	0.61^{f}	0.12^{ef}	2.92^{k}	0.87^{g}	0.18^{g}	4.29^{j}	1.85^{f}	0.36^{f}
	50	6.24^{b}	1.15^{b}	0.23^{b}	6.34^{b}	1.88^{b}	0.38^{b}	6.69^{c}	2.53^{b}	0.52^{b}
	100	2.96^{i}	0.97^{d}	0.19^{c}	4.03^{i}	1.48^{d}	0.29^{ef}	4.88^{h}	2.35^{c}	0.49^{c}
60 x 60	150	2.29^{j}	0.87^{e}	0.16^{d}	0.99^{n}	0.89^{g}	0.18^{g}	3.35^{l}	1.53^{g}	0.33^{g}
	50	5.49^{c}	0.62^{f}	0.13^{e}	5.55^{d}	1.49^{d}	0.30^{e}	7.55^{b}	2.35^{c}	0.47^{d}
	100	5.20^{d}	0.64^{f}	0.14^{de}	5.24^{e}	0.80^{h}	0.16^{h}	6.74^{d}	2.14^{e}	0.44^{e}
80 x 30	150	2.16^{j}	0.58^{fg}	0.13^{e}	2.28^{l}	0.56^{k}	0.12^{j}	3.58^{k}	1.45^{h}	0.29^{h}
	50	3.83^{f}	0.64^{f}	0.13^{e}	5.69^{c}	1.45^{e}	0.29^{ef}	6.17^{e}	2.40^{c}	0.47^{d}
	100	3.66^{g}	0.49^{h}	0.10^{f}	4.23^{i}	0.67^{i}	0.14^{i}	5.98^{f}	2.25^{d}	0.45^{e}
100 x 30	150	1.14^{m}	0.41^{i}	0.08^{g}	1.15^{m}	0.50^{l}	0.10^{jk}	1.39^{m}	1.15^{i}	0.24^{i}
	50	3.43^{h}	0.55^{g}	0.10^{f}	4.53^{g}	1.36^{f}	0.28^{f}	5.25^{g}	2.30^{d}	0.45^{e}
	100	2.24^{j}	0.29^{j}	0.06^{h}	4.30^{h}	0.60^{j}	0.13^{ij}	4.55^{i}	1.87^{f}	0.36^{f}
120 x 30	150	0.34^{l}	0.27^{j}	0.05^{h}	0.55^{o}	0.38^{m}	0.08^{k}	0.84^{n}	0.85^{j}	0.16^{j}
	SEM	0.04	0.02	0.01	0.02	0.02	0.01	0.03	0.05	0.01

a,b,c…m = means within the same row with different superscripts are significantly ($p<0.05$) different

As shown in Table 2, cutting interval had a significant effect on the percentage content of all the components measured, with dry matter percent and crude fiber percent increasing as the cutting interval increased from week 2 to 4. By comparison, crude protein and ash all showed a decrease as the cutting interval increased. This report agreed to the assertion of Pipat *et al.* (2014) who investigated the effect of cutting interval and cutting height on yield and chemical composition of king napier grass (*Pennisetum purpureum x Pennisetum americanum*). Consequently from Table 2, the harvested forage could serve as a means of feeding ruminant animals either as hay, haylage or silage, as the nutritive value of the forage could meet the nutrient requirements by ruminant for growth and maintenance purpose. The disparity in the crude protein and fibre contents could be attributed to the age at cutting and the leaf to stem ratio of the forage. Hence, the forage is considerably lignified. However, ruminants can utilize them with the help of the fibrolytic enzymes which will attack the fibre during ruminal fermentation for effective degradation. Moreso, the variation in the nutrient compositions of the foliage at different cutting intervals could be attributed to the period of cut. Perhaps, it contributed to its high lignifications of the stem and hence, could inhibit digestion.

Table.2: Proximate composition of Cajanus cajan forage harvested at different stages and heights

	***C. cajan* forage (DM basis)**			
Parameters (%)	**2 weeks**	**3 weeks**	**4 weeks**	**SEM**
Dry matter (DM)	86.34	86.77	87.09	0.12
Crude protein	15.53[a]	15.01[b]	14.97[b]	0.05
Crude fibre	27.43[c]	28.88[b]	30.55[a]	0.06
Ether extract	1.80	1.78	1.80	0.01
Ash	4.03	4.01	3.97	0.01
Nitrogen free extract	37.55[a]	37.09[ab]	36.01[b]	0.03
*Gross energy (KJ/100gDM)	14.12	14.19	14.26	0.02

abc = means within the same row with different superscripts are significantly ($p<0.05$) different
*Calculated as described by Ekanayake *et al*. (1999).

IV. CONCLUSION AND APPLICATION(S)

Cajanus cajan pasture could be established to serve a multi-purpose – fixing atmospheric nitrogen into soil, drought tolerant, and could bridge the gap of malnutrition affecting ruminant animals. By extrapolation, if *C. cajan* pasture is fully established on an hectare of land using 40 x 60 cm planting space, more fodder yield would be obtained at 4 weeks cutting interval and 50 cm cutting height. Thus, encourage pasture establishment for improved ruminant production especially in Nigeria to curb the incidence of Fulani herdsmen imbroglio.

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