



RESPONSE OF SOME WHEAT (*Triticum aestivum* L.) CULTIVARS TO SULFUR FERTILIZER AND CHITOKER UNDER SALINE SOIL CONDITIONS

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ABSTRACT

Two field experiments were conducted during 2010/2011 and 2011/2012 winter growing seasons in the Experimental Farm of Desert Research Center, Ras Suder region, South Sinai Governorate, on wheat. This work aimed to study the effect of sulphur (0, 100 and 150 kg/fad.), chitoker [control (without chitoker), seed soaked before sowing in chitoker solution (10 cm/L), for 12 hours, spraying plants at three times, 30, 45 and 60 days after sowing by chitoker solution (5 cm/L) and seed soaking before sowing in chitoker solution (10 cm/L) + spraying plants at three times, 30, 45 and 60 days after sowing by chitoker solution (5 cm/L)] on growth, yield, yield components and chemical composition of some wheat cultivars (Sids1, Sakha94 and Gemmeiza10). Results indicated that the differences between the cultivars for leaf area index, total chlorophyll, grain filling rate (mg/day), plant height (cm.), spike length (cm.), number of grains/spike, 1000-grain weight (g), grain yield/fad., (kg), nitrogen(%) and protein(%) were significant in the two seasons. Gemmeiza10 cultivar gave the highest values for most studied traits in the two seasons. Also, results indicated that sulphur levels increasing led to increase most studied traits. Application of 150 kg sulphur/fad., gave the maximum values for most studied traits. As well as, results indicated that soaking seed before sowing in chitoker solution (10 cm/L) + spraying wheat plants at three times, 30, 45 and 60 days after sowing with chitoker solution (5 cm/L) gave the heights values in the two seasons. The interactions between the cultivars x sulphur levels x chitoker treatments were significant for most studied traits in the two seasons. Also, results, showed that sowing Gemmeiza 10 cultivar with 150 kg sulphur/fad., and soaking seed before sowing in chitoker solution (10cm/ L) + spraying wheat plants at three times, 30, 45 and 60 days after sowing with chitoker solution (5 cm/L), significantly increased the growth, yield and yield components under saline soil conditions.

Key words: Wheat, sulphur fertilizer, chitoker, saline soil, yield and yield components.

INTRODUCTION

Limited water and arable land resources and slow and expensive desert reclamation have directed the policies and strategies of the Egyptian Government towards raising agricultural productivity. In Egypt, wheat has special importance because the local production is not sufficient to supply the annual demands. Increasing wheat production to decrease the gap between production and consumption is national goal. Sulphur is an important element to form some of amino acids such as cystine, cysteine, also, play an important role in formed the

thiamine and Biotin, sulphur is essential element in formation of glycosides such as singrin, chloroplasts, which, contain on chlorophyll, as well as, sulphur is important role in H₂SO₄ formation, which, led to increasing soil acidity, removal calcareous problem as product to mineralization process with chemotrophic sulphur bacteria and thiobacillus. While, chitoker is protein polymers used to stimulate plant growth, enhance the yield, reduce chemical fertilizer use, as well as, increase organic matter concentration into the cell. Consequently, increasing the cell tolerance to salinity and drought stress. Also, wheat

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cultivars, Sakha 94, Sids 1 and Gemmeiza 10 are high productivity cultivars and resisting to the effects of the three and cultivated in areas of northern. Ahmed *et al.* (2006) indicated that the differences between Sakha 69 and Sids 1 were significant for plant height, leaf area index, yield and yield components. Sakha 69 cultivar significantly surpassed Sids1 in most studied traits. Also, Ahmed *et al.* (2011) showed that the differences between Giza 168, Sakha 93 and Gemmeiza 10 were significant in the two seasons. Gemmeiza 10 cultivar significantly surpassed Giza 168 and Sakha 93 in growth, yield and yield component traits, while, Kandil *et al.* (2012) showed that the differences between Sakha 93, Sakha 94, Gemmeiza 7, Gemmeiza 9, Gemmeiza 10, Sids 1, Giza 168, Masr 1 and Masr 2 were significant for all studied traits. Gemmeiza 10 and Sakha 94 cultivars significantly exceeded all studied cultivars in most traits, as well as, Abd-Allah *et al.* (2013) found that the differences between Sakha 69 and Gemmeiza 10 cultivars were significant the two seasons. Gemmeiza 10 cultivar significantly surpassed Giza 168 cultivar. Also, Ali *et al.* (2012) showed that sulphur application with rate 50 and 75 kg/ ha, increased growth, yield and yield components of wheat. While, Bello (2012) indicated that sulphur application with rate 100 kg /ha. improved growth, yield and yield components of wheat in alkaline and salinity soils. Abd Allah *et al.* (2013) revealed that sulphur application with rate 100kg /fad, significantly increased growth, yield and yield components of wheat under calcareous soils conditions. Arshadullah *et al.* (2013) found that gypsum application (CaSO_4) with rate 150 kg/ ha, significantly enhanced yield and yield components of wheat compared with the control treatment. Qi-Zhong (2011) indicated that wheat seed soaking in chitosan before sowing with 4-6 mg/ml concentration, significantly increased the growth traits. Zeng and Luo (2012) showed that wheat seed and soybean treatment with 5% concentration from chitosan solution, significantly improved the growth, yield and yield components compared with the control. Also, Mondal *et al.* (2013) found that spraying mung bean with 75 and 100 ppm concentrations from chitosan led to significant increase for most studied traits compared with the control. In addition, Toanl and Hanh (2013) showed that yield of rice significantly increased by 31% with chitosan

solution applying compared with the control. Therefore, this work aimed to study the effect of sulphur and chitoker on growth, yield and yield components of some wheat cultivars in saline soil.

MATERIALS AND METHODS

To field experiments were conducted in Ras Sudr, Res. Station, Desert Res. Center, at South Sinai Governorate, Egypt, during 2010/2011 and 2011/2012 seasons, to study the effect of sulphur fertilizer and chitoker on growth, yield, yield components and chemical composition of some wheat cultivars under saline soil conditions.

Experimental design used was split split plot with three replications, every replicate included 36 treatments which were combinations between three wheat cultivars with three sulphur rates and four chitoker treatments. The main plots were devoted to the wheat cultivars, while the sub-plots were occupied with the sulphur rates and chitoker treatments were allotted in sub-sub plots. The experimental unit area was 10.5 m^2 ($3 \times 3.5\text{m}$) included 15 rows each of 3.5 m length and 20 cm apart. The soil analyses were carried out according to Richards (1954); Black and Editor (1965) and Jackson (1967). The mechanical and chemical analyses of the experimental soil are presented in Tables 1 and 2.

The experimental treatments were

1. Wheat cultivars were, Sakha 94, Sids 1 and Gemmeiza 10.
2. Sulphur rates were, 0, 100 and 150 kg S/fad., applied before sowing
3. Chitoker treatments, control (untreated), seed soaking before sowing in (10 cm/L) solution (soaking), spraying at three times, 30, 45 and 60 days after sowing with (5 cm/L) solution (foliar), seed soaking before sowing in 10 cm/L solution + spraying at three times, 30, 45 and 60 days after sowing with 5 cm /L solution (soaking + foliar). Chitoker commercial compound and the active ingredient is chitosan is a polysaccharide derived from a low acetyl form of chitin, mainly composed of glucosamine and N acetyl glucosamine. Its structure and composition is similar to both cellulose and chitin (Freepons, 1991; Hadwiger and McBride, 2006).

Table 1. Mechanical properties of the experimental soil at Ras Sudr station

Depth (cm)	CaCO ₃ (%)	Coarse sand (0.5–1mm)	Fine sand (0.1– 0.25 mm)	Silt (0.002- 0.05 mm)	Total sand (0.1-1mm)	Clay < (0.002mm)	Class texture
2010/2011							
0-30	56.99	38.31	41.52	10.38	79.83	9.79	Sandy loam
30-60	52.48	37.25	42.73	12.35	79.98	7.67	Sandy loam
2011/2012							
0-30	61.28	47.92	34.92	5.98	82.84	11.18	Sandy loam
30-60	54.71	39.42	41.30	10.80	80.72	8.48	Sandy loam

Table 2. Chemical properties of the experimental soil at Ras Sudr station

Depth (cm)	pH	E.C (dS/m)	Saturation soluble extract (mg/ 100g)						Available nutrients (mg Kg ⁻¹)				
			Cations			Anions			N	P	K	Fe	
			Ca ⁺⁺	Mg ⁺⁺	Na ⁺	CO ₃ ⁻	HCO ₃ ⁻	Cl ⁻					SO ₄ ⁻
			Ca ⁺⁺	Mg ⁺⁺	Na ⁺	CO ₃ ⁻	HCO ₃ ⁻	Cl ⁻	SO ₄ ⁻	N	P	K	Fe
2010/2011													
0-30	7.7	8.65	24.5	5.2	57.2	0.0	6.0	61.5	26.2	26.0	5.1	51.5	4.2
30-60	7.9	7.35	16.8	3.8	42.5	0.0	3.5	49.0	23.5	18.5	3.4	35.3	3.4
2011/2012													
30-60	7.8	8.82	25.2	5.7	57.8	0.0	6.2	61.9	26.4	26.2	5.2	51.5	4.3
30-60	7.9	7.50	17.3	4.2	42.9	0.0	3.8	50.2	23.7	18.6	3.6	35.4	3.6

Average ten samples from irrigation water were taken to determine chemical properties each season (Table 3).

Nitrogen fertilizer was applied as ammonium sulphate (20.5% N) at a level of 80 kg N fad., in three equal doses before sowing, after 30 days and after 60 days from sowing. Phosphorus fertilizer was added at the rate of 22.5 kg P₂O₅/fad., as calcium superphosphate (15.5% P₂O₅) during land preparation. Potassium fertilizer was added at the rate of 48kg K₂O/fad., as potassium sulphate (48-52% K₂O) in two doses with the second and third doses of nitrogen fertilizer. Sowing date was on 15 November in the two seasons. The experiment soil was irrigated at 8-10 days intervals along

plant life with surface irrigation method. All other cultural practices were conducted as recommended in wheat fields.

Studied Traits

Growth traits

Random samples, each after a prooted and the separation of five plants, were taken from each experimental plot at 75 days from sowing to determine the following traits:

Leaf area index (L.A.I.) was calculated by the following: leaf area per plant (cm²) = Length x maximum width x 0.75. Watson (1952).

$$\text{Leaf area index (LAI)} = \frac{\text{Leaf area / plant (cm}^2\text{)}}{\text{Ground area / plant (cm}^2\text{)}}$$

Table 3. Chemical properties of irrigation water at Ras Sudr station

Irrigation number	pH value	E.C. (dS/m)	T.D.S (ppm)	Cations (mg./ L.)				Anions (mg./ L.)			
				Ca ⁺⁺	Mg ⁺⁺	Na ⁺	K	Co ₃ ⁻	Cl ⁻	HCO ₃ ⁻	SO ₄ ⁻
Average	7.95	5.86	4339	14.91	15.63	34.09	0.53	-	56.07	1.60	4.11

Total chlorophyll, was determined with SPAD meter according to Kariya *et al.* (1982) and Inada (1985).

Grain filling rate (G.F.R.), was calculated by using the following formula:

$$\text{G.F.R.} = \frac{W_2 - W_1 \text{ (mg)}}{t_2 - t_1 \text{ (day)}}$$

According to Daynard *et al.* (1971).

Where, (G.F.R.) is grain filling rate; W_1 and W_2 are grain dry weight at t_1 and t_2 , respectively.

Also, at harvest ten individual plants after arooted and separation were taken at random from each sub-sub plot to record the experimental data. Plant height in cm. recorded at the harvest.

Yield and yield components

At harvest ten around plants were selected at random from each plot to determine yield components. Whereas the grain yield were determined from the center plot. The data taken at harvesting time were as follows:

1. Spike length, in cm.
2. Number of grains/spike.
3. 1000 - grain weight, in g.
4. Grain yield /fad., in kg.

Grain chemical composition

1. Nitrogen (%), was determined by micro kjeldahl according to Peach and Tracey (1956).
2. Protein (%), was determined by multiplying the total nitrogen (%) x 5.83.
3. Sulphur (%), was determined by the turbidimetric method according to Rowell (1993).

Statistical Analysis

The obtained data of plant parameters was statistically analyzed according to the methods

suggested by Snedecor and Cochran (1980). Treatment means were compared using least significant differences (LSD) test to 0.05 level of probability.

RESULTS AND DISCUSSIONS

Growth Characters

Effect of wheat cultivars

Results in Tables 4, 5, 6 and 7 show that the differences between cultivars regarding each of plant height, leaf area index, total chlorophyll and grain filling rate were significant in the two seasons. Sids1 cultivar gave the tallest plants, while, Gemmeizal0 gave the shortest ones in the two seasons. Gemmeizal0 gave the maximum values for leaf area index, total chlorophyll and grain filling rate (mg/spike/ day) however, the minimum values were obtained from Sids 1 in the two seasons for these characters. These results confirmed with the findings of Ahmed *et al.* (2011); Kandil *et al.* (2012) and Abd-Allah *et al.* (2013).

Effect of sulphur fertilizer

Results in Tables 4, 5, 6 and 7 indicate that growth characters were significantly affected by sulphur rates in the two seasons. Growth characters increased with increasing sulphur rate from 0 to 100 then to, 150 kg S/ fad., in the two seasons. The maximum values for these characters were obtained from using 150 kg S/ fad., while, the minimum values were obtained from control treatment (without application). Positive effect of sulphur treatment on growth traits may be due to the role of sulphur element in forming some of amino acids, which, form the proteins, also, sulphur is essential element in forming chloroplasts, as well as, its important role in forming H₂SO₄, which, led to decreased soil pH these in turn increases soil contents from available nutrients and hence could improve plant growth. These results were in agreement with Bello (2012); Abd Allah *et al.* (2013) and Arshadullah *et al.* (2013).

Table 4. Effect of sulphur and chitoker on plant height (cm) of some wheat cultivars at harvest in 2010/2011 and 2011 / 2012 seasons

Cultivars (C)	Sulphur rate (Kg/fad.) (S)	Chitoker treatments (ch)									
		2010 / 2011 season					2011 / 2012 season				
		Without Soaking	Foliar Soaking + Foliar	Mean	Without Soaking	Foliar Soaking + Foliar	Mean				
Sakha 94	Without	83.70	86.80	92.73	94.07	89.33	88.13	88.77	94.83	98.57	92.58
	100	86.03	89.07	94.20	95.93	91.31	88.17	90.40	93.97	98.27	92.70
	150	92.27	94.60	97.93	98.80	95.90	95.77	96.73	98.00	99.47	97.49
	Mean	87.33	90.16	94.95	96.27	92.18	90.69	91.97	95.60	98.77	94.26
Sids 1	Without	89.67	94.03	95.00	96.98	93.92	91.23	95.53	97.07	98.63	95.62
	100	90.53	97.63	98.97	99.70	96.71	89.70	98.17	98.87	100.60	96.84
	150	92.33	98.43	99.33	101.80	97.97	91.27	98.73	99.30	101.30	97.65
	Mean	90.84	96.70	97.77	99.49	96.20	90.73	96.14	98.41	100.20	96.37
Gemmeiza 10	Without	69.60	74.00	76.13	78.13	74.47	69.47	75.13	78.13	81.70	76.11
	100	72.30	75.60	77.93	78.70	76.13	74.40	72.60	77.80	80.00	76.20
	150	76.00	79.17	81.97	84.57	80.43	76.30	78.57	83.17	85.40	80.86
	Mean	72.63	76.26	78.68	80.47	77.01	73.39	75.43	79.70	82.37	77.72
Over all means of Sulphur	Without	80.99	85.28	88.29	89.73	86.07	82.94	86.48	90.01	92.97	88.10
	100	82.95	89.07	91.41	93.39	90.18	84.09	87.06	90.21	92.96	88.58
	150	86.87	101.1	105.0	107.4	99.13	87.78	99.01	105.5	107.7	99.99
General means		83.60	91.81	94.91	96.85	91.80	84.94	90.85	95.24	97.87	92.22
		c	su	ch	c x su	c x ch	su x ch	c x su x ch			
L.S.D at 5% (first season)		0.46	0.36	0.29	0.62	0.50	0.50	0.87			
L.S.D at 5% (second season)		0.40	0.64	0.62	1.11	1.09	1.09	1.89			

Table 5. Effect of sulphur and chitoker on Leaf area index (LAI) of some wheat cultivars at 75 days from sowing in 2010/ 2011 and 2011/2012 seasons

Cultivars (C)	Sulphur rate (Kg/fad.) (S)	Chitoker treatments (ch)									
		Without	Soaking	Foliar	Soaking	Mean	Without	Soaking	Foliar	Soaking	Mean
		2010 / 2011 season					2011 / 2012 season				
Sakha94	Without	4.94	4.99	5.15	5.26	5.09	4.95	4.99	5.18	5.25	5.09
	100	5.00	5.04	5.20	5.32	5.14	5.01	5.06	5.21	5.34	5.16
	150	5.42	5.48	5.52	5.56	5.50	5.40	5.49	5.52	5.57	5.50
	Mean	5.12	5.17	5.29	5.20	5.24	5.12	5.18	5.30	5.39	5.25
Sids1	Without	4.77	4.80	4.83	4.88	4.82	4.75	4.81	4.86	4.91	4.83
	100	4.92	5.00	5.04	5.20	5.04	4.90	5.01	5.06	5.21	5.05
	150	5.13	5.24	5.42	5.71	5.38	5.11	5.26	5.41	5.46	5.31
	Mean	4.94	5.01	5.10	4.99	5.08	4.92	5.03	5.11	5.19	5.06
Gemmeiza 10	Without	5.14	5.19	5.26	5.33	5.23	5.15	5.21	5.27	5.32	5.24
	100	5.18	5.26	5.30	5.32	5.27	5.21	5.26	5.31	5.36	5.29
	150	5.53	5.56	5.60	5.62	5.58	5.51	5.57	5.59	5.62	5.57
	Mean	5.28	5.34	5.39	5.42	5.36	5.29	5.35	5.39	5.43	5.37
Over all means of Sulphur	Without	4.95	4.99	5.08	5.16	5.05	4.95	5.00	5.10	5.16	5.05
	100	5.03	5.10	5.18	5.28	5.15	5.04	5.11	5.19	5.30	5.16
	150	5.36	5.43	5.51	5.63	5.48	5.34	5.44	5.51	5.55	5.46
General means		5.11	5.17	5.26	5.36	5.23	5.11	5.18	5.27	5.34	5.23
		c	su	ch	c x su	c x ch	su x ch	c x su x ch			
L.S.D at 5% (first season)		0.41	0.33	0.29	0.37	0.50	0.50	0.74			
L.S.D at 5% (second season)		0.39	0.30	0.26	0.35	0.50	0.50	0.74			

Table 6. Effect of sulphur and chitoker on total chlorophyll (SPAD readings) of some wheat cultivars, at 75 days from sowing in 2010/2011 and 2011 / 2012 seasons

Cultivars (C)	Sulphur rate (Kg/fad.) (S)	Chitoker treatments(ch)									
		Without	Soaking	Foliar	Soaking	Mean	Without	Soaking	Foliar	Soaking	Mean
		2010 / 2011 season					2011 / 2012 season				
Sakha 94	Without	40.76	45.12	46.25	46.58	44.68	42.87	45.87	46.97	49.03	46.19
	100	41.27	45.95	46.81	47.30	45.33	44.57	47.77	48.97	49.50	47.70
	150	45.30	45.23	47.03	47.80	46.34	44.50	47.57	49.30	49.47	47.71
	Mean	42.44	45.43	46.70	47.23	45.45	43.98	47.07	48.41	49.33	47.20
Sids 1	Without	35.13	39.63	39.80	39.97	38.63	34.23	38.03	39.63	41.37	38.32
	100	38.00	40.13	40.10	41.49	39.93	35.10	38.07	39.27	42.30	38.69
	150	42.92	43.26	43.93	45.07	43.80	42.33	43.80	44.80	46.33	44.32
	Mean	38.68	41.01	41.28	42.18	40.79	37.22	39.97	41.23	43.33	40.44
Gemmeiza 10	Without	44.16	45.18	45.77	47.98	45.77	44.90	47.13	47.67	48.67	47.09
	100	43.74	45.21	46.85	48.52	46.08	44.73	45.90	47.67	50.03	47.08
	150	45.53	46.66	47.20	50.12	47.38	47.43	48.93	49.67	50.53	49.14
	Mean	44.48	45.68	46.61	48.87	46.41	45.69	47.32	48.34	49.74	47.77
Over all means of Sulphur	Without	40.02	43.31	43.94	44.51	42.94	40.67	43.68	44.76	46.36	43.86
	100	41.00	43.76	44.25	45.10	43.53	41.47	43.91	45.30	47.61	44.57
	150	44.25	44.72	46.05	47.66	45.67	44.75	46.77	48.26	49.44	47.31
General means		41.76	43.93	44.75	45.76	44.05	42.30	44.79	46.11	47.80	45.25
		c	su	ch	c x su	c x ch	su x ch	c x su x ch			
L.S.D at 5% (first season)		0.37	0.33	0.27	0.58	0.46	0.46	0.81			
L.S.D at 5% (second season)		0.39	0.34	0.28	0.59	0.46	0.46	0.84			

Table 7. Effect of sulphur and chitoker on grain filling rate (GFR) (mg/spike/ day) of some wheat cultivars, in 2010/ 2011 and 2011/2012 seasons

Cultivars (C)	Sulphur rate (Kg/fad.) (S)	Chitoker treatments									
		Without	Soaking	Foliar	Soaking + Foliar	Mean	Without	Soaking	Foliar	Soaking + Foliar	Mean
		2010 / 2011 season					2011 / 2012 season				
Sakha 94	Without	0.933	0.955	0.973	0.993	0.964	0.934	0.950	0.980	0.995	0.965
	100	0.946	0.964	0.993	1.023	0.976	0.947	0.965	0.995	0.999	0.976
	150	0.958	0.973	1.006	1.043	0.983	0.958	0.975	1.010	1.042	0.983
	Mean	0.946	0.964	0.985	0.998	0.974	0.946	0.963	0.991	0.998	0.975
Sids 1	Without	0.924	0.938	0.922	0.961	0.944	0.925	0.940	0.950	0.960	0.944
	100	0.934	0.945	0.959	0.972	0.952	0.935	0.946	0.960	0.971	0.953
	150	0.947	0.958	0.971	0.992	0.967	0.947	0.957	0.970	0.993	0.967
	Mean	0.935	0.947	0.960	0.975	0.954	0.936	0.948	0.960	0.975	0.955
Gemmeiza 10	Without	0.953	0.967	0.981	0.995	0.974	0.954	0.968	0.982	0.996	0.975
	100	0.962	0.975	0.998	1.052	0.984	0.963	0.975	1.005	1.008	0.984
	150	0.975	0.987	1.000	1.067	0.991	0.976	0.988	1.013	1.017	0.991
	Mean	0.963	0.977	0.993	0.998	0.983	0.964	0.977	0.994	0.999	0.983
Over all means of Sulphur	Without	0.937	0.953	0.969	0.983	0.960	0.937	0.952	0.971	0.984	0.961
	100	0.947	0.961	0.983	0.991	0.971	0.948	0.962	0.985	0.990	0.971
	150	0.960	0.973	0.990	0.997	0.980	0.960	0.973	0.990	0.998	0.980
General means		0.948	0.962	0.981	0.990	0.970	0.949	0.962	0.962	0.990	0.971
		c	su	ch	c x su	c x ch	su x ch	c x su x ch			
L.S.D at 5% (first season)		0.020	0.029	0.067	0.005	0.038	0.038	0.075			
L.S.D at 5% (second season)		0.025	0.032	0.070	0.010	0.040	0.040	0.075			

Effect of chitoker treatment

Results in Tables 4, 5, 6 and 7 reveal that the differences between chitoker treatments for plant height, leaf area index, total chlorophyll and grain filling rate were significant in the two seasons. The highest value for each of these traits was obtained from seed soaking before sowing in chitoker solution, (10 cm/L) and spraying wheat plants at 30, 45 and 60 days after sowing with solution (5 cm/L)] in both seasons, while, the lowest values were obtained from dual treatment, the control, (untreated). Positive effect of chitoker may be attributed to chitoker role in stimulate plant growth and increase organic matter concentrations into the cell, consequently, increasing of the cell tolerance to salinity and drought stress under experimental soil conditions. These results were in agreement with Zeng and Luo (2012) and Mondal *et al.* (2013).

The interaction effect between cultivars and sulphur fertilizer on growth traits were significant affected in the two seasons. Results in Tables 4, 5, 6 and 7 show that the highest values for plant height, were obtained from Sids1 and adding 150 kg S/ fad., in the two seasons. Leaf area index, total chlorophyll and grain filling rate, were obtained from Gemmeiza 10 with 150 kg S/ fad., in both seasons, while, the lowest value were obtained from Sids1 and without sulphur application for most characters in the two seasons.

Effect of the interaction between cultivars and chitoker treatments

The interaction between cultivars and chitoker treatments show significant effect on growth characters. the interaction between Gemmeiza10 and seed soaking before sowing in chitoker solution (10 cm/L) + spraying plants at 30, 45 and 60 days after sowing with (5 cm/L) gave the highest values for most growth traits, however, the lowest value was from Sids 1 with control treatment (untreated) with chitoker in both seasons.

Effect of the interaction between sulphur fertilizer and chitoker

Concerning the interaction between sulphur rates and chitoker treatments, results in Tables 4, 5, 6 and 7 indicate that 150 kg S/ fad., and seed soaking before sowing in chitoker solution

(10 cm/L) + spraying the plants at 30, 45 and 60 days after sowing with (5 cm/L) gave the maximum values for all growth characters, while, interaction between the control (without sulphur application) and untreated plants with chitoker gave the minimum values for these characters.

Effect of the interaction between varieties, sulphur rates and chitoker treatments

With regard the second order interaction of cultivars, sulphur rates and chitoker treatments, the results in Tables 4, 5, 6 and 7 showed that the interaction between Gemmeiza 10 × 150 kg S / fad., rate × seed soaking in chitoker solution (10 cm./L.) + spraying the plants at 30, 45 and 60 days with (5 cm./L.) gave the highest values for most studied growth characters, while, the interaction between Sids 1 × without sulphur application × untreated plants with chitoker recorded the lowest values in the two seasons.

Yield, Yield Components and Chemical Composition

Effect of wheat cultivars

Results in Tables from 8-14 show that the differences between cultivars regarding spike length, number of grains/spike, 1000 grain weight, grain yield /fad., nitrogen (%) and protein (%) were significant in the two seasons. Gemmeiza 10 cultivars. gave the maximum values for all studied characters as compared with the other cultivars. These results were in agreement with Ahmed *et al.* (2011); Kandil *et al.* (2012) and Abd-Allah *et al.* (2013).

Effect of sulphur fertilizer

Results in Tables from 8-14 indicat that yield, yield component and chemical composition were significantly affected by sulphur rates in the two seasons. All studied traits increased with increasing sulphur rates in both seasons. The highest values for these traits were obtained from application 150 kg S/fad., while the lowest values were obtained from without application in the two seasons. Positive effect of sulphur on studied characters may be due to sulphur element importance in forming some of amino acids, which, help on forming proteins, also, sulphur is essential element in forming chloroplasts, which, contains chlorophyll, as well as, sulphur role importance

Table 8. Effect of sulphur and chitoker on spike length (cm) at harvest of some wheat cultivars, in 2010/ 2011 and 2011/2012 seasons

Cultivars (C)	Sulphur rate (Kg/fad.) (S)	Chitoker treatments(ch)									
		Without Soaking Foliar					Soaking Foliar + Foliar				
		2010 / 2011 season					2011 / 2012 season				
Sakha94	Without	8.83	9.11	9.66	10.33	9.48	9.20	9.67	9.80	10.07	9.74
	100	9.09	9.44	10.00	10.66	9.80	9.40	9.60	10.17	10.79	9.94
	150	9.61	10.11	10.55	12.11	10.60	9.90	10.20	10.67	11.77	10.64
	Mean	9.18	9.55	10.07	11.03	9.96	9.50	9.82	10.21	10.88	10.10
Sids1	Without	9.66	10.11	10.44	11.05	10.32	9.77	10.17	10.90	11.37	10.55
	100	10.61	10.83	10.94	11.39	10.94	10.67	11.20	11.17	11.73	11.19
	150	10.89	11.33	11.61	12.00	11.46	10.53	11.10	11.73	12.27	11.41
	Mean	10.39	10.76	11.00	11.48	10.91	10.32	10.82	11.27	11.79	11.05
Gemmeiza 10	Without	10.61	11.22	11.00	11.66	11.12	10.47	10.57	10.77	10.93	10.69
	100	11.05	11.22	11.77	12.11	11.54	10.67	10.77	11.10	12.10	11.16
	150	11.05	11.61	12.33	12.77	11.94	10.90	11.23	11.53	12.47	11.53
	Mean	10.90	11.35	11.70	12.18	11.53	10.68	10.86	11.13	11.83	11.13
Over all means of Sulphur	Without	9.70	10.15	10.37	11.01	10.31	9.88	10.14	10.49	10.79	10.32
	100	10.25	10.50	10.90	11.39	10.76	10.18	10.52	10.81	11.54	10.76
	150	10.52	11.02	11.50	12.29	11.33	10.44	10.84	11.31	12.17	11.19
General means		10.16	10.55	10.92	11.56	10.80	10.17	10.50	10.87	11.50	10.76
		c	su	ch	c x su	c x ch	su x ch	c x su x ch			
L.S.D at 5% (first season)		0.32	0.24	0.18	NS	NS	NS	NS			
L.S.D at 5% (second season)		0.33	0.15	0.12	NS	NS	0.22	0.38			

Table 9. Effect of sulphur and chitoker on number of grains/spike of some wheat cultivars in 2010/ 2011 and 2011/2012 seasons

Cultivars (C)	Sulphur rate (Kg/fad.) (S)	Chitoker treatments(ch)									
		Without	Soaking	Foliar	Soaking + Foliar	Mean	Without	Soaking	Foliar	Soaking + Foliar	Mean
		2010 / 2011 season					2011 / 2012 season				
Sakha94	Without	43.00	44.00	45.11	47.33	44.86	41.09	44.28	46.72	48.67	45.19
	100	44.78	46.44	47.77	48.33	46.83	45.58	47.77	49.77	50.79	48.48
	150	46.22	48.44	50.55	51.66	49.22	47.21	50.40	50.61	53.09	50.5
	Mean	44.67	46.66	48.55	48.00	46.97	44.63	47.48	49.03	51.08	48.06
Sids1	Without	40.33	43.44	45.55	46.55	43.97	40.90	44.92	46.63	47.53	45.00
	100	42.33	44.66	46.44	47.77	45.30	44.73	47.29	49.16	49.72	47.73
	150	44.88	46.44	47.99	51.22	47.63	47.24	48.88	50.26	54.01	50.47
	Mean	42.51	44.85	46.66	48.51	45.63	44.29	47.03	49.18	50.42	47.73
Gemmeiza 10	Without	44.67	45.00	47.22	49.33	47.56	44.06	46.33	47.69	49.39	46.87
	100	44.77	45.77	49.55	52.33	46.11	44.88	48.21	50.06	53.24	49.10
	150	47.77	48.33	51.33	53.44	49.72	48.49	49.43	52.84	54.40	51.29
	Mean	45.40	46.70	49.37	49.70	47.79	45.81	47.99	50.20	52.34	49.09
Over all means of Sulphur	Without	42.03	44.44	46.81	46.29	44.89	42.02	45.18	47.01	48.53	45.68
	100	44.29	46.14	47.85	49.18	46.87	45.06	47.76	49.66	51.25	48.43
	150	45.81	48.00	50.40	53.40	49.40	47.65	49.57	51.74	54.07	50.76
General means		44.05	46.19	48.35	49.63	47.05	44.91	47.50	49.47	51.28	48.29
		c	su	ch	c x su	c x ch	su x ch	c x su x ch			
L.S.D at 5% (first season)		0.18	0.31	0.23	0.32	0.40	0.40	0.70			
L.S.D at 5% (second season)		0.14	0.37	0.35	0.65	0.61	0.61	1.08			

Table 10. Effect of sulphur and chitoker on 1000-grain weight (g.) of some wheat cultivars in 2010/ 2011 and 2011/2012 seasons

Cultivars (C)	Sulphur rate (Kg/fad.) (S)	Chitoker treatments(ch)									
		Without	Soaking	Foliar	Soaking + Foliar	Mean	Without	Soaking	Foliar	Soaking + Foliar	Mean
		2010 / 2011 season					2011 / 2012 season				
Sakha94	Without	42.15	44.62	47.36	48.34	45.62	43.11	44.92	47.82	48.84	46.17
	100	44.22	46.03	47.48	49.60	46.83	43.92	46.11	47.75	49.04	46.71
	150	45.02	45.85	48.98	50.78	47.66	45.11	46.15	49.30	51.13	47.92
	Mean	43.80	45.50	47.94	49.57	46.70	44.05	45.73	48.29	49.67	46.93
Sids1	Without	40.70	42.93	45.45	48.67	44.44	41.91	43.03	45.89	48.82	44.91
	100	42.08	44.63	45.68	48.49	45.22	42.77	45.07	46.05	48.67	45.64
	150	43.48	44.71	45.99	48.90	45.77	44.05	44.97	46.42	49.07	46.13
	Mean	42.09	44.09	45.71	48.69	45.14	42.91	44.36	46.12	48.85	45.56
Gemmeiza 10	Without	45.26	46.81	47.74	49.47	47.32	46.09	47.81	48.84	49.50	48.06
	100	46.63	47.67	49.79	50.62	48.68	46.92	48.29	49.96	50.77	48.99
	150	47.11	48.04	50.67	51.60	49.36	47.89	48.96	51.07	52.03	49.99
	Mean	46.33	47.51	49.40	50.56	48.45	46.97	48.35	49.96	50.77	49.01
Over all means of Sulphur	Without	42.70	44.79	46.85	48.83	45.79	43.70	45.25	47.52	49.05	46.38
	100	44.31	46.11	47.65	49.57	46.91	44.54	46.49	47.92	49.49	47.11
	150	45.20	46.20	48.55	50.43	47.59	45.68	46.69	48.93	50.74	48.01
General means		44.07	45.70	47.68	49.61	46.77	44.64	46.15	48.12	49.76	47.17
		c	su	ch	c x su	c x ch	su x ch	c x su x ch			
L.S.D at 5% (first season)		0.21	0.14	0.21	0.25	0.37	0.37	0.64			
L.S.D at 5% (second season)		0.19	0.17	0.15	0.30	0.27	0.27	0.47			

Table 11. Effect of sulphur and chitoker on grain yield (kg /fad.) of some wheat cultivars in 2010/ 2011 and 2011/2012 seasons

Cultivars (C)	Sulphur rate (Kg/fad.) (S)	Chitoker treatments (ch)									
		Without	Soaking	Foliar	Soaking + Foliar	Mean	Without	Soaking	Foliar	Soaking + Foliar	Mean
		2010 / 2011 season					2011 / 2012 season				
Sakha94	Without	1690.0	1909.0	1976.0	2290.0	1966.3	1659.0	1907.0	2211.0	2255.0	2008.0
	100	1874.0	2058.0	2241.0	2443.0	2154.0	1928.0	2143.0	2365.0	2559.0	2248.8
	150	2012.0	2188.0	2505.0	2747.0	2363.0	2081.0	2331.0	2542.0	2873.0	2456.8
	Mean	1858.7	2051.7	2240.7	2493.3	2161.1	1889.3	2127.0	2372.7	2562.3	2237.8
Sids1	Without	1505.0	1754.0	1973.0	2198.0	1857.5	1583.0	1831.0	2076.0	2270.0	1940.0
	100	1663.0	1900.0	2084.0	2305.0	1988.0	1799.0	2064.0	2240.0	2445.0	2137.0
	150	1854.0	1991.0	2215.0	2535.0	2148.8	1975.0	2126.0	2341.0	2689.0	2282.8
	Mean	1674.0	1881.7	2090.7	2346.0	1998.1	1785.7	2007.0	2219.0	2468.0	2119.9
Gemmeiza 10	Without	1918.0	2122.0	2335.0	2466.0	2210.3	1910.0	2158.0	2318.0	2512.0	2224.5
	100	1941.0	2122.0	2490.0	2733.0	2321.5	2010.0	2271.0	2596.0	2841.0	2429.5
	150	2139.0	2272.0	2661.0	2899.0	2492.8	2249.0	2405.0	2837.0	2987.0	2619.5
	Mean	1999.3	2172.0	2495.3	2699.3	2341.5	2056.3	2278.0	2583.7	2780.0	2424.5
Over all means of Sulphur	Without	1704.3	1995.0	2061.3	2318.0	2069.7	1717.3	1965.3	2201.7	2345.7	2057.5
	100	1926.0	2026.7	2271.7	2493.7	2154.5	1912.3	2159.3	2400.3	2615.0	2271.8
	150	2001.7	2150.3	2460.3	2727.0	2334.8	2101.7	2287.3	2573.3	2849.7	2453.0
General means		1910.7	2057.3	2264.4	2512.9	2186.3	1910.4	2137.3	2391.8	2603.4	2260.8
		c	su	ch	c x su	c x ch	su x ch	c x su x ch			
L.S.D at 5% (first season)		31.25	21.40	15.10	35.81	22.75	22.75	37.64			
L.S.D at 5% (second season)		29.30	19.35	14.80	33.20	19.90	19.90	35.55			

Table 12. Effect of sulphur and chitoker on grain nitrogen content (%) of some wheat cultivars in 2010/ 2011 and 2011/2012 seasons

Cultivars (C)	Sulphur rate (Kg/fad.) (S)	Chitoker treatments (ch)									
		Without	Soaking	Foliar	Soaking + Foliar	Mean	Without	Soaking	Foliar	Soaking + Foliar	Mean
		2010 / 2011 season					2011 / 2012 season				
Sakha94	Without	2.20	2.22	2.25	2.30	2.24	2.21	2.23	2.26	2.31	2.25
	100	2.24	2.26	2.29	2.32	2.28	2.24	2.25	2.28	2.33	2.28
	150	2.34	2.38	2.39	2.41	2.38	2.33	2.39	2.39	2.40	2.38
	Mean	2.26	2.29	2.31	2.34	2.30	2.26	2.29	2.31	2.35	2.30
Sids1	Without	2.14	2.18	2.19	2.22	2.18	2.15	2.19	2.20	2.25	2.20
	100	2.20	2.25	2.29	2.32	2.27	2.21	2.26	2.28	2.31	2.27
	150	2.28	2.29	2.31	2.34	2.31	2.28	2.29	2.32	2.33	2.31
	Mean	2.21	2.24	2.26	2.29	2.25	2.21	2.25	2.27	2.30	2.26
Gemmeiza 10	Without	2.26	2.29	2.32	2.35	2.31	2.27	2.29	2.33	2.35	2.31
	100	2.39	2.40	2.43	2.44	2.42	2.41	2.38	2.44	2.43	2.42
	150	2.44	2.45	2.46	2.48	2.46	2.45	2.44	2.47	2.47	2.46
	Mean	2.36	2.38	2.40	2.42	2.39	2.38	2.37	2.41	2.42	2.39
Over all means of Sulphur	Without	2.20	2.23	2.25	2.29	2.24	2.21	2.24	2.26	2.30	2.25
	100	2.28	2.30	2.34	2.36	2.32	2.29	2.30	2.33	2.36	2.32
	150	2.35	2.37	2.39	2.41	2.38	2.35	2.37	2.39	2.40	2.38
General means		2.28	2.30	2.33	2.35	2.31	2.28	2.30	2.33	2.35	2.32
		c	su	ch	c x su	c x ch	su x ch	c x su x ch			
L.S.D at 5% (first season)		0.03	0.03	0.02	0.06	0.08	0.08	1.05			
L.S.D at 5% (second season)		0.03	0.03	0.02	0.06	0.08	0.08	1.05			

Table 13. Effect of sulphur and chitoker on grain protein content (%) of some wheat cultivars, in 2010/ 2011 and 2011/2012 seasons

Cultivars (C)	Sulphur rate (Kg/fad.) (S)	Chitoker treatments(ch)									
		Without	Soaking	Foliar	Soaking + Foliar	Mean	Without	Soaking	Foliar	Soaking + Foliar	Mean
		2010 / 2011 season					2011 / 2012 season				
Sakha 94	Without	9.66	10.49	11.12	11.69	10.74	9.37	10.74	11.50	12.55	11.04
	100	10.63	11.33	11.60	12.09	11.41	10.33	10.86	11.76	12.71	11.42
	150	11.42	12.08	12.53	13.17	12.30	11.81	11.91	12.65	12.92	12.32
	Mean	10.57	11.30	11.75	12.62	11.48	10.50	11.17	11.97	12.73	11.59
Sids 1	Without	9.15	10.05	11.27	11.90	10.59	9.18	10.41	10.90	11.99	10.62
	100	10.06	10.50	11.79	12.37	11.18	9.58	10.74	11.72	12.69	11.18
	150	11.31	11.75	12.53	13.44	12.26	10.89	11.37	12.55	13.20	12.00
	Mean	10.17	10.77	11.86	12.57	11.34	9.88	10.84	11.72	12.62	11.27
Gemmeiza 10	Without	9.78	10.03	11.91	12.35	11.02	9.74	10.18	12.18	12.38	11.12
	100	10.29	11.28	12.24	12.77	11.65	10.62	11.33	12.14	12.48	11.64
	150	11.07	11.93	12.79	13.33	12.23	11.65	12.00	12.46	13.30	12.28
	Mean	10.38	11.08	12.31	12.75	11.63	10.67	11.17	12.26	12.79	11.68
Over all means of Sulphur	Without	9.53	10.19	11.43	11.98	10.78	9.43	10.44	11.53	12.31	10.93
	100	10.33	11.04	11.88	12.41	11.41	10.18	10.98	11.87	12.63	11.41
	150	11.27	11.92	12.62	13.25	12.26	11.45	11.76	12.55	13.11	12.22
General means		10.37	11.05	11.98	12.55	11.49	10.35	11.06	11.98	12.68	11.52
		c	su	ch	c x su	c x ch	su x ch	c x su x ch			
L.S.D at 5% (first season)		0.26	0.17	0.18	NS	0.30	0.30	NS			
L.S.D at 5% (second season)		0.26	0.17	0.18	NS	0.30	0.30	NS			

Table 14. Effect of sulphur and chitoker on grain sulphur content (%) of some wheat cultivars in 2010/ 2011 and 2011/2012 seasons

Cultivars (C)	Sulphur rate (Kg/fed.) (S)	Chitoker treatments (ch)									
		Without	Soaking	Foliar	Soaking + Foliar	Mean	Without	Soaking	Foliar	Soaking + Foliar	Mean
		2010 / 2011 season					2011 / 2012 season				
	Without	0.43	0.44	0.46	0.47	0.45	0.44	0.45	0.46	0.48	0.46
Sakha 94	100	0.45	0.46	0.54	0.58	0.51	0.44	0.46	0.53	0.53	0.49
	150	0.46	0.46	0.46	0.66	0.51	0.46	0.51	0.56	0.58	0.53
	Mean	0.45	0.45	0.49	0.57	0.49	0.45	0.47	0.52	0.53	0.49
	Without	0.44	0.45	0.47	0.49	0.46	0.44	0.46	0.47	0.49	0.47
Sids 1	100	0.45	0.46	0.47	0.50	0.47	0.46	0.47	0.48	0.50	0.48
	150	0.47	0.48	0.50	0.59	0.51	0.46	0.48	0.53	0.67	0.54
	Mean	0.45	0.46	0.48	0.53	0.48	0.45	0.47	0.49	0.55	0.49
	Without	0.43	0.45	0.46	0.48	0.46	0.43	0.46	0.48	0.51	0.47
Gemmeiza 10	100	0.44	0.46	0.50	0.55	0.49	0.44	0.46	0.47	0.50	0.47
	150	0.45	0.51	0.55	0.62	0.53	0.46	0.47	0.57	0.63	0.53
	Mean	0.44	0.47	0.50	0.55	0.49	0.44	0.46	0.51	0.55	0.49
	Without	0.43	0.45	0.46	0.48	0.46	0.44	0.46	0.47	0.49	0.46
Over all means of Sulphur	100	0.45	0.46	0.49	0.53	0.48	0.45	0.46	0.49	0.53	0.48
	150	0.46	0.47	0.52	0.64	0.52	0.46	0.51	0.52	0.63	0.53
General means		0.45	0.46	0.49	0.55	0.49	0.45	0.48	0.49	0.55	0.49
		c	su	ch	c x su	c x ch	su x ch	c x su x ch			
L.S.D at 5% (first season)		NS	NS	NS	NS	NS	NS	NS			
L.S.D at 5% (second season)		NS	NS	NS	NS	NS	NS	NS			

in forming H_2SO_4 , which, led to decreased soil pH, which, decreased calcareous problem. These results were in agreement with Bello (2012); Abd Allah *et al.* (2013) and Arshadullah *et al.* (2013).

Effect of chitoker treatments

Results in Tables from 8-14 reveal that the differences between chitoker treatments for all studied characters were significant in the two seasons. The highest values for all studied characters were obtained from seed soaking with chitoker solution (10 cm/L) + spraying foliar with solution (5 cm/L) in both seasons, while, the lowest values were obtained from the control (untreated plants). Positive effect of chitoker may be attributed to chitoker role in stimulate plant growth and increased leaf area index, consequently, increased net assimilation rate, formed dry matter and yield, as well as, yield components, in addition to, increase organic matter concentrations into the cell, which, led to increase cell tolerance under experimental soil conditions (salinity conditions). The results were in agreement with Zeng and Luo (2012) and Mondal *et al.* (2013).

Effect of the interaction between cultivars and sulphur fertilizer

The interaction between cultivars and sulphur rates gave significant effect on studied characters in the two seasons. Results in Tables from 8-14 showed that the maximum values for these characters were obtained from Gemmeiza 10 and 150 kg S/fad., in both seasons, while, the lowest values were obtained from Sids 1 with the control (without application) for most characters in the two seasons.

Effect of the interaction between cultivars and chitoker treatments

The interaction between cultivars and chitoker treatments had significant effect on studied characters. The interaction between Gemmeiza 10 and seed soaking with (10 cm /L) + spraying foliar with solution (5 cm/L) gave the highest values for all studied characters except sulphur (%), however, the lowest values were obtained from Sids 1 with (untreated plants) in both seasons.

Effect of the interaction between sulphur rates and chitoker treatments

Concerning the interaction between sulphur rates and chitoker treatments, results showed that the interaction between 150 kg S /fad., and seed soaking with (10 cm /L) + spraying foliar with solution (5 cm /L) gave the highest values for all studied traits, while, the lowest values were obtained from the interaction between zero S/fad., and with (untreated plant) in both seasons.

Effect of the interaction between cultivars, sulphur rates and chitoker treatments

With regard the second order interaction of cultivars, sulphur fertilizer and chitoker treatments. The results in Tables from 8-14 indicated that the interaction between Gemmeiza 10 × 150 kg S/ fad., × seed soaking with solution (10 cm/L) + spraying foliar with solution (5 cm/L) gave the maximum values for all studied characters, while, the interaction between Sids 1 × without sulphur application × (untreated plants with chitoker) gave the minimum values in the two seasons.

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استجابة بعض أصناف القمح للكبريت والشيتوكير تحت ظروف الأرض الملحية

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أجريت تجربتان حقليتان في محطة بحوث رأس سدر التابعة لمركز بحوث الصحراء بمحافظة جنوب سيناء، جمهورية مصر العربية، خلال موسمي الزراعة ٢٠١٠/٢٠١١ و ٢٠١١/٢٠١٢. بهدف دراسة تأثير ثلاثة معدلات من الكبريت (صفر، ١٠٠، ١٥٠ كجم/فدان) وأربعة معاملات من الشيتوكير (كنترول، نفع التقاوى قبل الزراعة في محلول من الشيتوكير بتركيز ١٠ سم^٣/لتر لمدة ١٢ ساعة، رش النباتات عند أعمار ٣٠، ٤٥، ٦٠ يوم من الزراعة بمحلول من الشيتوكير تركيز ٥ سم^٣/لتر، التكمال بين نفع التقاوى قبل الزراعة في محلول من الشيتوكير بتركيز ١٠ سم^٣/لتر + رش النباتات عند نفس الأعمار السابقة في محلول من الشيتوكير بتركيز ٥ سم^٣/لتر) على النمو والمحصول ومكوناته والتركيب الكيميائي لبعض أصناف القمح (سخا ٩٤، سدس ١، جميزة ١٠) تحت ظروف الأرض الملحية الجيرية في منطقة رأس سدر، ويمكن تلخيص أهم النتائج المتحصل عليها كما يلي: أظهرت النتائج تأثيراً معنوياً لأصناف القمح على ارتفاع النبات، دليل مساحة الأوراق، محتوى الكلوروفيل، معدل إمتلاء الحبة، طول السنبل، عدد حبوب السنبل، وزن الألف حبة، محصول الحبوب / الفدان، نسبة النيتروجين والبروتين بالحبوب في موسمي النمو، كما أظهرت النتائج تفوق الصنف جميزة ١٠ على الصنفين الآخرين في معظم الصفات المدروسة خلال موسمي الدراسة كما أظهرت النتائج أيضاً تأثيراً معنوياً موجبا لمعدلات إضافة الكبريت على كل الصفات المدروسة خلال موسمي النمو، فيما عدا محتوى الحبوب من الكبريت والتي لم تتأثر معنوياً بإضافة الكبريت وقد أعطى معدل الإضافة ١٥٠ كجم كبريت/فدان أعلى القيم لكل الصفات المدروسة في موسمي النمو فيما عدا محتوى الحبوب من الكبريت والتي لم تتأثر معنوياً، كما أظهرت النتائج تأثيراً معنوياً موجبا لمعاملات الشيتوكير على كل الصفات المدروسة، وقد أعطت معاملة نفع التقاوى في محلول الشيتوكير بتركيز ١٠ سم^٣/لتر + الرش بتركيز ٥ سم^٣/لتر أعلى قيم معنوية لكل الصفات المدروسة في موسمي النمو، كما كانت معظم التفاعلات الممكنة بين العوامل الثلاثة تأثيراً معنوياً موجبا على كل الصفات المدروسة وقد أعطى التفاعل بين الصنف جميزة ١٠ ومعدل الإضافة ١٥٠ كجم كبريت/فدان مع نفع التقاوى في محلول الشيتوكير بتركيز ١٠ سم^٣/لتر + الرش بتركيز ٥ سم^٣/لتر أعلى القيم لمعظم الصفات المدروسة في موسمي النمو، بعض التفاعلات لبعض الصفات غير معنوية لذلك لا يمكن استعمال كل التفاعلات أو كل الصفات.

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