

Study Effect of NaCl Salinity and Nitrogen Form on Composition of Canola (*Brassica napus* L.)

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Abstract

The effect of two N forms (NH_4^+ and NO_3^-) and NaCl on accumulation of some essential mineral nutrients was examined in canola (*Brassica napus* L.) cv. 'SLM₀₄₆'. Eight-day-old plants were subjected for 21 day to Hoagland's nutrient solution containing 10 mM NH_4^+ and NO_3^- and salinized with 0, 50, 100 and 150 mm NaCl. N form and addition of NaCl to the growth had no significant effect on total N. However, root N of NH_4^+ supplied plants decreased significantly with increase in NaCl concentration, whereas that of NO_3^- supplied plants remained unaffected. Salinity of the rooting also did not show any significant effect on Na^+ concentration of leaves or roots of plants subjected to two different forms of nitrogen. NH_4^+ treated plants generally had greater concentration of Cl⁻ in leaves and roots and lower K⁺ content in leaves than NO_3^- supplied plants. Ca^{2+} concentration of leaves and roots concentration of leaves decreased in NH_4^+ supplied plants due to NaCl, but they remained unaffected in NO_3^- treated plants.

Keywords: ammonium, 'SLM₀₄₆', nitrate, salinity, canola

Introduction

Plant growth is adversely affected by root zone salinity (Sharma, 1995) but salt sensitivity of plant changes considerably during the development stages (Allen *et al.*, 1986). Nitrogen is required in lot of amount by plant and is major limiting factor to plant growth (Mengel and Kirkby, 1987). NO_3^- and NH_4^+ are nitrogen form that absorbed by all types of plants (Ashraf and Sultana, 2000). Differences for NO_3^- acquisition within species have been observed in many plants. Interaction of different N form with other ions is evident from many earlier reports.

The assimilation of NO_3^- usually occurs mostly in the leaves of plants, however the stage of NO_3^- assimilation seem to be linked closely enough to preclude accumulation of NH_4^+ (Brunetti *et al.*, 1972). Modification of $\text{NH}_4^+:\text{NO}_3^-$ ratio in the nutrient solution modulates the relative uptake of anions and cations (Cox and Reisenauer, 1973). The increase of $\text{NH}_4^+:\text{NO}_3^-$ ratio in the root zone impairs growth and reduces the yield (Feil, 1994). The presence of high concentration of NH_4^+ has been shown to induce a decreased concentration of cations such as K, Ca and Mg, while NO_3^- has the opposite effect (Hummadi, 1977; Lal and Singh, 1973). Under intensive fertigation, nitrogen not only affects plant growth, it may also alter the salinity tolerance of plants depending on its ionic form. The beneficial effects of nitrate under saline conditions have been attributed to the antagonism between NO_3^- and Cl⁻ ions (Leidi *et al.*, 1991). The balance of the cation to anion uptake ratio by secretion of H^+ , HCO_3^- , or organic anion from root cells also has an effect on the rhizosphere. Ad-

justing the $\text{NO}_3^-:\text{NH}_4^+$ ratio from the total cation to anion uptake ratio and maintain pH within desired range (Lewis and Chadwick, 1983). Whereas growth suppression by ammonium probably results from a shortage of sugar in the roots (Marschner 1995) or from inhibition of nitrate reductase activity in roots and shoots (Murphy and Lewis, 1987; Peterson *et al.*, 1988; Ravindra and Pandey, 1978).

There is considerable evidence that NO_3^- enhances translocation of cations Wilcox *et al.*, 1973; Smith and Fox 1977) and NH_4^+ inhibits cation translocation (Polizotto *et al.*, 1975). It is now evident that salt stress has a significant effect on N nutrition in plants. For example, Heikal (1977) found that total N content of the leaves of wheat and radish was decreased significantly by salinity, whereas that of sunflower leaves was increased, similarly, Helal and Mengel (1979), working with barley, found that total N control of roots decreased with increasing salinity of the rooting medium, whereas that of the shoot increased. This was ascribed to the fact uptake and assimilation of NO_3^- and NH_4^+ have different energy requirement and to interaction between NaCl and nitrogen uptake (Barker and Ready, 1989).

Materials and methods

The seeds of canola (*Brassica napus* L.) cv. 'SLM₀₄₆' obtained from a local seed supplier were surface sterilized in 5% sodium hydrochloride solution for 8 min. The experiment was carried out during 2008 in Agricultural research center of Azerbaijan.

Tab. 1. Effect of salinity rates in different N⁻ forms on dry matter and nutrient concentration

Parameter NaCl (mm)	N – NH ₄						N – NO ₃					
	Ca ²⁺ (gr.kg ⁻¹)	N (gr.kg ⁻¹)	K ⁺ (gr.kg ⁻¹)	Cl ⁻ (gr.kg ⁻¹)	Na (gr.kg ⁻¹)	Dry mater (gr.plant ⁻¹)	Ca ²⁺ (gr.kg ⁻¹)	N(gr.kg ⁻¹)	K ⁺ (gr.kg ⁻¹)	Cl ⁻ (gr.kg ⁻¹)	Na (gr.kg ⁻¹)	Dry Mater (gr.plant ⁻¹)
0	73.2' ±7.2	2.2 ^{ns} ±0.18	49.5 ^{ns} ±4.8	28.9 ^{ns} ±2.9	16.7' ±1.1	30.6' ±2.2	71.8' ±8.2	2.3 ^{ns} ±0.02	48.9 ^{ns} ±6.6	17.5 ^{ns} ±4.8	12.8' ±1.8	50.28' ±0.3
50	56.4' ±3.6	24.6 ^{ns} ±1.8	44.2 ^{ns} ±4.2	37.6 ^{ns} ±3.1	17.8' ±1.8	30.2' ±2.1	71.6' ±8.1	21.5 ^{ns} ±4.4	55.4 ^{ns} ±7.2	25.6 ^{ns} ±2.6	18.9' ±2.9	20.46' ±0.2
100	41.4' ±2.5	25.6 ^{ns} ±1.9	28.4 ^{ns} ±2.6	41.4 ^{ns} ±3.3	17.5' ±1.1	20.1' ±2.0	75.4' ±7.8	25.2 ^{ns} ±4.2	41.4 ^{ns} ±5.8	40.8 ^{ns} ±3.6	24.5' ±3.1	10.86' ±0.08
150	37.6' ±2.2	26.8 ^{ns} ±1.7	25.4 ^{ns} ±2.4	45.6 ^{ns} ±3.8	17.2' ±1.02	10.4' ±1.8	79.8' ±7.9	27.4 ^{ns} ±4.4	45.4 ^{ns} ±3.9	44.5 ^{ns} ±3.9	26.5' ±3.3	5.89' ±0.009
LSD(0.05)	19	12	18	22	9.8	1.8	35	17.8	28.9	25.6	11.8	2.22

* = significant at 0.05 ** = significant at 0.01 of canola in shoot/leaf ns = no significant

Tab .1. Effect of salinity rates in different N⁻ forms on dry matter and nutrient concentration

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	Ca ²⁺ (gr.kg ⁻¹)	N (gr.kg ⁻¹)	K ⁺ (gr.kg ⁻¹)	Cl ⁻ (gr.kg ⁻¹)	Na (gr.kg ⁻¹)	Dry mater (gr.plant ⁻¹)	Ca ²⁺ (gr.kg ⁻¹)	N (gr.kg ⁻¹)	K ⁺ (gr.kg ⁻¹)	Cl ⁻ (gr.kg ⁻¹)	Na (gr.kg ⁻¹)	Dry Mater (gr.plant ⁻¹)
0	83.5' ±7.2	15.5' ±0.18	47.5' ±5.8	28.2' ±2.9	17.2 ^{ns} ±1.8	60.45' ±0.09	73.5' ±9.9	19.2' ±2.2	37.66' ±5.6	19.65' ±3.3	19.45 ±3.4	45.85' ±0.06
50	67.7' ±8.7	15.2' ±2.6	27.5' ±2.7	25.2' ±2.4	21.5 ^{ns} ±2.2	50.32' ±0.07	83.6' ±10.2	16.5' ±1.8	25.7' ±4.4	42.4' ±5.8	32.3 ±6.2	30.82' ±0.002
100	34.8' ±4.9	15.1' ±2.4	18.2' ±1.4	66.8' ±7.8	33.6 ^{ns} ±6.8	40.28' ±0.06	75.5' ±9.2	17.2' ±1.7	22.5' ±4.2	44.5' ±4.9	31.4 ±6.1	20.54' ±0.002
150	29.6' ±2.2	14.8 ±1.8	15.5' ±1.1	71.8' ±8.2	36.8' ±7.2	20.22' ±0.04	70.2' ±8.9	15.2' ±1.4	19.2' ±3.2	47.8' ±5.1	30.8 ±	15.36' ±0.02
LSD(0.05)	11.4	8.6	9.8	14	12.8	1.8	19.2	7.6	8.6	21.8	9.6	2.28

* = significant at 0.05 ** = significant at 0.01 of canola in shoot/leaf ns = no significant

Plants were grown in a glasshouse with natural sunlight for 12 to 14 h. The irradiance measured at noon ranged from 750 to 1650 $\mu\text{mol m}^{-2} \text{S}^{-1}$. The day/night temperature was $31 \pm 6^\circ\text{C}$ and $20 \pm 4^\circ\text{C}$, respectively. Relative humidity during the day ranged from 32 to 45.5%.

Eight-day-old seedlings (at the first leaf stage) were transplanted into a plastic pod with aerated full strength. Hoagland's nutrient solution. The experiment was arranged in a completely randomized design with four replicates, four NaCl treatment (0, 50, 100 and 150 mm), and two nitrogen forms (10 mm NO_3^- or NH_4^+ applied as KNO_3 or $(\text{NH}_4)_2\text{SO}_4$; pH of the treatment solution was maintained at 6.5. The concentration of K, Ca, and SO_4 were begun 10 day after sowing. The NaCl concentration stepwise aliquots of 30 mm every day until the appropriate treatment concentration was attained. The solutions changed every other day for following 21 day and then the plants were harvested. All plants were deiced at 70°C and their dry masses were measured. Contents of Na, K, Ca, N and in plant the methods determined tissue described by Allen *et al.*, (1986) in fully expanded youngest leaves. Na and K were determined with a flame photometer (PFP 7, Jenway, Dunmow, UK) and Ca with an atomic absorption spectrophotometer (Analyst 100, Perkin Elmer, Beaconsfield, Bucks, UK). The mean values were compared with least significance difference test following snedecor and cochran (1980).

Results and discussion

NO_3^- supplied non-salinized canola plants had significantly greater dry masses of shoots and roots than NH_4^+ -supplied plants. Addition of NaCl to the growth medium caused more marked reduction in dry masses of shoots and roots in NO_3^- than NH_4^+ supplied canola plants (Tab. 1) in leaves and roots of both NO_3^- and NH_4^+ plants increased similarly with increase in NaCl concentration of the growth medium. NH_4^+ -supplied plants had a treated concentration of Cl^- (Tab. 1, 2) in leaves than NO_3^- supplied plants at 0 and 50 mm NaCl, whereas this difference was masked at the highest NaCl concentration while there was a large difference among NO_3^- and NH_4^+ supplied control plants in root K^+ content, these plants did not differ significant decrease in K^+ content was induced 150 mm NaCl in roots of NH_4^+ supplied plants (Tab. 1, 2). Ca^{2+} concentration in the leaves and roots (Tab. 1) of NH_4^+ supplied plants decreased significantly with increase in external NaCl concentration, whereas those in NO_3^- supplied plants remained unaffected. NH_4^+ supplied plants had significantly lower Ca^{2+} in leaves and roots than of NO_3^- supplied plants at 100 and 150 mm NaCl.

Plants, but there was an overall difference between NO_3^- supplied and NH_4^+ supplied plants in this variable. There was no significant effect of external NaCl on the leaf N content (Tab. 1, 2) of canola plants, and NH_4^+ supplied and NO_3^- supplied plants also did not differ significantly

in this variable. Root N of NH_4^+ supplied plants decreased significantly with increase in external NaCl concentration. And these plants had significantly higher total N in roots than NO_3^- supplied plants under non-saline conditions. NH_4^+ supplied plants as compared with that of NO_3^- supplied plants under non-saline medium may have resulted due the fact that NH_4^+ is mainly absorbed passively like other monovalent cations, whereas NO_3^- absorption is an active and energy requiring process. Ammonium, once absorbed is rapidly assimilated into organic compounds but the assimilation of NO_3^- costs a large number of energy (Salsac *et al.*, 1987). Despite N, other ions determined in the present study also show a considerable interaction with different N- forms of the growth medium. For instance, clearly K, Ca contents in leaves decreased considerably in NH_4^+ supplied plants, whereas these contents remained almost unchanged in NO_3^- supplied plants under NaCl treatments.

These results are in close conformity with earlier studies in which K, Ca and Mg contents in pea and cucumber plants were low when they were fed with only $\text{NH}_4^+\text{-N}$ (Barker and Maynard, 1972; Haynes and Goh, 1978). Whereas P and S content were increased in maize relative to those in plants grown with only $\text{NO}_3^- \text{N}$ (Blair *et al.*, 1970). However, the reduction in cation uptake in NH_4^+ supplied plants can be explained in view of the findings that NH_4^+ inhibits the translocation of cations (Mengel and Kirkby 1987). Cl^- concentration in the leaves or roots of NO_3^- supplied plants were lower than that in NH_4^+ supplied plants under non-saline conditions, and the highest NaCl treatment of the growth medium caused greater accumulation of Cl^- in the roots of NH_4^+ supplied plants than in that of NO_3^- supplied plants. These results can be partly explained in the light of some earlier studies in which a considerable interaction between uptake of Cl^- and NO_3^- ions was noted (Kafkafi *et al.*, 1982; Ashraf and Sultana, 2000).

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