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Herbage Yield and Quality Response of Plant Components of Jack Bean (*Canavalia ensiformis*) to Planting Density

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ABSTRACT

Jack bean (Canavalia ensiformis) was field grown at population densities of 10.0, 13.3, 17.8, 20.0, 26.7 and 40.0 x 10^3 plants/ha and evaluated for herbage yield and quality 63 days after planting. Dry matter (DM) yield of all the plant components examined increased up to a density of 26.7 x 10^3 plants/ha and then declined. The leaf fraction and the total plant recorded maximum of 3698 and 5787 Kg DM/ha respectively. As population density increased, the leaf: stem ratio decreased from 2.7 to 2.0 to 1.6. The leaf blade, leaf stalk, stem (main stem and young branches) and developing inflorescences fraction registered averages of 24.5, 8.6, 7.8 and 17.8 % crude protein respectively. It could be concluded that Jack bean has the potential to serve as supplement to low quality ruminant feed sources.

Introduction

During the dry seasons in the tropics, forage production can be very low and often there may be none at all for a long period of time. The forages when available are usually grossly deficient in energy, proteins and minerals. This adversely affects the productivity of livestock, as they tend to lose most of the weight gained during the wet season. It has been established that forage legumes form an important part of the ruminant animal diets and the high yielding, improved species have an important role to play in meeting dry season livestock feeding requirements. Most forage legumes can withstand the effect of dry season.

The Jack bean (*Canavalia ensiformis*) a robust, high yielding, drought resistance annual herbaceous legume is better known for its contribution to human and monogastric nutrition. It produces high protein seeds and in marginal areas, gives satisfactory food yield level where other pulses fail and can provide a plentiful green manure and forage. The Jack bean can grow under extremely difficult environmental conditions, offering a means for extending protein production to marginal areas with unpredictable climate or varying soil types high altitude and pest infestations (NAS, 1979). Jack bean is a hardy, deep rooted drought resistance annual legume. It has been reported to grow where rainfall is as high as 4200mm and as low as 700mm. The deep root system helps to absorb stored soil moisture and to such dry conditions. Jack been is advocated as a promising legume for extending protein production in marginal areas for both human/animal consumption. However the potential of the Jack bean seed is limited by the growth inhibiting and anti-nutritional factors such as lectin, concanavalin A and B (Jayne-Willans 1973; NAS 1979), the endogenous urease and the non protein amino acids, canavanine and canalin (Rosenthal, 1982; NAS 1979). There is a dearth of information on the forage potential of Jack bean.

This study was conducted to assess the dry matter yield and quality responses of different plant components of the Jack bean to a wide range of plant spacing.

Materials and Methods

Site

The experiment was conducted at the Teaching and Research farm, Ladoke Akintola University of Technology, Ogbomoso in the Derived Savanna zone of Nigeria. Seed sowing was carried out late August

Experimental design and Field

A randomized complete block design with three replicates was used. Six planting spacing were compared and comprised: 100 x 100, 100 x 75, 75 x 75, 100x 50, 75 x 50, and 50 x50 CM^2. These gave population densities of 10. 0, 13.3, 17.8, 20.0, 26.7 and 40.0 x 10^3 plants/ha respectively. Each plot measured 6mx6m with a pathway of 2m between plot and replicates. The total experimental area was 1021 M^2 (46 M x 22 M).

The *C. ensiformis* seed investigated were obtained from the International Institute of Tropical Agriculture (IITA), Ibadan, Nigeria. Two seeds were sown per hole and thinned to one seedling per stand at four weeks old. Weeds were controlled on the plot manually. Four plants were selected randomly from each plot and cut with a sharp knife at the cotleonary (first) node. The samples were weighed fresh, sub sampled and separated into the green leaf blade, leaf stalk, stem components (main stem, primary branches) and inflorescences. A sub sample was oven dried at 80^0C to constant weight to determine the DM content and subsequently dry matter herbage yield.

The dried plant samples were ground in a laboratory mill (1mm mesh) and analysed for crude protein contents (6.25 x % N) employing the standard kjeldahl procedure (AOAC, 1995)

Statistical Analysis

Data obtained were subjected to analysis of variance (ANOVA) using randomized complete block design and mean separations where there were significant differences was by Duncan multiple range F-test using Statistical Analysis System (SAS, 1995) package

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Table 1. Dry matter yield (Kg/ ha) of plant fraction and leaf: stem ratio of Jack bean (*Canavalia ensiformis*) grown at six plant population densities.

Plant population Density No^3/ha	Leaf Blade	Leaf Stalk	Total leaf	Main stem	Primary branches	Total stem	Inflore-scence	Whole plant	Leaf : Stem ratio
10.0	1730.9^c	332.9^b	2063.8^c	550.5	217.9	771.7^c	190.6^c	3026.1^c	2.8
13.3	2048.4 ^{bc}	360.4^b	2408.8^{bc}	702.9	228.4	931.4^{bc}	228.4^{bc}	3568.6^{bc}	2.5
17.8	2355.1 ^{abc}	439.2^{ab}	2794.3^{bc}	845.0	259.3	1104.3^{bc}	284.5^{bc}	4183.1^{bc}	2.5
20.0	2668.7^{bc}	458.3^{ab}	3127.0^a	1026.4	324.6	1351.0^{ab}	296.0^{bc}	4774.0^a	2.3
26.7	3101.7^a	596.0^a	3697.7^a	1197.8	462.9	1660.7^a	428.3^a	5786.7^a	2.2
40.0	2335.9^{abc}	435.7^{ab}	2771.6^{ab}	1010.8	372.8	1383.6^{ab}	336.9^{ab}	4492.1^{ab}	2.0
SEM	277.5	56.85	260.6	102.8	53.2	151.1	38.9	386.5	0.3

^{abc} Means within the same column with different superscript, differ significantly (P< 0.05)

Results and discussion

The effect of plantings density on dry matter yield distribution among the plant fractions and on leaf: stem ratio of *C. ensiformis* is presented in table 1. The planting densities had a significant (P<0.05) effect on the herbage yield of Jack bean. The data showed that the density 26.7 x 10^3 plants/ha gave the higher yield irrespective of plant fractions. The herbage yield increase as the densities increased but decreased beyond 26.7 x 10^3 plants/ha.

The main stem contributed most of the stem yield and was followed by the main branches. Planting density had significant (p<0.05) effects on the yield of the main stem, primary branches and inflorescences.

The stem: leaf ratio declined significantly (p<0.05) as density increased the values varied from 2.0 at the lowest to 1.6 at the highest density.

The decline in yield beyond 26.7 x 103 plants/ha could probably be due to the fact that the growing season had advanced. Evidence from a nearby *C. ensiformis* sown in July showed that establishing the experiment earlier could have resulted in higher yield at lower densities. The yield of 5787kg DM/ha recorded at this optimum density compared favourably with the 16-20t green matter yield/ha reported by Purseglove (1974) but fell below the 18-23t dry matter/he observed by Takahashi and Ripperton (1949). This planting density helped to conserve seen used at sowing. The seed conserved can be used for other purpose such as livestock seed meal, seed production etc. Time of cutting was appropriate because the weather then was suitable for hay making.

The forage can be conserved in form of silage. In Brazil and Cuba, silage has been made successfully from Jack bean plant (Skerman *et. al.*, 1988).

The crude protein of the leaf blade, leaf stalk, inflorescence, stem and whole plant components decreased as planting density increased (Table 2). The leaf blade averaged 24.6%, the leaf stalk, 8.7%, inflorescence, 17.7 %, the stem components 7.8%and whole plant17.8% crude protein. The average protein content in the leaf fraction of lablab ranging from 21.4% to 30.3% on a dry matter basis (Karachi, 1997; Murphy *et al*., 1999) compares favourably with this result but higher than report by Evans (2002) for whole plant of Lablab (12.7-14.1%).

Crude protein content of the Forage from *C. ensiformis* was well above 7 %, which is the critical level required for ruminal function (ARC, 1980; Van Soest 1994). The CP values were also higher than the 10 % recommendation for growth/maintenance in dairy goats (Ranjah, 1981). The protein content was higher than the recommended CP level for ruminant growth of 11% for young domestic ruminants (Minson, 1983) and could also satisfy the minimum CP requirement of 15% for lactation and growth (Norton 1982; McDonald *et al* 2002). . Lactating ruminants that required 130 g/kg DM crude protein (Ott *et. al*., 2004) are guaranteed adequate level of the nutrient from this forage.

The favourable leaf: stem ratio and the crude protein level obtained would suggest the suitability of *C. ensiformis* for fattening cattle in feedlot operation or for mixing with elephant grass or cereal crops to improve silage nutritive value

Table 2. Crude protein content (%DM) of plant Fractions of Canavalia ensiformis grown at six planting densities.

Plant population Density No^3/ha	Leaf Blade	Leaf Stalk	Inflorescence	Stem	Whole plant
10.00	26.2	9.6^a	20.5^a	8.6^a	19.5
13.33	25.4	9.1^a	18.8^{ab}	8.23^{ab}	18.8
17.78	24.2	9.2^9	17.9^{ab}	8.0^{ab}	17.9
20.00	25.1	8.8^{ab}	18.0^{ab}	7.7^{ab}	18.2
26.67	22.8	7.9^{ab}	15.9^b	7.0^b	16.2
40.00	23.4	7.0^b	15.1^b	7.1^a	16.2
	N.S	Sig	Sig	Sig	
SEM	1.38	0.58	1.27	0.45	
Mean:	24.5	8.6	17.6	7.8	17.8

^{abc} Means within the same column with different superscript, differ significantly (P< 0.05)

Table 3. Crude protein yield (Kg CP/ ha) of plant Fractions of Canavalia ensiformis grown at six planting densities.

Plant population density No^3/ha	Leaf Blade	Leaf Stalk	Inflorescence	Stem	Whole plant
10.00	453.5^b	32.0^b	39.1^c	66.4^d	591
13.33	520.3^{ab}	32.8^b	42.9^{bc}	76.4^{cd}	672.8
17.78	569.9^{ab}	40.0^{ab}	50.9^{bc}	87.2^{bcd}	748.0
20.00	669.8^{ab}	40.3^{ab}	53.8^b	104.0^{ab}	867.9
26.69	707.1^a	47.1^a	68.1^a	116.2^a	938.5
40.00	546.6^{ab}	30.5^b	50.9^{bc}	98.2^{abc}	726.2
SEM	73.5	14.8	4.4	7.9	

^{abc}Means within the same column with different superscript, differ significantly (P< 0.05)

Conclusion

The population density of 26.7 $x10^3$ plants/ha is recommended for maximum yield of *C.ensiformis* sown when the growing season had advanced in the Derived savanna zone of South – Western Nigeria.

Its leaf yield of 3700Kg DM/ha and 22.8% (749Kg crude protein/ha) are adequate to supplement the dry season grazing of poor available crop residue and native grasses.

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