Minia J. of Agric. Res. & Develop.
Vol. (36), No. 3, pp. 445-458, 2016

FACULTY OF AGRICULTURE

EFFECT OF IRRIGATION INTERVALS, PLANTING DENSITY AND NITROGEN FERTILIZATION ON YIELD AND QUALITY OF SWEET SORGHUM

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Received: 8 September (2016) Accepted: 19 September (2016)

ABSTRACT

Two field experiments were carried out at Shandaweel Agricultural Research Station, Sohag Governorate (latitude of 26°33'N, longitude of 31°41'E and Altitude of 69 m), in 2013 and 2014 seasons to study the effect of irrigation intervals, planting density and nitrogen fertilization on yield and quality of sweet sorghum [*Sorghum bicolor* (L.) Moench var. saccharatum]. Each field trail included twenty seven treatments represent the combinations among three irrigation intervals, three planting density and three nitrogen fertilization levels. A split-split plot design with four replications was used in both seasons, where the three irrigation intervals (14, 21 and 28 day) were arranged in the main plots, while planting densities (35.000, 52.500 and 70.000 plants/fed) were randomly allocated in the sub plots and the three nitrogen levels (70, 90 and 110 kg N/fed) were randomly distributed in the sub-sub plots. The results showed that stalk length, stalk diameter, sucrose %, reducing sugars% as well as forage and stripped stalk yields/fed were significantly affected by the three studied factors, in both seasons. Shortening irrigation interval from 28 to 21 and to 14 days was accompanied with a significant and gradual increase in stalk length and diameter as well as forage and stripped stalk yields. Sucrose % was increased with widening irrigation interval from 14 to 21 days and thereafter, it decreased as irrigation interval was prolonged to 28 days. Prolonging irrigation interval from 14 to 28 days caused a reduction in forage and stripped stalk yields. Increasing the density of plants per unit area from 35.000 to 52.500 and to 70.000 plants/fed resulted in a gradual increase in stalk height, forage and stripped stalk yields. Sucrose % tended to increase as planting population was raised from 35.000 to 52.500 plants/fed and decreased again at 70.000 plants/fed. Increasing N fertilization level from 70 up to 110 kg N/fed caused an ascending increase in stalk length and diameter, forage and stripped stalk yields of sweet sorghum. Sucrose and reducing sugar% tended to increase as N-level was raised from 70 to 90 kg N/fed, and decreased thereafter at 110 kg N/fed. Under conditions of the present study, growing 52.500 plants, irrigated each 21 days and fertilized with 90 kg N/fed, can be recommended to get the highest forage, stripped stalk and quality characteristics of sweet sorghum.

INTRODUCTION

Sweet Sorghum, as one of the C_4 plants, is adapted to widely differed climatic and soil conditions. It is a short-term crop, which matures earlier under high temperatures. It is not only known as a "high energy crop" because of its high photosynthetic rate, but it is also called "the camel among crops" due to its characteristics such as drought resistance. It can be grown on soils ranging from heavy clay to light sand. Sweet Sorghum can be grown as an agro-industrial crop for sugar syrup required for food industries, forage for animal production to feed animals as dairy live stock, sheep, *etc*. Also, it can be used as a source of fermentable juice to increase the production of bio-fuel "Ethanol". Moreover, bagasse remained after crushing of stalks can be concreted into activated carbon used in many industries or used to produce paper pulp and fiber boards. It responds efficiently to the available growth factors as water stress, planting density and nitrogen fertilization. In respect to water stress, Taha, *et al.* (1999) reported that irrigating sweet sorghum at 10-day intervals gave the highest values of growth characters, yield and yield components. Meantime, plants irrigated every 30-day intervals gave the maximum reducing sugars % and sucrose %. Da Silva and Da Costa (2001) indicated that the rate of shoot and leaves expansions are sensitive to irrigation, which affect plant height and diameter. Yanaso and Detpiratmongkol (2009) cleared that water deficit reduced plant height and stem fresh weight yield/ha of sweet sorghum. Ting and Peix (2011) found that the maximum stem and above ground biomass yield occurred in moderate drought stress condition with stem fresh weight of 77.3 tons/ha. El-Hawary, *et al.* (2012) studied the effect of three irrigation intervals irrigation of 10, 15 and 20 days. They found that prolonging irrigation period from 10 to 20 days significantly reduced stalk height, sucrose percentage and stalk yield/fed. Almodares, *et al*. (2013) concluded that delaying irrigation intervals from 7 to 21 days significantly decreased stem height, stem diameter and sucrose %.

As for the effect of planting density, Mahmoud, *et al*. (1999) reported that planting sweet sorghum at wider row-spacing (70 cm) produced the highest values of stalk diameter and sucrose % than that grown at closer one (50 cm). They added that reducing sugars were not significantly affected by inter-row spacing. Moreover, they mentioned that plants sown in rows of 50-cm apart had higher stalk length and stalk yield/fed. Abo El-Wafa and Abo El-Hamd (2001) grew sweet sorghum at three plant population densities of 28000, 56000 and 84000 plants/fed. They found that increasing plant population from one up to 84000 plants/fed remarkably reduced stalk diameter, but it had no effect on plant height and chemical characters. Amaducci, *et al*. (2004) studied the effect of two plant populations (10 and 20 plants/m^2). They found that higher plant density was associated to higher content of sucrose and lower content of glucose and fructose. Bekheet, *et al*. (2006) found that increasing planting population of sweet sorghum from 70000 to 140000 plants/fed resulted in a significant increase in stalk height, yield of stripped stalks. However, the mid plant density (93333 plants/fed) produced the highest forage yield/fed. They detected insignificant differences in sucrose% and reducing sugars % as affected by planting densities. Soleymani, *et al*. (2013) determined the growth of sweet sorghum planted with different plant densities (100, 200, 300, 400, 500 and 600 thousand plant/ha). They found that the effect of plant density was significant on plant height, stem diameter and sucrose%.

Concerning N fertilization level, El-Taweel (1994) concluded that the application of N fertilizer up to 90 kg N/fed significantly increased plant height, stalk yield and sucrose% in sweet sorghum cultivars. Besheit, *et al.* (1996) studied the effect of five N levels (60, 90, 120. 150 and 180 kg/fed) on yield and techno-chemical characteristic of sweet sorghum. They showed that increasing N level up to 120 or 150 kg N/fed significantly increased the whole stalk weight as well as length and diameter of the stalk. Sucrose % increased up to 120 kg N/fed, thereafter further application of N decreased it. Glucose coefficient rate (rate between reducing sugars and sucrose percentages) progressively increased as N level increased up to 180 kg N/fed. Mahmoud, *et al*. (1999) fertilized sweet sorghum with 50, 70 and 100 kg N/fed. They concluded that increasing nitrogen rate up to 100 kg N/fed markedly increased reducing sugar%, but decreased sucrose%. They added that stalk yield increased as nitrogen level up to 100 kg N/fed. Taha, *et al.* (1999) mentioned that when sweet sorghum cv. Honey was fertilized with 30, 60 or 90 kg N/fed, plant height, stalk diameter, stalk yield, green yield and sucrose % increased, while reducing sugars % decreased. El-Shafai, *et al.* (2005) reported that there were gradual and significant increases in stalk length, stalk diameter, reducing sugars%, stripped stalk and forage yields with increasing N-level from 40 to 60 and 80 kg N/fed. However, applying 60 kg N/fed was enough to obtain the highest sucrose%. Poornima, *et al*. (2008) evaluated the effect of nitrogen levels of 90, 120 and 150 kg N/ha on yield and juice quality of sweet sorghum. They found that the maximum millable cane yield and juice yield were recorded with the application of 150 kg N/ha. Thakur, *et al*. (2009) fertilized sweet sorghum with 30, 60, 90 and 120 Kg N/ha. They found that application of 120 kg N/ha level was suitable for the maximum growth and yield attributes. El-Hawary, *et al.* (2012) used four nitrogen levels to fertilize sweet sorghum (without nitrogen, 50, 70, and 90 kg N/fed). They cleared that increasing nitrogen fertilizer levels from 0 to 90 kg N/fed significantly increased all studied characters, except sucrose%. Almodres, *et al*. (2013) fertilized sweet sorghum with nitrogen levels of 0, 100, 200 and 300 kg N/ha. They showed that plant height and plant diameter increased up to 100 kg N/ha. On the other hand, sucrose was highest with the application of 300 kg N/ha. Uchino, *et al*. (2013) grew sweet sorghum under different nitrogen levels (0, 30, 60, 90,120 and 150 kg N/ha). They found that cane fresh weight increased significantly in line with higher N rate up to 90 kg N/ha.

The aim of this investigation was to study the effect of irrigation intervals, planting density and nitrogen fertilization on yield and quality of sweet sorghum .

MATERIALS AND METHODS

Two field experiments were carried out at Shandaweel Agricultural Research Station, Sohag Governorate (latitude of 26°33'N, longitude of 31°41'E and Altitude of 69 m), in 2013 and 2014 seasons to study the effect of irrigation intervals, planting density and nitrogen fertilization on yield and quality of sweet sorghum [*Sorghum bicolor* (L.) Moench var. saccharatum]. Each field trail included twenty seven treatments represent the combinations among three irrigation intervals, three planting densities and three nitrogen fertilization levels. A split-split plot design with four replications was used in both seasons, where the three irrigation intervals (14, 21 and 28 day) were arranged in the main plots, while planting densities (35000, 52.500 and 70.000 plants/fed) were randomly allocated in the sub plots and the three nitrogen levels (70, 90 and 110 kg N/fed) were randomly distributed in the sub-sub plots. Nitrogen was applied as urea (46.5% N) in two equal doses; after thinning (21 days from planting) and one month later. The studied planting populations were achieved as follows:

1. 35.000 plants/fed, resulted from sowing on one side of ridges of 60-cm, with hill spacing of 20.
2. 52.500 plants/fed, resulted from sowing 3 rows of plants on 120-cm terraces, with hill spacing of 20.

3. 70.000 plants/fed, resulted from sowing on both sides of ridges of 60-cm apart, with hill spacing of 20.

Seedlings were thinned to two plants/each hill after 21 days from sowing. The sub-sub plot area was 24.0 m^2 including 8 ridges of 60.0 cm apart and 5.0 m long. Prrandes variety was used in both seasons. Sowing dates took place during the 1st week of June, while harvesting was done at dough ripening stage, in both seasons. An overall dose of phosphorus fertilizer was added as calcium super phosphate (15.5% P_2O_5), at the rate of 30 kg P_2O_5/fed, during seed bed preparation. The other agricultural practices were done as recommended by Sugar Crops Research Institute, Agricultural Research Center. The soil was sand clay loam with a pH of 7.3.

The recorded data:

At harvest (120 days after sowing), the following traits were determined:

1. Stalk length, which was measured from the soil surface to the node at the base of panicle(cm).
2. Stalk diameter, which was measured at the middle of the fourth internodes of stalk from the ground(cm).

At harvest time (dough stage), a random sample of twenty stalks was taken from each sub-sub plot, stripped, cleaned and squeezed by electric roller pilot mill to determine the following traits:

3. Sucrose %, which was determined using the direct polarization method as described by De-Whalley (1964).
4. Reducing sugars, which was determined using "Fehling solution" according to Plews (1970).
5. Forage yield (tons/fed) was calculated on plot basis.
6. Net stripped-stalk yield (ton/fed) was calculated on plot basis.

The collected data were statistically analyzed according to Snedecor and Cochran (1967). Treatment means were compared by using LSD values at 5% level of significance, according to Steel and Torrie (1980). All statistical analysis was performed using computer software package analysis of variance technique of MSTAT-c (1989).

RESULTS AND DISCUSSION

Stalk length and diameter:

The results in Table 1 showed a significant response of stalk length and diameter of sweet sorghum to the studied irrigation intervals, in 2013 and 2014 seasons. It was found that shortening irrigation interval from 28 to 21 and to 14 days was accompanied with a gradual increase in stalk length and diameter. The positive response of these two growth traits to the reduction in irrigation interval is probably due to the abundance of water, which is the main factor for the biological and physiological processes in plants, especially photosynthesis and in turn growth of plant organs. These results are in agreement with those reported by Yanaso and Detpiratmongkol (2009), El-Hawary, *et al.* (2012) and Almodares, *et al*. (2013), who cleared that water deficit and prolonging irrigation intervals negatively reduced plant height, as well as Da Silva and Da Costa (2001) and Almodares, *et al*. (2013), who found that the abundance of water and shortening irrigation intervals positively affected stalk diameter.

The results in Table 1 point to a significant effect of the tested planting densities on both traits in both seasons. The results indicated that increasing the density of plants per unit area from 35000 to 52500 and to 70000 plants per feddan resulted in a gradual increase in stalk height. The increase in plant height as the population density increased could be attributed to the fact that, due to the competition among plants under dense planting, plants increase its height searching for solar radiation. These results are in harmony with those mentioned by Mahmoud, *et al*. (1999), Bekheet, *et al*. (2006) and Soleymani, *et al*. (2013). On the contrary, increasing plant population to 52500 and to 70000 plants/fed was associated with a negative influence on stalk diameter, compared with growing 35000 plants/fed, which resulted in the thickest stalks. The reduction in stalk diameter accompanying the increase in plant population density can be attributed to the competition among plants for growth factors as space, nutrients, water and solar radiation, which negatively reflected on plant growth. These results are in agreement with those reported by Abo El-Wafa and Abo El-Hamd (2001) and Soleymani, *et al*. (2013).

Data in Table 1 cleared that increasing the applied N-level caused ascending and significant increase in stalk length and diameter of sweet sorghum in the 1st and 2nd seasons. The increase in these two characters accompanying the increase in nitrogen fertilization level may be referred to the role of nitrogen as an essential element in building up plant organs. The obtained results are in line with those found by Taha, *et al.* (1999), El-Shafai, *et al.* (2005) and Almodres, *et al*. (2013).

The results in Table 1 revealed that stalk height was significantly affected by the interaction between irrigation intervals and planting density, in the 1st season as well as that between planting density and N-level, in the 2nd season.

Stalk diameter was significantly affected by the interactions between irrigation interval and N-level and the interaction between planting density and N-level, in the 1st season. In the 2nd one, stalk diameter was significantly influenced by the interactions between irrigation interval and N-level, as well as the 2nd order interaction among the three studied factors.

Sucrose and reducing sugars percentages:

Data in Table 2 revealed that sucrose% was significantly affected by the studied irrigation intervals in 2013 and 2014 seasons. The results indicated that the determined sucrose % was increased with widening irrigation interval from 14 to 21 days and thereafter, it decreased as irrigation interval was prolonged to 28 days, in both seasons. The increase in sucrose % accompanying widening irrigation interval from 14 to 21 days may be due to a reduction in water content in stalk juice at longer interval, which contributed to increasing sucrose, determined as a percentage on fresh weight basis. Meanwhile, further prolonging of irrigation interval to 28 days, reduced stalk water content, which is required for sugar translocation and storage. These results coincide with those reported by Taha, *et al.* (1999), Ting and Peix (2011) and El-Hawary, *et al.* (2012).

The results cleared that reducing sugars % was significantly affected by irrigation intervals, in both seasons. In the 1st one, it had the same response of that of sucrose % to lengthening irrigation intervals. However, in the 2nd season, reducing sugars % increased as irrigation from 14 up to 28 days, without significant variance between its recorded values at 21 and 28 days. These results are in agreement with reported by Taha, *et al.* (1999).

Data in Table 2 pointed out that sucrose % was significantly influenced by planting density, with a tendency to increase as planting population was raised from 35000 to 52500 plants/fed and decrease again in plants of the highest population (70000 plants/fed), in both seasons. These results are in line with those found by Mahmoud, *et al*. (1999) Amaducci, *et al*. (2004). However, the difference in this quality trait was insignificant in case of growing 52500 and 70000 plants/fed, in the 2nd season. Reducing sugars % had the same trend of that of sucrose in its response to planting density, in the 1st season, without significant variance between plants grown at the lowest and highest density. In the 2nd one, a gradual but insignificant increase of this trait was detected as planting density was increased from 35000 up to 70000 plants/fed. These results are in agreement with those mentioned by Bekheet, *et al.* (2006).

The applied N fertilization levels had a significant effect on the recorded values of sucrose and reducing sugar percentages. Both traits tended to increase as N-level was raised from 70 to 90 kg N/fed, and decreased thereafter at the highest N-level (110 kg N/fed). These results are in agreement with those given by El-Taweel (1994), Besheit, *et al.* (1996) and El-Safai, *et al.* (2005).

Forage and net stripped-stalk yields:

Data in Table 2 forage and stripped stalk yields/fed significantly responded to the applied irrigation intervals in 2013 and 2014 seasons. It was found that prolonging irrigation interval from 14 to 28 days caused a reduction in forage yield amounted to

0.24 and 0.18 ton/fed, corresponding to a reduction of 0.31 and 1.10 ton/fed in stripped stalk yield, in the 1st and 2nd season, respectively. These results may be attributed to the reduction in both stalk height and diameter as irrigation interval was prolonged (Table 1), which is probably due to the shortage of soil moisture, which negatively reflected on the biological and physiological processes in plants as photosynthesis and in turn decreased growth of plant organs. These results coincide with those reported by Taha, *et al.* (1999), Yanaso and Detpiratmongkol (2009) and El-Hawary, *et al.* (2012).

The results indicated that forage and stripped stalk yields/fed were significantly affected by the evaluated planting density. The results cleared that increasing plant population to 52500 and 70000 plants/fed resulted in increasing forage yield by (2.12, 3.66 and 2.12, 3.61 ton/fed) and stripped stalk yield by (3.21, 5.57 and 3.05, 5.48 ton/fed), in the 1st and 2nd season, successively, compared with sweet sorghum grown at 35000 plants/fed. These results can be referred to the gradual increase in stalk height (Table 1) and increasing plant number per unit area, which benefited from growth factors, *i.e.* water, solar radiation and nutrients, turning it into dry matter. These results coincide with those reported by Bekheet, *et al*. (2006), Thakur, *et al*. (2009) and Soleymani, *et al*. (2013).

Data in Table 2 point to a significant response of both forage and stripped stalk yields/fed to the applied N fertilization levels in both seasons. In the 1st one, raising N-level to 90 and 110 kg N/fed, led to an increase in forage yield amounted to 1.20 and 1.13 ton/fed, corresponds to an increase in stripped stalk yield of 0.99, 0.92 and 1.17, 1.92 ton/fed, compared to plants fertilized with 70 kg N/fed, respectively. Likewise, an increase in forage yield amounted to 1.63 and 1.71 ton/fed was detected, corresponds to an increase in stripped stalk yield of 0.92 and 1.92 ton/fed, compared to plants fertilized with 70 kg N/fed, successively. These results are probably due to the increase of both plant height and diameter as N-level was raised (Table 1), which may be referred to the role of nitrogen as an essential element in building up plant organs. These results are in harmony with those mentioned by El-Safai, *et al.* (2005), Poornima, *et al*. (2008**),** Thakur, *et al*. (2009), El-Hawary, *et al.* (2012) and Uchino, *et al*. (2013).

CONCLUSION

Under conditions of the present study, growing 52500 plants, irrigated each 21 days and fertilized with 90 kg N/fed, can be recommended to get the highest forage, stripped stalk and quality characteristics of sweet sorghum.

Table (1): Effect of irrigation interval, planting density, nitrogen level and their interactions on plant height and diameter (cm) harvest date in 2013 and 2014 seasons

Irrigation Interval (days) (A)	Planting density/fed (B)	Plant height (cm)								Plant diameter (cm)							
		2013 season				2014 season				2013 season				2014 season			
		Nitrogen, kg/fed (C)			Mean	Nitrogen, kg/fed (C)			Mean	Nitrogen, kg/fed (C)			Mean	Nitrogen, kg/fed (C)			Mean
		70	90	110		70	90	110		70	90	110		70	90	110	
14	35000	293.70	297.07	298.50	296.42	306.33	312.80	318.60	312.58	2.32	2.43	2.67	2.47	2.54	2.60	2.70	2.61
	52500	302.37	308.20	310.70	307.09	313.47	316.90	327.73	319.37	2.16	2.38	2.52	2.35	2.53	2.63	2.72	2.62
	70000	328.30	335.27	339.20	334.26	336.10	338.57	342.17	338.94	2.00	2.24	2.39	2.21	2.52	2.65	2.73	2.63
Mean		308.12	313.51	316.13	312.59	318.63	322.76	329.50	323.63	2.16	2.35	2.52	2.35	2.53	2.62	2.72	2.62
21	35000	261.00	287.20	296.90	281.70	299.97	304.17	310.50	304.88	2.06	2.34	2.50	2.30	2.52	2.65	2.62	2.59
	52500	295.40	296.40	305.70	299.17	313.93	317.63	321.00	317.52	2.02	2.25	2.33	2.20	2.33	2.48	2.58	2.47
	70000	312.40	320.30	325.93	319.54	305.97	310.50	315.77	310.74	2.08	2.17	2.28	2.18	2.29	2.38	2.6	2.43
Mean		289.60	301.30	309.51	300.14	306.62	310.77	315.76	311.05	2.05	2.25	2.37	2.23	2.38	2.51	2.61	2.50
28	35000	259.10	284.10	285.57	276.26	301.40	306.23	308.53	305.39	1.95	2.13	2.27	2.12	2.41	2.43	2.54	2.46
	52500	293.97	294.53	298.90	295.80	284.83	294.70	301.77	293.77	1.91	2.17	2.32	2.13	2.34	2.50	2.62	2.49
	70000	312.60	319.17	326.00	319.26	293.73	302.53	306.57	300.94	2.12	2.24	2.42	2.26	2.30	2.50	2.63	2.48
Mean		288.56	299.27	303.49	297.10	293.32	301.16	305.62	300.03	2.00	2.18	2.33	2.17	2.35	2.48	2.60	2.47
Mean of planting density/fed	35000	271.26	289.46	293.66	284.79	302.57	307.73	312.54	307.62	2.11	2.30	2.48	2.30	2.49	2.56	2.61	2.56
	52500	297.24	299.71	305.10	300.68	304.08	309.74	316.83	310.22	2.03	2.26	2.39	2.23	2.40	2.54	2.64	2.53
	70000	317.77	324.91	330.38	324.35	311.93	317.20	321.50	316.88	2.07	2.22	2.36	2.22	2.37	2.51	2.66	2.51
Overall mean of N-level			295.43	304.69	309.71		306.19	311.56	316.96	2.07	2.26	2.41		2.42	2.54	2.64	
LSD at 0.05 level for:																	
Irrigation interval (A)						2.21			1.38				0.05				0.04
Planting density (B)						2.84			0.99				0.02				0.02
Nitrogen level (C)						2.57			1.06				0.03				0.03
A x B						NS			1.72				0.04				0.03
A x C						4.45			1.83				NS				NS
B x C						4.45			NS				NS				0.05
A x B x C						7.70			3.17				0.08				NS

Table (2): Effect of irrigation interval, planting density, nitrogen level and their interactions on sucrose and reducing sugars percentages at harvest date in 2013 and 2014 seasons

Irrigation Interval (days) (A)	Planting density/fed (B)	Sucrose %								Reducing sugars %							
		2013 season				2014 season				2013 season				2014 season			
		Nitrogen, kg/fed (C)			Mean	Nitrogen, kg/fed (C)			Mean	Nitrogen, kg/fed (C)			Mean	Nitrogen, kg/fed (C)			Mean
		70	90	110		70	90	110		70	90	110		70	90	110	
14	35000	7.30	8.13	6.97	7.47	7.70	8.50	7.13	7.78	3.43	4.18	3.43	3.68	3.58	4.08	3.05	3.57
	52500	7.63	8.43	7.16	7.74	7.37	8.33	7.43	7.71	3.78	4.33	3.43	3.85	3.23	4.07	3.62	3.64
	70000	6.78	7.33	6.53	6.88	7.00	7.67	6.90	7.19	3.34	3.50	3.17	3.34	2.97	3.73	3.82	3.51
Mean		7.23	7.97	6.89	7.36	7.36	8.17	7.16	7.56	3.52	4.01	3.34	3.62	3.26	3.96	3.49	3.57
21	35000	8.67	9.07	8.00	8.58	8.57	9.80	8.47	8.94	4.51	4.78	4.00	4.43	3.93	4.43	3.93	4.10
	52500	8.03	9.47	8.60	8.70	8.13	9.13	9.67	8.98	4.00	4.85	4.45	4.43	3.63	4.27	4.25	4.05
	70000	8.63	9.50	8.68	8.93	9.80	8.80	9.23	9.28	4.42	4.85	4.40	4.56	4.40	4.20	4.48	4.36
Mean		8.44	9.34	8.42	8.74	8.83	9.24	9.12	9.07	4.31	4.83	4.28	4.05	3.99	4.30	4.22	4.17
28	35000	7.03	7.53	7.20	7.26	7.43	7.97	7.70	7.70	3.45	3.47	3.37	3.43	3.97	4.32	3.70	3.99
	52500	7.37	8.40	8.03	7.93	8.20	9.23	8.67	8.70	3.47	4.23	3.90	3.87	4.05	4.26	4.28	4.20
	70000	7.23	7.77	7.53	7.51	7.67	9.17	8.50	8.44	3.32	3.83	3.65	3.60	4.25	4.37	4.38	4.33
Mean		7.21	7.90	7.59	7.57	7.77	8.79	8.29	8.28	3.71	3.84	3.64	3.63	4.09	4.32	4.12	4.18
Mean of planting density/fed	35000	7.67	824	7.39	7.77	7.90	8.76	7.77	8.14	3.80	4.14	3.60	3.85	3.83	4.28	3.56	3.89
	52500	7.68	8.77	7.93	8.13	7.90	8.90	8.59	8.46	3.75	4.47	3.93	4.05	3.64	4.20	4.05	3.96
	70000	7.55	8.20	7.58	7.78	8.16	8.54	8.21	8.30	3.69	4.06	3.74	3.83	3.87	4.10	4.23	4.07
Overall mean of N-level		7.63	8.40	7.63		7.98	8.73	8.19		3.75	4.23	3.76		3.78	4.19	3.95	
LSD at 0.05 level for:																	
Irrigation interval (A)					0.43				0.40				0.32				0.13
Planting density (B)					0.22				0.31				0.13				NS
Nitrogen level (C)					0.20				0.21				0.12				0.15
A x B					0.47				0.53				0.23				NS
A x C					0.35				0.45				0.22				NS
B x C					0.35				0.45				0.23				0.36
A x B x C					NS				0.62				0.46				NS

Table (3): Effect of irrigation interval, planting density, nitrogen level and their interactions on forage and net stripped-stalk yields (ton/fed) at harvest date in 2013 and 2014 seasons

Irrigation Interval (days) (A)	Planting density/fed (B)	Forage yield (ton/fed)								Net stripped-stalk (ton/fed)							
		2013 season				2014 season				2013 season				2014 season			
		Nitrogen, kg/fed (C)			Mean	Nitrogen, kg/fed (C)			Mean	Nitrogen, kg/fed (C)			Mean	Nitrogen, kg/fed (C)			Mean
		70	90	110		70	90	110		70	90	110		70	90	110	
14	35000	4.80	5.54	6.22	5.52	4.81	6.07	7.17	6.01	17.33	18.63	19.57	18.51	19.21	20.60	21.50	20.44
	52500	6.54	7.90	8.40	7.62	7.73	8.20	8.82	8.24	21.27	22.00	22.40	21.89	22.88	23.77	24.13	23.59
	70000	8.10	9.67	9.67	9.15	8.33	10.09	10.23	9.55	23.00	24.30	25.60	24.30	24.83	25.82	26.70	25.79
Mean		6.48	7.70	8.10	7.43	6.96	8.12	8.73	7.94	20.53	21.64	22.52	21.57	22.31	23.40	24.11	23.27
21	35000	4.94	5.74	6.44	5.70	5.30	6.23	7.60	6.38	18.63	19.83	21.23	19.90	19.93	21.37	22.23	21.18
	52500	6.73	8.20	8.64	7.86	7.40	8.70	9.00	8.37	22.33	23.90	25.23	23.82	23.47	25.17	26.00	24.88
	70000	8.27	9.93	10.00	9.40	8.90	10.80	10.47	10.06	26.43	26.73	28.17	27.11	27.13	28.03	29.20	28.12
Mean		6.65	7.96	8.36	7.65	7.20	8.58	9.02	8.27	22.47	23.49	24.88	23.61	23.51	24.86	25.81	24.73
28	35000	4.50	5.24	6.07	5.27	5.13	5.77	6.60	5.84	17.77	19.50	20.33	19.20	18.63	20.30	21.33	20.02
	52500	6.24	7.84	8.07	7.38	6.83	8.10	9.02	7.98	21.60	21.47	21.47	21.51	22.10	22.47	22.40	22.32
	70000	8.20	9.10	9.47	8.92	8.93	9.57	9.86	9.45	22.07	22.97	23.67	22.90	23.03	24.27	25.23	24.18
Mean		6.31	7.39	7.87	7.19	6.97	7.81	8.49	7.76	20.48	21.31	21.82	21.20	21.26	22.34	22.92	22.17
Mean of planting density/fed	35000	4.75	5.50	6.24	5.50	5.08	6.02	7.12	6.08	17.91	19.32	20.38	19.20	19.26	20.76	21.62	20.55
	52500	6.50	7.98	8.37	7.62	7.32	8.33	8.94	8.20	21.73	22.46	23.03	22.41	22.82	23.80	24.18	23.60
	70000	8.19	9.57	9.71	9.16	8.72	10.15	10.19	9.69	23.83	24.67	25.81	24.77	25.00	26.04	27.04	26.03
Overall mean of N-level		6.48	7.68	8.11		7.04	8.17	8.75		21.16	22.15	23.07		22.36	23.53	24.28	
LSD at 0.05 level for:																	
Irrigation interval (A)					0.10				0.19				0.23				0.35
Planting density (B)					0.15				0.24				0.17				0.28
Nitrogen level (C)					0.22				0.25				0.23				0.22
A x B					NS				NS				0.39				0.32
A x C					NS				NS				0.47				NS
B x C					NS				0.43				0.47				0.45
A x B x C					NS				NS				0.74				0.71

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الملخص العربى

تأثير فترات الرى و كثافة الزراعة والتسميد النيتروجينى على حاصل وجودة الذرة الرفيعة السكرية

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أقيمت تجربتان حقليتان بمحطة البحوث الزراعية بجزيرة شندويل (دائرة عرض 26.33 درجة شمالاً وخط طول 31.41 درجة شرقاً وإرتفاع 69 متراً عن سطح البحر) خلال موسمي 2013 و 2014 وذلك لدراسة تأثير فترات الري ، كثافة الزراعة والتسميد النيتروجيني على حاصل وجودة الذرة الرفيعة السكرية.

إشتملت التجربة على 27 معاملة تمثل التوافقات بين ثلاث فترات للري وثلاث كثافات نباتية وثلاثة مستويات من التسميد النيتروجيني. إستخدم تصميم القطع المنشقة مرتين في أربعة مكررات في كلا الموسمين ، حيث وضعت مستويات الري (الرى كل 14 ، 21 و 28 يوماً) في القطع الرئيسية ، بينما وزعت الكثافات النباتية (35.000 ، 52.500 و 70.000 ألف نبات للفدان) فى القطع الشقية الأولى ، ووزعت مستويات السماد النيتروجيني (70 و 90 و 110 كجم نيتروجين للفدان) فى القطع الشقية الثانية. أوضحت النتائج أن طول وقطر العود والنسبة المئوية لكلٍ من السكروز والسكريات المختزِلة وكلاً من حاصل العلف الأخضر والعيدان النظيفة القابلة للعصر تأثرت معنوياً بعوامل الدراسة فى كلا الموسمين.

أدى تقصير فترات الري من 28 إلى 21 ثم إلى 14 يوماً إلى زيادة معنوية في طول وقطر العود و حاصل العلف الأخضر والعيدان النظيفة ، بينما إزدادت نسبة السكروز بزيادة فترات الرى من 14 الى 21 يوماً ثم نقصت بزيادة الفترة إلى 28 يوماً. حققت زيادة الكثافة النباتية للفدان من 35.000 إلى 52.500 وحتى 70.000 ألف نبات للفدان زيادة معنوية في طول العود و حاصل العيدان النظيفة القابلة للعصر ، بينما إزدادت النسبة المئوية للسكروز حتى 52.500 ثم نقصت بعد ذلك عند 70.000 نبات للفدان. بينت النتائج أن زيادة مستوى التسميد النيتروجينى من 70 كجم إلى 110 كجم قد حققت زيادة معنوية فى طول وقطر و حاصلى العلف الأخضر والعيدان النظيفة ، بينما إزدادت النسبة المئوية للسكروز حتى 90 كجم نيتروجين ثم نقصت عند 110 كجم للفدان.

تحت ظروف هذ البحث، يوصى بزراعة الذرة السكرية بكثافة نباتية 52.500 ألف نبات للفدان والرى كل 21 يوماً والتسميد بمعدل 90 كجم نيتروجين للفدان للحصول على أعلى إنتاجية فدانية من العلف الأخضر والعيدان النظيفة وصفات الجودة للذرة السكرية.