

## Effect of Different Nitrogen Levels and Seed Rate on Irrigated and Rainy Forages of Abu-Sabeen (*Sorghum bicolor* L. Moench) Under Semi-Arid Condition

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### Abstract

A two field experiments was conducted at the demonstrated farm of faculty of Natural Resources and Environmental Studies, University of Kordofan, during 13<sup>th</sup> Feb., and 10<sup>th</sup> June, 2014 under irrigated and rainy condition, to study the effect of nitrogen fertilizer level and seed rate on traditional sorghum forage cultivar Abu-Sabeen under different environmental. The experiment was conducted by using a Randomized Complete Block Design (RCBD) with three replicates. The treatments were four seed rates and three levels of urea doses. The seed rates were 15, 20, 25 and 30 g per m<sup>2</sup> which were equivalent to 36, 48, 60 and 71 kg seed per ha. The urea doses were control, 20.70 and 41.40 g per m<sup>2</sup> (0N, 1N and 2N per ha) which were equivalent to zero, 87 and 174 kg per ha. The parameters measured were: number of leaves /plant, fresh weight (ton/ha) and dry weight (ton/ha), during both seasons. The results revealed for the dry season showed significant differences in growth attributes, thus the maximum number of leaves observed in Seed rate four SR4 (71kg/ha) and 2N dose registered the highest number of leaves per plant (7.4). Also the results revealed positive significant effect during both seasons in terms of fresh and dry forage yield which indicated the possibility to grow sorghum cultivar Abu-sabeen during February (dry season) as a fodder crop in the area. The results recorded that, fourth and third seed rate having the highest values of (3.22 and 3.28 ton/ha), (8.14 and 9.54 ton /ha) and (0.98 and 0.89 ton /ha), (3.06 and 3.59 ton /ha) successfully during both seasons. 2N dose registered the highest values (3.19 and 0.73 ton /ha) in fresh and dry weight during the dry season. However the interaction effect was significant in the same traits.

**Keywords:** Nitrogen Levels; Seed Rate; Irrigated Forages; Rainy Forages; Semi-Arid Condition

### Introduction

Sorghum (*Sorghum bicolor* (L.) Moench) is a cereal plant member of the family of Poaceae [1]. It is the fifth important cereal in the world after maize, rice, wheat and barley [2]. It is extensively grown under rain-fed and irrigated conditions for grain and forage production [3]. The main forage crops produced in the country was Abusabien (*Sorghum bicolor* (L.) Moench cv.), It is exclusively the most important annual forage cereals crops in Sudan [4,5]. The crop constitute about 43% of the total annual yield and occupying an area 70 thousand hectares [6]. Its production system is mainly under irrigation [4]. Locally in North Kordofan State the latest estimates of the live-

stock population of Kordofan [7] indicated that, there are now 31 million heads, composed of 8, 12.5, 8, and 3 million of cattle's, sheep's, goats and camels respectively, totaling about 13 million animal units. Fertilizer application is the principal factor markedly affects the fodder yield. Nitrogen is an essential nutrient for physiological, growth and yield point of view [8], but at the same time establishment of an optimum plant stand is equally important to get maximum yield [9], and to maintain high level of forage production, choice of suitable cultivars and fertilization programs are great importance [10]. Also to harvest the higher fodder yield agronomic factors such as seed rate and nitrogen level are important. Low or excessive plant population may lead to reduction in the overall efficiency of the crop [11]. Hence, kordofan sandy soil deficit in nitrogen and other nutrient elements so proper seed rate and optimum dose of nitrogen fertilizer would be of great importance for higher yields and efficient use of the available resources. The present investigation was conducted to study the effect of nitrogen levels and seed rate on irrigated and rainy forage of Abu-Sabeen cultivar.

## **Material and Methods**

### **Experimental site**

The two experiments were conducted at the Nursery of Crop Sciences Department, Faculty of Natural Resources and Environmental Studies, University of Kordofan (latitude 11 - 15 and 16 - 30 N and longitude 27 - 32 E). The climate of the area is arid and semi arid. The soil is sandy, annual rain fall ranges between 350 - 450 mm [12]. Average maximum daily temperature ranges between 30 - 50 C<sup>0</sup> throughout the year.

### **Experimental work and plant material**

The experimental layout was Randomized Complete Block Design (RCBD) with three replicates. Two weeding were applied (after 15 and 30 days from emergence). The experimental units were irrigated regularly. Well watering continued from the sowing up to five days with equal amount of water at intervals (between 5 and 7 days). Urea fertilizer was applied to the experimental units on two doses, the first one after 21 days from sowing. The experimental materials were Abu-Sabeen seed and urea fertilizer.

### **Studied characters**

#### **Growth attributes**

##### **Number of leaves /plant**

It was obtained by counting the number of leaves per plant at 50% flowering stage.

#### **Yield attributes**

Yield parameters (Fresh and dry weight) per plot were estimated in (g) per m<sup>2</sup> and converted to tons per hectare.

##### **Fresh forage yield (ton/ha)**

It was obtained by using sensitive balance by weighing the fresh weight of the whole plant per plot after cut immediately in the field and final fresh weight expressed in ton/ha.

##### **Dry forage yield (ton/ha)**

It was estimated by weighing the weight of the same of fresh weight after shade-drying for 21 days.

### **Statistical procedure**

Data were collected and analyzed using analysis of variance (ANOVA) [13] and mean separations were obtained by using the Duncan Multiple Range Test (DMRT) at 0.05% level.

## Results and Discussion

### Growth attributes

#### Number of leaves

During the dry season the fourth seed rate (71kg/ha) produced significantly the highest number of leaves per plant (7.0) compared with 6.4 (Table1) which was produced by the second seed rate (48kg/ha). Regarding nitrogen levels, 2N level scored the highest number of leaf per plant (7.4). 8.5 and 5.8 are the highest and the lowest number of leaf per plant that were produced by the first seed rates with 2N level of nitrogen and second seed rate with 0N level of nitrogen, respectively. A high number of leaves which produced in fourth seed rate and 2N dose of urea per plant could be attributed to the optimum nutrient availability of the plant in these treatments. Yagub and Abdelsalam (2010) reported the significant effect of nitrogen when they studied the effect two doses nitrogen and three seed rates. Whereas during the rainy season the results showed that, there were no effect due seed rate and the interaction of nitrogen and seeds rate. A range between 7.2 and 7.5 was the effect of seed rates, 7.3 and 7.5 was the effect nitrogen levels and 6.8 to 8.2 was the effect among their interactions (Table 1). This non significant results could be attributed to that fact, addition of urea fertilizer during rainy season might be leached under root zone, in this case urea had little effect on growth attributes in sandy soils, Mustafa and Abdemaged [14] reported same results, sometimes addition of nitrogen has little effect on number of leaves per plant under various soils.

Treatments	Dry season 2014 (Feb.)				Rainy season 2014 (July)			
	Number of leaves /plant				Number of leaves /plant			
	0N	1N	2N	Mean	0N	1N	2N	Mean
SR <sub>1</sub>	5.9 <sup>d</sup>	5.8 <sup>d</sup>	8.5 <sup>a</sup>	6.7 <sup>ab</sup>	7.4	8.2	7.1	7.6
SR <sub>2</sub>	5.8 <sup>d</sup>	6.4 <sup>d</sup>	7.0 <sup>c</sup>	6.4 <sup>c</sup>	6.8	7.2	7.7	7.2
SR <sub>3</sub>	5.8 <sup>d</sup>	7.5 <sup>bc</sup>	6.2 <sup>d</sup>	6.5 <sup>bc</sup>	8.1	7.8	7.3	7.3
SR <sub>4</sub>	6.2 <sup>d</sup>	7.0 <sup>c</sup>	7.7 <sup>b</sup>	7.0 <sup>a</sup>	6.9	7.1	7.5	7.2
Mean	5.9 <sup>c</sup>	6.7 <sup>b</sup>	7.4 <sup>a</sup>		7.3	7.6	7.3	
Grand mean	<b>6.7</b>				<b>7.3</b>			
	Seed rate	Nitrogen level	Interaction (S×N)		Seed rate	Nitrogen level	Interaction (S×N)	
SE±	0.04	0.03	0.11		0.063	0.047	0.188	
CV%	4.8 %				8.8 %			

**Table 1:** The effect of four seed rates and two levels of nitrogen fertilizer on number of leaves /plant, of Abusabien (*Sorghum bicolor* (L.) Moench) cultivated under irrigated and rain-fed condition, season 2014. Values having similar letter are not significantly different. Values having normal, bold and italic letters compare among seed rates, fertilizer levels and their interactions, respectively.

### Yield attributes

#### Fresh forage yield (ton/ha)

The effect of nitrogen application and seed rate on fresh weight of fodder sorghum showed significant differences in the two seasons. However, fourth and the third seed rates (71, 60 kg/ ha) during the dry season, produced significantly the highest fresh forage yield (3.22 and 3.28 ton/ ha, respectively), compared with 1.23 and 2.06 t/ ha which were produced by the second and the first seed rates (48 and 36 kg /ha), respectively. Regarding nitrogen levels, 2N level scored the highest fresh forage yield (3.19 t/ha). The third seed rate with 2N

level of nitrogen produced 4.63 t/ha significantly as the highest forage fresh weight (Table 2). All the results denoted that the highest yield production was in the third and fourth seed rates and 2N urea application. Sufficiency of nutrients, space and moisture in the soil (no competition among plants) in the third and fourth seed rates could justify these results. And significant results from fertilizer and their interactions could be attributed to, urea used contain nitrogen which positively increased and improved growth parameters such as, plant height, number of leaves and leaf area as well as forage yield. This is in agreement with Reddy, *et al.* [15] and Singh, *et al.* [16] Sheoran and Rana [17] and Joshi Kuldeep and Kumar [18].

Treatments	Dry season 2014 (Feb.)				Rainy season 2014 (July)			
	Fresh forage yield ( ton /ha)				Fresh forage yield (ton/ha)			
	0N	1N	2N	Mean	0N	1N	2N	Mean
SR <sub>1</sub>	1.57 <i>cd</i>	2.27 <i>bc</i>	2.33 <i>bc</i>	2.06 <b>b</b>	5.77 <i>def</i>	5.57 <i>def</i>	5.80 <i>def</i>	5.71 <b>c</b>
SR <sub>2</sub>	1.33 <i>cd</i>	0.63 <i>d</i>	1.77 <i>cd</i>	1.23 <b>b</b>	5.40 <i>ef</i>	4.43 <i>f</i>	6.40 <i>cdef</i>	5.41 <b>c</b>
SR <sub>3</sub>	3.7 <i>ab</i>	1.33 <i>cd</i>	4.63 <i>a</i>	3.22 <b>a</b>	9.03 <i>b</i>	11.60 <i>a</i>	8.00 <i>bc</i>	9.54 <b>a</b>
SR <sub>4</sub>	2.0 <i>cd</i>	3.8 <i>ab</i>	4.03 <i>a</i>	3.28 <b>a</b>	9.40 <i>b</i>	7.37 <i>bcde</i>	7.67 <i>bcd</i>	8.14 <b>b</b>
Mean	2.14 <b>b</b>	2.01 <b>b</b>	3.19 <b>a</b>		7.40 <sup>a</sup>	7.20 <sup>b</sup>	6.97 <b>b</b>	
Grand mean	2.5					7.2		
	Seed rate	Nitrogen level	Interaction (S×N)		Seed rate	Nitrogen level	Interaction (S×N)	
SE±	4.25	1.84	7.35		0.129	0.097	0.386	
CV%	9.9 %				17.9%			

**Table 2:** The effect of four seed rates and two levels of nitrogen fertilizer on Fresh forage weight (ton/ha), of *Abusa bien* (*Sorghum bicolor* (L.) Moench) cultivated under irrigated and rain-fed condition, season 2014. Values having similar letter are not significantly different. Values having normal, bold and italic letters compare among seed rates, fertilizer levels and their interactions, respectively.

In the second season (rainy) there were slight increased in all nitrogen application treatments, seed rates and their interactions (Table 2). The third seed rate significantly scored the highest estimate (9.54 t/ ha). On the other hand, the first and the second seed rates scored the least estimates (5.71 and 5.41 t/ha, respectively). The mean fresh weight among nitrogen levels ranged between 6.98 and 7.40 t/ha. Range of variation between 4.43 and 11.60t/ha was reported in the interaction. The highest fresh yield in zero dose of nitrogen among nitrogen levels could be attributed to the fact that water of rain contain adequate amount of soluble nitrogen in form of nitrate that contain sufficient dose of nitrate to plants. So urea fertilization in 1N and 2N might be overdoses. Yagoub and Abdelsalam [6] obtained different results when they studied the effect of nitrogen doses at Shambat area.

**Dry forage yield (ton/ha)**

Forage yield in terms of dry matter production was investigated in this study during the dry and rainy season. Table 3, showed that, the third seed rates (60kg/ha) in dry season produced significantly the highest dry forage yield (0.98 t/ha) compared with 0.47 and 0.40 t/ha that were produced by the first and the second seed rates, respectively (36 and 48kg/ha). Regarding nitrogen levels, 2N level scored the highest dry forage yield (0.73 t/ha). The third seed rate with 0N level of nitrogen produced significantly the highest forage dry weight

(1.34 t/ha). Generally, fertilization increased forage yield during the growing period and application of urea increased the fresh weight might be due to that fact the dry weight was also increased, this results was in agreement with Khair and Salih [19]. On the other hand on rainy season the significance effect on this trait was only observed among seed rates (Table 3). The third seed rate significantly scored the highest fresh weight (3.06 t/ha). However, the first and the second seed rates scored the least estimates (1.67 and 1.35 t/ha, respectively). The mean fresh weight among nitrogen levels ranged between 2.13 and 2.33 t/ha (Table 3). This result could be attributed the high number of plant in third and fourth seed rate strongly contributed in increasing fresh and dry forage weight at same time. Similar results were obtained by Khair (1999) reported that *Sorghum bicolor* increased in yield with increase of plant population from 8-15 plants/m<sup>2</sup>.

Treatments	Dry season 2014 (Feb.)				Rainy season 2014(July)			
	Dry forage yield ( ton /ha)				Dry forage yield (ton/ha)			
	0N	1N	2N	Mean	0N	1N	2N	Mean
SR <sub>1</sub>	0.53 <i>de</i>	0.42 <i>f</i>	0.45 <i>ef</i>	0.46 <i>c</i>	1.84	1.43	1.73	1.67 <i>c</i>
SR <sub>2</sub>	0.45 <i>ef</i>	0.32 <i>g</i>	0.43 <i>ef</i>	0.40 <i>d</i>	1.18	1.11	1.78	1.35 <i>c</i>
SR <sub>3</sub>	1.34 <i>a</i>	0.52 <i>def</i>	1.08 <i>b</i>	0.98 <i>a</i>	2.98	3.38	2.82	3.06 <i>a</i>
SR <sub>4</sub>	0.61 <i>d</i>	1.13 <i>b</i>	0.96 <i>c</i>	0.89 <i>b</i>	2.51	2.30	2.97	2.59 <i>b</i>
Mean	0.73 <i>a</i>	0.60 <i>b</i>	0.73 <i>a</i>	0.69	2.13	2.05	2.33	
Grand mean	0.68				<b>2.2</b>			
	Seed rate	Nitrogen level	Interaction (S×N)		Seed rate	Nitrogen level	Interaction (S×N)	
SE±	0.006	0.005	0.018		0.44	0.33	1.32	
CV%	8.5 %				16.1 %			

**Table 3:** The effect of four seed rates and two levels of nitrogen fertilizer on dry forage yield (ton/ha), of Abusabien (*Sorghum bicolor* (L.) Moench) cultivated under irrigated and rain-fed condition, season 2014. Values having similar letter are not significantly different. Values having normal, bold and italic letters compare among seed rates, fertilizer levels and their interactions, respectively.

## Conclusion

Wide range of variation in growth attributes, and forage yields (fresh and dry) were observed between the two seasons. Forage yield of Abusabien was significantly improved by using the fourth seed rate (71 kg of seed / ha) in dry or rainy seasons and 2N of urea fertilization in dry season only. Urea fertilization gave negative results in some traits during rainy season experiment. A more exploring study with smaller levels of nitrogen and different sorghum cultivars is recommended.

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