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Effect of sowing dates and nitrogen fertilization levels on green forage yield and chemical composition of Sorghum hybrid

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Abstract

This investigation was conducted at two field experiments in research farm of the Agricultural Research Center, Sakha, Kafr El- Sheikh Governorate, during the two successive summer seasons of 2022 and 2023. This aimed to study the effect of four planting dates (T1 (1st may,), T2 (15th May), T3 (1st June) and T4 (15th June) with four nitrogen fertilization levels (without N addition (N1), 20 kg N/fad. (N2), 30 kg N/Fad. (N3), and 40 kg N/fad. (N4), on forage yield and quality of sorghum hybrid. A split-plot design with three replications was used in both growing seasons. The most important findings could be summarized as follows: the results showed that planting date in 1st May led to a significant increase in fresh forage yield (cut) / fad. This increase compared to the other planting dates (15th May, 1st June, and 15th June) which recorded to 17.46%, 20.97% and 33.05 % in the first cut, 9.08% ,25.70%, and 31.28% in the second cut and 10.67%, 10.28% and 23.55 % in the third cut respectively, in the combined. Also planting date in 1st May, resulted significant increase in dry matter %, dry leaves / stem ratio, crude protein %, and Ash % While the percentage of crude fiber decreased in this planting date. Increasing nitrogen level from 0.0 kg to 40 kg/N fad. Increase fresh forage yield (cut) / fad; by 61.14%, 26.08% and 14.74% in the 1st cut, 54.20%, 22.13 % and7.85 % in the 2nd cut and 77.70%, 24.27% and 7.77% in the 3rd cut respectively, in the combined. Also, the dry matter percentage increased by increasing N –level from 0 up to 40 kg/fad. and was produced gradual and significant increases in fresh forage yield (cut) / fad., dry leaves/stem ratio, Crude protein %, crude fiber % and Ash %. Regarding the interaction effect, the treatment of sowing date in 1st May and nitrogen fertilization levels of 40 kg / fad., was recorded the highest values of most studied characters in this respect.

Keywords: Sorghum, Sowing dates, Nitrogen fertilization levels.

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1. Introduction

The fodder sorghum crop is a green summer fodder resulting from the hybridization of sorghum and Sudan grass. This hybrid is characterized by abundant branching, large leaf area, and increased yield, reaching (45-50 tons/fad.) per season, and also an increase in its protein content from (10-14%). It is offered to livestock either in fresh, green form (mowed, grazed) or preserved in the form of hay. The nutritional value varies according to age of plant, as the percentage of protein decreases, the percentage of fiber increases, and animal appetite, palatability, and the amount of digested matter decrease as the plant ages. It is taken from 3-4 cuttings per season, and it may reach five cuttings in the case of early planting the first of May [1]. Sorghums are warm –season (C4 photosynthesis bath way) short-day annual grass it grows best under relatively high temperature and under gunny conditions sorghums as a crop originated as far back as 3000 years ago. Forage sorghums is similar to grain types early times was for grain more than forage, however, forage varieties have been occurring for the last hundred years, forage sorghum is similar to grain types, but is taller and has higher forage quality, the forage sorghums are further grouped into four types (a) hybrid forage sorghum, (b) Sudan grass, (c) sorghum. Sudan grass hybrid (also known as Sudan grass hybrids), and (c) sweet sorghum. Sorghum, Sorghum bicolor L., is an important fodder crop for both arid and semi-arid regions of the world. This importance is due to its higher water use efficiency, relatively good to tolerance to drought and salt stresses, potential for tillering in high amounts, and good competitiveness with weeds in advanced growth stages.

Planting date has a key role in establishment the crop, especially in mild cold areas, where sorghum is damaged from early or late sowing dates. In such a climatic condition, proper nitrogen application has an important role for fast growth and green forage production too. Increasing productivity can be achieved in several ways, including planting dates and adding fertilizers to plants to increase green forage productivity and their quality. A previous study [2] evaluated the effect of sowing dates of hybrid silage sorghum and found that the sowing dates caused changes in the green and dry mass yield, with decreasing yields as the sorghum sowing time was delayed. Also, he found that the lowest value observed in the last sowing date. [3] evaluated the effect of plant density and sowing date on Forage Sorghum. He found it The highest and the lowest forage dry weight were achieved from sowing date of 23 July and 2 August, respectively. Stem diameter and the number of tiller per plant were significantly redacted as sowing date was delayed. With early planting, leaf to stem dry weight ratio was significantly increased. The lowest forage dry weight (787.91 gr m-2) was produced at the sowing date of 2 Aug and density of 15 plants m-2 (633.98 gr m^{-2}).

A previous study [4], reported that planting date of June 10th gave the highest values of forage yield, crude protein, Crude fiber percentage and ash percent compared to planning dates of June 26th and July 11th. A previous study [5] described the effect of sowing dates on sorghum (11th June, 26th June and 10th July), He found that the crop sown on 11th June and 26th June recorded significantly higher plant height, dry matter accumulation and leaf area index as compared to 10th July sowing. Sowing of 11th June and 26th June also recorded significantly highest green fodder yield and dry matter yield. Crude protein content was also found higher values in the first two sowings however the crude fiber content was found higher in 3rd sowing. These results are in agreement with those obtained by [6,7]. [8] in Pakistan studied the forage sorghum under five sowing dates (1st February, 15th February, 1st March, 15th March and 1st April) during 2018 as well as 2019 at Faisalabad. The line AK-113 showed the highest green fodder yield as an average of 3 cuts on the 15th of March during 2018 as well as 2019. In addition, green fodder yield as average of 3 cuts (tons/ha) were gradually increased with delaying planting date from 1st February to 1st April in the two seasons for check hybrid Pak Sudex.

Nitrogen is an important nutrient because of its many functions in the vital processes of plant growth and development. Nitrogen deficiency imposes most limits on crop production compared to the other nutrients.Sorghum yield and its attributed physiological properties is significantly affected by nitrogen fertility. Nitrogen fertilizer application increases forage yield and its quality [9,10,11]. Several reports showed that sorghum had severed reaction to nitrogen fertility on sorghum reported that highest yield was produced by application 125 kg nitrogen per hectare.

A previous study [12] evaluated forage sorghum (*Sorghum bicolor*) (*Avena strigosa*) under nitrogen fertilization in Brazil, in Rhodic Hapludox soil. Treatments included 0, 37.5, 75, 150, 225, 300, and 375 $kgNha^{-1}$ in the summer seasons of 2010/2011 and 2011/2012. The highest sorghum forage production and N extraction were under 230 to 300 $kgNha^{-1}$. [13] investigated the effects of nitrogen fertilizer on yield and quality of three forage sorghum cultivars in Iran, during 2010-11 cropping season. Four levels of nitrogen fertilizer (0, 50, 100 and 150 kg ha^{-1}) were used. Increasing nitrogen levels increased the values of forage yield, protein % and ash %, and the highest forage yield was obtained with 150 kg ha^{-1} nitrogen at first harvesting time.

A previous study [14] found that the N fertilization significantly increased all growth parameters and forage yield of sorghum over control., application of 100 kg /ha-1 significantly enhanced the growth parameters such as dry matter accumulation and Forage yield was significantly enhanced with an increase in level of N fertilization and application of 100 kg /ha^{-1} resulted in the production of highest forage yield. [15] evaluated the effects of different levels of nitrogen fertilizer on the sorghum forage yield and quality. Use nitrogen fertilizer application from urea source at four levels (0, 150, 300, and 450 kg ha^{-1}) The effect of nitrogen fertilizer was significant on the forage yield, plant height, and quality characteristics of sorghum forage (except hemicellulose) and the highest dry-matter and protein yield (40.03 and 3.48 t ha^{-1}, respectively).

This study aims to investigate the effect of sowing dates and nitrogen fertilization levels on forage yield and quality composition of sorghum hybrid under Egyptian conditions.

2. Materials and Methods

This investigation was conducted at two field experiments in research farm of the Agricultural Research Center in Sakha, Kafr El- Sheikh Governorate, Egypt, during the two successive seasons of 2022 and 2023. This investigation aimed to study the effect of four planting dates and four levels nitrogen fertilization on growth characteristics, forage yield and forage quality of sorghum hybrid.

2.1. Soil preparation

The soil of the experimental site is clay in texture. The mechanical and chemical analysis of soil at the planting depth in the two growing seasons are given in Table (1).

2.2. Factors under study

1- Planting dates: four planting dates were studied as follows:

1st May b) 15th May c) 1st June d) 15th June

2- Nitrogen fertilization: four levels nitrogen fertilization were applied:

Zero (control) b) 20 kg N / fad. c) 30 kg N / fad. d) 40 kg / fad.

Table 1: Some physical and chemical properties of the experimental sites at 30 cm soil depth (in the two seasons

Soil fertility characteristic	First Season (2022)	Second Season (2023)
Mechanical analysis		
Sand %	14.02	13.46
Silt %	28.99	25..83
Clay %	57.19	60.71
Soil texture	Clay	Clay
Chemical analysis		
pH (1: 2.5susp.)	7.99	8.03
ECe (Soil paste at 25°C)	0.93 ds / m	0.96 ds / m
Soil-CEC (cmol kg-1) (Amm. acetate ext.)	45.20	44.80
O.M % (Wakely & Black method)	1.35	1.47
Available N (mg/kg) (K2SO4 ext.)	30.01	29.75
Available P (mg/kg) (Olsen ext.)	9.59	9.13
Available K (mg/kg) (Amm. acetate ext.)	321	297
Available Zn (mg/kg)	0.27	0.23

Notes: 1- Soil analyses were done using representative composite samples.
2- Extraction solution for available N (KCl), P (Na-bicarbonate), K (NH4-acetate)

2.3. Experimental design

The split plot design as a form of the randomized complete block design with three replications was followed in both growing seasons. Since, planting dates treatments were allotted in the main plots, while the four nitrogen fertilizer levels were arranged at random in the sub plots. Each sub- plot area was 9 m2 [3 x 3 m]. The plot contained 6 rows 50 cm apart and the three meters in length.

2.4. Cultural practices

The preceding crop was wheat in both growing seasons, sorghum hybrid (Sakha-1) cultivar seeds were drilled in rows on 1st May, 15th May, 1th June and 15th June in both successive growing seasons 2022 and 2023. Seeding rate was 15 kg/fad. Seeds of sorghum hybrid (Sakha-1) were obtained from Forage Crops Department, Agriculture Research Center, ministry of Agriculture, Egypt.

Nitrogen fertilizer was added at three equal doses: one third was added two weeks after sowing, the second dose was added after the first cutting and the third dose was added after the second cutting. Seeds were sown in rows. All other agronomic practices were applied as recommended for this crop.

Three cuts were taken during each growing season; first cutting was taken at 60 days after sowing, the second cutting at 50 days from the first one and third cutting was taken after 45 days from the second one. At each cutting five surrounded plants were randomly taken from outer two rows to determine vegetative growth parameter as an average per plant.

2.5. Data recorded

1– Fresh forage yield / cut (ton/ fad.). Six m2 from each plot was cut to determine the fresh forage yield per faddan (ton), plots were clipped by a hand sickle to a stubble height of about 10 cm. above land surface and weighted for the determination of fresh forage yield.

2 – Dry matter percentages.

3 – Dry leaves/stem ratio.

4 – Crude protein percentage/cut (%). Was determined according to method [16] which mentioned by [16].

The amount of proteins in the sample could be estimated via reading the absorbance (at 750 nm) using a spectrophotometer (Shimadzu, UV-2450, Tokyo, Japan). The concentration of protein in the sample compared against a standard curve of a protein solution (in our case; Bovine serum albumin-BSA-solution).

5 – Crude fiber percentage per cut. Crude fiber was determined as percentage according to [16].

6 – Ash percentage.

2.6. Statistical analysis

The proper statistical analysis of spilt plot design was used combined analysis was performed for the characters recorded in both seasons. The collected data were statistically analyzed using the Analysis of Variance (ANOVA) to detect significance if any at treatment level. Differences among treatments were judged according to [17]. Means followed by different letters were statistically significant. Small and capital letters were used to compere values of the interaction and average, respectively.

3. Results and Discussion

Data in table 2,3,4,5,6 and 7 show that fresh forage yield, dry matter %, dry leaves/stem ratio, cured protein %, Cured fiber %, and Ash % significantly affected by planting dates. Planting took place on 1st may since.

3.1. Fresh forage yield/cut (ton/fad.)

The average of fresh forage yield/cut (ton/fad.) of different cuts as influenced by sowing dates, nitrogen fertilization levels and their interaction in each season and over the two seasons are presented in Table (2). It was noted that, the fresh forage yield /cut decreased consistently and significantly as planting was delayed from 1th May to 15th June in the 3rd cuts in the two seasons. Moreover, data in Table (2) shows that comparing to sowing in 1st may, over the two seasons, the forage yield /cut (fad.) decreased in the first cut by 3.73, 4.48 and 7.06 tons/fad., in the second cut by 1.53, 4.33 and 5.27 tons/ fad.,1.35, 1.30, and 2.98 in the third cut, i.e the yield decreased in the first cut by 17.46% , 20.97% and 33.05%, in the second cut by 9.08%, 25.70% and 31.28 and in the 3rd cut by 10.67% , 10.28% and 23.55% with delay sowing to 15th May, 1st June and 15th June respectively. While the planting date at 15th May gave the highest yield at the third cut. Here, as mentioned before, the more favorable prevailing contestations during may planting resulted in a high germination percentage and more vigorous seedling hence, a good planting density, establishment and growth were mentioned by [18,19,5,8].

The results presented in Table (2) show also, that the differences among nitrogen fertilization rates over the four sowing dates studied in fresh forage yield/cut(fad.), were significant and to 40 kg N/fad; had always the greatest and highest values of fresh forage yield /cut (fad.), followed by 0, 20 and 30 kg N/fad. These were true in the combined. The increase in growth, fresh forage yields might be attributed to increase in photosynthetic and meristematic activities of plant and improvement the synthesis of protein and amino acids in the presence of adequate available N supply. The highest gross and net monetary returns and benefit: cost ratios were also obtained at 40kg N/fad., that reported by [4,13,14,20].

The interaction effect between sowing dates and nitrogen fertilization levels on fresh forage yield /cut (ton / fad.) at the three cuts in both seasons as well as their combined was significant with except that the second cut in the second season and combined analysis revealed that this interaction no significant .The highest values of fresh forage yield /cut were attained in planting date at 1st May or 40 kg.N / fad., While the lowest values in this respect was attained when sowing date at 15th June with without N fertilization .

3.2. Dry matter percentage

The differences in dry matter % among the 1th May,15th May and 1th June planting dates the average of the second cut in the first season and the 1st cut in the second seasons, were not significant. While the planting date in 1st May gave the highest values. This was true in the third cut in average of combined. However, dry matter % decreased consistently and significantly as planting was delayed from 1th May to 15th June in the three cuts in the two seasons. Moreover, data in table (3) shows that comparing to swing in 1st May, over the two seasons, dry matter % decreased in the first cut by 0.75 ,0.06 and 5.87%, in the second cut by 0.71, 1.13 and 2.03% and 0.66, 1.43 and 1.44 in the 3ed cut of the combined, with delay sowing to 15th may, 1st June and 15th June, respectively. While the planting date of 1th May gave the highest dry matter % in the combined data. Here, as mentioned before, the more favorable prevailing contestations during may planting resulted in a high germination percentage and more vigorous seedling hence, a good planting density, establishment and growth were obtained by [18,21,22,23]**.**

The results presented in Table (3) show also, that the differences among nitrogen fertilization rates over the four sowing dates studied in dry matter percentage were significant and to 40 kg N/fad; had always the greatest and highest dry matter %. Followed by 0, 20 and 30 kg N/fad; in the first cut in the two seasons and combined while there was non- significant increase fertilization by 30 and 40 kg N/fad; in the second and third cuts in both seasons and combined. The increase in growth, dry matter % might be attributed to increase photosynthetic and meristematic activities of plant and improvement in the synthesis of protein and amino acids in the presence of adequate available N supply. The highest gross and net monetary returns and benefit: castrations were also obtained at 40kg N/fad., investigated by [24,25,26,27,28,14,20.29,15].

The interaction effect between the two studied factors on dry matter percentage per sorghum hybrid plant was not significant neither in each growing season nor in the averages of the two seasons and this held true at the third cuts took place.

3.3. Dry leaves / stem ratio

The average of dry leaves/stem ratio as affected by sowing dates, nitrogen fertilization level and their interaction at the three cuts of each season and over the two seasons are given in Table (4). In general, and over the four planting dates dry leaves / stem ratio decreased consistently and significantly as sowing was delayed from 1stMay to 15th June that was true in the different cuts in each season and over the two seasons. However, in the sowing dates of 15th May ,1st June and 15th June in the 1st cut, and in the 1st June and 15th June in the 3rd cut in the combined were not significant in each season and over the two seasons respectively. These results are in the same trend with those obtained by [22,30,31].

The results presented in Table (4) show also, that the differences among nitrogen fertilization rates over the four sowing dates studied in dry leaves / stem ratio, were significant and to 40 kg N/fad. had always the greatest and highest dry leaves/stem ratio followed by 0, 20 and 30 kg N/fad. The increase in dry leaves/stem ratio might be attributed to increase photosynthetic and meristem tic activities of plant and improvement in the synthesis of protein and amino acids in the presence of adequate available N supply. The highest gross and net monetary returns and benefit: Castrations were also obtained at 40kg N/fad., reported by [32,25,33,34,35].

Table 2: Effect of Sowing dates, Nitrogen fertilization rates and their interaction on (fresh forage yield /cut (ton/fad.)) in both seasons (2022 and 2023) and combined

Nitrogen levels (kg/fad).															
	2022season					2023 season					combined				
	0	20	30	40	average	0	20	30	40	average	0	20	30	40	average
								1st cut							
1st May	11.39 ij	17.32 def	19.03 cd	21.96a	17.42 A	21.16 de	25.33 c	30.00 b	34.33 a	27.70 A	16.06 d	19.25 c	23.26 b	26.90 a	21.36 A
15th May	12.30 hij	15.61 fg	18.22 cde	21.45ab	16.89 A	12.16 ij	17.30 e-h	19.80 def	22.00 cd	17.82 B	11.78 g	17.32 d	19.43 c	21.98 b	17.63 B
1st June	11.72 ij	14.23 gh	16.34 ef	18.31cde	15.15 B	15.67 ghi	16.50 fgh	16.00 f-i	19.33 dg	16.87 B	13.98 f	16.05 de	17.11 d	20.39 d	16.88 C
15th June	10.95 j	13.17 hj	16.53 ef	19.46bc	15.03 B	11.33 j	13.66 hij	13.83 hij	15.00 hij	13.40 C	11.53 c	13.95 g	15.09 f	16.65 ef	14.30 D
average	11.59 D	15.08 C	17.53 B	20.298A		15.08 C	18.20 B	19.92 B	22.66 A		13.33 D	16.64 C	18.72 B	21.48 A	
								2nd cut							
1st May	10.36 fg	13.76 cde	15.96 abc	17.43 ab	14.38 A	15.00 a	17.66 a	22.33 a	24.00 a	19.75 A	12.45 a	15.44 a	18.70 a	20.33 a	16.85 A
15th May	14.82 bcd	15.53 a-d	15.03 bcd	18.46 a	15.96 B	9.33 a	15.06 a	17.66 a	19.00 a	15.26 B	12.00 a	14.41 a	16.81 a	18.21 a	15.32 B
1st June	10.40 fg	12.50 d-g	12.96 c-g	14.2cde	12.518 C	7.83 a	12.33 a	14.33 a	13.83 a	12.61 C	11.33 a	12.43 a	13.68 a	14.15 a	12.52 C
15th June	9.87 g	11.22 efg	13.06 c-f	13.66cde	11.95 C	8.53 a	11.5 a	11.83 a	12.33 a	11.09 C	9.47 a	11.20 a	12.40 a	13.26 a	11.58 D
average	11.36 C	13.25 B	14.25 B	15.94 A		10.17 B	14.14 A	16.54 A	17.29 A		10.77 D	13.60 C	15.40 B	16.61 A	
								3rd cut							
1st May	6.43 g	11.97 bcd	12.84 bc	15.87 a	11.70 A	9.33 fg	12.00 cde	18.00 a	17.60 a	14.23 A	7.56 h	11.40 g	15.00 ab	16.50 bc	12.65 A
15th May	7.00 fg	11.43 bcd	13.20 b	13.39 b	11.26 AB	7.60 gh	11.33 def	12.66 bcd	14.16 b	11.44 B	6.51 i	11.48 ef	12.00 de	14.93 a	11.30 B
1st June	8.07 ef g	10.91 cd	10.88 cd	11.75 bcd	10.40 B	6.60 h	11.00 def	11.16 def	14.00 bc	10.73 BC	7.30 hi	11.38 ef	12.93 cd	13.18 bc	11.35 B
15th June	7.00 fg	6.80 fg	10.00 de	8.66 ef	8.10 C	7.86 gh	10.20 ef	10.00 ef	10.93 def	9.73 C	7.97 h	10.55 f	10.00 fg	10.34 ef	9.67 C
average	7.13 C	10.28C	11.73A	12.42A		7.85 D	11.13 C	12.96 B	14.19 A		7.49 D	10.71C	12.35 B	13.31 A	

Table 3: Effect of Sowing dates, Nitrogen fertilization rates and their interaction on (Dry matter %), in both seasons (2022 and 2023) and combined

						Nitrogen levels (kg/fad).									
		2022season					2023 season					combined			
	0	20	30	40	average	0	20	30	40	average	0	20	30	40	average
								1stcut							
1st May	18.03 a	21.03 a	22.13 a	22.93 a	21.03 A	18.67 a	21.33 a	22.33 a	23.33 a	21.41 A	18.30 a	21.00 a	22.23 a	22.50 a	21.20 A
15th May	16.54 a	19.87 a	21.73 a	22.67 a	20.20 B	17.33 a	20.30 a	22.71 a	23.68 a	21.00 A	16.70 a	19.90 a	21.69 a	23.13 a	20.45 B
1st June	16.67 a	20.93 a	22.67 a	23.20 a	20.71 AB	18.00 a	22.00 a	22.60 a	23.60 a	21.58 A	17.33 a	21.46 a	11.31 a	23.4 a	21.14 C
15th June	12.57 a	14.67 a	16.23 a	17.9 a	15.31 C	13.13 a	13.60 a	16.26 a	18.35 a	15.35 B	12.85 a	14.13 a	16.24 a	18.12 a	15.33 D
average	15.95 D	19.13 C	20.51 B	21.67 A		16.78 D	19.33 C	20.98 B	22.25 A		16.29 D	19.12 C	17.86 B	21.78 A	
								2nd cut							
1st May	14.32 a	15.70 a	17.36 a	15.79 a	15.79 A	14.00 a	15.60 a	18.50 a	17.20 a	16.30 A	14.16 a	15.6 a	17.84 a	16.49 a	16.05 A
15th May	11.70 a	14.83 a	16.77 a	16.25 a	14.89 A	12.80 a	16.33 a	17.00 a	17.03 a	15.79 A	12.25 a	15.58 a	16.89 a	16.64 a	15.34 AB
1st June	13.02 a	14.65 a	15.97 a	15.07 a	14.67 A	14.00 a	15.00 a	16.00 a	15.60 a	15.17 AB	13.51 a	14.82 a	15.99 a	15.33 a	14.92 B
15th June	10.83 a	12.88 a	15.67 a	17.27 a	14.06 B	11.00 a	12.33 a	14.97.a	17.63 a	13.98 C	10.69 a	12.60 a	15.11 a	17.45 a	14.02 C
average	12.47 C	14.52 B	16.35 A	16.08 AB		12.95 C	14.83 B	16.57 AB	16.88 A		12.71 C	14. 75 B	16.464 A	16.48 A	
								3rdcut							
1st May	12.07 a	13.26 a	14.32a	13.40 a	13.25 A	11.00 a	13.33 a	13.83 a	12.30 a	12.63 A	11.53 a	13.30 a	14.05 a	12.86 a	12.92 A
15th May	9.50 a	12.40 a	14.79a	13.76 a	12.66 B	12.00 a	11.66 a	11.66 a	12.50 a	11.92 AB	10.75 a	12.03 a	13.23 a	13.05 a	12.26 B
1st June	9.97 a	11.00 a	12.0a	13.33 a	11.55 C	10.33 a	12.00 a	11.90 a	12.10 a	11.42 B	10.15 a	11.33 a	11.83 a	12.66 a	11.49 C
15th June	13.00 a	12.80 a	14.0a	12.10 a	12.97 AB	12.00 a	8.00 a	8.00 a	11.00 a	10.00 C	10.50 a	10.40 a	12.50 a	12.55 a	11.48 C
average	11.13 B	12.37 AB	13.76 A	13.15 A		10.33 B	11.167 AB	12.04 A	12.41 A		10.73 C	11.67 BC	12.03 A	12.78 AB	

Table 4: Effect of Sowing dates, Nitrogen fertilization rates and their interaction on (dry leaves/stem ratio). in both seasons (2022 and 2023) and combined

						Nitrogen levels (kg/fad).									
		2022season					2023 season					combined			
	0	20	30	40	Average	0	20	30	40	average	0	20	30	40	average
								1stcut							
1st May	38.62 a	42.097a	45.283a	50.47 a	44.12 A	39.73 d	43.70 bcd	47.16 abc	52.66a	45.81 A	39.17 de	42.89cd	46.22 bc	51.52 a	44.98 A
15th May	36.58 a	38.95a	40.043a	48.97 a	41.13 B	38.71 de	40.20 d	41.56 cd	50.56a	42.75 AB	37.62 ef	39.57de	40.80 de	49.76 ab	41.94 B
1st June	31.30 a	37.5a	40.933a	47.57 a	39.32 B	33.66 ef	40.33 d	42.66 cd	49.0ab	41.41 B	32.48 fg	38.91de	41.80 cde	48.28 ab	40.37 B
15th June	30.12 a	37.983a	42.033a	48.60 a	39.68 B	31.53 f	39.20 de	43.06 cd	49.667a	40.86 B	30.82 g	38.59de	42.55 cde	49.13 ab	40.27 B
Average	34.15 D	39.13C	42.07B	48.90 A		35.90 D	40.86 C	43.62 B	50.475A		35.02 D	39.99B	42.84 C	49.68 A	
								2nd cut							
1st May	35.66 a	40.00 a	42.66a	46.83 a	41.29 A	38.00 efg	42.33 cde	44.66 bcd	48.66ab	43.42 A	36.83 fgh	41.16 de	43.67 cd	47.75 ab	42.35 A
15th May	33.17 a	36.20 a	38.767a	44.03 a	38.04 B	33.33 hi	40.33 def	44.60 bcd	48.40ab	41.66 b	32.21 i	39.70 ef	43.80 cd	47.32 ab	40.76 AB
1st June	31.10 a	39.06 a	43.0a	46.25 a	39.85 AB	35.00 gh	38.00 efg	40.46 def	45.96abc	39.86 c	34.08 hi	37.10 fg	39.61 ef	45.00 bc	38.95 BC
15th June	28.43 a	34.67 a	39.33a	47.86 a	37.57 B	30.60 i	36.60 fgh	41.40 de	49.80a	39.60 c	29.52 j	35.63 gh	40.37 e	48.83 a	38.58 C
Average	32.09 D	37.48 C	40.94B	46.24 A		34.23 D	39.32 C	42.78 B	48.208A		33.16 D	38.4C	41.86 B	47.23 A	
								3rdcut							
1st May	33.50 def	37.50 cd	39.33 bc	44.00 a	38.58 A	35.00 de	39.07 bcd	40.40 bc	45.66a	40.03 A	34.25 ef	38.28 cd	39.86 bc	44.83 a	39.31 A
15th May	29.50 f	35.50 cde	39.33 bc	43.66 a	37.00 A	32.66 e	38.00 de	41.33 cd	45.66ab	39.41 A	31.08 g	36.75 de	40.33 bc	44.67 a	38.20 A
1st June	30.50 f	32.76 ef	35.66 cde	39.66 bc	34.65 B	32.90 e	35.50 cd	38.17 abc	43.0a	37.39 B	31.70 fg	34.13 ef	36.91 de	41.33 b	36.02 B
15th June	23.33 g	30.33 f	35.00 de	43.16 ab	32.95 B	26.33 f	33.40 e	38.00 cd	45.667a	35.83 B	24.83 h	31.86 fg	36.50 de	44.41 a	34.39 B
Average	29.20 D	34.02 C	37.33 B	42.62 A		31.73 D	36.4* C	39.48 B	45.0A		30.46 D	35.25 C	38.41 B	43.83 A	

The interaction effect between sowing dates and nitrogen fertilization levels on dry leaves/stem ratio at the three cuts in both seasons as well as their combined was significant with except that the first and second cuts in the 1st season that this interaction no significant. The highest values of dry leaves/stem ratio were attained in planting date at 1st May or 40 Kg. N/fad., While the lowest values in this respect was attained when sowing date at 15th June with without N fertilization.

3.4. Crude protein percentage

Data recorded in Table (5) show the influence of sowing dates, sorghum hybrid and their interaction on protein percentage on forage on dry basis at all cuts studied in the two seasons of experimentation as well as their averages. The differences in crude protein % between the three planting dates were significant. This was true in the three cuts in average of combined. However, crude protein %. Decreased consistently and significantly as planting was delayed from 1th May to 15th June in the 3rd cuts in the two seasons. Moreover, data in table (5) shows that comparing to sowing in 1st may, over the two seasons, the Crude protein %. decreased in the first cut by 0.91%, 2.29% and 3.41%, in the second cut by 1.57%, 3.78% and 6.40%, and 1.4%, 1.45% and 4.47% respectively in the third cut of the combined, with delaying sowing to 15th May, 1st June and 15th June, respectively. While the planting date of 15th May gave the highest crude protein% in than third cut. Here, as mentioned before, the more favorable prevailing contestations during may planting resulted in a high germination percentage and more vigorous seedling hence, a good planting density, establishment and growth were obtained by [36,4,23,37,38,5]**.**

Crude protein percentage of green forage yield of sorghum hybrid plants in Table (5) was affected significantly during all cuts of the two growing season. Application nitrogen fertilizer rate 40 kg / fad. Produced sorghum hybrid plants have greatest value of crude protein percentage comparatively to other three rates used.

The results presented in Table (5) show also that the differences among nitrogen fertilization rates over the four sowing dates studied in crude protein %, were significant and to 40 kg N/fad. The effect of nitrogen levels on crude protein content was significant at three cuts in combined. Whereas, crude protein content increased with increment of nitrogen level. Thus it can be concluded that nitrogen level significantly increased crude protein content in forage sorghum up to 40 kgN/cut. These results are agreed with those reported by [39,36,32,33,27,28,20].

The interaction effect between the two studied factor on protein percentage per sorghum hybrid plant was not significant neither in each growing season nor in the averages of the two seasons and this held true at the third cuts took place, except that of 1st season in 1st and 2ed cuts.

3.5. Crude fiber /cut %

The effect of sowing dates, nitrogen fertilization levels and their interaction on crude fiber percentage recorded at the three cuts in both growing seasons, as well as the combined analysis are presented in Table (6). Cured fiber/cut % increased consistently and significantly as planting was delayed from 1th May to 15th June in the three cuts in the two seasons and combined. The planting date of 15th June gave the highest crude fiber% in than third cut. The data were going vice versa to the same trend of protein percentage. These results are in accordance with the result reported by [18,4,23]**.**

The results presented in Table (6) show also, that the differences among nitrogen fertilization rates over the four sowing dates studied in crude fiber /cut %, were significant and to 40 kg N/fad. The effect of nitrogen levels on crude fiber content was significant at three cuts in the two seasons and combined. Whereas, crude fiber content increased with higher nitrogen application. Since any increase in the percent of insoluble fiber in acid and ash percent has adverse effect on digestibility, the forage sorghum up to 40 kgN/cut. These results are agreed with those reported by [40,34,6].

The interaction effect between the two studied factor on crud fiber percentage per sorghum hybrid plant was not significant neither in each growing season nor in the averages of the two seasons and this held true at the third cuts took place, except that of 3rd cut in the second season and combined.

3.6. Ash Content %

The differences in ash content % between the 1th and 15th May planting dates were not significant. This was true in the three cuts in average of combined. Also the differences ash content % between the 1st June and 15th June % in the three cuts in the second season and 2nd and 3rd cuts in the combined. While the planting date of 1st or 15th may gave the highest values of ash content % in the two seasons and combined. Here, as mentioned before, the more favorable prevailing contestations during may planting resulted in a high germination percentage and more vigorous seedling hence, a good planting density, establishment and growth were obtained by [4,41]**.**

The results presented in Table (7) show also, that the differences among nitrogen fertilization rates over the four sowing dates studied in ash content %, were significant at three cuts in the two seasons and combined. The effect of nitrogen levels on ash content % was significant whereas, ash content % decreased with increment of nitrogen level, thus. It can be concluded that, nitrogen level significantly decreased ash content % in forage sorghum up to 40 kgN/cut. These results are agreement with those reported by [36,32,13]. The interaction effect between the two studied factor on Ash percentage per sorghum hybrid plant was significant in the two seasons and combined, except that of 3rd cut in the first and second seasons was no significant.

4. Recommendation

The results of this study recommends that the planting sorghum hybrid in 1th May and fertilizing with 40 kg N / fad; under condition of Kafr El- Sheikh Governorate, Egypt.

Table 5: Effect of Sowing dates, Nitrogen fertilization rates and their interaction on (Crude protein%) in both seasons (2022 and 2023) and combined

						Nitrogen levels (kg/fad).									
		2022season					2023 season					combined			
	0	20	30	40	Average	0	20	30	40	Average	0	20	30	40	Average
								1stcut							
1st May	11.23 h	15.76 bc	15.90 bc	17.21 a	15.03 A	14.27 a	15.67 a	16.84 a	17.39 a	16.04 A	12.75 a	15..72 a	16. 37 a	17.30 a	15.54 A
15th May	12.53 g	14.67 d	15.73 bc	17.39 a	15.09 A	12.53 a	14.00 a	15.76 a	16.84 a	14.78 B	12..53 a	14.34 a	15.75 a	17.12 a	14.94B
1st June	8.63 j	13.58 ef	15.21 cd	16.30 b	13.43 B	11.36 a	11.60 a	13.04 a	16.30 a	13.07 C	10..00 a	12.59 a	14.13 a	16.30 a	13.26 C
15th June	13.80 e	10.32 j	12.95 fg	15.76 bc	13.21 C	8.33 a	9.73 a	11.95 a	14.13 a	11.03 D	11.07 a	10.03 a	12.45 a	14.95 a	12.13 D
average	11.37 C	13.58 B	14.94 A	16.63 A		11.62 D	12.75 C	14.48 B	16.21 A		11.59 D	13.17 C	14.68 B	16.42 A	
								2nd cut							
1st May	15.00 bcd	16.84 ab	16.84 ab	18.47 a	16.79 A	15.00 a	14.33 a	15.21 a	15.22 a	14.94 B	15..00 a	15.59 a	16.03 a	16.85 a	15.87 A
15th May	12.40 ef	14.67 cd	15.21 bc	16.30 bc	14.65 B	12.40 a	14.00 a	14.13 a	15.21 a	13.93 A	12..40 a	14.35 a	14.67 a	15.76 a	14.30 B
1st June	10.50 fg	10.86 fg	13.04 de	15.21 bc	12.41 B	10.60 a	11.00 a	11.93 a	13.58 a	11.77 B	10.55 a	10.93 a	12.49 a	14.40 a	12.09 C
15th June	8.00 h	8.97 gh	9.24 gh	11.95 ef	9.54 C	7.33 a	9.07 a	9.24 a	11.95 a	9.39 C	7.67 a	9.02 a	9.24 a	11.95a	9.47 D
average	11.47 D	12.83 C	13.58 B	15.48 A		11.33 D	12.1 C	12.62 B	13.99 A		11.41D	12.47 C	13.11 B	14.74 A	
								3rdcut							
1st May	12.53 a	15.75 a	17.21 a	17.38 a	15.74 A	13.04 a	13.86 a	15.76 a	16.40 a	14.76 A	12.79 a	14.81 a	16.49 a	16.89 a	15.25 A
15th May	11.23 a	14.67 a	15.90 a	16.30 a	14.53 AB	11.41 a	12.33 a	13.58 a	15.33 a	13.16 B	11.37 a	13.50 a	14.74 a	15.82 a	13.86 B
1st June	13.80 a	15.21 a	15.73 a	15.75 a	15.12 C	11.95 a	10.73 a	13.04 a	14.20 a	12.48 C	12.88 a	12.97 a	14.39 a	14.98 a	13.81 B
15th June	8.63 a	10.32 a	12.95 a	13.58 a	11.37 D	9.24 a	7.80 a	12.49 a	11.20 a	10.18 C	8.94 a	9.06 a	12.72 a	12.39 a	10.78 C
average	11.57 D	13.98 C	15.35 B	15.63 A		11.41 C	11.18 C	13.72 B	14.28A		11.50 D	12.59 C	14.59 B	15.02 A	

Table 6: Effect of sowing dates, Nitrogen fertilization rates and their interaction on (crude fiber %) in both seasons (2022 and 2023) and combined

						Nitrogen levels (kg/fad).									
		2022season					2023 season					combined			
	0	20	30	40	average	0	20	30	40	average	0	20	30	40	Average
								1stcut							
1st May	24.40 a	27.57 a	27.40 a	28.67 a	27.01 D	21.70 i	23.00 hi	24.00 h	24.00 h	23.18 D	23.05 a	25.29 a	25.70 a	26.34 a	25.10 C
15th May	30.20 a	30.67 a	31.43 a	33.00 a	31.33 C	26.00 g	26.00 g	27.30 fg	29.00 ef	27.08 C	28.10 a	28.34 a	29.37 a	31.00 a	29.20 B
1st June	33.50 a	33.67 a	34.31 a	35.00 a	34.12 B	29.40 de	31.00 cd	31.00 cd	34.50 ab	31.48 B	31.45 a	32.34 a	32.66 a	34.75 a	32.80 B
15th June	34.30 a	35.77 a	36.42 a	37.00 a	35.87 A	32.67 bc	32.70 bc	32.50 c	35.00 a	33.22 A	33.49 a	34.24 a	34.46 a	36.00 a	34.55 A
average	30.60 D	31.92 C	32.39 B	33.43 A		27.44 D	28.08 C	26.2 B	30.62 A		29.02 D	30.05 C	29.30 B	32.02 A	
								2nd cut							
1st May	18.67 a	19.34 a	19.00 a	23.00 a	20.00 D	15.70 a	16.00 a	19.67 a	22.40 a	18.44 D	17.19 a	17.67a	19.34.a	22.70 a	19.23 D
15th May	22.00 a	23.00 a	26.67 a	25.00 a	24.16 C	20.20 a	22.66 a	23.00 a	26.67 a	23.13 C	21.10 a	22.83 a	24.84 a	25.84 a	23.66 C
1st June	25.67 a	26.70 a	30.43 a	29.13 a	27.98 B	23.33 a	25.66 a	27.30 a	30.30 a	26.65 B	24.50 a	26.18 a	28.82 a	29.72 a	27.31 B
15th June	30.00 a	32,00 a	31.00 a	33.00 a	31.5 A	29.67 a	29.00 a	30.00 a	33.10 a	30.44 A	29.84 a	30.50 a	30.50 a	33.05 a	30.97 A
average	24.08 D	24.17 C	26.52 B	27.53 A		22.22 D	23.16 C	24.33 B	28.11 A		23-16 D	24.30 C	25.88 B	37.83 A	
								3rdcut							
1st May	23.00 a	22.00 a	25,00 a	26.67 a	24.16 D	19.30 ef	21.00 def	21.67de	26.00 b	21.99 B	21.15de	21.50 ef	23.34 bc	26.34 a	23.08 C
15th May	18.80a	19.00 a	19.10 a	23.00 a	26.30 C	26.3b	26.60 b	24.60 bc	32.00 a	27.38 A	22.55 cd	22.80 bc	21.85 ab	27.50 a	23.68 c
1st June	30.00 a	31.00 a	32.00 a	33.00 a	31.50 B	14.00 g	16.00 g	19.40 f	20.00 ef	17.35 B	22.00 h	23.50 fg	25.70 gh	26.50 de	24.43 B
15th June	26.70 a	25.67 a	29.40 a	30.33	28.02 A	22.6cd	25.00 bc	23.50 cd	31.00 a	25.52 C	24.65	25.34 jk	26.45 kl	30.67 ij	26.78 A
average	24.62 D	24.17 C	26.37 B	28.25 A		15.55 D	28.72 C	16.14 B	27.43 A		22.59 D	23.29 C	24.34 B	27.75 A	

Table 7: Effect of Sowing dates, Nitrogen fertilization rates and their interaction on (ASH%). in both seasons (2022 and 2023) and combined

						Nitrogen levels (kg/fad).									
		2022 season					2023 season					combined			
	0	20	30	40	average	0	20	30	40	average	0	20	30	40	average
								1st cut							
1st May	11.13 b	10.60 bc	9.34 ef	9.76 fg	10.72 A	11.26 a	10.23 bc	10.07 abc	9.03 def	10.42 A	10.72 ab	11.07 a	10.30 b	9.77 b	10.44 A
15th May	11.85 a	11.20 ab	9.70 ef	8.70 fg	10.49 A	10.30 bc	10.23 bc	10.40 ab	9.84 cd	10.20 A	10.41 b	11.20 a	9.66 cd	9.18 b	10.27 A
1st June	9.29 de	9.40 cd	9.03 g	8.10 g	9.07 B	9.83 ef	10.54 ab	9.50 de	7.90 fg	9.40 B	10.70 b	9.11 c	8.68 fg	8.72 de	9.29 B
15th June	9.70 de	10.00 de	8.10 de	7.40 h	8.49 C	8.93 cd	10.20 abc	9.26 de	8.43 g	9.20 B	10.45 ab	9.76 e	8.52 ef	8.05 g	8.93 C
average	10.63 A	9.94 B	9.18 C	8.92 D		10.30 A	10.29 B	9.74 C	8.78 D		10.56 A	10.24 A	9.31 B	8.89 B	
								2nd cut							
1st May	10.73 a	10.40 a	9.50 bc	9.53 b	10.04 A	10.50 a	10.17 a	10.10 a	9.50 b	10.02 A	10.45 ab	10.00 c	10.27 abc	9.51 d	10.04 A
15th May	10.70 a	9.50 bc	9.40 bc	9.30 bcd	9.75 A	10.70 a	10.40 a	8.56 def	9.67 bcd	9.84 A	10.55 a	10.10 bc	9.02 e	9.18 de	9.72 A
1st June	9.7 bc	8.80 def	8.60 cde	8.70 ef	9.02 B	9.34 g	9.10 g	8.23 f	8.30 fg	8.70 B	9.22 ef	9.15 i	8.51 ghi	8.50 hi	8.82 B
15th June	9.06 b-e	8.30 f	8.67 ef	8.26 f	8.57 C	7.40 bc	8.73 cde	8.03 ef	7.90 ef	8.04 B	8.90 de	8.03 de	8.16 fg	8.10 fgh	8.28 B
average	10.02 A	9.75 B	8.95 C	8.57 D		10.00 A	9.68 B	8.74 C	8.03 D		10.05 A	9.71 B	8.95 C	8.60 D	
								3rd cut							
1st May	10.73 a	10.4a	9.53 a	9.50 a	10.03 A	9.47 a	9.20 a	9.03 a	8.76 a	9.05 A	10.08 a	9.80 ab	9.70 bc	9.32 d	9.70 A
15th May	10.70 a	9.5a	9.30 a	9.50 a	9.73 A	7.76 a	8.16 a	7.80 a	8.17 a	9.00 A	9.43 cd	9.25 d	9.23 d	8.86 e	9.20 A
1st June	9.34 a	8.8a	8.70 a	8.96 a	8.94 B	8.63 a	8.86 a	8.17 a	8.13 a	8.55 B	9.08 de	8.48 f	8.45 f	8.27 fg	8.65 B
15th June	9.06 a	8.3a	8.26 a	8.66 a	8.53 C	10.13 a	9.96 a	9.33 a	7.13 a	8.58 B	8.38 fg	8.05 gh	7.82 h	8.16 fg	8.09 B
average	10.02 A	9.75B	8.95 C	8.57 D		9.04 A	9.01 A	8.45 B	7.98 C		9.725A	9.19 B	8.57 C	8.11 D	

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