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FORAGE YIELD AND NUTRITIVE VALUE OF *ARACHIS PINTOI* AS INFLUENCED BY PHOSPHORUS FERTILIZER (SSP) RATES AND IRRIGATION REGIMES IN NORTHERN GUINEA SAVANNA OF NIGERIA

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Abstract

An experiment was conducted to evaluate the effects of SSP fertilizer rates and irrigation regimes on forage yield and nutritive quality of *Arachis pintoi* at different cutting ages in Shika, Zaria. The experimental design was a split-plot with 3 x 3 factorial arrangements with three replicates. There were three levels of SSP fertilizer rates (0, 30 and 60 kg/ha) and three irrigation regimes (l, 2 and 3 days). Results indicated that the highest ($P<0.05$) forage yields (3.49 vs 3.24 t/ha) were obtained at 12th week after sowing, using 30 kg/ha level of SSP fertilizer and 2 days' irrigation regime, respectively. Interactions between the factors were not significant ($P>0.05$). Nutritive quality (crude protein) of the forage decreased with increasing rates of SSP fertilizer and water stress. It was concluded that 30 kg/ha SSP fertilizer rate or irrigation regime of 2 days are important factors to be considered by farmers before establishing *Arachis pintoi* in northern Guinea Savannah of Nigeria.

Key words: Fertilizer, herbage, irrigation, nutritive value, yield

Introduction

Increasing demands for livestock products in Nigeria have greatly offered opportunities for farmers to intensify their production systems. However, there is an erratic supply of these products especially during the dry season due to poor quality feed resources and management (Roothaert *et al.*, 2005). In order to overcome these problems, several researchers are of the opinion that intensive forage management systems exploiting land, labour and water resources coupled with utilization of suitable forage species need to be developed for livestock holders in developing countries (Miranda *et al.*, 2003; Millar and Photakoun, 2008). One of such high quality leguminous fodders that can be exploited in Nigeria is *Arachis pintoi* which has the ability to produce forage of better nutritional quality and also improve of soil fertility (Omokanye, 2001; Miranda *et al.*, 2003). According to FAO (2007), *Arachis pintoi* is a productive and highly persistent palatable pasture legume with a high feeding value for subtropical climates that is tolerant to heavy grazing, shading and low soil fertility (Argel *et al.*, 1997). Irrespective of the season, farmers in Nigeria spend huge amount of money in purchasing concentrate feeds to supplement poor quality forages. This practice increases the cost of production per animal which has negative impact on the system. Fertilization and soil moisture level are two major limiting factors that affect growth, forage yield and quality of tropical legumes (Rao *et al.*, 1999; Huang *et al.*, 2004). Knowledge about forage production potential of *Arachis pintoi* under varying nitrogen (urea) fertilizer rates and irrigation frequencies has been reported elsewhere (Paris *et al.*, 2009; Rita *et al.*, 2013). However, information on forage yield and quality of *Arachis pintoi* under varying irrigation regimes and phosphorus application rates is lacking in Nigeria. The aim of this study was to investigate forage yield and quality of *Arachis pintoi* under flood irrigation and varying phosphorus application rates in northern Guinea Savanna of Nigeria.

Materials and Methods

The study was conducted at the National Animal Production Research Institute (NAPRI), Shika, Nigeria, located in the northern Guinea Savanna ecological zone (l0°11'N, 7°8'E; 650 m asl). The area receives an annual rainfall of 1100 mm, spread between April and October. The mean minimum (night) and maximum (day) temperatures during the study were 20°C and 34°C, respectively, with relative humidity ranging between 85% and 50%. Mean day length was 12 hours (IAR, 2016). Seeds of *Arachis pintoi* were obtained from the Feed and Nutrition Research Program in NAPRI Shika, Zaria. Soil samples (5) were taken for routine analysis using soil auger at 15 cm depth from four corners and the centre of the undisturbed field. A total land area of 75 m^2 was cleared of weeds, harrowed and ploughed. The net plot was subdivided into 27 plots of 1.5 m^2 each with 0.5 m pathways in-between. The experimental design was a split plot design with a 3 x 3 factorial arrangement replicated three times. There were 3 single super phosphate (SSP) fertilizer levels (0, 30 and 60 kg/ha) and 3 irrigation regimes (daily, 2 and 3 days). Plots were irrigated until the soil was saturated to field capacity. Two seeds were planted per hill on the 18th of February, 2016 at planting depth of 2 cm. Irrigation regime was imposed three weeks after germination. Weeds were controlled manually using hoes. Forage yield was estimated using 0.5 m^2 quadrat at 4, 6, 8, 10 and 12 weeks after sowing (WAS). Fresh forage yield was recorded in the field after weighing with a sensitive scale and sub-samples were oven dried for 48 hours at 65°C, until constant weight was attained. Dry matter production (Dry matter kg/ha) was calculated as: Total FW x (DWss/FWss) x 10 (Tarawali *et al.*, 1995), where Total FW = Total fresh weight from 1 m^2 in (g); DWss = Dry weight of the sub-sample in (g); FWss = Fresh weight of the sub-sample in (g). Oven dried forage samples were ground using a hammer mill and passed through 1-2 mm sieve for chemical analysis. Proximate analysis was done to determine nitrogen (N) for crude protein determination (N x 6.25), crude fibre (CF), ether extract (EE), and ash contents according to AOAC (2005). Nitrogen free extract (NFE) was calculated as = 100 - (%CP + %CF + %EE + %Ash). Data were analyzed using the General Linear Model Procedure (Proc. GLM) of SAS (2005). Significant ($P<0.05$) differences among treatment means were compared using the LSD.

Results and Discussion

The routine soil analysis result shows that the loamy-sand soil of the experimental site had 13% clay, 18% silt, 69% sand and 0.09% carbon. The pH (CaCl2) was 7.20, exchangeable Ca was 5.50 Cmol/kg, Na was 2.05 Cmol/kg and Mg was 1.60 Cmol/kg. The total N and available P were 0.09% and 25.25 ppm with cation exchange capacity of 8.98 Meq/100g. Table 1 shows the effect of SSP fertilizer rates and irrigation regimes on forage yield of *Arachis pintoi* at different stages of growth.

Table 1: Effect of SSP fertilizer rates and irrigation regimes on forage yield of *Arachis pintoi*

	Forage yield (t/ha) at different stages of growth (weeks)				
SSP Fertilizer rates (kg/ha)	4	6	8	10	12
0	0.78^b	2.08^b	2.60^a	2.77^a	2.61^b
30	2.92^a	2.67^a	2.78^a	2.45^b	3.49^a
60	2.21^a	2.75^a	2.50^b	2.59^b	2.98^b
SEM*	1.00	0.95	0.94	0.86	0.86
Irrigation Regimes (day)					
1	1.77^b	2.07^b	2.06^b	2.76^a	2.52^b
2	2.51^a	2.66^a	2.77^a	2.88^a	3.24^a
3	2.20^a	2.25^a	2.85^a	2.59^b	2.94^a
SEM*	1.00	0.95	0.94	0.86	0.86
F×I	NS	NS	NS	NS	NS

[ab]Means with different superscripts differed significantly (P<0.05), SEM=Standard Error of Means; F×I = Interactions between fertilizer rates and irrigation regimes.

Applying SSP fertilizer at 30 kg/ha had significantly (P<0.05) higher forage yield than 60 kg/ha rate, at 12 weeks. The implication of this result is that the tested legume has the ability to acquire and utilize inorganic soil P from the infertile soil of the Nigerian savanna. Rao *et al.* (1999) reported similar finding when *Arachis pintoi* CIAT 17434 was tested with *Brachiaria dictyoneura* CIAT 6133 under greenhouse condition. Generally, the forage yield obtained in this study was higher than the value of 1.14 kg/ha reported in white clover (Elgersma and Søegaard, 2018) but was lower than annual yield values of 5t DM/ha/yr in pure stand or 10t /ha/yr in mixtures (Cook, 1992). Irrigation regimes had significant (P<0.05) increasing trend on forage yield with the highest value recorded at 12 weeks in 2 days' irrigation regime. Although previous reports showed that *Arachis pintoi* is tolerant to dry spell condition (Cook, 1992; Rita, 2013), results in this study indicated that irrigation regimes promoted shoots growth which could be due to increased chlorophyll formation and sugar deposition in the shoot resulting from available soil moisture content (Yinghao *et al.*, 2018; Rita, 2013). Results of proximate composition of *Arachis pintoi* forage is presented in Table 2.

Table 2: Proximate composition (%) of *Arachis pintoi* forage as influenced by varying SSP fertilizer rates and irrigation regimes at 6 weeks after planting

SSP fertilizer rate (kg/ha)	DM	OM	CP	CF	Ether extract	Ash	NFE
0	37.55	82.54	17.64	38.34	1.80	17.46	46.36
30	39.05	77.58	16.96	14.86	1.95	22.42	43.81
60	33.57	77.57	16.71	12.80	1.75	22.43	46.31
Irrigation regimes (d)							
1	35.28	73.79	18.50	13.90	1.77	26.21	39.61
2	37.79	82.30	16.33	16.09	1.93	17.70	47.91
3	37.10	81.61	16.44	14.40	1.81	18.39	48.96

DM, dry matter; OM, organic matter; CP, crude protein; CF, crude fibre, EE, ether extract; NFE, nitrogen free extract

The low dry matter observed in this study might be related to the early sampling period of the forage since P fertilization has been reported to increase shoot and roots of *Arachis pintoi* (Rao *et al.*, 1999). Also it has been reported that dry matter production in white clover is higher in late than early stage of growth (Elgersma and Søegaard, 2018). The crude protein content of the forage decreased with increasing water availability and this can be explained by the fact that water availability in the soil affects N-fixation capacity of legumes (Yinghao *et al.*, 2018) and low N content in the soil has a strong positive effect on CP content of white clover forage (Elgersma and Søegaard, 2018). The high ash content observed in this study might be related to high calcium content of *Arachis pintoi* forage (Francisco *et al.*, 2017).

Conclusion and Recommendations

It can be concluded from this study that forage yield and nutritive quality of *Arachis pintoi* can be improved through the application of 30kg/ha of SSP fertilizer or 2 days irrigation regime for better economic gain. However, irrigation beyond 2 days could affect biomass yield and quality. Hence, 30 kg SSP/ha or 2 days irrigation are recommended for farmers in the study area for production of *Arachis pintoi* forage.

References

AOAC. (2005). *Official Method of Analysis*.International, Association of Official Analytical Chemists, 24th edition Washington D.C. USA.200-210.

Argel, P. J., Kerridge, P. C. and Pizarro, E. A. (1997). *Arachis pintoi:* a multipurpose legume for sustainable land use. Proceedings XVIII International Grassland Congress 1997 Winnepeg, Manitoba, Session 19: 83-84

Cook, B. G. (1992). *Arachis pintoi* Krap. and Greg., nom. nud . In: 't Mannetje, L. and Jones, R.M. (eds) Plant Resources of South-East Asia No. 4. *Forages*. pp. 48-50.

Elgersma, A. and Søegaard, K. (2018). Changes in nutritive value and herbage yield during extended growth intervals in grass–legume mixtures: effects of species, maturity at harvest, and relationships between productivity and components of feed quality. *Grass and Forage Science*, 73:78-93

FAO (2007, August 20). *Arachis pintoi*: Retrieved June 11, 2018 from FAO: Http://www.fao.org/aglAGP/doc/GBASE/Data/pfD00463.html.

Francisco, D.F., Allan, K.B.R., Marcelo, A. C., Giovana, A. M., Giselle, A. and Gustavo, J. B. (2017). Forage yield and nutritive value of Arachis spp genotypes in the Brazilian savanna. Tropical Grasslands-Forrajes Tropicales, 5(1):19

Huang, Y. B., Tang, L. F., Zheng, Z. D., Chen, E. and Ying, Z. Y. (2004). Utilization of *Arachis pintoi* in red soil region and its efficiency on water-soil conservation in China. 13th International Soil Conservation Organisation Conference - Brisbane, July 2004, Paper 950

IAR (2016). Institute for Agricultural Research Meteorological Station, Samaru, Zaria.

Millar, J.and Photakoun, V. (2008) Livestock development and poverty alleviation: revolution or evolution for upland livelihoods in Lao PDR?, *International Journal of Agricultural Sustainability*, 6:1, 89-102, DOI: 10.3763/ijas.2007.0335

Miranda, C.H.B., Vieira, A. and Cadisch, G. (2003). Determinação da fixação biológica de nitrogênio no amendoim forrageiro (*Arachis* spp.) por intermédio da abundância natural de ^{15}N. *Revista Brasileira de Zootecnia*, 32(6):1859-1865.

Omokanye, A.T (2011). Evaluation of forage legumes yield and Nutritive value. *Journal of Agricultural Science*. ISSN 1910-9752 (print). ISSN 9760 (online)

Paris, W., Cecato, U., Branco, A. F., Barbero, L.M. and Galbeiro, S. (2009). Beef heifer production in Coastcross-1 and *Arachis pintoi* mixed pasture with or without nitrogen fertilization. *Rev. Bras. Zootec.*, 38 (1): 122-129

Rao, L.M., Borrero, V., Ricaurte, J. and Garcia, R. (1999). Adaptive attributes of tropical forage species to acid soils. IV. Differences in shoot and root growth responses to inorganic and organic phosphorus sources. *J. Plant Nutr.*, 22 (7): 1153- 1174

Rita, M.P.S., Daniela, D. F., Aureliano, J. V.P., Paulo, B., Lasminy, S. S., Cleide, N. C. Paulo, H. R. B. and Mateus, S. B. (2013). Chlorophyll and carbohydrates in *Arachis pintoi* plants under influence of water regimes and N-fertilization. *Zootec.* 42(6): On-Line Version

Roothaert, Ralph L., Binh, L.H., Magboo, Ed., Yen, V.H., Sanguinhon, J. (2005). Participatory forage technology development in Southeast Asia [on line]. In: Yimegnuhal, A., Degefa, T. (eds.). Participatory innovation and research: Lessons for livestock development: Proceedings of the 12th annual conference of the Ethiopian Society of Animal Production (ESAP) held in Addis Ababa, Ethiopia, August 12-14, 2004, vol.1: Plenary session. Ethiopian Society of Animal Production (ESAP), Addis Ababa, ET. p. 21-30.

SAS, (2005). Statistical Analysis Software (CD-ROM), Version 8.1, SAS Institute Inc., Cary, N.C., USA.

Tarawali, S.A., Tarawali, G., Larbi, A and Hanson, J (1995). Methods of evaluation of legumes, grasses and fodder tress for use as livestock feed.*International Livestock Research Institute, Manual.* Nairobi, Kenya: 1-12.

Yinghao, L., Qian, W., Gentu, G., Guodong, H and Yushan, J. (2018). Influence of drought stress on Alfalfa yields and nutritional composition. *Plant Biology*, 18:13