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Effects of planting dates on the crude protein and nutrient uptake of two varieties of millet (*Pennisetum typhoides* (Burm. f.)) Stapf & Hubbard in a forest-savanna transition zone of Edo state.

Efectos de las fechas de siembra en la absorción de proteínas crudas y nutrientes de dos variedades de mijo (*Pennisetum typhoides* (Burm. f.)) Stapf & Hubbard en una zona de transición entre bosques y sabanas del estado de Edo.

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ABSTRACT

A field experiment was carried out to determine the effectof planting dates on the nutrient uptake of two varieties of millet in a forest-savanna transition zone of Edo State. The experiment was a 2 x 5 factorial scheme fitted into a randomized complete block design. The two varieties of pearl millet (Gero Bida and Gero Badeggi) and five sowing dates (April, May, June, July and August) constituted the treatments. The treatment combinations were replicated three times. Data were obtained on forage and dry matter yields. The mineral composition and nutrient uptake were determined. Data obtained were analyzed by the use of analysis of variance (ANOVA) and Duncan's Multiple Range Test was employed in the separation of means. The results obtained showed that the forage and dry matter yields, crude protein and nutrient uptake of pearl millet were significantly affected by sowing dates. Varieties significantly affected the forage and dry matter yields, crude protein and nutrient uptake. The highest and least forage and dry matter yields were obtained from Gero Badeggi sown in April/May. Millet sown in April to August had sufficient crude protein content when compared with the established critical levels. Gero Badeggi sown in April had the highest CP content (26.63%) while GeroBida sown in July had the least (21.31%). Early sown crops (April/May) had the higher uptake of both the macro-and micro-nutrients than other dates. Gero Badeggi had higher crude protein and uptake of the macro-and micro-nutrients than GeroBida. Gero Badeggi sown in April/May is recommended for feeding ruminants in the forest-savanna transition zone of Edo State.

Keywords: Crude protein; nutrient uptake; millet; planting dates; milk; meat; animal production

RESUMEN

Se llevó a cabo un experimento de campo para determinar el efecto de las fechas de siembra en la absorción de nutrientes de dos variedades de mijo en una zona de transición entre bosques y sabanas del estado de Edo. El experimento fue un esquema factorial de 2 x 5 ajustado en un diseño de bloques completos al azar. Las dos variedades de mijo perla (Gero Bida y Gero Badeggi) y cinco fechas de siembra (abril, mayo, junio, julio y agosto) constituyeron los tratamientos. Las combinaciones de tratamiento se repitieron tres veces. Se obtuvieron datos sobre rendimientos de forraje y materia seca. Se determinó la composición mineral y la absorción de nutrientes. Los datos obtenidos se analizaron mediante el uso de análisis de varianza (ANOVA) y la prueba de rango múltiple de Duncan se empleó en la separación de medias. Los resultados obtenidos mostraron que los rendimientos de forraje y materia seca, proteína cruda y absorción de nutrientes del mijo perla se vieron afectados significativamente por las fechas de siembra. Las variedades afectaron significativamente los rendimientos de forraje y materia seca, proteína cruda y absorción de nutrientes. Los mayores y menores rendimientos de forraje y materia seca se obtuvieron de Gero Badeggi sembrado en abril / mayo. El mijo sembrado de abril a agosto tuvo suficiente contenido de proteína bruta en comparación con los niveles críticos establecidos. Gero Badeggi sembrado en abril tuvo el mayor contenido de PB (26,63%) mientras que Gero Bida sembrado en julio tuvo el menor contenido (21,31%). Los cultivos de siembra temprana (abril / mayo) tuvieron la mayor absorción de macro y micronutrientes que otras fechas. Gero Badeggi tenía una mayor cantidad de proteína cruda y una mayor absorción de macro y micronutrientes que Gero Bida. Se recomienda la siembra de Gero Badeggi en abril / mayo para la alimentación de rumiantes en la zona de transición bosque-sabana del estado de Edo.

Palabras llave: Proteína cruda; absorción de nutrientes; mijo; fechas de siembra; Leche; carne; producción animal.

INTRODUCTION

Pearl millet (*Pennistum typhoides*) is an important cereal crop and rankedthird in the world after rice and wheat (Remison, 2005).The cereal crop is widely grown in the arid and semi-arid regions of the African and Asia, and can be grown in areas where rainfall is not sufficient (200-600mm) for the cultivation of maize and sorghum.

Millet has been noted to tolerate wide variety of soils. The crop has the potentials of producing fairly high grain and forage yield with low nutrients following good crop husbandry (Ahmad *et al.* (2011). The rapidincrease in livestock population and scarcity of quality feeds with each passing year has necessitated the inclusion of drought and heat resistant crops like millet in cropping patterns. As a matter of grave concern,millet continues to remain underutilized despite numerous benefits and importance (Gupta *et al*., 2012 and Omoregie *et al*., 2020).

Millet grains are used for human consumption, while the crop residues are good source of dry matter for livestock especially during lean periods. Major cereals can produce high amount of stem and leaf together with their saleable product, which is usually seed.The straw is usually over half the harvestable vegetation of the crop (Nwajei *et al*., 2018). Such coarse roughages cannot be consumed by humans, but they can be transformed into economic products by livestock (Gupta *et al*., 2012). The stover of pearl millet are often called 'by-product' of grain production even though it is increasingly important and as a result, plant breeders, agronomists, animal nutritionists and economists have to pay more attention than before to the total value of the whole cropplant value in which both stover and grain play a part (Parihar *et al*., 2010).

Planting of millet is important for the change of land use from grazing to cereal production and thushamper the availability of roughage for livestock, as the quantity of straws will be as great as or more than the natural herbage previously on offer when sown at the appropriate time. The ratio of stover to grain varies from one sowing date to another and according to yield level (very low grain yields have a higher proportion of straw - the proportion is infinite when a crop fails through drought due to planting time) but is usually, slightly, over half the harvestable biomass (Parihar *et al*., 2009).

Appropriate time of planting of pearl millet for straw yield and nutrient uptake has been known to make good fodder ofabout 61% total digestible nutrients (NRC, 1996). Millet therefore,sown at early April to May offers great opportunity in nutrient uptake for development of fodders for livestock production (Khan *et al*., 2009). The major problems that have reduced nutrient uptake and utilization by pearl millet include planting at the wrong time, shortage of improved varieties, poor crop management practices, pests and diseases, poor soil fertility among others (Uzoma*et al*., 2010; Siddig*et al*., 2013).The mitigation of these challenges has the ability to increase productivity. A comparison of the nutrient composition has shown that the quality of pearl millet is relatively higher than that of maize and sorghum in terms of calcium, potassium, and phosphorus levels in their forageswhen sown at the appropriate time (Amanuallah *et al*., 2015).

Appropriate sowing dates encourages farmers in meeting consumer demand for more meat, milk and other livestock products is dependent on the availability of regular supplies of appropriate, cost-effective and safe animal feeds. Millet takes up sustainable or optimum nutrients from the soil to produce good quality forages and supplies forages from June through August (Uzoma*et al*., 2010). Millet planted in spring (April) should be ready for grazing 30 – 40 days after planting. Imran (2007) observed highest dry matter yield of 13.5 t/ha and green fodder yield of 65.4 t/ha in PARC-MS-6 variety when planted in July in Pakistan. Sowing date is an important production component that can be manipulated to counter the effects of environmental stress. However, delay in sowing decreased nutrient uptake capacity of the millet plant and in turn if well managed can increasethe fodder yield of the crop (Arif*et al*., 2001 and Khan *et al*., 2009). Planting date can have a dramatic effect on crop development and proper planting date is important for maximum nutrientuptake, because optimum sowing dates establish healthy and vigorous plants (Caliskan*et al*., 2008). Generally, nutrient uptake in millet is greatly influenced by the nutrient concentration, forage and dry matter yields (Pandey*et al*., 2003).

Most millet production in the forest-savanna transition zone is rain-dependent with only limited awareness amongst farmers on using a proper planting time and low preparedness for dry periods. Availability of quality fodder is a serious issue, particularly for resource-poor dairy farmers with little or no land for cultivation. High livestock population growth rate, together with the traditional land inheritance, norms and poor land policies, have culminated in subdivision of land which exert high pressure on animal feed resources.

Grazing land is decreasing due to expansion of cropping to meet the demands for food, urbanization and land use for other activities such as industries. Consequently, the scarcity and low capacity of plant nutrient absorption in the production of quality feed and fodder resources, in addition to the irregular sowing dates and nutrient contents in the plants, may contribute significantly to low milk and meat production in this zone (Nwajei and Omoregie, 2017).

Small holder farmers in rural environments will continue to depend on crop residues to feed livestock among other feed resources for some time to come (Bakhashwain *et al*., 2013). However, farmers with less land for fodder production have to compete with production of food crops. In this case, a well-functioning fodder supply chain combined with provision from the grain would constitute a solution. While the crop is necessarily grown for grain, to mix farm enterprises this way, proper crop management, appropriate sowing dates and utilization could help to optimize production.

In improving the quality and quantity of livestock production for human consumption; it is therefore necessary to determine its nutrients content as it relates to their nutrient uptake by the crop. The nutrition of the varieties of millet may not only affect animal production but also improve the quality of milk and meat from a view point of its crude protein contents. Keeping this in view, the present study was undertaken to assess the effect of planting dates on the nutrient uptake of two varieties of pearl millet in a forest-savanna transition zone.

MATERIALS AND METHODS

Experimental location:The research was carried out at the Teaching and Research Farm, Faculty of Agriculture, Ambrose Alli University, Ekpoma. Ekpoma lies between Longitude $6^{0}08^{1}$ East and Latitude $6^{0}45^{1}$North. The mean rainfall of 154.72 mm (total 1237.8 mm), temperature 26.3^{0}C, relative humidity 87.5 and rain days 11.4 (total 91 days) were recorded during the period of the experiment.

Experimental materials: The two varieties used were Gero Bida and Gero Badeggi with a maturity range of 70-95 days in the zone (Omoregie and Nwajei, 2015). The seeds were obtained from the National Cereals Research Institute, Badeggi, Niger State.

Planting:Before planting, the site was manually cleared, debris packed out and the plots demarcated. The individual plots measured 3 m x 1.25 m with a spacing of 1 m within and between the replicates. A pinch of seeds each of the two local varieties were sown on a minimally prepared beds at a spacing of 75 cm x 25 cm inter-and-intra rows, which was later thinned down to one growing plant per stand at 8 days after sowing (DAS). A total of thirty (30) plots with twenty (20) plants each were involved to give a total of 600 plants, equivalent to 53,333 plants/ha.

Experimental design: The experiment was a 2 x 5 factorial scheme, laid out in a randomized complete block design (RCBD). The two varieties were planted at 5 sowing dates to give 10 treatment combinations replicated three times. The 5 planting dates were April, May, June, July and August. Plantings were done on the 10^{th} of each month.

Soil analysis: Prior to planting, soil samples were randomly obtained at 0-15 cm depth with soil Auger. The soil samples were bulked and taken to the laboratory.The bulked samples were air dried, sieved with a 2 mm mesh sieve and analyzed for physical and chemical properties according to the method described by Anderson and Ingram (1993).

Data collection-Fresh forage yield: The fresh forage weight for four plants/plot from two middle rows were determined by harvesting the whole plant at 2 cm above the ground level as described by Naeem*et al*. (2002); Nwajei and Omoregie (2017).

Data collection-Dry matter: The dry matter weight of the four plants/plot were determined by oven-drying the plant at 70°C to a constant weight (Saifullah*et al*., 2011; Nwajeiand Omoregie, 2017).This was calculated to t/ha using the formula below:

$$Dry\ matter\ yield(t/ha) = \frac{dryweight\ (kg)}{Plot\ size(\mathrm{m}^2)} \times \frac{10{,}000(\mathrm{m}^2)}{1} \times \frac{1}{1000}$$

Data collection-Mineral composition: Prior to harvesting of grains, the flag leaves were harvested (14 weeks after planting), put into envelop and taken to the laboratory for the determination of the crude protein and mineral composition; following the procedure of AOAC (2016).

Data collection-Nutrient uptake: The Nutrient uptake was calculated using the formula described by Parishar *et al*. (2009); Nwajei*et al*. (2019) as follows:

$$Nutrient\ uptake\ (kg/ha) = Dry\ matter\ yield\ (kg/ha)\ x\ mineral\ composition(\%)$$

Data analysis: The analysis of variance at 5% level of the yield and nutrient uptake data were computed using SAS(2008) software programme and means separated using Duncan's Multiple Range Test (DMRT) at 5% level of probability.

RESULTS AND DISCUSSION

Physico-chemical properties of soil prior to planting of millet: The results of the physico-chemical properties of the experimental site prior to planting of millet (Table 1) showed that the soil used was sandy loam, slightly acidic with moderate organic carbon and low in nitrogen, marginal available phosphorus and exchangeable bases. Millet can produce high yields in low, poor nutrient soil status with little water holding capacity.The crops ability to yield optimum forages in low status soils may be due to the crops ability to take up the available nutrients from of the soil. Imran *et al*. (2007); Amanullah *et al*. (2015) reported high millet fodder yield from low nutrient soils.

Effects of planting dates on the forage and dry matter yields millet: Sowing date significantly affected the forage and dry matter yields of millet. There were significant differences on the forage and dry matter yields among the varieties of millet. There was a significant variety × sowing date interaction on the forage and dry matter yields of millet (Table 2). As reflected by the result, April and June sown crops had the highest and least forage and dry matter yields, respectively. Early sown crops (April and May)were observedto have a bettermean rainfall (130.69 mm) with favourable temperature (28.75 ^{0}C)and relative humidity (85.90 %) during the vegetative growth compared to 205.73 mm, 24.68 ^{0}Cand 87.88% values of rainfall, temperature and relative humidity, respectively, obtained during the vegetative growth stage for the late sown crops (June-August) . These favourable conditions may have facilitated light penetration for more and better photosynthetic tissue and dry matter accumulation. Consequently, higher vegetative growth promoted photosynthetic material accumulation and in turn reflected in better forage and dry matter production. This observation is in conformity with the results of Maas *et al*. (2007); Abd EL-Lattief (2011); who observed that the forage and dry matter yields were significantly affected by planting date.

Table 1. Physico-chemical properties of the soil of the experimental site prior to planting

Parameters	Values
Sand (gkg^{-1})	830
Silt (gkg^{-1})	60
Clay (gkg^{-1})	110
Textural Class	Sandy loam
pH (H_20 1:1)	5.80
Organic carbon (gkg^{-1})	8.40
Total nitrogen (gkg^{-1})	0.43
Available phosphorus ($mgkg^{-1}$)	13.05
Exchangeable calcium ($cmolkg^{-1}$)	1.04
Exchangeable magnesium ($cmolkg^{-1}$)	0.45
Exchangeable potassium ($cmolkg^{-1}$)	1.03
Exchangeable sodium ($cmolkg^{-1}$)	0.07
Total Exchangeable Bases ($cmolkg^{-1}$)[Ca^{2+} + Mg^{2+} + K^+ + Na^+]	2.59
Total Exchangeable Acidity ($cmolkg^{-1}$)[Al^{3+} + H^+]	0.12
Effective cation exchange capacity ($cmolkg^{-1}$)	2.71
Base saturation %	95.57

Effects of planting dates on the mineral composition of millet: The flag leaves of the investigated crops sown in April/May contain higher crude protein and mineral composition than other dates (Table 3). The crops had sufficient amount ofcrude protein, phosphorus (P), potassium (K), calcium (Ca), iron (Fe), and zinc (Zn). It was found to be marginal in sodium (Na) and magnesium (Mg) and deficient in copper (Cu) and manganese (Mn) for ruminant animal production when compared with the critical levels suggested by Kessler (1991); McDowell (1992).

Effects of planting dates on the nutrient uptake of millet: Planting date significantly affected the uptake of both macro-and micro-nutrients uptake. The varieties planted also influenced the nutrient uptake by the crop. There were significant variety × planting date interaction on the nutrient uptake by millet crops (Table 4). Early sown crops (April/May) had higher uptake of both micro- and macro- nutrients than the late sown crops (June-August). However, Gero Badeggi had higher nutrient uptake than Gero Bida. Consequently, higher nutrient concentration and uptake by Gero Badeggi is a direct reflection of its ability to absorb nutrient from the soil which eventually enhanced high vegetative performance. As observed from the weather conditions, the rainfall during the vegetative growth influenced the absorption of nutrient and uptake for the crops sown in April and May. Parihar *et al*. (2009); Vajantha *et al*. (2015) reported significant difference in nutrient uptake of millet due to varietal difference.

Table 2. Forage and dry matter yields of two varieties of millet as affected by sowing dates

Crop variety	Planting date	Forage yield	Dry matter yield
		← t/ha	→
Gero Bida	April	21.28^{abc}	3.68^{cde}
	May	20.15^{bc}	4.48^{abcd}
	June	10.94^{d}	2.49^{e}
	July	12.11^{d}	3.05^{de}
	August	14.63^{cd}	4.07^{bcd}
	Mean	15.82	3.55
Gero Badeggi	April	27.64^{a}	5.80^{a}
	May	25.86^{ab}	5.40^{ab}
	June	15.93^{cd}	3.37^{cde}
	July	17.17^{bc}	3.60^{cde}
	August	20.65^{bc}	4.82^{abc}
	Mean	21.45	4.60
	SL		
	Planting date	*	*
	Variety	*	*
	Interaction (V× D)	*	*

Means followed by same superscript(s) indicated in columns are not significantly different at 5 % level of probability using Duncan multiple range test. SL: Significant level; *: Significant at the 0.05 level; V: Variety; D: Planting date

Table 3. Mineral composition of two varieties of millet as affected by sowing dates

Variety	Planting dates	Cp	N	P	K	Na	Ca	Mg	S	Fe	Mn	Zn	Cu
		←			%			→		←	mg/kg		→
Gero Bida	April	21.75	3.48	0.21	2.22	0.07	0.35	0.15	0.20	128.70	3.21	52.80	1.67
	May	22.13	3.54	0.33	1.10	0.31	0.16	0.11	0.27	510	5.10	147	2.06
	June	25.38	4.06	0.39	1.96	0.12	0.25	0.17	0.28	198	3.66	32.10	1.27
	July	21.31	3.41	0.27	1.16	0.76	0.13	0.09	0.22	575	2.30	57	0.56
	August	22.31	3.57	0.35	1.52	1.04	0.16	0.09	0.38	165.80	3.56	38.40	1.50
	Mean	22.58	3.61	0.31	1.59	0.46	0.21	0.12	0.27	315.50	3.57	65.46	1.41
Gero Badeggi	April	26.63	4.26	0.37	2.84	0.10	0.40	0.16	0.21	210.20	7.60	80.20	5.08
	May	18.81	3.01	0.36	0.96	0.28	0.22	0.13	0.39	479	9.05	160	3.62
	June	25.81	4.13	0.38	2.15	0.09	0.24	0.21	0.25	221	9.13	63.60	3.80
	July	24.00	3.84	0.28	1.18	0.78	0.24	0.10	0.31	387	3.40	52	0.84
	August	21.75	3.48	0.33	1.50	1.04	0.17	0.09	0.41	164.20	2.86	23.70	0.60
	Mean	23.40	3.74	0.34	1.73	0.46	0.25	0.14	0.31	292.28	6.41	75.90	2.79
	SE	0.76	0.12	0.02	0.19	0.13	0.03	0.01	0.03	52.67	0.83	14.73	0.49

SE: Standard error

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Table 4. Nutrient uptake of two varieties of millet as affected by sowing dates

Crop Variety	Planting date	N	P	K	Na	Ca	Mg	Fe	Mn	Zn	Cu
		←			kg/ha					→	
Gero Bida	April	12807.95^{bcd}	772.89^{f}	8170.59^{b}	257.63^{f}	1322.43^{b}	552.07^{bc}	36.81^{g}	1.18^{d}	19.43^{d}	0.61^{de}
	May	15871.79^{bc}	1479.57^{cd}	4931.91^{cde}	1389.90^{de}	717.37^{cd}	547.85^{bc}	224.18^{b}	2.29^{bc}	65.91^{b}	0.92^{d}
	June	10095.87^{d}	969.80^{ef}	4873.98^{cde}	298.40^{f}	621.67^{cd}	422.73^{cd}	49.73^{fg}	0.91^{d}	7.98^{e}	0.32^{ef}
	July	10386.10^{cd}	822.36^{f}	3533.10^{e}	2314.79^{bc}	395.95^{d}	274.12^{d}	182.75^{c}	0.77^{d}	17.36^{de}	0.15^{f}
	August	14688.68^{bcd}	1424.11^{cd}	6184.71^{bcd}	4231.97^{a}	651.02^{cd}	366.20^{cd}	81.38^{def}	1.45^{cd}	15.52^{de}	0.61^{de}
	Mean	12770.08	1093.75	5538.86	1698.54	741.69	432.59	114.97	1.32	25.26	0.52
Gero Badeggi	April	24696.65^{a}	2145.02^{a}	16464.43^{a}	579.74^{ef}	2318.94^{a}	927.58^{a}	115.94^{d}	4.41^{a}	46.50^{c}	2.94^{a}
	May	16233.93^{b}	1941.60^{ab}	5177.60^{cde}	1504.13^{cd}	1208.53^{b}	701.13^{b}	269.67^{a}	4.88^{a}	86.29^{a}	1.96^{b}
	June	13900.66^{bcd}	1278.99^{cde}	7236.42^{bc}	302.92^{f}	807.79^{c}	706.81^{b}	67.32^{efg}	3.07^{b}	21.37^{d}	0.28^{c}
	July	13830.83^{bcd}	1101.83^{def}	4250.10^{de}	2809.39^{b}	864.43^{c}	360.18$_{cd}$	164.16^{c}	1.23^{d}	18.73^{d}	0.30^{ef}
	August	16789.06^{b}	1592.07^{bc}	7236.66^{bc}	5017.42^{a}	820.16^{c}	434.20^{cd}	96.49^{de}	1.38^{d}	11.43^{de}	0.29^{ed}
	Mean	17090.23	1611.90	8073.04	2042.72	1203.97	625.98	142.72	2.99	36.86	1.35
	SL										
	Planting date	*	*	*	*	*	*	*	*	*	*
	Variety	*	*	*	*	*	*	*	*	*	*
	Interaction (V× D)	*	*	*	*	*	*	*	*	*	*

Means with same letter (s) superscript indicated in colunms and not significantly different at 5% level of probability using Duncan' Multiple Ranged Test. SL: Significant level; V: Variety; D: Planting dates; *: Significant

Generally, nutrient uptake contributes immensely to the vegetative growth and development of millet varieties which in turn result to a higher composition of nutrients in the plant. Nutrient uptake is related to dry matter production, as the variety and sowing date with higher vegetative growth and dry matter yield significantly had higher nutrient uptake. Yakubu*et al*. (2010) reported that the relative tolerance exhibited by millet varieties in terms of nutrient uptake is a reflection of their performance during vegetative growth stages as well as dry matter yield.

As conclusion, there were significant differences in the response among the varieties in terms of, sowing dates and variety × planting date interaction on the forage, dry matter production and uptake of both macro-and micro-nutrients in millet. The April and May sown crops showed better performance than those of June-August. It was concluded that apart from the uptake of Na, Fe and Zn, Gero Badeggi sown in April had the highest uptake of both macro- and micro-nutrients compared to GeroBida at other plantingdates.

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