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Effect of Different Levels of NaCl and KCl on Growth and Some Biological Indexes of Wheat Plant

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Abstract: In this study, it was aimed to determine the effects of different levels (0, 15, 30 and 60 mM) of NaCl and KCl salt on seedling growth and some biological indexes of wheat. Shoot height, stem diameter, leaves number of plant, fresh weight of shoot and dry matter weight index were investigated. The results showed that biological index of wheat decreased with increasing salt in comparison to control. The adverse affect of NaCl on wheat plant was obtained higher than that of KCl. This should carefully be considered if wheat is grown under saline soil condition.

Key words: Saline, wheat, NaCl, KCl, biological index

INTRODUCTION

Soil salinity is one of the major abiotic factors affecting crop yields in arid and semiarid irrigated areas (Szabolcs, 1989). Approximately one-third of the world's irrigated soils and a large proportion of soils in dry land are saline (Carter *et al*., 2005).

Two major effects have been identified as the probable causes of high salt toxicity in crop plant i.e., the ionic effect and the osmotic effect. The ionic effect results in alterations in enzymatic processes, disturbances in accumulation and transport of different ions or a combination of all these factors. As a result, shoot and root growing reduce and uptake of nutrient elements by plants is adversely affected (Azevedo *et al*., 2000; Tjera *et al*., 2005; Huang *et al*., 2006).

While excess Na accumulated in plants under salinity stress conditions hinders K uptake (Huang *et al*., 2006); Cl hinders NO_3 uptake by plants and destroys ionic balance in plants (Mer *et al*., 2000).

Soluble salts in high concentration affect plant growth in three ways; i) excess Na, Cl and B concentration causes in physiological problems; ii) destroys ionic balance of plant; iii) hinders water use of plants through decreasing water potential due to osmotic effect of these salts (Netonto *et al*., 2004; Tjera *et al*., 2005; Carter *et al*., 2005; Huang *et al*., 2006).

A pot experiment was carried out with three wheat varieties under greenhouse conditions. Percentage of germination, shoot and root growing, fresh and dry matter yield decreased with increasing of salt concentration (Iqbal *et al*., 1998).

The effect of Na_2SO_4, $CaCl_2$ and NaCl salts three levels on growing of wheat investigated by Iqbal *et al*. (2006). At the end of experiment, dry matter yield, phosphorus concentration of plant, K/Na ratio and Ca/Na ratio significantly decreased 5 and 10 dS m^{-1} salinity level according to control.

In this research, the effect of the application of NaCl and KCl salts in increasing doses on some biological indexes of wheat was investigated.

MATERIALS AND METHODS

This research was conducted in Trakya University Tekirdağ Agricultural Faculty during August and September 2005. Soil sample was collected from Tekirdağ Agricultural Faculty experimental area. Some physical and chemical properties of soil sample are given in Table 1.

Wheat was grown in pots under greenhouse conditions with three replications Air-dried 4 kg soil was filled into plastic pots. Fifteen wheat (*Triticum aestivum* L.) seeds were sown into each pot. After

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Table 1: Some physical and chemical properties of soil sample

pH (1:2.5 water)	EC (dS m^{-1})	$CaCO_3$ (%)	Organic matter (%)	Available (kg ha^{-1}) P_2O_5	K_2O	Texture
7.20	0.22	6.18	0.94	74.3	327.9	SL

emergence, the plants were thinned to 10. 90 kg N ha^{-1} nitrogen and 90 kg P_2O_5 ha^{-1} phosphorus (as 20-20-0 fertilizer) were applied to each pot. Sodium chloride and KCl salts were applied to pots 0, 15, 30 and 60 mM levels with three replications.

Plant shoot height, stem diameter and the number of leaf in a plant were determined for each week after germination. Plants were harvested 6 weeks after germination. All plants samples were washed with distilled water and fresh weight and dry weight of plants were obtained. Experiment was done according to split spot experimental design and results were evaluated statistically (Soysal, 2000).

RESULTS AND DISCUSSION

The effect of salt types (NaCl and KCl) and levels on wheat plant shoot height: Wheat shoot height increased with increasing rates of NaCl and KCl by time, but these increases both salts levels decreased compare to control treatment. This decrease was found statistically significant at the level of 1% (Table 2).

The reason for the decrease in plant shoot height the increase may be explained by the in osmotic pressure due to increasing salt level, which lessens the available water to plant (Iqbal *et al*., 2006; Huang *et al*., 2006; Al-Ahmadi and Kafi, 2006).

The effect of salt types (NaCl and KCl) and levels on wheat stem diameter: Stem diameter decreased with increasing rates of salt application. This decrease was higher NaCl application than KCl application. Decreasing in stem diameter with both salt applications were found statistically significant at the level of 1% (Table 2).

Similar results were found by some previous researchers for different plants (Elkhatib *et al*., 2004; Tjera *et al*., 2005; Chang *et al*., 2005; Abdelgadir *et al*., 2005).

The effect of salt types (NaCl and KCl) and levels on the number of leaf per wheat plant: The average number of leaf per plant increased with time, however when this increase compared with the control, the number of leaf per plant decreased with increasing rate of salt application (Table 2). The effect of salt application on the average number of leaf per wheat plant was determined statistically significant at the level of 1%.

The reason for this decrease is that the uptake of nutrient elements and water availability are limited under saline conditions (Carter *et al*., 2005; Pessarakli *et al*., 2005). Another interpretation for this result, destroy of ionic balance in plant with high salinity levels (Mer *et al*., 2000; Huang *et al*., 2006).

The effect of salt types (NaCl and KCl) and levels on fresh weight of wheat plant: Average fresh weight of wheat plant decreased with increasing rates of both salt applications (Table 2).

Average fresh weight of plant was 35.95 g pot^{-1} for control treatments while it was 17.92 g pot^{-1} for 60 mM NaCl and 19.91 g pot^{-1} for 60 mM KCl applications. The effect of NaCl and KCl applications to on fresh weight was found statistically significant at the level of 1%.

Plant yield decreased under saline soil conditions, because of toxic effects of Na and Cl ions to plants and destructive effect of ionic balance in plants (Tjera *et al*., 2005; Huang *et al*., 2006).

The effect of salt types (NaCl and KCl) and levels on dry matter yield of wheat plant: Average dry matter yield of wheat plant decreased with increasing rates of NaCl and KCl applications in comparison to control (Table 2). Average dry matter yield of wheat plant was found to be 8.81 g pot^{-1} for control, 4.13 g pot^{-1} for 60 mM NaCl

Table 2: The effect of salt types and levels on some biological indexes of wheat plant*

		NaCl				KCl		
Variables	Date	Control	15 mM	30 mM	60 mM	15 mM	30 mM	60 mM
Plant height (cm)	5.9.05	24.00d	22.00f	22.00f	21.00g	23.00d	23.00d	22.00e
	12.9.05	26.00b	24.00d	24.00d	23.00e	25.00c	23.00d	22.00e
	19.9.05	28.00a	26.00b	25.00c	23.00e	27.00b	23.00d	22.00e
Stem diameter (cm)	5.9.05	0.30c	0.20d	0.20d	0.20d	0.26c	0.26c	0.26c
	12.9.05	0.35b	0.30c	0.30c	0.20d	0.30b	0.30b	0.30b
	19.9.05	0.40a	0.30c	0.30c	0.20d	0.30b	0.30b	0.30b
No. of leaf in plant	5.9.05	6.00d	6.00d	5.00de	4.00e	6.00d	5.00de	5.00de
	12.9.05	11.00b	9.00c	6.00d	6.00d	9.00c	7.00d	7.00d
	19.9.05	15.00a	12.00b	10.00c	7.00d	11.00b	9.00c	7.00d
Fresh weight (g pot^{-1})		35.95a	30.11b	22.25c	17.92d	30.79b	22.08c	19.91d
Dry weight (g pot^{-1})		8.81a	7.63b	7.23c	4.13d	8.55b	8.40b	6.02c

*: Each biological index is evaluated individually and the same letter signs no statistically significant differences between them at the confidence level of 0.01

and 6.02 g pot^{-1} for 60 mM KCl applications. The negative effect of salts was obtained statistically significant at the level of 1%.

In conclusion, the negative effects of NaCl salt were higher than KCl salt. This result indicates Na toxicity in addition to Cl toxicity to plants (Maathius and Amtmann, 1999; Mer *et al*., 2000; Huang *et al*., 2006).

Dry matter yield of plants was adversely affected under saline soil conditions. The reason for this is that osmotic pressure was higher, which hinders uptake of nutrient elements and water and destroys ionic balance between nutrient elements of plants in saline conditions (Ashraf and Khanum, 1997; Zhu, 2001).

CONCLUSIONS

Some biological indexes of wheat plant were negatively affected by increasing rates of NaCl and KCl applications.

Plant shoot height, stem diameter, leaf number of plant, fresh and dry matter weights of plant decreased when compared to control treatments with increasing rates of NaCl and KCl applications.

According to the results of this experiment, wheat plant was negatively affected by increasing salinity in the soil. Soil salinity should be controlled for wheat growing. NaCl and KCl compounds should be applied in a precise amount to wheat. Otherwise, quantity and quality of wheat plant will be decreased.

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