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The Effect of Seed Size and Harvest Stage on Growth and Yield of Forage Sorghum (*Sorghum bicolor* cv. Abu Sabin)

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Abstract: ***A pot experiment was carried out in the autumn season of year 2015 to investigate the effects of seed size and compare it with the small seed size on the germination and some growth parameters of forage sorghum (cv.Abu Sabin) and harvest stage on yield components. The experiment was laid in a split plot design with seed size as main plot and the harvest stage as sub– plot with three replicates. The results indicated that the seed size had no significant effect on germination and number of leaves, shoot dry weight in late bloom stage and root fresh weight in boot stage. However a significant effect was observed in plant weight, tiller density also there was significant effect on crude protein, crude fiber and sucrose percentage. The interaction between seed size and harvest stage didn't show any significant effects on each measured traits. The significant growth observed in larger size seed showed that larger size seed are good seed size for sorghum planting.***

Keywords: forage sorghum, seed size, growth stage, germination percentage

1. Introduction

Sorghum is an important cereal crop which is grown globally for food and feed purposes. It is most widely grown in the semi-arid tropics where water availability is limited and frequently subjected to drought. Sorghums in general can be classified into two types: forage types (mainly for forage or animal feed) and grain types (mainly for human consumption). In recent years its usefulness has been considerably extended by the production of new hybrids and the study of cultural species. Forage sorghums are similar to grain types but are taller and have higher forage quality (Newman *et al*. 2013). Its low water requirements in addition to its adaptability to warm conditions have resulted in a recent increment in its use as forage plant in some parts of the world where it was minor silage (Bantilan, 2003; Getachew *et al.* 2016).

In Sudan, the traditional sorghum cultivar, known locally as Abu Sabin, is the most important cultivar grown for forage. In Khartoum state, for example, it represents more than 60% of the total area cultivated (Mohammed *et al*. 2012).

Crop yield is generally associated with efficient seed germination (Nisar *et al*., 2011). For a successful crop production, the use of good quality seed is very essential which increase the yield by 15-20 %. The extent of this increase is directly proportional to the quality of seed that is being sown. The needs of a seed lot may differ by size, wight and density due to production environment and cultivation practices. Seed size is one of the components of seed quality which affects the performances of crop (Adebisi *et al*., 2011). Size is a widely accepted measure of seed quality and large seeds have high seeding survival growth and establishment (Jerlin and Vadivelu, 2004). The vigorous seed ensures vigorous seedling that leads to high yield of crops. The improvement in seed germination have been achieved by different pre-sowing treatments including selection of high quality seeds and one of the criteria of the seed quality is seed size. Seed size is a parameter for predicting germination and seedling growth rates. In Sudan several previous studies on the effect of seed size and growth stages on germination and other growth parameters have been reported (Abdullahi and Vanderlip 1972, Idris 2008, Siddig and Idris 2015)

The aim of this study was to investigate the effect of seed size and harvest stage on germination and some growth parameters of the forage *sorghum bicolor*.

2. Materials and Methods

Pot experiment was conducted in the Faulty of Education, University of Alzaiem Alazhari, Omdurman, Sudan, in August 2015. The seed of forage sorghum cv. Abu Sabin was used as forage crop. The seeds were graded into two size classes: large and small, by means of a copper screen (4-mm diam.). The large size seed class was retained by the 4-mm screen and ranged in weight from 25-30 mg.

Seeds were planted in perforated plastic pots containing 5 kg river silt. Ten seeds of forage sorghum cv. Abu Sabin were sown (1cm deep) per pot and later thinned to 5 seedlings to prevent within-species competition. Pots were watered daily using tap water. Urea (46% N) was applied as a basal dressing at a rate of 54 KgN ha^{-1}.

The treatments were arranged in a split-plot design in which the main plots were the seed sizes (large or small), and the sub-plot treatments were established by harvesting plants at two growth stages (boot and late bloom). The boot stage was recognized when the head become extended into the flag leaf-sheath. The late bloom stage was identified when nearly 90% of the plants were at stage of bloom.

Germination count was made within the first ten days of planting. Seed considered germinated upon the emergence of seedling from the soil. Forage height was then measured and forage tillers counted. Forage sucrose was determined from juice of fresh plants by means of Refractometer. The juice samples were taken from internodes 20 to 30cm above soil level. A hand sickle was then used to harvest the fresh forage at 5cm height above soil level from each pot. The root dry weight was obtained by washing the root render with tap water to remove all soil particles. The washed roots were then placed in paper bags and oven dried (50^{o}C) for 48 hours before their dry weight was recorded. Also the forage green chop yield was determined at harvest from each pot. Crude protein and crude fiber were determined from oven-dried forage material previously harvested for green chop yield determination. Crude protein, determination of total nitrogen was conducted using kjeldahl method. The sample was digested in sulfuric acid using ‹K2So4 /CuSo4 as a catalyst. Nitrogen was converted into NH3, then distilled in trapped bovic acid and treated with H2So4 (Galyean, 2010). Determination of crude fiber (CF) which consists of cellulose, hemicelluloses and polysaccharides which are bound to protein and phenols, especially to lignin. Crude protein was calculated as N ×6.25%. Crude fibre was determined by soxhlet method. Analysis of variance was performed on all data to detect significant differences between treatments.

3. Results and Discussion

Germination assessment

Germination percentages for both small and large seed of Sorghum, 10 days after sowing, are illustrated in table 1. The results indicated that the seed size did not have significant effect on seed germination (P> 0.05), although, large seeds had relatively a higher (100%) cumulative germination percentage than the small seeds (97%). Similar results have been reported for other plant species (Shipley and Parent, 1991; Gonzalez, 1992; Missanjo *et al*., 2013; Mtambalika *et al.*, 2014). In contrast to these results, several authors (e.g. Chacon *et al*., 1998; Uniyal, 2007) reported the influence of seed size on germination percentage of some other plant species.

Table 1: The effect of seed size on germination percentage

Treatment	Total no. of seeds planted	Total no. of seed germinated	Germination percentage (mean)
Large size seeds	30	30	100
Small size seeds	30	29	97

Growth and yield assessment

The results showed that seed size (Table 2) had significant (P=0.05) effect on plant height. The height of large seed class recorded (142.00 cm) in boot stage, while the small seed attained (136.33cm). However, in late bloom the large seed recorded (143.00cm) and the small seed reached (130.00cm). These results are in line with Simmone *et al.* (2000), who found that seed size has a strong influence on growth and biomass increment of a plant. Similar results were reported by Yanju Du and Zhongliana (2008), who found that the mean height of *Castanupis chinensis* was significantly greatest for large seeded seedlings and significantly lowest for small-seeded ones, irrespective of emergence time and light conditions.

On the other hand the growth stage did not have any significant difference between the two seed size classes since both the large and small seeds attained very close height in boot and late bloom periods.

Tiller density showed significant effect (P=0.05) between the two seed size classes (Table 2). This result is in line with Rukavina *et al.* (2002) on Croatian spring malting barleys. Similar results were obtained from Roozrokh *et al.* (2005) on chickpea and Nagaraju (2001) on sunflower. Contrary to this result Hampton (1981) reported that seed size has no effect on tiller density in New Zealand wheat. On the other hand the interaction between the seed size and the growth stage was not significant on tiller density.

Seed size, growth stage and their interaction did not have any significant effects on the number of leaves per plant (P=0.05). This result is not in agreement with the findings of Cookson *et al.* (2001) on wheat, and that of Nagarju (2001) on sunflower who observed that the number of leaves is positively correlated with seed size.

The leaf area exhibited significant effect (P=0.05) between large and small seeds in both boot and late bloom stages. These results are consistent with Owoh *et al* (2011) who found that large seed has positive effect on the leaf area of *Gmelina Arborea* plant. Similar results were obtained from Lima *et al.* (2005) on common bean, Khurana and Singh (2000) on *Albizia procera*.

Table 2: The effect of seed size and harvest stage on forage sorghum plant height, tiller density, number of leaves and leaf

Growth stage	Seed size	Parameter measured			
		Plant height (cm)	Tiller density	Number of leaves	Leaf area (cm^2)
Boot	Large	142.00*	6.00*	30.00^{NS}	494.00*
	Small	136.33*	5.66*	29.00^{NS}	472.66*
Late bloom	Large	143.00*	6.00*	30.33^{NS}	400.66*
	Small	138.00*	5.88*	30.00^{NS}	333.33*

, *Significant, NS non-significant (P=0.05)

The shoot fresh weight showed significant effect (P=0.05) between large and small seed (Table 3) while the shoot dry weight showed significant effect in boot stage and non-significant effect in late bloom stage. Pertinent to shoot fresh weight these results are in agreement with the findings of Akinyosoye *et al.* (2014) on three wheat cultivars and Shaukat *et al.*(1999) on *Acacia nilotica*. Similar results were obtained by Zareian *et al.* (2013) who found that the seedling dry weight is positively correlated with seed size. In contrast Rezapour *et al.* (2013) reported that seed size did not have influence on seedling dry weight. The interaction between seed size and growth stage did not have significant effect except for shoot fresh weight.

The root fresh and dry weight showed significant difference between seed sizes (Table 3). These results are consistent with the results of many studies (e.g. Owoh *et al* 2011; Siddig and Idris, 2015).

Table 3: The effect of seed size and harvest stage on forage sorghum shoot and root fresh and dry weight

Growth stage	Seed size	Parameter measured			
		Shoot fresh weight (gm)	Shoot dry weight (gm)	Root fresh weight (gm)	Root dry weight (gm)
Boot	Large	43.33*	8.40*	10.36 NS	3.60*
	Small	39.80	7.40	10.16	4.16
Late bloom	Large	48.56*	8.60 NS	10.46*	3.7.5*
	Small	47.06	8.16	10.88	4.20

*Significant, NS = Not significant (P=0.05)

The crude protein, crude fiber and sucrose contents showed significant differences between large and small seed in boot and in late bloom stages. The content of forage sucrose at late bloom stage (p=0.05) exceeded that of the boot stage (Table 4). The results of this study support the earlier work of Broadhead (1972).

Table 4: The effect of seed size and harvest stage on the forage sorghum crude protein, crude fiber and sucrose percentage

Growth stage	Seed size	Parameter measured (%)		
		Crude protein	Crude fiber	Sucrose
Boot	Large	13.39*	28.34*	1.93*
	Small	11.74*	25.28*	1.83*
Late bloom	Large	18.84*	28.36*	3.33*
	Small	16.72*	25.32*	3.00*

*Significant (P=0.05)

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