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INTERACTION BETWEEN CHLORINE AND NITROGEN UNDER SALT STRESS AMONG DURUM WHEAT (*Triticum durum* Desf.)

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ABSTRACT

The effect of sodium chloride on nitrogen and chlorine contents of the aerial parts was studied in four genotypes of durum wheat (*Triticum durum* Desf.) which have different sensitivity to salt stress. Tolerant cultivars 'Jori' and 'Karim' maintain relatively high nitrogen content and limiting accumulation of chlorine compared to susceptible cultivars 'Acsád 65' and 'Kyperounda'. Evolution of nitrogen/chlorine rapport depending on salinity can demonstrate competitive antagonism.

INTRODUCTION

Soil salinity and irrigation water represent a major obstacle to the growth and development of plants [1, 2]. Faced with this constraint, selection of varieties tolerant to high levels of salt is of the prime importance for crop plants. It requires knowledge of responsible mechanisms according to the plant tolerance to salinity. Two main strategies developed by plants to limit salt stress, which could be called *exclusion* and *inclusion* [3, 4].

For most crops, salt stress causes a nutrition imbalance of essential elements for growth and development of plants, including nitrogen, potassium, phosphorus and calcium [5, 6]. These effects reduce the growth and development of the plant and therefore the production and yield [7, 8].

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The reduction nitrate absorption in the salt stress conditions can be a limiting factor in growth [9]. In this work, we studied the change in salt stress conditions of nitrogen and chlorine of aerial parts of four genotypes of wheat that differ in their salt tolerance.

MATERIALS AND METHODS

Plant Material

Four cultivars of durum wheat (*Triticum durum* Desf.) were chosen for their tolerance to Nacl at germination stage. Their degree of tolerance to Nacl at germination stage are: Kyperounda < Acsád 65 < Karim < Jor [5].

Experimental protocol

The test was conducted in hydroponic culture. The 20 seeds selected were disinfected with sodium hypochlorite (1%), washed in distilled water and geminated Petri dishes (containing the filter paper dampened with distilled water0 in the dark at 20°C. After emergence of the radicle plant in three following days, the seedlings were transplanted in crystallizers (0, 2 m^3 of diameter) containing Hoagland nutrient solutions at 6.3 pH (Hoagland and Arnon, 1938). Different concentrations of Nacl (0, 50, 100 and 150 mm) were added to the culture media. To avoid significant variations in pH caused by the ionic imbalance, the nutrient solutions were continuously aerated and renewed every two days. The cultures were placed in a growth chamber with following conditions: lighting of 300 mmol/m^2/s2 PAR, 16 hours of photoperiod, temperature of 18°C night and 24°C day, a humidity of 60% day and 80 % night. The experimental scheme adopted is a block five repetitions of 20 seedlings by crystallizer for each treatment. The test was done on the seedling roots of 30 days old.

Analysis Methods

For each treatment and each crystallizer, the seedlings of each cultivar were taken one month after transplant (or at 4-5 leaf stage). The roots were separated from the aerial parts and rinsed with distilled water. One gram of dry matter (determined after drying in an oven at 80°C for 48 hours) was collected, crushed, incinerated 4 hours at 450°C and then cooled.

The ash obtained was dissolved in 5 ml of hydrochloric acid (2N), heated for 10 min, filtered with distilled water and the volume is reduced to 100 ml. From this solution was taken for the determination of total nitrogen by Kjeldahl method and chlorine using a chloridometer (Buchler).

Table 1. Evolution of nitrogen/chlorine ratio of aerial parts depending on the salt treatment in four durum wheat cultivars

NaCl (mM)	'Jori'	'Karim'	'Acsad 65'	'Kyperounda'
0 (witness)	10,67	10,57	10,96	11,61
50	2,58	1,91	1,45	1,22
100	1,86	1,36	0,88	1,59
150	1,32	0,98	0,62	0,42

Figure 1. Variation of the nitrogen content of the aerial parts of four varieties of durum wheat in the 4-5 leaf stage according to the saline treatment

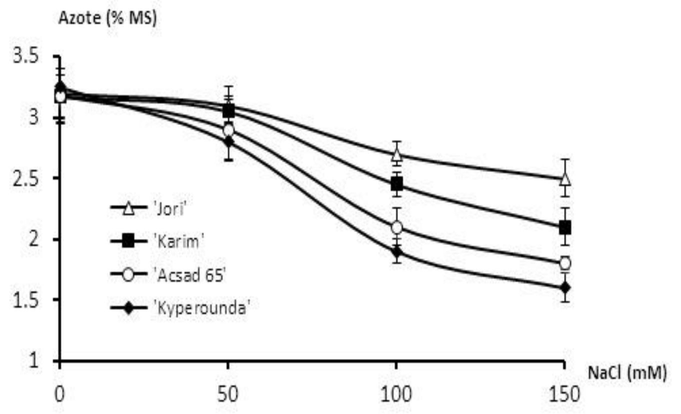
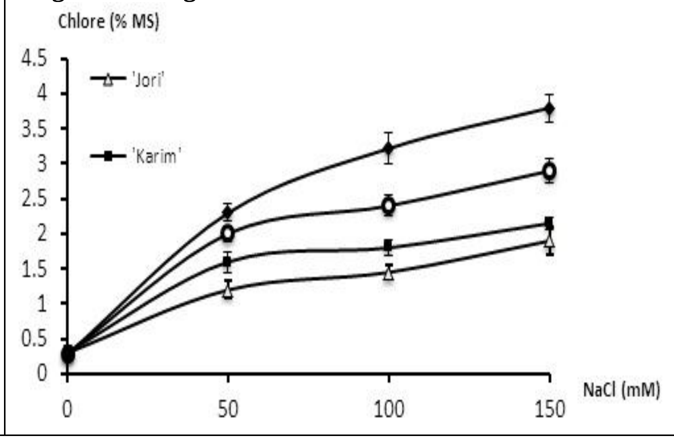


Figure 2. Variation of the chlorine content of the aerial parts of four varieties of durum wheat in the 4-5 leaf stage according to the saline treatment



RESULTS AND DISCUSSION

The saline treatment leads to a reduction in nitrogen uptake and an accumulation of chlorine in the aerial parts of four cultivars of Durum studied (Figures 1 and 2). Tolerant varieties 'Jori' and 'Karim' have managed to maintain a relatively high nitrogen and low chlorine content in their aerial parts compared to the other two varieties.

At 150 mM Nacl, reductions in nitrogen contents of the aerial parts are around 51% compared to the witness in the most sensitive cultivar 'Kyperounda', against 22% in the most salt tolerant cultivar 'Jori'.

The accumulation of chlorine compared to the witness cultivar of aerial parts of 'Kyperounda' and 'Jori' are 93 and 84 % at 150 mM Nacl.

The nitrogen/chlorine ratio follows the interdependence of the two elements in relation with the salt tolerance of the four genotypes. Some antagonism was observed between nitrogen and chlorine when Nacl concentration of the media increased (Table 1). This antagonism is more pronounced in susceptible varieties 'Kyperounda' and 'Acsád 65'.

CONCLUSION

The inhibition of the nitrogen uptake in salt stress conditions has been reported by several authors on different plant species [9-11]. This inhibition is often attributed to competition between nitrates and chlorides which limiting the accumulation of nitrogen and plant growth [8,9,12]. According to [11], the high concentration of chlorides is considered as antagonist for the decrease of the nitrates absorption and may inhibit the nitrate reductase activity which is positively correlated with the influx of NO_3^-. The competitive effect between the essential elements for growth and development of the plant and the elements responsible of salinity including Na^+ and Cl^- was reported by several authors in different species and varieties [12].

'Jori' and ' Karim ' varieties have managed to maintain a relatively high nitrogen content and limiting the accumulation of chlorine in their aerial part, even in conditions of high salinity. This difference in absorption capacity of Cl^- ions was also reported by [13] where a large variability in the ability of exclusion and accumulation of chloride was observed in some genotypes of rosebush. The exclusion of Cl^- ions of aerial parts is a criterion that can be used for selection of species or tolerant varieties. Imene *et al* [14] suggested that salt tolerance observed in a tomato plant is associated with its ability to maintain low concentration of Cl^- in its photosynthetic organs, and also to reduce the depressive effect of salt in feeding by cations and anions necessary for growth of these bodies.

Ions Nitrate content in the cell plant can be separated into two fractions, for metabolism and storage. If cell metabolism was affected, chlorine is responsible for the decreased of nitrates absorption. In the case of four cultivars studied, it appears that the Cl^- ions were substituted for of NO_3^- ions of storage.

We therefore suggest that in the Durum wheat, chlorine would have a competitive effect on nitrogen nutrition and would be responsible for reducing its absorption.

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