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Relationship of Biomass Production with Nitrate Assimilation in Canola (*Brassica napus* L.) under Salinity Stress

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ABSTRACT

The influence of salinity on biomass production and the nitrate reductase activity (NRA) was assessed in eight lines/cultivars of canola (*Brassica napus* L.) under greenhouse conditions. Plants were grown in soil and sand (2:1) culture, salinized with NaCl. The salinity levels were 2.4 (control), 4.0, 8.0 and 12.0 dS m^{-1}. Under higher salinity levels, a significant decrease in biomass production was recorded in all the lines. cv Dunkeld was the highest, whereas Cyclon the lowest in both fresh and dry weight at the highest, salinity, level. The other lines tested were found to be intermediate in biomass productivity. Similarly, the NRA decreased significantly with increase in salt concentration in the growth medium. At the highest salinity level, Cyclon, followed by Dunkeld, had higher NRA, although the pattern of decrease in NRA was not consistent in all the lines/cultivars. In conclusion, biomass production had a positive relationship with nitrate reductase activity.

Key Words: Canola; Salinity; Biomass; Nitrate reductase activity

INTRODUCTION

Nitrogen (N), which is 78% of the air, cannot as such be metabolized either by the plants or animals. In fact NO_3^- is the predominant form of N, which is assimilated by plants. It was found that nitrate reductase (NR, EC 1.6:6.1) is the first enzyme in the nitrate assimilation pathway and is a limiting factor of the plant growth and development (Solomonson & Barber, 1990). It was observed that nitrate reductase activity (NRA) was influenced by variety of environmental factors (Crawford, 1995). The adaptation of plants to saline environment, their growth and yield attributes are critically concerned with NO_3^- assimilation (Sagi *et al.*, 1997). Since the reduction of NO_3^- was dependent on its availability, therefore, the rate of reduction of NO_3^- ultimately decreased by salts, i.e. NaCl has inhibitory effect on NO_3^- efflux from vacuoles. Sagi *et al.* (1997) found that in plants under saline conditions, biomass is generally reduced particularly in shoots than roots. It was also found that increase in salinity in the growth medium, increased the N concentration in the shoots, than the plants grown under non-saline conditions that resulted in increased NRA. It is notable that different scientists (Helal *et al.*, 1975; Helal & Mengal, 1979; Aslam *et al.*, 1984) reported controversial results about NO_3^- assimilation and biomass productivity. Therefore, the present investigation was conducted to draw relationship between NO_3^- assimilation and the productivity of biomass in canola lines under salinity stress.

MATERIALS AND METHODS

Eight lines/cultivars of canola (*Brassica napus* L.) were grown under different salinity levels in a net-house under ambient environment conditions. The salinity levels i.e., EC 2.4 (control), 4.0, 8.0 and 12.0 dS m^{-1} were maintained by adding 1.5, 2.34, 4.68 and 7.02 g L^{-1} of NaCl in distilled water to clay pots containing 14 kg soil. Fresh and dry weights of shoots were measured after 35 days of salt treatment.

At maturity, the sample leaves (500 mg) were chopped (4-5 mm slices) in 50 mL test tube containing 5 mL of medium having 0.01 *M* phosphate buffer (pH 7.0) and 0.02 *M* KNO_3. The test tubes were incubated in dark at 32°C for 1 h. The enzyme assay was carried out through nitrite analysis, as the NO_3^- of the medium was converted into NO_2^- by the nitrate reductase.

After 1 h incubation, 1 mL of the medium was mixed with sulphanilamide (10 g L^{-1}) in 3 *M* HCl. Immediately after shaking, 0.5 mL of N-1-naphthyl ethylene diamine dihydrochloride (0.2 g L^{-1}) was added to produce pink dense complex with NO_3^-. After 20 min, the dye solution was diluted with 5 mL of distilled water and centrifuged for 3 min at 2050 x g to remove turbidity, if present. Absorbance was read at 542 nm against a set of standards using spectrophotometer (Hitachi-220).

RESULTS AND DISCUSSION

Analysis of variance of the data shows that the salt treatments had a significant inhibitory effect on both the biomass production and the activity of nitrate reductase for assimilation of NO_3^-.

It was observed that fresh weight of all eight lines decreased at all the salt treatments. Lines also differed significantly. The lines x treatment interaction in all four

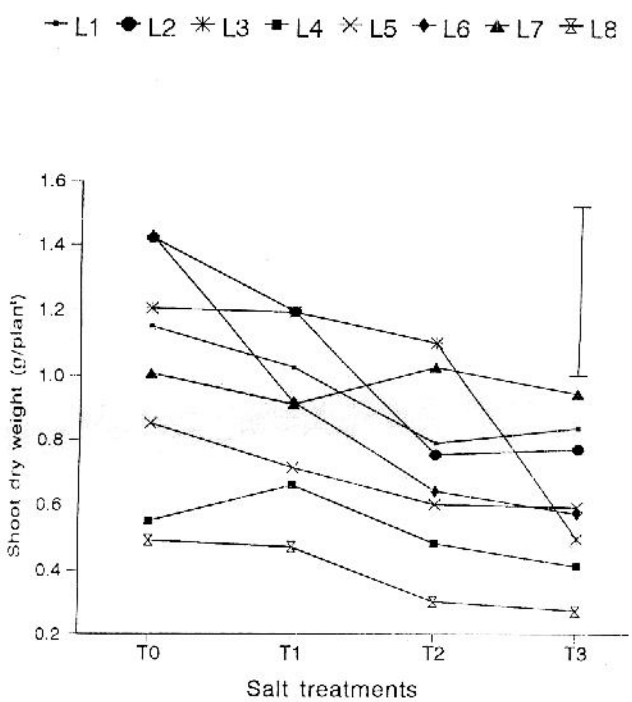
Table I. Effect of different NaCl treatments on nitrate reductase contents (μg g^{-1} fresh leaf tissue per hour) of eight lines of canola (*B. napus*)

Lines	NaCl concentration (dS m^{-1})			
	24 (control)	4.0	8.0	12.0
DGL	90.21 b	44.31 cd	33.07 b	32.06 a
Con-II	78.20 bc	65.44 bc	45.64 ab	39.30 a
Con-III	90.26 b	38.27 d	41.28 ab	33.52 a
Rainbow	143.69 a	140.08 a	59.70 a	38.22 a
Oscar	79.23 bc	60.47 bc	47.18 ab	32.33 a
AC Excel	62.60 c	51.74 bcd	39.24 ab	36.42 a
Dunkeld	82.145 bc	72.33 b	51.06 ab	39.59 a
Cyclon	68.30 bc	63.66 bc	45.77 ab	41.40 a

Means with the same letters in each column do not differ significantly at the 5% level

variables was non-significant showing that the lines also differed in their response to varying salt concentrations. It is evidently clear that cv. Dunkeld was markedly higher in biomass production than all the other lines. However, Cyclon was the lowest in shoot biomass of all the lines (Fig. 1).

Fig. 1. Shoot dry weight of eight lines of canola (*B. napus*) after 40 days of salt (NaCl) treatment.
Key to lines: L1, DGL; L2, Con II; L3, Con III; L4, Rainbow, L5, Oscar; L6, Excel; L7, Dunkeld; L8, Cyclon
Key to salt treatments: T0, 2.4; T1, 4.0; T2, 8.0; T3, 12.0
Bar shows LSD value at 5% level



The dry weight of all the eight lines of canola was adversely affected by increase in salt concentration in the rooting medium. The Cyclon had the lowest (salt sensitive); whereas, Dunkeld the highest (salt tolerant) in biomass production at higher salinity levels. All the other lines/cultivars were found to be intermediate in dry matter production under saline conditions.

Saline medium differentially affected NRA in canola. Increase in the salinity level in the assay medium, decreased NRA at all the salt treatments. In fact, salinity had a similar effect on enzyme activities in all the lines of canola. Nevertheless the pattern of reduction of NO_3^- in stressed leaves was not uniform (Table I).

The salt sensitive line Cyclon followed by salt tolerant Dunkeld had the highest NRA at the higher salinity level, whereas DGL, followed by Oscar and Con-III, were the lowest. All the other lines were intermediate, however, the differences among the lines were not consistent. Similar results have been observed by Aslam *et al.* (1984), Helal and Mengal (1979), but the results are contradictory to Helal *et al.* (1975), Langdale *et al.* (1973) and Sagi *et al.* (1997).

CONCLUSION

Salinity decreased the shoot biomass production and NR activity in all eight lines of canola. NRA was found to be positively correlated with biomass accumulation under salt stress.

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