Potassium and Manganese Fertilizer in Millet Production: Effect on Grain Yield and Quality and Forage Potential of Residual Stalks.

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Abstract

Millet is an important grain and summer forage crop and unlike sorghum, it seed has less anti-nutrient factors and is a better choice for formulation of feed used for small ruminant, poultry, hog, and swine production. Residual stalk after seed harvest have forage potential and could be hayed and used as feed to satisfy maintenance energy needs in adult dry animals. The quality of seed used as feed in these animal production systems could be dependent on both macro- and micronutrient fertilizer management strategies during its production. This study carried out at Virginia State University Research and Demonstration FarmThe objectives of the study were to determine effect of potassium (K) and manganese (Mn) fertilizer on; i) Grain yield and quality; ii) Forage quality of residual stalks. Two varieties of millet; Pearl millet (*Panicum miliaceum*-Tifgrain102) and Browntop (*Pennisetum glaucum*) were studied. Fertilizer rates used were 0, 40, 80, or 120 kg K ha^{-1} and 0, 10 and 25 kg Mn ha^{-1}. Though insignificant, there was increasing trend with K and Mn on grain yield, seed oil and seed protein content. Browntop seed had greater content of protein, P, S, Ca, Mn, Fe, Zn, and Cu than Pearl millet. Residual stalk had good forage quality to meet maintenance needs of dry animals.

Introduction

Millet is an important cereal grain tolerant to moisture stress and low soil fertility. As a forage crop, millet is free of prussic acid poisoning common in sorghums (Teutsch, 2009). Millets for seed may be used as a dual crop. Once seed is harvested, left-over stalks are removed and used as hay and may be able to satisfy maintenance energy needs in adult dry animals. Millet seed use as feed/or feed supplements is common in swine and poultry production, and is also fed directly to wild and pet birds by bird enthusiasts. Millets seeds have high protein and essential amino acid content and are used as feed in poultry and hog operations (Ejeta et al., 1987; Haydon and Hobbs, 1991). The quality of seed used for feed in these systems may vary depending on both macro- and micronutrient fertilizer management strategies during production. While there are numerous studies on macronutrients requirements of millets (Bartiano et al., 1993), there is limited information on micronutrient elements requirements and their effects on seed and stalk forage quality. Potassium is a key element in protein synthesis, and its availability may improve protein and amino acid content in seeds (Zou et al., 2006). It is also reported to improve N use efficiency in crops (Fixen and West, 2002) and play a role in moisture stress tolerances. Manganese is a micronutrient required by all plant species for growth and reproduction (Marschner, 1995). It is a component of the water splitting protein complex PS II, a constituent of superoxide dismutase (MnSOD), and a key activator in a number of critical metabolic enzymes (Marshner, 1995). Because of its role in PSII, Mn concentration in the leaves has a direct effect on photosynthetic rates and may affect biomass accumulation. Sufficient Mn in forage is important for animal nutrition because of its role in animal bone development and reproductive growth (Underwood, 1977).

Project Objectives

Determine the effect of potassium (K) and manganese (Mn) fertilizer on

- Seed yield and quality
- Left-over stalk forage quality

Materials and Methods

Materials

Two millet varieties;
Pearl millet (*Panicum miliacium*)
Browntop (*Panicum ramosa)*
Potassium rates were; 0, 40, 80, 120 kg K ha^{-1}
Manganese fertilizer supplied as $MnSO_4.H_2O$ at rates of 0, 10, and 25 kg Mn ha^{-1}
The experiment was a randomized complete block design (RCBD) with three replication. Treatments were arranged in a split-split arrangement
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Sample preparation and analysis

Seed were harvested manually from selected area in the middle two rows.
After seed weight was obtained, a subsample was obtained ground and analyzed for
Crude protein and oil content
Macro- & micro-nutrient element content
Residual stalks were obtained and analyzed for forage quality
Crude protein and oil content
Macro- & micro-nutrient element content
ADF and NDF

Results

a b

Figure 1. Pearl millet (a) and browntop (b) as they appear during early reproductive stage

Data Trends/Patterns

While some traits of interest showed increasing trend with K fertilizer, the results were not significant at P=0.05
Similarly, no significant response to manganese fertilizer were observed for all other measurements
Only variety comparisons showed significant differences

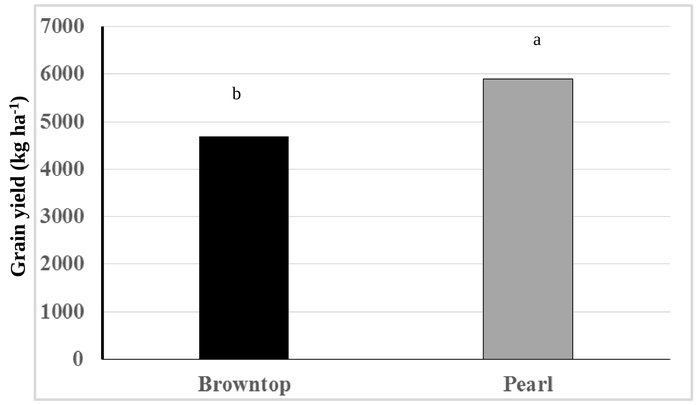

Figure 2. Grain yield in browntop and pearl millet

Table 1. Macro- and micronutrient content of browntop and pearl millet

Variety	Macronutrient content (g kg^{-1})			
	P	K	Mg	Ca
Browntop	3.56a	3.40b	1.78a	0.25a
Pearl	2.90b	4.61a	1.15b	0.14b
	**	**	**	**

	Micronutrient content (mg kg^{-1})			
	Mn	Fe	Zn	Cu
Browntop	25.0a	56.3a	41.6a	7.5a
Pearl	16.4b	44.7b	31.7b	4.9b
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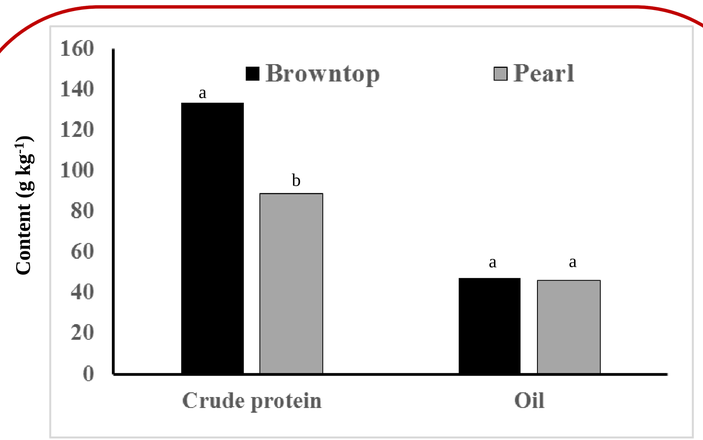

Figure 2. Seed protein and oil content

Table 2. Crude protein and macronutrient content of browntop and pearl millet residual stalks

Forage Attribute	Content (g kg^{-1})	
	Browntop	Pearl
Crude protein	60.2a	51.3b
P	1.3b	2.7a
K	22.2b	49.5a
Mg	6.5a	2.7b
Ca	12.0a	7.4b
S	1.2a	1.5a

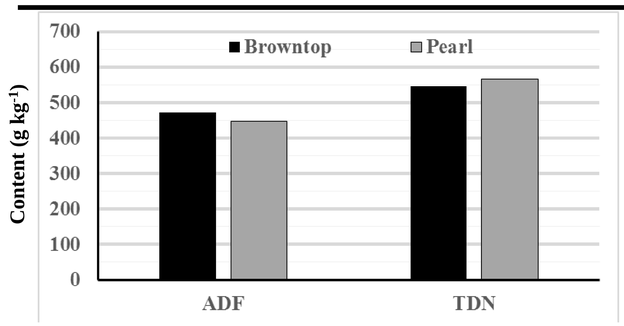

Figure 3. ADF and TDN content of left-over stalks of millet after seed harvest

Conclusions

Potassium and Mn fertilizer application did not affect seed quality in both varieties
Seed yield was greater in pearl millet
Browntop seed had greater crude protein content than pearl millet, but their seed oil contents were similar
Except for seed K content, macro-and micro-nutrient content were greater in browntop
Browntop seed may provide better quality animal feed compared to pearl millet seed
Residual stalks may be hayed and used to supply maintenance energy needs for mature & dry animals

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