RESPONSE OF SOME GRAIN SORGHUM CULTIVARS TO PLANTING DENSITY AND NITROGEN FERTILIZATION

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Abstract: Two field experiments were conducted at Assiut Univ. Exp. Farm during 2000 and 2001 summer seasons to study the response of four grain sorghum cultivars (Dorado, Shandaweel-2, Mina and Horus) to planting densities (46,666, 70,000 and 140,000 plants/fed.) and nitrogen fertilization (80, 100 and 120 kg N/fed.). The results indicated that cultivars differed significantly in panicle width, length and weight. Mina cultivar had the widest and heaviest panicles of 19.04 cm and 140.32 g, while the longest panicles were obtained from Horus cultivar (30.84 cm). Dorado cultivar had the lowest values for the three traits. Cultivars also exerted a significant influence on all yield and yield components traits. Mina cultivar had higher values of seed index, grain yield/plant and feddan, shelling % and nitrogen recovery as compared with other cultivars, especially Dorado. The lowest values of yield and its components were obtained from cultivar Dorado except for shelling % which was obtained from Horus cultivar. The lowest number of plants bearing heads/fed. was obtained from Horus.

Plant densities exerted a significant influence on panicle width and weight. Dense planting decreased both panicle width and weight as compared to those produced from less dense plants. Increasing plant density from 46,666 to 70,000 or 140,000 plants/fed. increased grain yield/fed., shelling % and nitrogen recovery. Grain yield/plant and seed index decreased by increasing plant population.Plant density had insignificant influence on protein content of grain sorghum.

Nitrogen application increased panicle width, weight and length. Increasing N-rates from 80 to 100 or 120 kg N/fed. increased significantly seed index, grain yield/plant and feddan, shelling % and nitrogen recovery.

Protein percentage revealed insignificant differences between cultivars. However, increasing N-rates from 80 to 100 or 120 kg N/fed. increased significantly protein content in grain sorghum.

In general, many interactions exerted significant effects on yield and its components. The highest grain yield/fed. (28.65 ardab/fed.) was obtained from Mina cultivar sown at

70,000 plants/fed. and received 120 kg N/fed This yield was similar statistically to that obtained from Shandaweel-2 sown at 140,000 plants/fed. and receiving the same amount of nitrogen.

Introduction

Grain sorghum (*Sorghum bicolor* (L.) Moench) is an important cereal crop in Upper Egypt. Similar to other cereals, its yield is usually affected by cultural practices. Accordingly, the best procedure required for the highest yield of the new cultivars must be identified especially under Upper Egypt conditions The application of nitrogen at a rate of 80 kg N/ha increased significantly grain weight/ear, 1000-grain weight and grain yield (Kumawat and Bansal, 1993, Mohammad and Hasan, 1993).

Ragheb and El-Nagar (1997) reported that the application of 125 kg N/fed produced the highest grain yield of 15.1 ardab/fed. under Upper Egypt conditions. Gonzalez and Graterol (2000) indicated that yield and panicle length increased with increasing N fertilizer rate. However, panicle length was greater without fertilizer.

In grain sorghum, plant density is considered one of the major factors limiting grain yield. Eweis *et al.* (1992) reported that increasing plant density of grain sorghum variety Dorado from 70,000 to 93,000 plants/fed significantly decreased grain weight/head and 1000-grain weight. However, grain yield/fed. increased significantly with the increase in plant population. Galal (1997) found that decreasing plant population, by increasing hill spacing, increased the panicle weight as well as grain yield/plant and decreased the threshing rate. She reported that plants sown at 70x30 cm^2 produced the highest panicle weight, seed index and grain yield/plant On the other hand, highest number of plants/fed at harvest was obtained when plants were sown at 50x20 cm^2 The highest threshing rate was obtained when plants were sown at 60x20 cm^2 or 50x20 cm^2. The response of grain sorghum cultivars to plant population was studied by many investigators such as Marwat *et al.* (1999), Paulpandi *et al.* (1999) and Gonzalez and Graterol (2000).

Concerning sorghum cultivars, Wade *et al.* (1992) reported that yield, yield components, and quality differed according to cultivars Eid *et al.* (1993) found that Giza 15 cultivar gave the greatest grain yield as compared to Giza 3 and SEL 1007 El-Nagouly *et al.* (1997) reported that each of the two new hybrids, Shandaweel-1 and Shandaweel-2 had yield increase over Dorado by 4.19 and 6.12 ardabs per feddan in experimental trial, and 1.11 and 2.26 ardabs per feddan in farm trials. Brogna *et al* (2000) found that mean yield for the hybrids under studies ranged from 6.68 t/ha for Arprim cultivar to 9.1 t/ha for DK34 cultivar.

The present study was undertaken to determine the response of some grain sorghum cultivars to plant density and nitrogen fertilization under Upper Egypt condition in order to find out the optimum plant density needed for maximum yield using different levels of nitrogen fertilization.

Materials and Methods

This investigation was carried out at the Experimental Farm of Assiut University, during the summer of 2000 and 2001 seasons to study the effect of planting density and nitrogen fertilization on grain yield and its components of four grain sorghum cultivars (Dorado, Shandaweel-2, Mina and Horus). The experiment was laid in a completely randomized block design with a split-split plot arrangement of treatments using four replications. Plot area was 1/400 fed. The preceeding crop was wheat in both seasons. The cultivars were assigned to the main plot while plant densities (140,000, 70,000 and 46,666 plants/fed.) were fitted in the sub-plot. The different densities were obtained by planting on one side of ridges 60 apart, with hills 10, 20 or 30 cm spaced apart, respectively. Nitrogen fertilization was added in the form of Ammonium nitrate 33% N (three rates of 80, 100, 120 kg N/fed). The rates were distributed randomly in the sub-sub plots. One-half of N doses was applied after three weeks after planting and the other half was added before flowering with irrigation. Sowing dates for 2000 and 20001 seasons were on June 27th and 25th, respectively. Plants were thinned to two plants per hill after full emergence. All other cultural practices were carried out as recommended in grain sorghum for both seasons.

The physical and chemical analysis of soil of experimental sites are presented in Table (1).

Table (1): Average of some physical and chemical characteristics of the experimental site over two growing seasons (2000 and 2001).

Chemical Analysis					Mechanical Analysis			
E.C. mmoh/cm	pH 1:2.5	Total N %	P mg/kg Soil	Kme/100g soil	Sand %	Silt %	Clay %	Texture
0.67	7.32	0.10	27.0	0.51	12.4	45.9	41.7	Silty Clay

In each seasons, a random sample of ten guarded plants from each plot was drawn and the following characters were recorded

1) Panicle width (cm).

2) Panicle length (cm).

3) Panicle weight (g)

4) Grain yield/plant (g).

5) Shelling %.

6) Seed index (g).

Furthermore, number of plants bearing heads and grain yield (ardab/fed.) (Ardab= 160 kg) were calculated based on plot data

Protein percentage was determined in seed samples according to A.O.A.C. (1980) using kjeldahl method and was used to calculate nitrogen recovery. kg/fed.

Data were statistically analyzed separately for each season Bartlet test of variance homogeneity was carried out before the combined analysis (Snedecor and Cochran, 1980) Analysis of variance for all characters was made according to Gomez and Gomez (1984). Means were compared using L.S.D at 5% level

Results and Discussion

Bartlet test of homogeneity indicated that the variance of data of both seasons was insignificant. Thus. combined analysis was carried out for data for all traits, year effects and its interactions with the factors under investigation were insignificant Accordingly, means of both seasons were calculated and are given in the discussion below..

I - Panicle characters:

The combined analysis of the data as shown in Table (2) revealed that cultivars exerted a significant influence on panicle width, length and weight. It is clear from these data that plants of Mina cultivar were superior in panicle width and weight, while the longest panicle was obtained from Horus plants as compared to other cultivars. In addition, plants of Dorado cultivar had the lowest values for the three traits. The differences between cultivars is mainly due to the interaction between their genetic make up during growth periods and the environmental factors prevailing during their development. These results are in agreement with those reported by Wade *et al.* (1992), Eid *et al.* (1993), Mulik *et al* (1994). Ragheb and El-Nagar (1997), Galal (1997), Marwat *et al.* (1999), Khatik *et al.* (1999) and Brogna *et al* (2000)

The application of nitrogen fertilizer to grain sorghum cultivars exerted a significant influence on panicle width and weight. Data revealed that increasing N rates increased panicle width and weight, where the maximum value was obtained when the highest rate was applied (120 kg N/fed.). The increase in panicle width when N rate increased from 80 to 100 and 120 kg N/fed. were 6.13 and 8.38% respectively. Panicle weight percent increase were 7.27 and 12.83% for the same respective rates as compared to the lowest rate. It is clear from these data that N application to grain sorghum enhanced the vegetative growth of the plants, increased photosynthetic activity and the metabolites required to produce vigorous growth and consequently produced wider and heavier panicles. These resnlts are in the same line with those reported by Powell and Hons (1992), Kumawat and Bansal (1993), Mohamad *et al.* (1998), Attia (1999) and Gonzalez and Graterol (2000).

Plant density exerted a significant influence only on panicle width and weight (Table 2). It is clear from these data that dense plants had the lowest panicle width and weight compared to wider spaced plants. This is due to the fact that under dense plants the competition between plants on environmental, particularly light, and soil factors were higher. The increase in plant density tends to decrease the photosynthetic activity and consequently produce less amount of metabolites. Under less dense plants the activity of all processes especially photosynthesis were higher and consequently the plant has more metabolites devoted to produce wider and heavier panicle. These results are supported by other researchers such as by Schatz *et al.* (1990), Gowily (1995), Galal (1997), Patil *et al.* (1999) and Gonzalez and Graterol (2000).

The interaction between cultivars and plant density or nitrogen fertilizer, exerted significant influence on panicle width and weight (Table 2). The highest values of panicle width (19.68 cm) was obtained from Mina cultivar when sown at the lowest dense plants (46,666/fed.). Meanwhile, for nitrogen x cultivar interaction, the highest values were obtained from Mina cultivar receiving the highest nitrogen rate (120 kg N/fed.). Panicle weight was significantly affected also by nitrogen x density interaction. In general, the highest values were obtained from Mina cultivar when sown at lower density (46,666 plants/fed.) and receiving hight N. rates (120 or 100 kg/fed.).

II- Seed index (g):

The combined analysis of the data in Table (3) revealed that grain sorghum cultivars exerted a significant effect on seed index. Mina cultivar produced significantly higher value (33.97 g) than the other three cultivars. The other cultivars were statistically similar. Similar differences were reported by Ragheb

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Table (2): Effect of plant density and nitrogen fertilizer on panicle width, length and weight of some grain sorghum cultivars (combined data)

Plant density/fed (D)	N fert. kg/fed (N)	Panicle width, cm					Panicle length, cm					Panicle weight, g				
		Cultivars (V)														
		Dorado	Shanda-weel-2	Mina	Horus	Mean	Dorado	Shanda-weel-2	Mina	Horus	Mean	Dorado	Shanda-weel-2	Mina	Horus	Mean
46.666	80	16.80	18.51	18.51	17.47	17.83	26.29	29.45	28.58	30.59	28.73	116.29	154.78	154.93	128.36	138.59
	100	17.73	20.03	19.90	18.35	19.00	22.60	29.74	27.23	31.18	27.69	127.15	158.87	166.76	141.04	148.45
	120	18.85	20.04	20.63	17.39	19.23	24.49	29.07	27.55	31.88	28.25	128.07	163.94	171.00	157.95	155.36
	Mean	17.79	19.52	19.68	17.74	18.69	24.46	29.42	27.79	31.21	28.22	123.87	159.19	164.23	142.45	147.43
70.000	80	15.59	17.95	18.08	17.06	17.17	23.77	29.89	27.40	30.75	27.95	93.02	112.86	128.50	109.70	111.02
	100	17.18	18.71	19.34	18.29	18.37	23.95	29.24	28.77	31.37	28.33	98.88	126.90	135.32	112.44	118.38
	120	16.72	19.24	19.79	18.36	19.25	23.30	29.98	28.72	30.89	28.22	102.89	136.59	137.48	118.37	123.88
	Mean	16.90	18.63	19.06	18.10	18.12	23.67	29.70	28.29	31.00	28.17	98.26	125.45	133.77	113.57	117.76
140.000	80	13.80	16.15	17.64	15.73	15.83	24.21	29.27	28.71	30.18	28.09	66.00	101.54	115.12	98.82	95.37
	100	14.56	16.91	18.56	16.22	16.55	22.90	29.68	28.34	30.63	27.89	74.48	106.96	121.34	109.90	103.22
	120	15.29	17.26	19.07	16.55	17.04	24.37	30.63	29.98	30.06	28.76	86.12	111.06	132.22	111.59	110.24
	Mean	14.56	16.77	18.42	16.16	16.48	23.83	29.86	29.01	30.29	28.55	75.53	106.52	122.96	106.76	102.94
V/N	80	15.39	17.33	18.08	16.75	16.94	24.76	29.54	28.23	30.50	28.26	91.77	123.06	137.85	112.29	114.99
	100	16.49	18.55	19.26	17.61	17.98	23.15	29.55	28.11	31.06	27.97	100.17	130.91	141.20	121.13	123.35
	120	17.36	18.84	19.66	17.43	18.36	24.06	29.89	28.75	30.94	28.41	105.72	137.19	146.90	129.37	129.75
	Mean	16.42	18.31	19.04	17.27		23.99	29.66	28.36	30.84		99.22	130.38	140.32	120.93	

LSD at 5% level for:

Panicle width				Panicle length				Panicle weight			
V =	0.20	VN =	0.45	V =	0.96	VN =	N.S	V =	1.93	VN =	3.14
N =	0.22	VD =	0.45	N =	N.S	VD =	N.S	N =	2.57	VD =	3.14
D =	0.23	ND =	N.S	D =	N.S.	ND =	N.S.	D =	1.57	ND =	2.45
VDN =	N.S.			VDN =	N.S			VDN =	5.44		

and El-Nagar (1997), El-Nagouly *et al* (1997). Galal (1997), Marwat *et al* (1999) and Brogna *et al.* (2000). Furthermore, the increase in N rates from 80 up to 120 kg N/fed. increased seed index significantly. The increase in seed index due to increasing N rate from 80 to 100 or 120 kg N/fed. were 6 72 and 15.32% respectively. This means that nitrogen increased seed weight by increasing the amount of metabolite directed to the grains during filling period. These findings are in harmony with those reported by Kumawat and Bansal (1993), Tripathi and Surajbhan (1993), Surakad and Itnal (1997), Mohamed *et al* (1998) and Gordon and Whitney (2000)

The data also revealed that increasing plant density from 46.666 up to 140 000 plants/fed. decreased seed index significantly. This mean that increasing number of plants/unit area increased the competition between plants and consequently reduced metabolites required to build up heavy seeds On the other hand, under less dense planting the plants had the ability to supply more metabolites required to increase seed size rather than elongation to compete for light. Similar findings were reported by Eweis *et al* (1992), Galal (1997), Lamani *et al.* (1997), Marwat *et al.* (1999)

The data also showed that seed index was significantly affected by all interactions under study In general, the highest value (37 08 g) was obtained from Mina plants when sown at lower density (46.666 plants/fed.) and received the highest N rate (120 kg N/fed). This value was similar statistically to that obtained from the same cultivar sown at 70.000 plants/fed. and received the same rate of nitrogen.

III- Shelling percentage (%):

The combined analysis Table (3) revealed that shelling % was significantly affected by grain sorghum cultivars where the highest value (63 70%) was obtained from Mina cultivar and the lowest one (56.36%) was obtained from Horus cultivar. The increase in shelling % may be due to the increase in grain yield/plant and/or to the relative reduction in panicle weight. Similar results in this respect were reported by Abu-Kreshe *et al.* (1996), Galal (1997) and Mohamed *et al.* (2000).

The application of nitrogen to grain sorghum cultivars exerted a significant influence on shelling % Increasing N rates from 80 to 100 or 120 kg N/fed. increased shelling % by 3.68% and 4.14%, respectively These results are in agreement with those obtained by Abu-Kreshe *et al* (1996), Galal (1997) and Mohamed *et al.* (2000).

The data showed that increasing plant density increased shelling %. the increase due to increasing plant density from 46,666 to 70,000 or 140,000 plant/fed were 4.12 and 7.45%, respectively The differences in shelling % may be due to the differences in panicle weight as well as grain yield/plant. These results are in accordance with those obtained by Galal (1997) and Mohamed *et al.* (2000)

Shelling % was significantly affected by all interactions under investigation The interaction between cultivars and nitrogen fertilizer exerted a significant effect on shelling percentage The highest values were obtained from Shandaweel-2 and Mina cultivar when their plants received the highest N rates (120 kg N/fed or 100 kg N/fed. for Mina). Shandaweel-2 cultivar produced similar values of shelling % when their plants received the highest, N rate. The interaction between cultivars and plant density exerted a significant influence on shelling percentage, where the lowest values (53.12%) was obtained from Horus cultivar when sown at the lowest dense population Also, the differences in shelling % of Horus cultivar were insignifcant when sown at 70,000 or 140,000 plant/fed. The highest shelling percentage (66 66%) was obtained from Mina cultivar when sown at the highest plant density

The interaction between nitrogen and plant density exerted a significant influence on shelling %. where the highest values were produced all N levels under 140,000 density along with 100 or 120 kg N under 70,000. In general the highest value (67 64%) was obtained from Mina cultivar plants sown with the highest dense population (140,000 plants/fed.) and received the lowest N rate (80 kg N/fed.)

VI. Grain yield/plant (g):

The data in Table (3) revealed that grain yield/plant was significantly affected by sorghum cultivars where the highest value was obtained from Mina cultivar (89 07 g). The increase in grain yield/plant is mainly due to the increase in panicle weight and/or seed index These results are in accordance with those reported by Galal (1997), Chouhan and Dighe (1999), Marwat *et al* (1999) and Khatik *et al* (2000)

The data in Table (3) showed that grain yield/plant increased significantly by increasing N rates from 80 to 120 kg N/fed. The increase in grain yield/plant as result of increasing N rates from 80 to 100 or 120 kg N/fed were 10 65 and 17.53% respectively The increase in grain yield/plant may be due to the increase in panicle weight and/or seed index. These results are in harmony with those reported by

Table (3): Effect of plant density and nitrogen fertilizer on grain yield/plant, shelling % and seed index of some grain sorghum cultivars (combined data).

Plant density/fed (D)	N fert kg/fed. (N)	Seed index, g.					Shelling, %					Grain yield/plant, g				
		Cultivars (V)														
		Dorado	Shanda-weel-2	Mina	Horus	Mean	Dorado	Shanda-weel-2	Mina	Horus	Mean	Dorado	Shanda-weel-2	Mina	Horus	Mean
46,666	80	29.31	29.37	33.48	28.58	30.18	58.53	56.12	60.31	52.94	56.97	68.17	86.85	93.55	67.44	79.00
	100	32.02	31.24	35.14	30.24	32.16	57.34	61.39	59.44	55.57	58.43	73.05	97.55	99.30	78.32	87.05
	120	32.98	32.43	37.08	32.68	33.79	60.30	62.70	63.28	50.87	59.28	77.44	102.9	108.34	80.37	92.26
	Mean	31.43	31.01	35.23	30.50	32.04	58.72	60.07	61.01	53.12	58.22	72.88	95.76	100.39	75.37	86.08
70,000	80	27.97	28.66	29.49	28.49	28.63	57.64	58.51	60.46	54.25	57.71	54.69	65.76	78.74	57.47	64.29
	100	29.95	30.80	31.76	30.30	30.70	60.63	62.70	63.34	62.84	62.37	69.34	77.29	85.42	66.87	72.48
	120	31.93	32.86	36.02	33.81	33.65	58.38	64.85	66.51	57.48	61.80	60.67	86.96	91.40	67.00	76.50
	Mean	29.95	30.77	32.42	30.83	30.99	58.88	62.02	63.43	58.19	60.62	58.56	76.67	85.18	63.94	71.09
140,000	80	25.39	24.20	29.40	26.49	26.37	60.19	62.63	67.64	58.06	62.13	40.50	63.00	77.53	52.16	58.29
	100	26.68	27.24	30.64	27.65	28.05	62.07	63.78	67.18	56.97	62.50	47.11	67.61	81.35	58.04	63.52
	120	28.74	30.17	33.78	30.52	30.80	61.45	67.25	65.16	58.35	63.05	53.20	73.28	86.05	60.11	68.16
	Mean	26.93	27.20	31.27	28.22	28.40	61.23	64.55	66.66	57.79	62.56	46.93	67.96	81.64	56.77	63.32
V/N	80	27.55	27.41	30.79	27.82	28.39	58.78	59.08	62.80	55.08	58.93	54.45	71.87	83.27	59.19	67.19
	100	29.55	29.76	32.51	29.39	30.30	60.01	62.62	63.32	58.46	61.10	60.16	80.81	88.69	67.74	74.35
	120	31.21	31.83	35.62	32.33	32.74	60.04	64.93	64.98	55.56	61.37	63.77	87.71	95.26	69.16	78.97
	Mean	29.43	29.66	33.97	29.84		59.61	62.21	63.70	56.36		59.46	80.13	89.07	65.36	

LSD at 5% level for:

Seed index				Shelling				Grain yield/plant			
V =	0.95	VN =	1.10	V =	1.70	VN=	1.76	V =	2.57	VN =	2.81
N =	0.55	VD =	1.10	N =	0.88	VD =	1.76	N =	1.41	VD =	1.44
D =	0.56	ND =	0.95	D =	1.27	ND =	1.53	D =	1.41	ND =	2.44
VDN =	1.90			VDN =	3.05			VDN =	4.88		

Powell and Hons (1992), Kumawat and Bansal (1993), Tripathi and Surajbhan (1993), Surakad and Itnal (1997), Kumar *et al.* (1998), Mohamed *et al.* (1998) and Gonzalez and Graterol (2000).

Increasing plant density from 46,666 to 70,000 or 140,000 plants/fed significantly decreased grain yield/plant. This is due to the fact that increasing plant density/unit area increased the competition between plants and consequently produced plants with low panicle weight and/or seed index. Similar findings were reported by Schatz *et al.* (1990), Eweis *et al.* (1992), Galal (1997) and Gonzalez and Gratorol (2000).

The data revelaed that grain yield/plant was significantly affected by all interactions under study. In general, the highest value of grain yield/plant (108.34 gm) was obtained from Mina plants when sown at lowest density (46666 plants/fed.) and received the highest N rate (120 kg N/fed.). The increase in such value may be due to the increase in panicle weight and seed index.

V- Number of plants bearing heads/fed.

The combined data as shown in Table (4) revealed that number of plants bearing heads at harvest was significantly affected by cultivars, where the lowest value was obtained from Horus with significant differences compared to the other three cultivars. The differences between cultivars may be due to the difference in vegetative growth of such cultivar. These results are in agreement with those obtained by Galal (1997), Lamani *et al.* (1997), Marwat *et al.* (1999) and Brogna *et al.* (2000). Increasing plant density increases the number of plants bearing heads at harvest where the highest value was obtained from plants sown at the highest dense plants and the lowest value was recorded from the lowest dense plants (46,666 plants/fed.). These results are supported by Eweis *et al.* 1992, Galal (1997), Marwat *et al.* (1999) and Gonzalez and Graterol (2000).

Nitrogen application had insignificant influence on number of plants bearing heads/fed. at harvest. These resnlts are in line with those obtained by Mohamed *et al.* (1998) and Mohamed *et al.* (2000). The number of plants at harvest was significantly affected by the interaction between nitrogen fertilizer and plant density where the highest value (106.14) was obtained from the application of 80 kg N/fed. and sown at plant density of 140.000 plant/fed.

VI- Grain yield/fed. (Ardab):

The combined analysis of the data in table (4) showed that grain yield/fed. was significantly affected by cultivars. The highest grain yield/fed. was obtained from Mina cultivar (24.27 ardab/fed.) followed by Shandaweel (22.83 ardab/fed.) and the lowest yield was recorded from Dorado cultivar (19.08 ardab/fed.). The increase in grain yield/fed. in Mina may be due to the increase in panicle weight, grain yield/plant and seed index. The reduction in grain yield of Dorado cultivar is mainly due to the reduction in panicle weight and consequently grain yield/plant. These results are in line with Ragheb and El-Nagar (1997), Galal (1997), Marwat *et al.* (1999) and Brogna *et al.* (2000)

The data in Table (4) showed that grain yield/fed. increased significantly by increasing N rates from 80 to 100 or 120 kg N/fed. The increase in grain yield as a result of increasing N rates from 80 to 100 or 120 kg N/fed. were 9.28% and 15.35% respectively. The increase in grain yield/fed. is mainly due to the increase in grain yield/plant as well as seed index. Similar results were reported by Mohammad and Hasan (1993), Dashora and Porwal (1994), Mulik *et al.* (1994), Abu-Kreshe *et al.* (1996), Ragheb and El-Nagar (1997), Mohamed *et al.* (1998), Atta (1999) and Gonzalez and Graterol (2000)

The data in Table (4) showed that grain yield/fed increased significantly by increasing plant population from 46,666 to 70,000 or 140,000 plants/fed. This increase amounted 15.02 and 26.83% respectively. The increase in grain yield/fed. is mainly due to the increase in number of plants at harvest. Similar results in this respect were recorded by Eweis *et al.* (1992), Gowily (1995), Galal (1997), Patil *et al.* (1999) and Gonzalez and Graterol (2000)

The data indicated that grain yield/fed. was significantly affected by all interactions under study. In general, the highest grain yield/fed. (28.65 ardab/fed.) was obtained from Mina cultivar when sown at 70,000 plants/fed. and receiving 120 kg N/fed. Grain yield of Shandaweel-2 (27.60 ardab/fed.) was obtained by planting at the highest density plants (140,000 plants/fed.) and receiving the highest N rates. This value was not significantly different from that of Mina (28.65 ardab/fed.) when sown at 70,000 plant/fed and receiving the highest N rates.

VII- Protein percentage:

The combined data (Table 4) revealed that protein content in grain was significantly affected by nitrogen fertilizer and the interaction between plant density and nitrogen. The data showed that increasing N application increased protein content in grains.

Table (4): Effect of plant density and nitrogen fertilizer on no. of plants bearing head/fed., grain yield/fed. and protein % of some grain sorghum cultivars (combined data).

Plant density/fed (D)	N fert. kg/fed. (N)	No. of plants bearing heads/fed. (thousand)					Grain yield/fed. (Ardab)					Protein %				
		Cultivars (V)														
		Dorado	Shanda-weel-2	Mina	Horus	Mean	Dorado	Shanda-weel-2	Mina	Horus	Mean	Dorado	Shanda-weel-2	Mina	Horus	Mean
46,666	80	42.58	40.40	43.54	39.60	41.53	15.50	17.78	20.91	16.93	17.78	9.62	9.10	9.27	9.08	9.27
	100	42.74	38.67	42.00	39.49	40.72	17.24	19.17	21.36	18.73	19.12	9.96	9.41	9.65	9.61	9.66
	120	45.05	42.99	44.93	41.53	43.62	18.51	20.23	24.92	19.56	20.80	10.12	9.98	9.75	10.04	9.97
	Mean	43.45	40.68	43.49	40.21	41.96	17.08	19.06	22.39	18.40	19.23	9.9	9.50	9.56	9.58	9.63
70,000	80	60.98	61.46	65.01	63.12	62.64	18.60	21.03	20.32	19.57	19.88	9.48	9.30	9.45	9.36	9.40
	100	62.26	61.71	65.70	61.19	62.71	18.33	24.56	24.99	22.41	22.57	9.82	9.64	9.99	9.56	9.75
	120	54.78	61.72	60.43	60.22	59.29	19.34	24.39	28.65	23.40	23.94	10.41	9.90	10.20	9.71	10.05
	Mean	59.34	61.63	63.71	61.51	61.54	18.75	23.32	24.65	21.79	22.12	9.90	9.61	9.88	9.54	9.73
140,000	80	112.35	106.84	103.75	101.65	106.14	20.07	24.48	25.03	22.89	23.11	9.59	9.27	9.18	9.38	9.35
	100	110.53	104.20	104.82	101.28	104.95	22.19	26.23	25.81	24.60	24.70	9.79	9.52	9.54	9.82	9.67
	120	100.05	105.15	101.66	100.40	101.81	22.05	27.62	26.53	25.21	25.35	9.94	9.86	9.90	10.00	9.92
	Mean	107.64	106.40	103.08	101.11	104.30	21.43	26.11	25.79	24.23	24.39	9.77	9.55	9.54	9.73	9.65
V/N	80	71.97	69.56	70.76	68.12	70.10	18.05	21.09	22.08	19.79	20.25	9.56	9.22	9.30	9.27	9.34
	100	71.84	68.19	70.84	67.32	69.55	19.25	23.32	24.05	21.91	22.13	9.86	9.52	9.73	9.66	9.69
	120	66.63	69.95	69.00	67.38	68.24	19.96	24.08	26.70	22.72	23.36	10.16	9.91	9.95	9.92	9.98
	Mean	70.15	69.23	70.20	67.60	69.29	19.08	22.83	24.27	21.47		9.86	9.55	9.66	9.62	9.67

LSD at 5% level for:

V =	2.09	VN =	N.S.	V =	1.64	VN=	0.72	V =	N.S.	VN =	N.S.
N =	N.S.	VD =	N.S.	N =	0.38	VD =	0.75	N =	0.13	VD =	N.S.
D =	2.42	ND =	4.20	D =	0.37	ND =	0.65	D =	N.S.	ND =	0.19
VDN =	N.S.			VDN =	1.30			VDN =	N.S.		

this is logic since nitrogen is an essential element in protein formation. Also, the highest percentage of protein (9.92%) was obtained from the highest density and the application of N at a rate of 120 kg N/fed. These results are in accordance with those obtained by Ragheb and El-Nagar (1997), Mohamed *et al* (1998), Attia (1999) and Gonzalez and Graterol (2000).

VIII. Nitrogen recovery:

The data in Table (5) revealed that nitrogen recovery was significantly affected by cultivars, where the highest values were obtained from Mina cultivar and the lowest one was obtained from Dorado cultivar. The increase in nitrogen recovery may be due to the increase in grain yield/fed rather than the increase in protein content. The results are in agreement with those reported by Ragheb and El-Nagar (1997), Galal (1997), Khatik *et al* (1999) and Brogna *et al.* (2000)

Plant density exerted a significant influence on nitrogen recovery as shown from data in Table (5), where the highest values were obtained with the highest density (140,000 plants/fed.). The increase here is mainly due to the increase in grain yield/fed. Similar results were reported by Galal (1997), Patil *et al* (1999) and Gonzalez and Graterol (2000)

The data in Table (5) showed that the application of nitrogen fertilizer to grain sorghum increased nitrogen recovery, where the highest values were obtained when N rates increased up to 120 kg N/fed. This is mainly dne to the increase in protein and grain yield/fed. These data are in line with those obtained by Ragheb and El-Nagar (1997) who concluded that increasing N levels increased N uptake in grains

The data in Table (5) revealed that nitrogen recovery was significantly affected by all interactions under study. The significant effect for the different interactions may be due to the significant influence of main factors on such trait. In general, the highest value was obtained from Mina cultivar when received the highest N rate and sown at moderately plant density (70,000 plant/fed.)

It could be concluded that the highest grain yield/fed was obtained from Mina cnltivar when sown with 70,000 plants/fed. and received the highest N rate (120 kg N/fed.). As well as from Shandaweel-2 cultivar when sown with 140,000 plauts/fed and received the highest N rate (120 kg N/fed.) This indicate the need to publicize the proper planting density for each cultivar.

Table (5): Effect of plant density and nitrogen fertilizer on N-recovery (kg N/fed.) of some grain sorghum cultivars (combined data).

Plant density/fed, (D)	N fert. kg/fed. (N)	Cultivars (V)				
		Dorado	Shandaweel-2	Mina	Horus	Mean
46,666	80	33 37	36.23	43.51	34.35	36.86
	100	38.49	40.44	46.25	40.20	41.34
	120	41.92	44.33	54.50	43 88	46.16
	Mean	37.92	40.33	48.08	39.47	41.45
70,000	80	39.53	43.77	42.80	40.95	41.76
	100	40 30	53 18	55.90	47 96	49.34
	120	45.14	54.09	65.45	50 77	53.86
	Mean	41.66	50.35	54 72	46.56	48.32
140,000	80	44 21	51.06	51.45	48.03	48.69
	100	48 57	56 05	55.17	54.08	53.47
	120	48.86	61.14	58.84	56.47	56.33
	Mean	47.21	56 08	55.15	52.86	52.83
V/N	80	39 04	43 69	45.92	41.11	42.44
	100	42 45	49.89	52.44	47.41	48.04
	120	45 31	53 19	59.60	50 37	52.11
	Mean	42.27	48.92	52 65	46 30	47.53

LSD at 5% level for:

V =	1.84	VN=	0.64
N =	0.98	VD =	1.76
D –	1.26	ND =	0 83
VDN =	1.28		

References

Abu-Kreshe, M A , B.S. Farghly and A.A. Zohary (1996). Effect of tillage systems. Preceding Crops and Nitrogen Fertilizer on grain yield of sorghum under Upper Egypt condition. Assiut J Agric. Sci., 27 (4): 77-89.

A.O.A.C. (1980). Association of Official Agriculture Chemists "Official Methods of Analysis" 13th Ed., Washington, D.C., USA.

Attia, K.K. (1999). Interaction effect of elemental sulfur and nitrogen fertilizer on yield and nutrient of sorghum grown on a clay soil. Assiut J. Agric. Sci., 30 (5): 107-122.

Brogna, G.; E. Desiderio; A A. Bianchi, M Monotti; R. Santilocchi; M. Fornara and G. Novembre (2000). Grain sorghum: comparative variety trials in central Italy Informatore Agrario., 56 (14): 31-36. (C.F. Field Crop Abst. 53 (10) 687, 2000)

Chouhan, S.S and J.M. Dighe (1999) Chemical composition, yield and yield attributes of sorghum genotypes under different fertility levels in Malaw region Crop Res. (Hisar), 17 (2) 149-152.

Dashora. L.N. and B.L Porwal (1994). Response of promising sorghum (*Sorghum bicolor*) genotypes to applied nitrogen in rainy season. Indian J. of Agron., 39 (2) 308-309.

Eid. H M , M I Bashir, N G Ainer and M A Rady (1993) Climate change and crop modeling study on sorghum Annals of Agric. Sci , Cairo. No 1 special Issue. (219-234).

El-Nagouly. O O.; M.S.A. Mostafa: A M El-Kady, M I Bashir; A H. Ali and M R. Asran (1997). Release of two new grain sorghum hybrids for Egypt Egyptian J. of Agric. Res., 75 (4). 1007-1018

Eweis. S O ; M.I Bashir, Z H Darweesh and S.M.M Abd El-Salam (1992). Effect of plant density and nitrogen fertilization on growth, yield and chemical composition of grain sorghum Egypt J Appl. Sci., 7 (12): 700-708

Galal. A H (1997) Effect of row and hill spacings on yield and yield components of some grain sorghum cultivars (*Sorghum bicolor* (L.) Moench). Assiut J Agric Sci., 28 (4): 131-141.

Gomez. K.A. and A.A. Gomez (1984) Statistical Procedures for Agricultural Research John Wiley and Sons, Inc. New York

Gonzalez, R and Y. Graterol (2000). Effect of row spacing and fertilizer application on yield and yield components of grain sorghum (*Sorghum bicolor* L. Moench) in Portuguesa. Revista Unellez de Ciencia y Technologia. production-Agricola (C F CAB Abstracts 2000-2001)

Gordon, W B. and D A Whitney (2000) Effects of phosphorus application method and rate on furrow-irrigated ridge-tilled grain sorghum. J. of Plant Nutrition. 23 (1): 23-34 (C F Field Crop Abst. 52 (3) 1751. 2000)

Gowily. A.M. (1995) Influence of plant density and sulpher treatment in controlling anthracnose disease and grain yield of sorghum. Bull Fac Agric.. Cairo Univ., 46 49-54

Khatik. R.L., L.L. Somani and A L. Mali (1999). Response of promising sorghum genotypes to varying fertilizer levels in a Haplustalfs Crop Research (Hisar), 17 (3) 302-306 (C F Field Crop Abst 52 (11) 8215. 1999)

Kumar, R.N ; M Lawrence and S. Mohammad (1998) Technological manipulations in sowing method and nitrogen application rates to parental lines in seed production of CSH 14 sorghum hybrid. Crop Res. (Hisar), 16 (2) 150-155 (C.F Field Crop Abst 52 (3) 1750. 1999).

Kumawat. S.M and K N Bansal (1993) Residual effect of sulphur sources in combination with nitrogen and plant growth regnlator on sorghum (*Sorghum bicolor*) Indian J. of Agron., 14 (4). 647-649

Lamani. B B., V P Chimmad; B B. Channappagoudar and M B. Chetti (1997) Impact of plant population in partitioning of dry matter in sorghum genotype. Karnataka, J. of Agric. Sci., 10 (4): 1220-1222. (C.F CAB Abstracts 1998-2000)

Marwat. M.I.; Jan, Amanullah and Iftikar Ahmad (1999). Effect of seeding density and genotypes on sorghum plant hight, forage and grain yield under rainfed conditions. Sahad J. of Agric , 15 (5) 387-392 (C.F Field Crop Abst. 53 (3) 1716, 2000)

Mohamed, A.B.; A.M. Badreldin and N O Mohamed (1998) Response of some sorghum hyhrids and their parents to nitrogen fertilization. Sudan J of Agric Res., 1 (1): 9-12. (C F Field Crop Abst. 53 (3) 1718, 2000)

Mohamed, E.I., M R.A. Hovny and K.A O. El-Aref (2000) Effect of splitting both nitrogenous and phosphatic fertilizers on sorghum (*Sorghum bicolor* L.) productivity and chemical composition. Assiut J. Agric. Sci , 31 (1)

Mohammad. S and M R Hasan (1993) Planting date adjustments, nitrogen management and genotypic alterations of sorghum in a scarce rainfall-shallow soils ecosystem Intern J of Tropical Agric . 11 (4) 255-261 (C F CAB Abstracts 1995).

Mulik, S P ; H.L. Ghadge. A S Jadhav and J D. Patil (1994). Response of winter season sorghnm (*Sorghum bicolor*) varieties to sowing time and nitrogen. Indian J of Agron , 41 (2): 252-255

Patil. S.L.: M.S R M Rao; S K Nalatwadmath and K.K. Reddy (1999) Response of Rabi sorghum to moisture, plant population and nitrogen levels and its residual effect on Bengal gram growth and yield in the vertisols of Deccan plateau. Advances in Agric Res. in India.

12: 17-26 (C F CAB Abstracts 2000-2001)

Paulpandi, V K., U. Solaiappan and S.P Palaniappan (1999) Effect of plant geometry and fertility levels on yield and yield attributes in irrigated sorghum. Indian J. of Agric Res., 33 (2): 125-128.

Powell, J M. and F M Hons (1992) Fertilizer nitrogen and stover removal effects on sorghum yields and nutrient uptake and partitioning. Agriculture, Ecosystems and Environment, 39 (3/4) 197-211. (C.F CAB Abstracts 1993-1994).

Ragheb, H.M A and G. El-Nagar (1997). Response of grain sorghum to nitrogen fertilization and irrigation intervals Assiut J Agric. Sci , 28 (2) 145-157

Schatz, B G , A.A. Schneiter and J.C Grander (1990). Effect of plant density on grain sorghum production in North Dakota. North, Dakota. Farm Res., 47 (5): 15-127. (C F. CAB Abstracts 1990-1991)

Snedecor, C.W and W.C. Cochran (1980) Statistical method. 7th Ed. Iowa State Univ. Press, Ames, Iowa

Surakad, V.S. and C.J. Itnal (1997) Response of rabi sorghum to tillage practices and nitrogen levels in deep black soil under dry land conditions. Karnataka J of Agric. Sci , 10 (2): 307-310

Tripathi, R.Y and Surajbhan (1993) Effect of level and method of nitrogen application and moisture conservation practices on growth and yield of rainfed sorghum (*Sorghum bicolor*) under light textured, eroded soil of central uttar pradesh. Indian J of Agron., 40 (1) 47-50

Wade, L.J ; A.C L Douglas and K.L. Bell (1992) Effect of plant density on grain yield and yield stability of diverse grain sorghum hybrids. AIAS - Occasional - Publication, 1992, No 68, Vol. 2, 414-422 (C.F. CAB Abstracts 1993-1994).

استجابة بعض أصناف الذرة الرفيعة الحبوب للكثافة النباتية والتسميد النيتروجينى

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أجريت تجربتان حقليتان بمزرعة التجارب بجامعة أسيوط خلال صيف موسمى ٢٠٠٠ و ٢٠٠١م لدراسة استجابة أربعة أصناف من الذرة الرفيعة (دورادو – شندويل ٢ ميا – حورس) للكثافة النباتية (٤٦,٦٦٦ – ٧٠,٠٠٠ – ١٤٠,٠٠٠ ألف نبات / فدان) وللتسميد النيتروجينى بمعدلات (٨٠ ، ١٠٠ ، ١٢٠ كجم ازوت / فدان) . أوضحت النتائج ما يلى :

١ - تباينت استجابة الأصناف الأربعة معنويا للصفات المقاسة مثل طول القنديل ووزن القنديل وعرض القنديل ، حيث تفوق الصنف ميا في هذه الصفات ماعدا طول القنديل تفوق الصنف حورس . كما كانت استجابة الأصناف معنوية في صفات الحاصل ومكوناته وتفوق أيضا الصنف ميا في جميع الصفات المقاسه عن باقي الأصناف الاخرى وخاصة الصنف دورادو . كانت اقل القيم للحاصل ومكوناته من الصنف دورادو ماعدا نسبة التفريط كانت اقل قيمة لها من الصنف حورس . ايضا كانت استجابة الأصناف تحت الدراسة غير معنوية بالنسبة لصفة محتوى البروتين .

٢ ادت زيادة الكثافة النباتية من ٤٦,٦٦٦ إلى ٧٠,٠٠٠ أو ١٤٠,٠٠٠ ألف نبات للفدان إلى زيادة محصول الحبوب للفدان ونسبة التفريط والنيتروجين الممتص بينما أدت إلى نقص حاصل النبات الواحد ووزن ١٠٠٠ حبة . كذلك لم تظهر الكثافة النباتية تأثير معنويا على نسبة البروتين في الحبوب .

٣ - أدت التسميد النيتروجيني إلى زيادة معنوية في طول وعرض ووزن القنديل وكذلك زادت معنويا كل من وزن ١٠٠٠ حبة ، حاصل النبات الواحد ، حاصل حبوب الفدان ، نسبة التفريط، نسبة النيتروجين الممتص وكذا المحتوى البروتينى .

بصفة عامة أظهر معظم التفاعلات تأثيرا معنويا على المحصول ومكوناته ووجد ان اعلى حاصل من الحبوب كان ٢٨,٦٥ اردب للفدان عند زراعة الصنف ميا بكثافة نباتية ٧٠,٠٠٠ الف نبات بالفدان والتسميد بمعدل ١٢٠ كجم أزوت / فدان ، وكان هذا الحاصل متماثل معنويا مع محصول الصنف شندويل-٢ المزروع بكثافة ١٤٠,٠٠٠ ألف نبات / فدان والمسمد بنفس معدل السماد الازوتي.