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Influence of Seeding Rate on Growth Performance and Yield of Early Maturing Sorghum

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Abstract

Heavy grazing pressure in Tanzanian semi-arid rangelands coupled with climate change and variability has resulted into severe decline in forage production and changes in vegetation composition. To increase forage biomass production in the face of climate change and variability, climate resilient fodder crops such as early maturing sorghum have been recommended in arid and semi-arid regions. However, paucity of information on the best agronomic practices especially the optimal seeding rate and row spacing fostered the need to carry out research on growth performance and yield of early maturing sorghum. The experiment was conducted at Magadu Dairy Farm to assess the Influence of Seeding Rate on Growth Performance and Yield of Early Maturing Sorghum. The experiment adopted the Complete Randomized Design (CRD), where different seeding rate (such as 8kg/ha, 12kg/ha, 16kg/ha, 20kg/ha) were assigned randomly and replicated three times making a total of 12 subplots. The row spaces were also varied in reciprocal order with seeding rate (60cm in 8kg/ha, 50cm in 12kg/ha, 40cm in 16kg/ha and 30cm in 20kg/ha). Parameters collected include, number of plants germinated, circumference of the plant, Dry matter (DM) yield and height of the plants. The data were subjected to One Way Analysis of Variance (ANOVA) using SAS program of 2014 to analyse the effect of seeding rate on growth attributes and yield of early maturing sorghum. The study established the positive correlation of seeding rate and number of plant as well as plant heights. On the contrary, seeding rate was found to be inversely proportion to plant thickness and number of leaves per plant. The above ground biomass was found to increase with increasing seeding rate up to 22.20 tonnes per ha and slightly declined at the highest seeding rate. We recommend further studies on nutritive values and palatability of sorghum to livestock.

Introduction

Increasing effects of climate change and variability coupled to shrinkage of grazing lands due to other land uses has resulted to severe pressure on natural grazing lands. Heavy grazing pressure in Tanzanian semi-arid rangelands coupled with climate change and variability has resulted into severe decline in forage production and changes in vegetation composition (Selemani 2018). To increase forage biomass production, climate resilient fodder crops have been recommended in arid and semi-arid regions (Abduselam *et al.* 2018). Sorghum has become most popular dual purpose fodder crop adapted in wide range of ecological zones with high yield and nutritious forage potential for livestock production (Ayub *et al.* 2002).

Using appropriate agronomic practices for growing early maturing sorghum could make a large contribution to livestock feedstock and human food in Tanzania. Although, the early maturing sorghum has been recommended as potential fodder species to enhance biomass production in a wide range of ecological zones (Mishra *et al.* 2015), there is paucity of information on the best agronomic practices especially the optimal seeding rate and row spacing. Understanding of appropriate seeding rate is imperative to optimize dry matter yield. The current study examined the effects of seeding rate on growth performance and dry matter yield of early maturing sorghum. The current findings and recommendations informed different stakeholders, such as farmers, extension officers, researchers and policy makers on the optimal seeding rate for maximum biomass yield from early maturing sorghum.

Methods and Study Site

Description the Study Area

The on-station experiment was conducted at Magadu farm, Sokoine University of Agriculture (SUA), situated at 37° 39'E and 06° 5' S about 5 km from the center of Morogoro Municipal. The average annual temperature in the region is ranging from 18°C to 30°C and the rainfall is bi-modal, ranging from 600-900mm per annum (Selemani 2018) and relative humidity ranges from 39 to 64% (Kizima 2014). Short rain is

normally occurs in November to December while long rain occurs between March and May. The farm is located in the western slope of Uluguru Mountain and the common vegetation is a mixture of grassland and woodland. Soil texture of the study area is dominated by sandy (12% clay, 4% silt, and 84% sandy) with pH of 5.7 (Kizima *et al* 2014). The common livestock managed in the farm are cattle, goats, sheep and few horses.

Research design and sampling procedure

This study used Complete Randomized Design (CRD) whereas seeding rate was considered as a testing factor with four levels. These levels were; 8 kg/ha, 12 kg/ha, 16k g/ha and 20 kg/ha in respective order. These four levels were replicated randomly three times each making a total of 12 sub-plots. The size of each sub-plot was 2 x 2 m. The row spacing in each subplot were varied in reciprocal order of seeding rate levels such as 30 cm (for 20 kg/ha), 40 cm (for 16 kg/ha), 50 cm (for 12 kg/ha) and 60 cm (for 8 kg/ha). All seeds were sown at the same planting depth of 0.5 cm deep. Prior to sowing the seedbeds were prepared before rainy season and sowing was done at the beginning of the rainy season in early March using hand hoe.

Data collection

Data collection started two weeks after sowing and proceeded after every two weeks for three months consecutively. The following parameters were recorded; number of plants germinated, number of tillers, and number of leaves and estimation of above ground biomass. The quadrat of 0.5 x 0.5 m was used as sampling unit and was thrown randomly in each sub-plot. Within the quadrat the number of germinated plants were counted and recorded. Four plants within the quadrat were selected randomly for counting number of tillers and leaves per plant. The heights of four selected plants were also measured using tape measure. At the end of experiment after two months, dry matter was estimated by using destructive method, where all plants with 0.5 x 0.5 m were harvested from each sub-plot and weighed in the field when still fresh. All harvested samples were taken to the laboratory of the Department of Animal, Aquaculture and Range Sciences, SUA for estimation of dry matter. In the laboratory samples were force-dried using an oven for 48 hours under the temperature of 105° C.

Data analysis

Data were subjected to One Way Analysis of variance (ANOVA) to analyze the effect of seeding rate on growth attributes and yield of early maturing sorghum using Statistical Analytical System (SAS) programme of 2014. The mean values were separated using the Duncan Multiple Range Test as post hoc test. The study used the following model; Responses (No. of plants, No. of tillers, No. of leaves, stem circumference and biomass in kg/ha) = General mean + Seeding Rate + Residual error

Results

The mean numbers of plant per square meter, number of leaves recorded per plant, plant height and thickness are presented in Table 1. While number of leaves found to be inversely proportion to the seeding rate, the thinner plants were recorded in the plots with relatively higher density of plants (Table 1). Results also indicate that increasing seeding rate was proportional with increasing plants' heights.

Table 1: Growth attributes of the Early Maturing Sorghum

Seeding rate	No. of plants/m ²	No. of leaves per plant	Plant height (cm)	Circumference (cm)
8kg/ha	162.65c	8.15a	95.22b	3.82a
12kg/ha	120.25c	7.50b	104.17a	3.50b
16kg/ha	210.21b	7.63b	105.14a	3.60b
20kg/ha	172.08a	6.88c	105.27a	3.03c
SEM	3.06	0.13	1.57	0.1

In addition to seeding rate, temporal growth patterns were established among different growths attributes. For example, number of plants were found to decrease with increasing time (Figure 1), with a sharp decline from week 1 to week 3 which finally stabilized all the way to week 6.

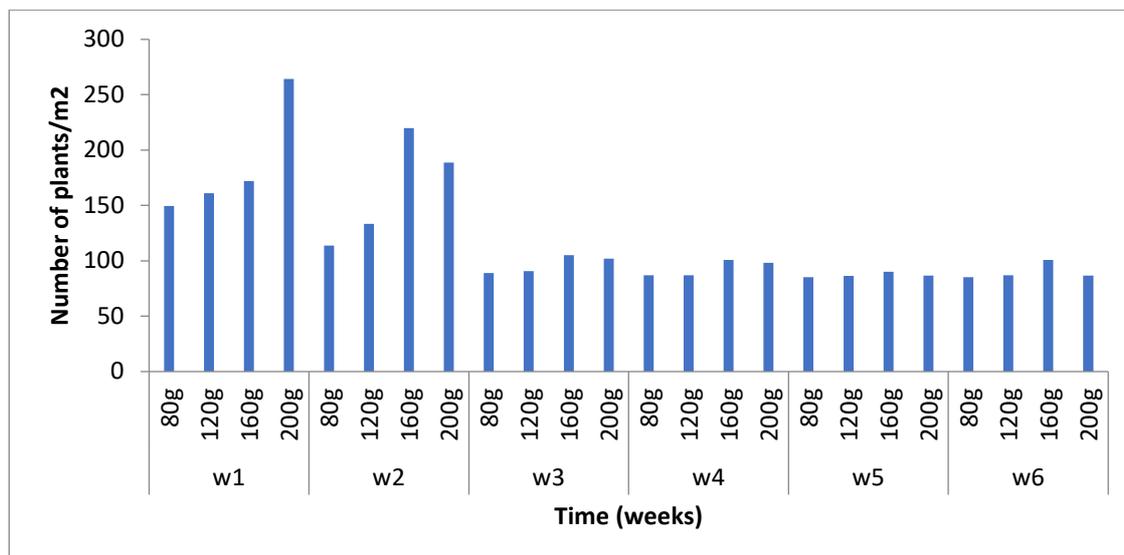


Figure 1: Interaction effects of seeding rate and time (weeks) on plant number

Generally, the biomass yield of Early Maturing Sorghum was high ranging from 13 to 28 tonnes per ha. The results shown that the highest value of biomass was found in the lowest seeding rate (Figure 2).

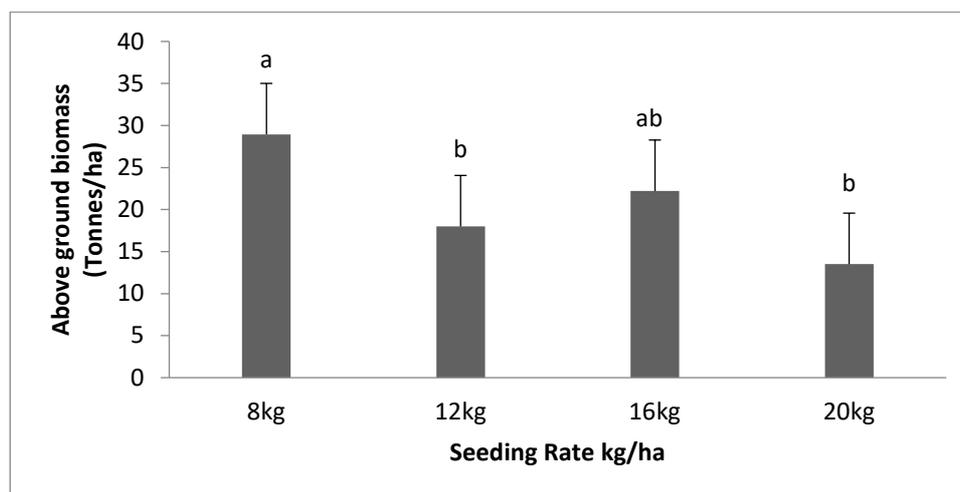


Figure 2: Above ground biomass of Sorghum at different seeding rate

Discussion [Conclusions/Implications]

The study established a positive correlation between seeding rate and number of plants germinated. The number of plants per unit area increased with increasing seeding rate where the highest mean value was recorded in 20 kg/ha seeding rate and lowest was at 8 kg/ha seeding rate. However, increasing seeding rate found to have negative effects on growth performance of the Early Maturing Sorghum as evidenced by number of leaves and thickness of stems. The mean numbers of leaves recorded per plant were inversely proportion to the seeding rate (Table 1). Nevertheless, the weakest plants with thinner stems were recorded at plots with relatively higher density of plants. The relatively higher number of leaves and thick stems observed in the lower seeding rate could probably be associated with the minimum competition for light and nutrients. Low plant density reduces competition for nutrient, moisture and sun-light, which in turn favor individual plant to quick growth and attain maximum number of leaves.

On the other hand, increasing plant height with increasing seeding rate was proportional to Saheb (1997) who reported that increasing seeding rate resulted into slight increments in the heights of plants. Although height of plants is largely controlled by plant genetic makeup, but to some extent the environmental factors such as light intensity can significantly influence plant growth (Baloch et al. 2010). Densely populated plants normally compete for solar energy which resulted into thin elongated plants.

Decreasing plant number with time could be attributed to seedling mortality. Hossen et al. (2018) also established similar pattern on rice seedlings mortality which were found to increase with seeding rate. High seedlings mortality few weeks after germination is associated with severe competition particularly the plots received higher seeding rate (Figure 1). On the other hand, number of leaves increased with increasing time up to week 5 and slightly declined at the last week of the experiment. Decreased number of leaves at week 6 implies that, the planted sorghum matured early and some leaves reached their senescence stage.

Although the current study failed to establish the linear pattern with regard to seeding rate and above ground biomass, the lowest value of biomass was found in the highest seeding rate (Figure 2). The low biomass in the highest seeding rate could be associated with densely populated plants which resulted into severe competition for water, nutrient resources and light. Snider et al. (2011), concluded that, high seeding rate do not positively affect yield, rather can cause morphological changes such as reduction in tiller number and stem diameter. On the contrary, low seeding rate, allows optimal growth of plants because of little competition for available resources. Sparsely spaced grasses tend to accumulate abundance leaves and tillers which in turn resulted to high biomass production. Plants in the low seeding rate facilitate more biomass yield (Boe and Casler 2005; Lee et al. (2017)). The study therefore recommends the seeding rate of 8 kg/ha for optimal performance of early maturing sorghum in terms of growth and yield. However, a further study is recommended on nutritive values and palatability of sorghum to livestock.

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