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A STUDY ON SALT SENSITIVITY OF TWO WHEAT DURUM CULTIVARS: SOHAG AND BENI SWEF

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Abstract

Salt sensitivity of two durum wheat cultivars, Sohag 1 and Beni Swef 1 was evaluated using NaCl (0-50 mM), fertilizers $Ca(NO_3)_2.4H_2O$, NH_4NO_3+Ca superphosphate, Viral and CCC growth regulator on two growth seasons.

Cv. Beni Swef 1 is more salt sensitive than Cv. Sohag 1. The inhibitory effect concerning germination, vegetative and reproductive growth and grain and straw yield was alleviated to varying degrees due to nitrate, phosphate, sulphate, Ca and NH_4 ions of fertilizers and CCC application.

It is recommended to apply 750 ppm and not to exceed 1500 ppm NaCl using Cv. Sohag 1 accompanied by normal fertilization practice in cases of obligate use of saline water irrigation.

Introduction

Wheat is the main cereal crop in Egypt. Great efforts are done for increasing its yield and improving the yield quality. The extension of cultivated lands to other newly reclaimed areas in the desert plains and wadis and semi desert coastal regions depends on the availability of irrigation by low salinity water of wells or water from unpolluted drains.

The aim of this piece of work is to investigate the level of salinity tolerance of two recently local cultivars of durum wheat used for noodles production and to elucidate the role of interactive effects of salinity with various fertilizers and growth regulators. Several reports have been already recorded on this line. Ebad and El-Gaaly, (1984) found a progressive and constant decrease of total protein content in maize with increase of salinity. Nerson et al. (1990) indicated a significant increase in yield, straw and number of spikelets with application of highest rate of nitrogen. Also a promoting

effect of phosphorus on the number of spikelet has been recorded by Rahamn and Wilson, (1977). Badr et al. (1991), Abdel Hadi et al. (1987), Altman et al. (1983) and El-Hawary et al. (1987) indicated an increase in grain yield of wheat by spraying with micronutrients. El-Fouly, (1983) indicated that most Egyptian soils suffer from shortage of micronutrient availability. El-Fouly and Fawzy (1970) reported an average 23% yield increase of cultivars Giza 155 and 144 with CCC, the increase in yield was due to more grains/ear and more tillers surviving to harvest. Ehrat et al. (1990) showed that Ca deficiencies in wheat and barley were induced by increased salinity.

Material And Methods

Beni Sweff and Sohag1 cultivars of durum wheat grains were obtained from Research Centre, Ministry of Agriculture, Giza, Egypt.

An experiment was carried out at the experimental garden of Botany Department, Women's College, Ain Shams University, on 1990-1991 growing season and a second experiment on 1991-1992 season. Four replicate pots (30 cm diameter and 30 cm depth), were kept for every treatment. Each pot is filled with 10 kg of dry sandy-loam soil; 10 grains were sown at the beginning. Samples were taken for growth parameter determinations at 60, 90 and 120 days; 6 plants were kept for yield determination.

In the first experiment (1990-1991 season) the treatments were as follows:

0- Irrigated with water.

1- Irrigated with 12.5 mM NaCl (731 ppm).

2- Irrigated with 25 mM NaCl (1462 ppm).

3- Irrigated with 50 mM NaCl (2924 ppm).

4- Irrigated with 12.5 mM NaCl (731 ppm)+0,185 g/l $Ca(NO_3)_2.4H_2O$.

5- Irrigated with 25 mM NaCl (1462 ppm)+0.37 g/l $Ca(NO_3)_2.4H_2O$.

6- Irrigated with 50 mM NaCl (2924 ppm)+0.37 g/l $Ca(NO_3)_2.4H_2O$.

In the second experiment (1991-1992 season) the treatments were as follows:

0- Irrigated with water.

1- Irrigated with water+0.3 g/pot NH_4NO_3+0.3 g/pot Ca superphosphate (normal

fertilization practice).

2- Irrigated with 25 mM NaCl (1462 ppm)+0.3 g/pot NH_4NO_3+0.3 g/pot Ca superphosphate.

3- Irrigated with 25 mM NaCl (1462 ppm)+0.3 g/pot NH_4NO_3+0.3 g/pot Ca superphosphate+3 ml/l CCC (foliar spray).

4- Irrigated with 25 mM NaCl (1462 ppm)+3 ml/l Viral (foliar spray).

5- Irrigated with 25 mM NaCl (1462 ppm)+3 ml/l Viral+3 ml/l CCC (foliar spray).

Cycolel : CCC, plant growth regulant (2-chlorethyl trimethyl ammonium chloride).

Viral : 11% N, 5% P_2O_5, 0.10% Zn, 0.12% Fe, 0.12% Mn, 0.25 Mg, 0.10% Cu, 0.01% B, 0.001% Mo.

Growth parameters:

Four random plants were taken for determination of growth parameters after 60, 90 and 120 days. At the end of the experiment, the yield weight of grains/plant and weight of 1000 grains were determined.

Mineral ions content:

Content of N, P, K, Ca, Na and Mg ions in grains were determined. A.O.A.C. (1975).

Protein content:

Analysis for grain protein content was done. A.O.A.C. (1975).

Ash content and grain humidity:

Ash content and % humidity of grains were also determined.

Results

1990-1991 season experiment:

Germination:

Grain germination rates for Sohag1 and Beni Swef1 Cvs. are presented in Tables (1 and 2). Germination rates showed some reduction with salinity levels and promotion with Ca nitrate addition.

Growth parameters:

The change in growth parameters of Cvs. Sohag1 and Beni Swef1 wheat are presented in Tables (1 and 2). Fresh and dry weight and number of leaves under 731 & 1462 ppm NaCl after 60 and 90 days did not show much difference from control (irrigation with water) in Cv. Sohag1 but decreased slightly in Cv. Beni Swef1. By 120 days Cv. Sohag1 showed slight rise in growth parameters of 731 ppm NaCl irrigated plants and inhibition of growth by higher concentrations. Beni Swef Cv. growth showed increased inhibition by increased concentration of irrigation NaCl solution. This indicates that Sohag cultivar could be regarded as relatively more salt tolerant than Beni Swef Cv.

Addition of calcium nitrate to NaCl caused considerable rise of growth by (731 ppm NaCl+185 ppm Ca-nitrate) in both cultivars and varying degrees of rise with remaining treatments.

Reproductive growth:

Parallel results were obtained concerning reproductive growth including mean number of spikes and spikelets.

Yield:

It is revealed (Fig. 1 and Tables 1 & 2) that highest yield was obtained at 731 ppm NaCl+185 ppm Ca-nitrate treatment for Cv. Sohag1 while 1462 ppm NaCl+370 ppm Ca-nitrate treatment resulted in a more or less equal yield to the control (water irrigation) in the two cultivars.

The rise in grain yield is generally caused by both components of yield i.e. number and weight of grains.

1991-1992 season experiment:

In this experiment, irrigation was by 1462 ppm NaCl with various fertilizer treatments. Results of Cvs. Sohag1 and Beni Swef1 were compared with control receiving the normal field fertilizer practice i.e. ammonium nitrate and Ca superphosphate (Tables

3 and 4). Maximum vegetative growth was attained by non saline irrigation+normal fertilizer practice. A slight reduction in growth was observed by irrigating with 25 mM NaCl solution+normal fertilizer+CCC, this is followed by the treatment irrigated by 25 mM NaCl solution+Viral fertilizer. The remainder treatments resulted in some inhibition of growth; least growth was obtained with plant receiving no fertilizer.

Concerning reproductive growth of the two cultivars, parallel results were also noticed.

Yield:

Results of yield of Cv. Sohagiare presented in Table (3) and Fig.(2). Maximum grain yield/plant (100%) was obtained by normal fertilizer application followed by 90% in case of NaCl+normal fertilizer+cycocel (only 10% reduction) and by 82% (18% reduction) with NaCL+normal fertilizer, and 78% and 77% (22% & 23 reduction) with NaCl+Viral and NaCl+Viral+CCC respectively. The lowest yield value 52% was obtained with water irrigation without any fertilizer.

Inspection of grain yield components (grain weight and grain number/plant) (Table 3, Fig. 2) reveals that the resulted reduction was always due to the two components together rather than being due to one component only.

Straw yield was highest (108%) with NaCl+normal fertilizer application+CCC and followed by normal fertilizer practice and normal fertilizer practice with NaCl treatment (100%).

Results for Cv. Beni Swef (Table 4, Fig. 2) with respect to the effect of different treatment used on yield followed a rather similar trend to the above. Reduction of yield under salt+normal fertilizer and salt+Viral+CCC was more evident than the respective values for Cv. Sohag. This gives some confirmation to the conclusion obtained from the first experiment that Beni Swef cultivar is relatively more sensitive to NaCl salt than Sohag cultivar.

Grain character:

Protein content in the two experimented cultivars, Table (5), was highest with normal fertilizer treatment followed by normal fertilizer+NaCl+CCC (Treatment 3). All treatments including NaCL addition caused lowering of protein content of grain and the least value was obtained by water treatment.

Concerning N, P, K, Mg and Ca content in wheat grains for the two cultivars, it is noticed that the highest mineral content was recorded with the normal fertilization practice treatment. NaCl salinity caused in general some reduction in these mineral content. Least reduction from control was recorded by normal fertilizer+25 mM NaCl+CCC, which indicates good grain quality.

Discussion

Results of the two experiments presented, showed that germination, vegetative reproductive, yield and grain quality of the two wheat cultivars were affected by th different rates of salinity used. The two wheat cultivars showed , in general, a moderat degree of salt tolerance with interactions between salinity and different forms and rate of fertilizers.

Sohag1cultivar is rather slightly higher salt tolerant than Beni Swef1cultivar. Th former cultivar is thus recommended for use with irrigation water of 750-1500 pp NaCl salinity. Application of calcium or ammonium nitrate and Ca superphospha resulted in attenuation of the deleterious effect of salinity. Reduction in grain yield Cv. Sohag1amounts to only 10% and 18% with 25 mM NaCl (1462 ppm)+norm fertilizer application+CCC and without CCC respectively, accompanied by increased unchanged straw yield. Irrigation water of lower salinity rate than 1462 ppm, w obviously result in minimising yield reduction. The toxic effect of chloride ion compensated by nitrate, sulphate and phosphate anions. The deleterious effect of N is alleviated by ammonium and calcium cations. Several reports including Cramer et (1986) and Kent and Lâchli (1985) confirmed the importance of adequate level of in alleviating the deleterious effects of salinity on plant growth. Gramer et al. (19 and Greenway and Munns (1980) postulated that in some plants, elevated

concentration in the nutrient solution mitigated the adverse effects of NaCl by inhibiting Na uptake. Ammonium nitrate is applied commonly in the normal fertilization practice in Egypt, which results in better growth of wheat. This agrees with Russels, (1988) who stated that supplying wheat with both NH_4 and NO_3 is better than providing only one source of nitrogen. Gibson, (1988) among others pointed out that addition of phosphorus decreased salt toxicity.

It is recommended, therefore, that in such cases of obligate use of saline water irrigation, it is better to apply 750 ppm and do not exceed 1500 ppm using Cv. Sohag 1 Durum wheat accompanied by normal fertilizer practice. This results to only 10-18% yield reduction at most with 1500 ppm+CCC and without, respectively, owing to salinity treatments interactions.

Fig. (1)

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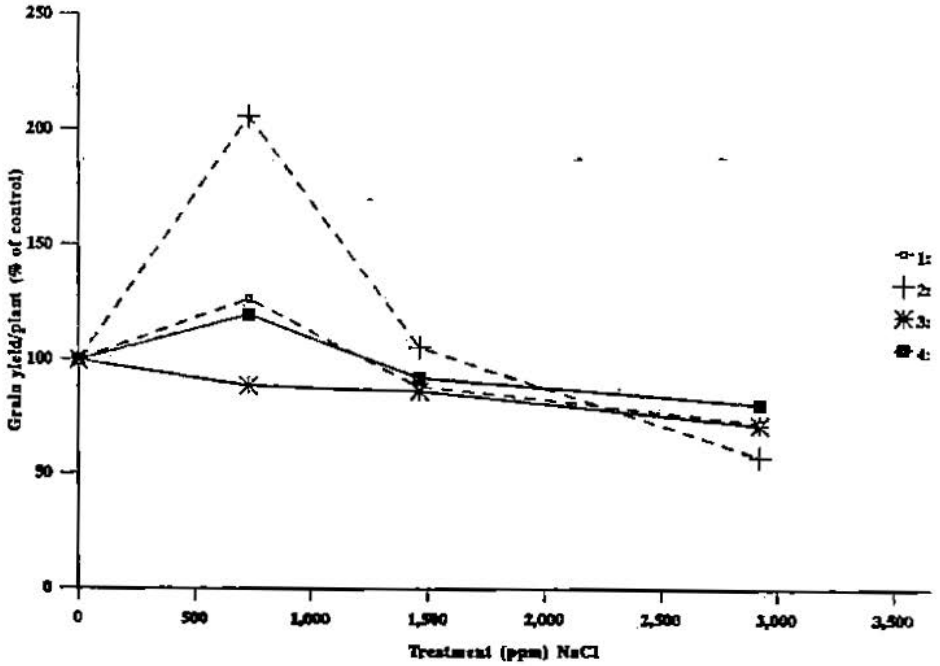
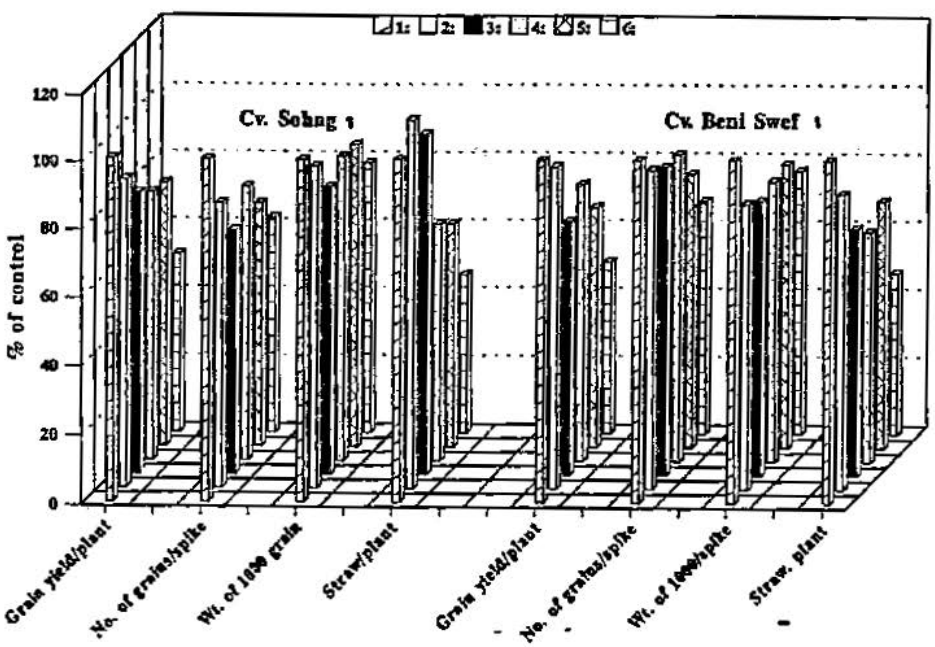


1: Cv. Sohag (NaCl), 2: Cv. Sohag (NaCl+Ca(NO$_3$)$_2$)
3: Cv. Beni Swef (NaCl)
4: Cv. Beni Swef (NaCl+Ca (NO$_3$)$_2$)

Fig. (2)



1: NH$_4$NO$_3$+Ca superphos. 2: NaCl+NH$_4$NO$_3$+Ca superphos.+CCC.
3: NaCl+NH$_4$NO$_3$+Ca superphos. 4: NaCl+Viral.
5: NaCl+Viral+CCC 6: Water.

Table (1): Growth parameters and yield of wheat Cv. Sohag under different treatments. 1990-1991 season Experiment.

Germination and vegetative growth							
Treatment	Age of plant (days)	% of germination	Plant height (cm)	Fresh weight (g)	Dry weight (g)	No. of levels /plant	No. of tillers /plant
0	7 and 60	96	35.4	0.85	0.15	5	
1		97	37.6	1.05	0.16	6	
2		90	35.6	0.92	0.16	5	
3		85	35.1	0.75	0.13	5	
4		100	38.9	1.33	0.20	6	
5		99	36.5	1.00	0.18	5	
6		96	36.4	0.78	0.14	5	
L.S.D. at 1%				0.112	N.S.		
0	30		60.9	3.38	0.55	8	
1			58.0	4.00	0.71	8	
2			57.5	3.25	0.50	7	
3			53.4	3.13	0.51	7	
4			63.0	4.50	0.76	8	
5			62.5	4.15	0.67	8	
6			61.6	3.83	0.61	7	
L.S.D. at 1%				0.139	0.119		
0	120		66.8	3.25	1.08	8	2
1			69.8	4.08	1.45	8	3
2			67.3	3.70	1.28	6	3
3			66.5	3.03	1.05	5	1
4			76.0	4.75	1.54	10	3
5			73.8	4.38	1.31	9	3
6			64.3	3.70	1.20	7	3
L.S.D. at 1%				0.35	0.22		

	Reproductive growth			Yield					
	Mean no. of spikes /plant	Mean length of spike (cm)	Mean no.of spikelets /spike	Grain yield /plant (g)	Grain yield /plant % of control	No. of grains/main spike	Wt. of 1000 grains (g)	Wt. of 1000 grains % of control	Straw /plant (g)
0	2	14.4	13	0.71	100	18	27.0	100	1.0
1	2	15.6	13	0.90	127	21	26.0	96	0.8
2	1	14.9	12	0.63	89	15	23.0	85	0.7
3	1	14.3	12	0.52	73	16	21.7	80	0.7
4	3	16.1	14	1.46	206	23	29.5	109	1.2
5	2	15.9	12	0.75	106	20	29.0	107	0.9
6	2	15.5	12	0.60	85	14	28.5	106	0.8
L.S.D. at 1%						2.45	1.19		

1: H_2O, 2: 731 ppm NaCl, 3: 1462 ppm NaCl, 4: 2924 ppm NaCl, 5: 731 ppm NaCl+185 ppm $Ca(NO_3)_2$, 6: 1462 ppm NaCl+370 ppm $Ca(NO_3)_2$, 7: 2924 ppm NaCl+730 ppm $Ca(NO_3)_2$.

Table (2): Growth parameters and yield of wheat Cv. Beni Swefiunder different treatments. 1990-1991 season Experiment.

Germination and vegetative growth							
Treatment	Age of plant (days)	% of germination	Plant height (cm)	Fresh weight (g)	Dry weight (g)	No. of leaves /plant	No. of tillers /plant
0	7 and 60	87	38.9	1.11	0.19	6	
1		91	36.5	1.01	0.19	6	
2		86	35.1	0.98	0.19	5	
3		80	32.4	0.93	0.16	5	
4		98	41.4	1.35	0.19	7	
5		92	41.4	1.28	0.19	6	
6		88	40.3	1.15	0.18	5	
L.S.D. at 1%				0.199 at 5%	N.S.		
0	90		55.0	3.65	0.81	9	
1			51.5	3.65	0.71	8	
2			51.8	3.38	0.68	8	
3			49.8	2.70	0.48	7	
4			57.1	4.88	0.89	9	
5			56.6	4.55	0.84	9	
6			53.8	3.81	0.83	9	
L.S.D. at 1%				0.163	0.133		
0	120		62.8	3.30	1.15	7	2
1			60.8	2.50	1.13	7	2
2			54.0	2.23	0.90	7	1
3			51.8	1.85	0.80	6	1
4			67.3	4.50	1.55	8	2
5			64.5	3.93	1.43	8	2
6			64.5	3.43	1.15	7	1
L.S.D. at 1%				0.283	0.145		

	Reproductive growth			Yield					
	Mean no. of spikes /plant	Mean length of spike (cm)	Mean no.of spikelets /spike	Grain yield /plant (g)	Grain yield /plant % of control	No. of grains/main spike	Wt. of 1000 grains (g)	Wt. of 1000 grains % of control	Straw /plant (g)
0	2	15.6	13	1.13	100	28	22.5	100	0.82
1	2	15.3	12	1.01	89	25	22.3	99	0.73
2	2	15.3	12	0.98	87	25	21.8	97	0.72
3	2	14.9	11	0.81	72	22	21.0	93	0.69
4	2	17.3	15	1.35	120	34	29.6	131	0.89
5	2	16.5	16	1.05	93	29	27.5	122	0.88
6	2	16.3	14	0.92	81	27	26.5	118	0.87
L.S.D. at 1%				0.249		2.439	0.868		

1: H_2O, 2: 731 ppm NaCl, 3: 1462 ppm NaCl, 4: 731 ppm NaCl+185 ppm $Ca(NO_3)_2$,

5: 1462 ppm NaCl+370 ppm $Ca(NO_3)_2$, 6: 2924 ppm NaCl+730 ppm $Ca(NO_3)_2$.

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Table (3): Growth criteria and yield of wheat Cv. Sohag4under different treatments. 1991-1992 season Experiment.

Vegetative growth						
Treatment	Age of plant (days)	Plant height (cm)	Fresh weight (g)	Dry weight (g)	No. of leaves /plant	No. of tillers /plant
0	60	37.3	1.70	0.30	4	
1		38.0	3.92	0.65	7	
2		51.0	2.52	0.35	4	
3		40.3	3.32	0.59	5	
4		42.0	2.45	0.36	6	
5		35.7	1.92	0.32	5	
L.S.D. at 1%			0.21 at 5%	0.104		
0	90	63.0	4.7	1.20	4	
1		74.6	9.0	2.27	8	
2		74.7	5.4	1.27	9	
3		59.7	8.5	2.20	8	
4		69.3	5.9	1.50	5	
5		59.0	4.9	1.30	5	
L.S.D. at 1%			0.348	0.191		
0	120	68.5	4.9	1.50	3	1
1		80.6	9.5	3.20	8	4
2		80.0	5.5	1.62	9	3
3		61.0	9.0	2.70	8	3
4		71.2	6.1	1.80	5	1
5		62.0	5.2	1.70	5	1
L.S.D. at 1%			0.366	0.498		

	Reproductive growth			Yield							
	Mean no. of spikes /plant	Mean length of spike (cm)	Mean no.of spikelets /spike	Grain yield /plant (g)	Grain yield /plant % of control	No. of grains /spike		Wt. of 1000 grains (g)	Wt. of 1000 grains % of control	Straw /plant	
						spike	% of Con.			(g)	% of Con.
0	1	15.3	11	0.75	52	22	63	36.9	79	1.2	46
1	3	18.2	14	1.45	100	35	100	47.0	100	2.6	100
2	3	18.3	12	1.19	82	25	71	39.5	84	2.6	100
3	3	18.5	13	1.30	90	29	83	44.4	94	2.8	108
4	1	17.7	11	1.13	78	28	80	41.7	89	1.8	69
5	1	17.0	11	1.20	77	25	71	42.0	89	1.7	65
L.S.D. at 1%				0.1		0.257		1.693			

0: H_2O, 1: NH_4NO_3+Ca superphosphate, 2: NaCl+NH_4NO_3+Ca superphosphate, 3: NaCl+NH_4NO_3+Ca superphosphate+CCC, 4: NaCl+Viral, 5: NaCl+Viral+CCC.

Table (4): Growth criteria and yield of wheat Cv. Beni Swef 1 under different treatments. 1991-1992 season Experiment.

Treatment	Age of plant (days)	Vegetative growth: Plant height (cm)	Fresh weight (g)	Dry weight (g)	No. of leaves /plant	No. of tillers /plant
0	60	36.7	1.45	0.25	5	
1		42.0	2.95	0.50	9	
2		46.0	2.72	0.38	8	
3		44.3	2.80	0.45	9	
4		38.0	1.75	0.28	6	
5		35.0	2.07	0.32	5	
L.S.D. at 1%			0.182	0.148		
0	90	48.0	2.70	0.65	5	
1		72.7	10.50	2.07	13	
2		76.3	7.00	1.52	13	
3		59.0	10.00	1.92	10	
4		71.7	3.60	0.88	5	
5		57.7	4.30	1.00	7	
L.S.D. at 1%			0.457	0.140		
0	120	53.0	3.1	1.10	4	1
1		79.2	11.2	2.92	13	4
2		82.0	7.6	2.30	12	4
3		61.3	10.4	2.45	10	3
4		72.5	4.0	1.22	5	1
5		60.2	5.1	1.40	7	1
L.S.D. at 1%			0.399	0.148		

	Reproductive growth: Mean no. of spikes /plant	Mean length of spike (cm)	Mean no.of spikelets /spike	Yield: Grain yield /plant (g)	Grain yield /plant % of control	No. of grains /spike: /spike	No. of grains /spike: %of Con.	Wt. of 1000 grains (g)	Wt. of 1000 grains % of control	Straw /plant: (g)	Straw /plant: % of Con.
0	1	15.5	13	0.91	50	27	68	30.4	77	1.7	47
1	2	16.6	16	1.90	100	40	100	39.4	100	3.6	100
2	2	17.7	17	1.41	74	36	90	31.4	80	2.6	72
3	2	17.5	15	1.78	94	37	93	32.8	83	3.1	86
4	1	17.2	16	1.53	81	36	90	32.4	82	2.4	67
5	1	18.3	15	1.33	70	32	80	32.6	83	2.6	72
L.S.D. at 1%				0.182		3.148		0.366			

0: H_2O, 1: NH_4NO_3+Ca superphosphate, 2: NaCl+NH_4NO_3+Ca superphosphate, 3: NaCl+NH_4NO_3+Ca superphosphate+CCC, 4: NaCl+Viral, 5: NaCl+Viral+CCC.

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Table (5) Protein, Ash., Humidity and Mineral content of wheat grains under different treatments. 1991-1992 season Experiment.

Treatment	Cv. Sohag				Cv. Beni Swef			
	Protein % Fr. wt.	Protein % Dry wt.	Ash. %	Humidity %	Protein % Fr. wt.	Protein % Dry wt.	Ash. %	Humidity %
0	11.5	11.7	1.6	2.3	11.9	12.3	1.4	3.3
1	19.5	20.1	1.7	3.3	16.8	17.4	1.8	3.3
2	11.6	12.0	1.6	3.0	13.6	13.9	1.9	3.2
3	14.3	14.6	1.4	3.0	15.5	15.9	2.1	3.0
4	11.3	11.7	1.3	3.8	12.5	13.0	1.7	3.4
5	11.5	11.8	1.4	2.3	10.7	11.1	1.3	3.8

Treatment	Cv. Sohag						Cv. Beni Swef					
	N %	P %	K %	Mg %	Na %	Ca %	N %	P %	K %	Mg %	Na %	Ca %
0	1.84	0.47	0.35	0.15	0.03	0.07	1.90	0.45	0.35	0.17	0.03	0.07
1	3.12	0.60	0.51	0.20	0.03	0.14	2.69	0.55	0.50	0.22	0.03	0.13
2	1.86	0.51	0.37	0.15	0.04	0.12	2.16	0.50	0.40	0.17	0.04	0.11
3	2.29	0.56	0.45	0.18	0.04	0.10	2.48	0.52	0.43	0.20	0.04	0.13
4	1.80	0.46	0.40	0.15	0.03	0.09	2.02	0.48	0.40	0.18	0.04	0.11
5	1.84	0.49	0.37	0.16	0.03	0.10	1.71	0.43	0.35	0.15	0.03	0.09

0: H_2O, 1: NH_4NO_3+Ca superphosphate, 2: NaCl+NH_4NO_3+Ca superphosphate, 3) NaCl+NH_4NO_3+Ca superphosphate+CCC, 4: NaCl+Viral, 5: NaCl+Viral+CCC.

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