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REGULAR ARTICLE

EFFECT OF CYCOCEL AND NITROGEN ON CARBONIC ANHYDRASE ACTIVITY AND MUSTARD BIOMASS

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SUMMARY

Addition of 30 mM nitrogen (in the form of NaNO3) inhibited after 80 d the activities of carbonic anhydrase and nitrate and nitrate reductase and net photosynthetic rate in mustard (Brassica juncea L.). However, when nitrogen was applied in association with the foliar spray of cycocel, the inhibition was reversed and the above parameters and also leaf area index and dry mass were enhanced.

Key words: *Brassica juncea*, Dry mass, Leaf area index, Net photosynthetic rate, Nitrate reductase

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1. Introduction

Carbonic anhydrase (CA) is a key enzyme which catalyses the reversible conversion of HCO_3 and CO_2, the predominating carbon molecules. Earlier studies have shown that phytohormones enhance CA activity in plants (Zhang and Cothren, 1990; Wang and Yin, 1995; Hayat *et al*., 2001) and thereby increases CO_2 diffusion around Rubisco. The goal of the present study was to find out the effect of different concentrations of nitrogen applied with or without CCC on carbonic anhydrase (CA) and nitrate reductase (NR) activities, net photosynthetic rate (P_N), leaf area index (LAI) and dry mass of mustard.

Mustard (*Brassica juncea* L. Czern & Coss) cultivar Alankar plants (three per pot) were grown in earthen pots filled with acid washed sand in a glass house under natural conditions. At alternate days in the morning each pot was supplied with 200 cm^3 (from day 30 with 500 cm^3) of Hoagland nutrient solution with various nitrogen concentrations. In addition to this, 250 cm^3 of de-ionized water was added to every pot in the evening as the plants matured. Nitrogen was given in the form of $NaNO_3$ and sodium ion was balanced by NaCl. There were three nitrogen treatments: 10 mM (N_{10} - suboptimal N), 20 mM (N_{20} - sufficient N) and 30 mM (N_{30}-supraoptimal N) with and without spraying with 400 ppm CCC at 60 d after sowing (after flowering stage), every treatment in eight replications. CA, NR, P_N, LAI and dry mass were recorded at 80 d after sowing.

The carbonic anhydrase (CA) activity in leaves was estimated by the Dwivedi and Randhava (1974) method, the nitrate reductase (NR) activity was determined according to Jaworski (1971). Photosynthesis (P_N) in the leaf samples that were later selected for the estimation of CA was measured by LI 6200 portable photosynthesis system (LICOR, Lincoln, USA). Leaf area index (LAI) was calculated as the leaf area covered by unit area of land (Watson 1958). The plants were oven dried and total dry mass was determined. The results were analyzed for variance according to Gomez and Gomez (1984).

CA and NR activities and P_N were found higher at N_{20} than at N_{10}. However, N_{30} inhibited these activities (Table 1). When CCC was applied along with different concentrations of nitrogen, the CA activity increased from suboptimal N_{10} to the supraoptimal N_{30}, and therefore available concentration of inorganic carbon was higher for Ribulose -1,5 bisphosphate carboxylase. Numi (1979) has also reported that CCC increases RuBPCase activity. This resulted in an increase P_N. NR activity, LAI and dry mass showing similar pattern (Table 1).

Table 1. Effect of cycocel [CCC : 400 ppm] and nitrogen (10, 20 and 30 mM $NaNO_3$) on carbonic anhydrase (CA) activity [mol (CO_2) kg^{-1} (f.m.) s^{-1}], nitrate reductase (NR) activity [μmol(No_2) kg^{-1} (f.m.) s^{-1}], net photosynthetic rate (P_N) [mol(CO_2) m^{-2} s^{-1}], leaf area index [LAI] and dry mass [g $plant^{-1}$] of mustard

Treatments	CA activity	NR activity	P_N	LAI	Dry mass
N_{10}	1.98	0.35	13.16	2.66	1.94
N_{20}	2.18	0.49	16.90	4.12	3.10
N_{30}	1.76	0.47	15.82	4.65	4.08
CCC N_{10}	2.26	0.39	15.11	3.10	2.45
CCC N_{20}	2.34	0.55	17.15	4.53	4.05
CCC N_{30}	2.46	0.66	18.20	5.02	6.66
CD at 5%	0.03	0.01	1.24	0.48	0.37

Enhancement of NR activity by CCC in wheat genotypes was reported by Sairam *et al*. (1991). Our work confirmed the results of Everson (1970) that inhibition by supraoptiomal nitrate supply can be reserved if HCO_3 concentration is raised. Cycocel (CCC) at various concentrations of nitrogen increased LAI through altering the cell morphology. The increase in LAI provided larger photosynthetic area and the enhancement in P_N resulted in increased accumulation of dry mass. The correlation coefficients between LAI and dry mass and P_N and dry mass were 0.984* and 0.987*, respectively, showed a dependence of dry mass on both LAI and P_N.

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