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# Effect Of Seed Rate And Nitrogen Fertilizer On Forage Yield Of Sudangrass (Sorghum Sudanense "Piper" Stapf) In Central Sudan

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***Abstract: Sudan grass is an important forage crop in the Sudan. The objective of this study was to study the effect of seed rate and nitrogen fertilizer on forage yield of Sudan grass. A field experiment was conducted at the experimental farm, of the faculty of Agricultural Sciences, University of Gezira, Wad Medani, Sudan for two seasons summer and autumn of 2012. Four seed rates namely, 12, 24, 36 and 48 kg/ha and three levels of nitrogen fertilizer in form of urea 0, 43 and 86 kg/ha were used. Treatments were arranged in a randomized complete block design (RCBD) with four replications. The results showed that growth characteristics plants/m$^2$, plant height, and dry forage yield of sudangrass were affected by both seed rate and nitrogen fertilizer application. Seed rate significantly increased dry forage yield of Sudan grass. The highest dry forage yield of 4.4 and 4.5 t/ha was obtained when a seed rate of 48 kg/ha was used in summer and autumn seasons, respectively, however, there was no significant difference in dry forage yield of Sudan grass between 36 and 48 kg/ha. Addition of nitrogen significantly increased dry forage yield. The highest dry forage yield of 5.2 t/ha was obtained when 86 kg of nitrogen per hectare was added. Interaction effect of seed rate and nitrogen on dry forage yield was significant. The highest dry forage yield of 5.8 t/ha was obtained when a seed rate of 36 kg/ha coupled with 86 kg N/ha was used during the autumn season. Based on these results it could be recommended that to obtain high dry forage yield from sudangrass, a seed rate of 36 Kg/ha and nitrogen at the rate of 86 kg/ha (187 kg urea/ha) should be used.***



## I. INTRODUCTION

The use of forage crop has increased in recent years to meet an increasing demand for animal products for both local consumption and export (Kambal, 1972). Plans are under way to develop new areas for intensive forage production.

Since Sudan grass (*Sorghum sudanense*) is a promising forage crop that can be grown under irrigation, it is of interest to study the performance of the crop under different technological packages to improve it's forage production which was neglected in the Sudan for a long period of time. Recently policies to include forage crops in the rotation of the irrigated agricultural schemes of the Sudan have initiated some minor research activities (Hassan, 2005).

Sudan grass is a tropical forage crop with a good nutritive value, the crop is not widely known, so that it is only found in very limited areas along the Nile river in the central and Khartoum States. Skerman and Rivers (1990) reported that Sudan grass is a very distinct type of forage which was considered one of the most commonly used summer forage crops in the subtropical areas of the world.

The crop is very leafy with very fast regrowth after cutting or grazing. Sudan grass can be a promising crop to solve the forage dry matter shortage during the winter season and emergencies.

Sudan grass is a drought tolerant forage crop (McKinley, 1999). Bogdan (1977) reported that Sudan grass is suitable only for areas with warm or hot dry summer and has little success in humid tropics. According to Relwani, (1968) in the USA, Sudan grass and Lucerne mixtures are grown successfully in irrigated areas.

The crop flowers a round two months from sowing (Al-Bakri *et al*., 2003) and it's herbage is rich in crude protein. According to Farhoomand and Wedin, (1968) ,the average crude protein content of Sudan grass in the herbage reaches about 12% whereas, young plants contain up to 16% crude protein. The crude fiber content of the crop is not high and seldom exceeds 30%. Also Ipats and Brohi (2003) reported that the positive response to nitrogen in increasing crude protein content of sudangrass has been obtained by many investigators. El telib and Ali (2006) reported that nitrogen treatment significantly increased the forge dry matter yield of Sudan grass.

Research dealing with the effects of seed rate and nitrogen fertilizer on forage yield of sudangrass in Sudan is scarce, therefore this study is designed with the objective of studying the effect of seed rate and nitrogen fertilizer on forage yield of sudangrass.

## II. MATERIALS AND METHODS

### A. EXPERIMENTAL SITE

An experiment was conducted at the experiment farm of the faculty of Agricultural Sciences, University of Gezira, Wad Medani, Sudan for two seasons. The first season (summer) was executed in the 15$^{th}$of March, 2012 and the second season (autumn) was done in the 15$^{th}$ of July, 2012 (Latitude 14°06′ N and longitude 33° 38′ E) 407 m above sea level. The soil of the experimental site is dark brown and deep cracking heavy clay with low permeability when moist with low nitrogen content (0.03%) and the available phosphorus ranges from (4 -6) mg/kg soil. The soil of the site non-saline and non-sodic (A.I Adam. personal communication).

### B. TREATMENTS, DESIGN AND CULTURAL PRACTICES

Treatments consisted of four seed rates of sudangrass namely 12, 24, 36, 48kg/ha and three levels of nitrogen, viz, 0, 43 and 86 kg N/ha, giving a total of 12 treatments arranged in a randomized complete block design (RCBD) with four replications. Urea (46% N) was used as the nitrogen source. Seeds of sudangrass used in this experiment were obtained from the local market.

The experiment was sown on the 15$^{th}$ of March 2012 (summer) and 15$^{th}$ of July 2012 (autumn). The experimental site was disc plowed, harrowed, leveled and ridged into 80cm. The size of each experimental unit was 6 m × 4 m. The spaces between experimental units was 1.00 m and between replication was 2.00 m. Seeds of sudangrass were broadcast on flat before ridging. The crop was irrigated immediately after sowing and then at 7 -10 day intervals according to the crop needs. Each plot was irrigated separately to avoid nitrogen movement to adjacent plots. Nitrogen fertilizer was applied after ridging. The experimental plots were kept weed free by hand weeding. In each season, one cut was taken at the flowering stage.

### C. PARAMETERS MEASURED INCLUDE

Plant population, number of tillers per plant, plant height and dry matter yield.

### D. NUMBER OF PLANTS/M$^2$

Plant population was determined three weeks after sowing and at the flowering stage by taking a sample of one m$^2$ (125cm along 80cm ridge) twice from each experimental unit at random. Plants of each square meter were counted and the average was determined.

### E. NUMBER OF TILLERS PER PLANT

Number of tillers/plant was counted at flowering by taking five plants from each experimental unit randomly and then the average number of tillers per plant was determined.

### F. PLANT HEIGHT (CM)

Plant height was measured as an average height of five plants per plot at the 100% flowering stage taken from the soil surface to the tip of the inflorescence

### G. AIR DRY FORAGE YIELD (T/HA)

Air dry forage yield was obtained by taken a fresh sample of one meter square which was repeated three times from each experimental unit, air dried for four weeks, weighed till a constant weight was reached, which represented average dry matter yield.

### H. STATISTICAL ANALYSIS

Statistical analysis of data was done using the standard analysis of variance procedure and means were separated using Duncan's Multiple Range Test (DMRT).

| Month | Temperature(C$^o$) | | Relative humidity (% ) | Rain fall (mm ) |
|---|---|---|---|---|
| | Max. | Min. | | |
| January | 32.4 | 19.5 | 31 | Nil |
| February | 37.0 | 16.6 | 27 | Nil |
| March | 39.1 | 19.1 | 24 | Nil |
| April | 42.5 | 21.0 | 28 | Nil |
| May | 48.0 | 36.0 | 47 | Nil |
| June | 40.0 | 25.1 | 63 | 130.6 |
| July | 35.8 | 23.1 | 69 | 89.1 |
| August | 34.0 | 22.1 | 60 | 37.0 |
| September | 44.1 | 22.9 | 48 | 39.6 |
| October | 37.1 | 18.7 | 40 | Nil |
| Total | | | | 296.3 |

*Source: Meteorological Station, Agricultural Research Corporation (ARC), Wad Medani, Sudan*

*Table 1: Monthly means of selected meteorological data recorded during (summer, 2012) and (autumn, 2012) seasons*

## III. RESULTS AND DISCUSSION

### A. NUMBER OF PLANTS/M$^2$

Effect of seed rate and nitrogen fertilizer application on number of plant/m$^2$ of sudangrass is shown in table (2). The results showed significant differences among treatments for number of plants/m$^2$ in both seasons.

Seed rate has a significant effect on number of plants/m$^2$. Number of plants/m$^2$ significantly increased with the increase in seed rate. There were no differences in number of plants/m$^2$ between summer and autumn seasons (2012). The highest number plants/m$^2$ 211 plants/m$^2$, in the first season and 195 plants/m$^2$ in the second season, were obtained at the seed rate of 48kg/ha, whereas the lowest number plants/m$^2$ were obtained at seed rate of 12 kg/ha, which gave 118 and 107 plants/m$^2$ in the first and second seasons, respectively.

The increase in number of plants/m$^2$ can be attributed mainly to the differences in seed rates. These results agreed with Khair (1999) who found that the highest seed rate of sudangrass significantly increased the number of plants/m$^2$.

Nitrogen application had no significant effect on number of plants/m$^2$ in both seasons. However, the seed rate and nitrogen Fertilizer application interaction for number of plants/m$^2$ was significant in both seasons. The highest number of plants/m$^2$ was obtained by the 48 kg/ha seed rate and 86 Kg N/ha which gave 217 and 213 plant/m$^2$ in the summer and autumn seasons respectively, whereas the lowest number of plant/m$^2$ were obtained at 12 kg/ha seed rate and 0N which gave 112 and 83 plant/m$^2$ in the first and second seasons, respectively.

| Seed rate(Kg/ha) | Nitrogen rate (kg N/ha) 0 | 43 | 86 | Mean |
|---|---|---|---|---|
| **Summer season** | | | | |
| 12 | 112 h | 140 g | 101 i | 118 D |
| 24 | 139 g | 148 f | 140 g | 142 C |
| 36 | 164 e | 186 d | 153 f | 168 B |
| 48 | 211 b | 205 c | 217 a | 211 A |
| Mean | 157 A | 170 A | 153 A | |
| SE ± | | 14.95 | | |
| CV(%) | | | 18.64 | |
| **Autumn season** | | | | |
| 12 | 83 h | 113 g | 125 f | 107 D |
| 24 | 167 d | 156 e | 127 f | 150 C |
| 36 | 177 c | 182 bc | 158 e | 172 B |
| 48 | 183 bc | 188 b | 213 a | 195 A |
| Mean | 153 A | 160 A | 156 A | |
| SE ± | | 20.23 | | |
| CV(%) | | | 25.96 | |

*Table 2: Effect of seed rate and nitrogen on number of plants/m$^2$ of sudangrass grown at the Experimental Farm of the Faculty of Agricultural Sciences, during summer and autumn seasons (2012)*

Means within column or row followed by the same letter (s) are not significantly different at 0.05 probability level according to Duncan's Multiple Range Test (DMRT)

The increase in number of plants/m$^2$ may be due to increasing seed rate, this result agree with Burnside *et al.*, (1964) concluded that the narrow spacing increased plant sorghum number of plants and sorghum heads number per acre.

### B. PLANT HEIGHT (CM)

Effect of seed rate and nitrogen fertilizer application on plant height of Sudan grass is shown in table (3).Seed rate had significant effects on plant height in both seasons. However, the average of plant height in the autumn season (177.9cm) was higher than the summer season (152.6cm). That was probably due to the suitable growth conditions during the autumn season, such as availability of moisture and optimum temperature which encouraged plant growth.

Nitrogen rate application had significant effects on plant height in both seasons. Taller plants were obtained by the use of 86 kg/ha which gave 173.4 and 206.6cm in the summer and autumn seasons, respectively. Whereas the shorter plants were obtained by the use of the control (ON kg/ha) which gave 119.6 and 144.5cm in the summer and autumn seasons, respectively.

The interaction between the seed rate and nitrogen application on plant height was significant in both seasons. The tallest plants (178 and 210.6cm) in the summer and autumn seasons, respectively were obtained by the use of 12 kg seed rate/ha of seed rate and application of 86 kg N/ha whereas the shortest plants were obtained by the use of 48 kg/ha seed rate coupled with the control (ON kg/ha) which gave (111.5 and 136.9cm) in the summer and autumn season respectively. The decrease in plant heights can be attributed to competition for nutrients in summer season only whereas, the decrease in plants heights in winter season cane be attributed to competition for light(cloudy conditions). These results were in disagreement with Arnon (1975), who reported that plants grow taller in denser population i.e. narrow spacing also Sharma (1973) showed that the addition of nitrogen fertilizer increased the plant height. Lourenco and Beasichem (1993) in Portugal reported that application of nitrogen fertilizer up to 100kg/ha increased the plant height and number of sudangrass. Abdelrauf *et al.*, (1976) studied the influence of nitrogen fertilizer on plant height of sorghum plants and reported that plant heights of 177.5, 180.7, 206.4, and 210.5cm were obtained at nitrogen rates of 21.5, 41.6, 61.5 and 82 kg N/ha, respectively.

Mustafa and Abdelmagied (1982) working on forage sorghum also found that nitrogen significantly increased plant height, Pokle *et al.*, (1974) and Naik (1978) in India reported that 240 kg N/ha increased the plant height of forage sorghum, a similar trend was found by Banaras *et al.*, (1983) in India who recommended 240 kg N/ha rate for greatest plant height. These results however disagreed with Reddy and Husain, (1968) in India Stated that sorghum height was not influenced by nitrogen. Abukhraiz, (2007) in Sudan, reported that plant height of Sudan grass was not significantly affected by the application of NPK fertilizer.

### C. EFFECT OF SEED RATE AND NITROGEN FERTILIZER ON NUMBER OF TILLERS/PLANT

Both seed rate and nitrogen fertilizer has no significant effect on tiller number plant. The average number of tillers/plant ranged from one to two tillers/plant (Table 4)

| Seed rate (Kg/ha) | Summer season Nitrogen rate (kg N /ha) | | | Mean |
|---|---|---|---|---|
| | 0 | 43 | 86 | |
| 12 | 130.5 e | 155.4 e | 178 a | 154.6 A |
| 24 | 122.7 g | 170.7 c | 174.3 abc | 155.9 A |
| 36 | 113.7 h | 172.3 bc | 176.7 ab | 154.3 A |
| 48 | 111.5 h | 160.2 d | 164.6 d | 145.4 B |
| Mean | 119.6 C | 164.7 B | 173.4 A | |
| SE ± | | 10.51 | | |
| | CV(%) | | 13.78 | |
| | | **Autumn season** | | |
| 12 | 136.9 h | 174.9 d | 210.6 a | 174.1 C |
| 24 | 138.4 h | 189.9 c | 209.1 a | 179.1 B |
| 36 | 156.6 f | 164.5 e | 207.8 a | 176.3 B |
| 48 | 145.9 g | 202.1 b | 199 b | 182.3 A |
| Mean | 144.5 C | 182.9 B | 206.6 A | |
| SE ± | | 9.62 | | |
| | CV(%) | | 10.82 | |

*Table 3: Effect of seed rate and nitrogen fertilizer on Plant height (cm) of sudangrass grown at the experimental farm of the Faculty of Agricultural Sciences, during summer and autumn seasons (2012)*

Means within column or row followed by the same letter(s) are not significantly different at 0.05 probability level according to Duncan's Multiple Range Test (DMRT)

| Seed rate(Kg/ha | Summer season Nitrogen rate (kg N/ha) | | | Mean |
|---|---|---|---|---|
| | 0 | 43 | 86 | |
| 12 | 1a | 1a | 1a | 1A |
| 24 | 1a | 1a | 1a | 1A |
| 36 | 1a | 1a | 1a | 1A |
| 48 | 1a | 1a | 1a | 1A |
| Mean | 1A | 1A | 1A | |
| SE ± | | 0.143 | | |
| | CV(%) | | 24.8 | |
| | | **Autumn season** | | |
| 12 | 1a | 1a | 2a | 1A |
| 24 | 1a | 1a | 2a | 1A |
| 36 | 1a | 1a | 2a | 1A |
| 48 | 1a | 1a | 1a | 1A |
| Mean | 1B | 1B | 2A | |
| SE ± | | 0.1 | | |
| | CV(%) | | 21.57 | |

*Table 4: Effect of seed rate and nitrogen fertilizer on number of tillers /plant of sudangrass grown at the experimental farm of the Faculty of Agricultural Sciences during summer and autumn seasons (2012)*

Means within column or row followed by the same letter (s) are not significantly different at 0.05 probability level according to Duncan's Multiple Range Tests (DMRT)

## D. DRY FORAGE YIELD

Effect of seed rate and nitrogen application on dry forage yield of sudangrass is shown in table (5). The results showed that there were significant differences among treatments in both seasons. The average dry forage yield in the autumn season (4.4 t/ha) was relatively the same that of the summer season (4.5 t/ha).

Effect of seed rate had a significant effect on dry forage yield in both seasons. The highest mean dry forage yield of 4.4 and 4.5t/ha in the summer and autumn seasons, respectively were obtained by the use of 48kg/ha of seed rate in the summer season and 36 and 48 kg/ha of seed rate in the autumn season. The lowest dry forage yield was obtained at seed rate of 12 kg/ha, which gave 3.2 and 3.3 t/ha in the summer and autumn seasons, respectively.

The influence of nitrogen fertilizer on dry forage yield was significant in both seasons. The higher dry forage yield of 5.2 in the summer and autumn seasons, respectively were obtained by the application of 86 kg N/ha. However, the lowest mean dry forage yield was obtained by the control (0 kg N/ha) which gave 2.3 and 2.4 t/ha in the summer and autumn seasons, respectively.

The interaction effect of seed rate and nitrogen fertilizer on dry forage yield was significant in both seasons. The highest mean dry forage yield of 5.6 and 5.8 t/ha in the summer and autumn seasons, respectively were obtained by using 36 kg/ha seed rate coupled with 86 kg N/ha. The lowest mean dry forage yield were obtained by the use of 12kg/ha of seed rate coupled with the control (0kg N/ha) which gave 1.9 and 2 t/ha in summer and autumn seasons, respectively.

The results were also in agreement with the results reported by Bebawi and Mazloum (1986) who studied the effects of sowing pattern and seed rate on yield of forage sorghum, and found that yield was greater when a seed rate of 70 kg/ha was used as compared to 35kg/ha.

In the Sudan the application of 88 kg N/ha significantly increased the total dry matter yield of forage sorghum "Abu Sabeen" and *Sorghum sudanense* (Ibrahim, 1994b). Bowman *et al*., (1991) stated that nitrogen application increased dry matter yield and crude protein content of Sudan grass hybrid. Also, Rai *et al.* (1980), Prasad *et al.*( 1984), Sharma *et al.*, (1984), and El telib *et al.*, (2006) reported that nitrogen treatments increased forage dry matter significantly over the control by 30% for 2N and 24.4% for 3N. Lunnan and Nesheim, (2002) reported that application of urea increased the fresh weight of Abu sabeen and pioneer 988. However, Bebawi (1988) stated that nitrogen application did not affect the dry matter yield. Abu Suwar and Mohammed (1997), Khalil (1987) working with forage sorghum found that there was positive relationship between nitrogen and dry forage yield.

The combined effects of seed rate and seasons on dry forage yield of sudangrass is presented in table (6). Significant differences were recorded for dry forage yield between the two seasons. The higher dry forage yield (4.1 t/ha) was obtained at the autumn season compared to the summer season (3.9 t/ha) for the combined effects of seed rate and nitrogen application. The highest dry forage yield (4.5 t/ha) was obtained during autumn season when 48 kg/ha seed rate was practiced. The increase in dry forage yield can be attributed to increasing in seed rate.

The combined effects of nitrogen application and seasons on dry forage yield (t/ha) of sudangrass is shown in table (7). The highest dry forage yield (5.2 t/ha) was obtained during both seasons when 86 kg N/ha was practiced. The increase in dry forage yield in both seasons was due to application of nitrogen, which significantly increased plant height and number of tillers/plant. These results agreed with the findings of Sulieman (2009) who reported a significant increase in dry matter yield in Sudan grass crop by addition of 86 kg N/ha.

| Seed rate(Kg/ha | Nitrogen rate (kg N/ha) 0 | 43 | 86 | Mean |
|---|---|---|---|---|
| **Summer season** | | | | |
| 12 | 1.9 i | 3.2 f | 4.5 d | 3.2 C |
| 24 | 2.3 h | 4.0 e | 5.3 b | 3.9 B |
| 36 | 2.2 h | 4.4 d | 5.6 a | 4.1 A |
| 48 | 2.7 g | 5.2 c | 5.3 b | 4.4 A |
| Mean | 2.3 C | 4.2B | 5.2 A | |
| SE ± | | 0.5667 | | |
| CV(%) | | | 29.2 | |
| **Autumn season** | | | | |
| 12 | 2 h | 3.5 e | 4.4 d | 3.3 C |
| 24 | 2.3 g | 4.4 d | 5.2 c | 4.0 B |
| 36 | 2.4 f | 5.0 c | 5.8 a | 4.5 A |
| 48 | 2.4 f | 5.7 a | 5.4 b | 4.5 A |
| Mean | 2.4 C | 4.7 B | 5.2 A | |
| SE ± | | 0.4210 | | |
| CV(%) | | | 22.7 | |

*Table 5: Effect of seed rate and nitrogen fertilizer on dry forage yield (t/ha) of sudangrass grown at the experimental farm of the Faculty of Agricultural Sciences during summer and autumn seasons (2012)*

Means within column or row followed by the same letter (s) are not significantly different at 0.05 probability level according to Duncan's Multiple Range Tests (DMRT)

| **Season** | **Seed rate kg/ha** 12 | 24 | 36 | 48 | **Mean** |
|---|---|---|---|---|---|
| Summer | 3.2 c | 3.9 b | 4 b | 4.4 a | **3.9 A** |
| Autumn | 3.3 c | 4 b | 4.4 a | 4.5 a | **4.1 A** |
| Mean | **3.3 D** | **4 C** | **4.2 B** | **4.5 A** | |
| SE ± | | 0.21 | | | |
| CV (%) | | | | 25 | |

*Table 6: Combined effects of seed rate and seasons on dry forage Yield (t/ha) of sudangrass grown at the experimental Farm of the Faculty of Agricultural Sciences, University of Gezira, Sudan, during (summer, and autumn 2012)*

Means within column or row followed by the same letter(s) are not significantly different at 0.05 probability level according to Duncan's Multiple Range Test (DMRT)

| **Season** | **Combined Analysis** **Nitrogen rate kg N/ha** 0 | 43 | 86 | **Mean** |
|---|---|---|---|---|
| Summer | 2.24 d | 4.2 c | 5.2 a | **3.9 A** |
| Autumn | 2.3 d | 4.7 b | 5.2 a | **4.1 A** |
| Mean | **2.3 C** | **4.5 B** | **5.2 A** | |
| SE ± | | 0.18 | | |
| CV (%) | | | 25 | |

*Table 7: Combined effects of nitrogen fertilizer and seasons on dry forage Yield (t/ha) of sudangrass grown at the experimental Farm of the Faculty of Agricultural Sciences, University of Gezira, Sudan, during summer and autumn seasons (2012)*

Means within column or row followed by the same letter (s) are not significantly different at 0.05 probability level according to Duncan's Multiple Range Test (DMRT).

## IV. SUMMARY AND RECOMMENDATION

Seed rate and nitrogen effect on growth performance and forage yield of sudangrass was studied in summer and autumn of 2012. The results of the study showed that:

- ✓ Increasing seed rate up to 48 kg/ha significantly increased number of plants/m2 and dry forage yield, however the differences was not significant different from 36 kg seed rate/ha.
- ✓ Nitrogen application up to 86 kg N/ha significantly increased the dry forage yield, however the difference was not significant different from 36 kg seed rate/ha.
- ✓ Different parameters (plant height, number of tillers/plant and dry forage yield) studied showed higher values at autumn season than the summer season.

## V. RECOMMENDATION

Based on these results it could be suggested that, to obtain high forage yield of sudangrass a seed rate of 36 kg/ha and nitrogen at a rate of 86 kg N/h(187 kg urea/ha) should be adopted.

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