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. ‘SLM$_{046}$’. Eight-day-old plants of 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, ‘SLM$_{046}$’, 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 a 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 NH$_4^+$ : NO$_3^-$ ratio in the nutrient solution modulates the relative uptake of anions and cations (Cox and Reisenauer, 1973). The increase of NH$_4^+$ to 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 uptakertatio by secretion of H$^+$, HCO$_3^-$, or organic anion from root cells also has an effect on the rhizosphere. Adjusting the NO$_3^-$: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. ‘SLM$_{046}$’ 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.
| Parameter | NaCl (mm) | N – NH₄ | N – NO₃ |
|-----------|-----------|---------|---------|
| Na⁺ (gr.kg⁻¹) | 0 | 2.2±0.15 | 5.8±0.37 |
| N (gr.kg⁻¹) | 50 | 64.4±3.6 | 44.8±6.2 |
| K⁺ (gr.kg⁻¹) | 100 | 25.6±2.5 | 17.5±1.1 |
| Cl⁻ (gr.kg⁻¹) | 150 | 7.2±1.9 | 17.6±1.1 |
| Na (gr.kg⁻¹) | LSD(0.05) | 19 | 12 |
| Dry mater (gr.plant⁻¹) | 18 | 22 | 9.8 |

* = 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
Plants were grown in a glasshouse with natural sunlight for 12 to 14 h. The irradiance measured at noon ranged from 750 to 1650 µmol m⁻² s⁻¹. The day/night temperature was 31 ± 6°C and 20 ± 4°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 NO₃⁻ or NH₄⁺ applied as KNO₃ or (NH₄)₂SO₄). pH of the treatment solution was maintained at 6.5. The concentration of K, Ca, and SO₄ 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 died 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 (PPF 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 cochrans (1980).

Results and discussion

NO₃⁻ supplied non-salinized canola plants had significantly greater dry masses of shoots and roots than NH₄⁺-supplied plants. Addition of NaCl to the growth medium caused more marked reduction in dry masses of shoots and roots in NO₃⁻ than NH₄⁺ supplied canola plants (Tab. 1) in leaves and roots of both NO₃⁻ and NH₄⁺ plants increased similarly with increase in NaCl concentration of the growth medium. NH₄⁺-supplied plants had a treated concentration of Cl⁻ (Tab. 1, 2) in leaves than NO₃⁻ 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 NO₃⁻ and NH₄⁺-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 NH₄⁺-supplied plants (Tab. 1, 2). Ca²⁺ concentration in the leaves and roots (Tab. 1) of NH₄⁺-supplied plants decreased significantly with increase in external NaCl concentration, whereas those in NO₃⁻ supplied plants remained unaffected. NH₄⁺ apply plants had significantly lower Ca²⁺ in leaves and roots than of NO₃⁻ supplied plants at 100 and 150 mm NaCl.

Plants, but there was an overall difference between NO₃⁻ supplied and NH₄⁺ 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 NH₄⁺-supplied and NO₃⁻-supplied plants also did not differ significantly in this variable. Root N of NH₄⁺-supplied plants decreased significantly with increase in external NaCl concentration. And these plants had significantly higher total N in roots than NO₃⁻-supplied plants under non-saline conditions. NH₄⁺ supplied plants as compared with that of NO₃⁻ supplied plants under non-saline medium may have resulted due the fact that NH₄⁺ is mainly absorbed passively like other monovalent cations, whereas NO₃⁻ absorption is an active and energy requiring process. Ammonium, once absorbed is rapidly assimilated into organic compounds but the assimilation of NO₃⁻ 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 NH₄⁺-supplied plants, whereas these contents remained almost unchanged in NO₃⁻-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 NH₄⁻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 NO₃⁻ N (Blair et al., 1970). However, the reduction in cation uptake in NH₄⁺-supplied plants can be explained in view of the findings that NH₄⁺ inhibits the translocation of cations (Mengel and Kirkby 1987). Cl⁻ concentration in the leaves or roots of NO₃⁻ supplied plants were lower than that in NH₄⁺-supplied plants under non-saline conditions, and the highest NaCl treatment of the growth medium caused greater accumulation of Cl⁻ in the roots of NH₄⁺-supplied plants than in that of NO₃⁻-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 NO₃⁻ ins was noted (Kafkafi et al., 1982; Ashraf and Sultana, 2000).

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