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EFFECT OF ETHREL AND NITROGEN ON NITRATE REDUCTASE ACTIVITY, PHOTOSYNTHESIS, BIOMASS AND YIELD OF MUSTARD (*BRASSICA JUNCEA* L. CZERN AND COSS)

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Abstract

The plants of mustard (*Brassica juncea* L. Czern and Coss; cultivar Alankar) were treated with 200 µL/L ethrel (2-chloro ethyl phosphonic acid) at flowering stage (60 d after sowing) along with basal application of nitrogen 40, 60, and 80 kg N ha^{-1}. Effect of ethrel and nitrogen on leaf area index (LAI), net photosynthetic rate (P_N), nitrate reductase (NR) activity and plant dry mass were recorded at 80 and 100 d after sowing. At harvest pods $plant^{-1}$, 1000 seed mass and seed yield were recorded. Ethrel 200 µL/L x 80 kg N ha^{-1} treatment enhanced all the characteristics studied during the experiment.

Key Words: *Brassica juncea*; Leaf Area Index; Dry Mass; Thousand Seed Mass; Number of Pods Per Plant; Seed Yield.

Introduction

Nitrate reductase (NR) is the key enzyme involved in the process of nitrate assimilation in plants. The global rate of nitrate assimilation by plants is roughly about 2 x 10^{13} kg nitrogen per year. This is 100 fold greater than the rate of biological N_2 fixation. Nitrate reductase activity has been suggested as an indicator of nitrogen requirement (Ahmad and Abdin 1999). Exogenous application of ethrel enhanced the photosynthesis and seed yield in mustard (Khan, 1996; Khan 1998; Khan et al 2000; Khan, 2004).

The goal of the present study was to find out the effect of different concentrations of nitrogen applied with or without ethrel on nitrate reductase (NR) activities, leaf area index (LAI), net photosynthetic rate (P_N), plant dry mass, thousand seed mass, number of pods per plant and seed yield. Completely randomized field experiment was conducted on mustard *(Brassica juncea* L. Czern and Coss; cultivar Alankar) during the winter season at the Experimental Farm of Aligarh Muslim University, Aligarh, India. The soil was sandy loam having available N of 210 kg N ha^{-1}. Seeds of the mustard cultivar Alankar were sown in 10 m^2 plot at the rate of at 10 kg ha^{-1}. At seedling establishment, plant spacing of 30 x 15 cm was maintained. Nitrogen was applied as basal doze in the form of urea at 40, 60 (sub optimal) and 80 (optimal) kg N ha^{-1} at the time of sowing. At 60 d after sowing (at flowering stage), ethrel (2-chloroethyl phosphonic acid) at a concentration of 200 µL/L were sprayed at the rate of 600 L ha^{-1} (600 ml/plot) together with 0.5% teepol (a surfactant). A control group of plants was sprayed with an equal amount of deionized water and 0.5% teepol. Each treatment was replicated three times. LAI, NR, P_N and dry mass were recorded at 80 and 100 d after sowing.

The NR activity was determined according to Jaworski (1971), the P_N in plants was measured by the LICOR-6200 portable photosynthesis system (Nebraska, USA). LAI was calculated using graph paper outlining the leaves. The plants were oven dried and total dry mass was determined. At harvest 1000 seed mass, pod number and seed yield were recorded. The results were analyzed for variance according to Gomez and Gomez (1984).

It is evident from the table 1 that nitrogen affected the parameters studied and response was more pronounced with basally applied nitrogen 80 kg N ha^{-1}. Ethrel spray also enhanced all the variables significantly in comparison to untreated plants. In table 1 ethrel with 80 kg N ha^{-1} increased nitrate reductase NR activity, LAI, P_N and dry mass as compared to

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other treatments at all sampling times. Similarly pod number per plant, 1000 seed mass and seed yield were enhanced by ethrel with 80 kg N ha^{-1} as compared to other treatments (table 1). However, at 40 or 60 kg N ha^{-1} the ethrel spray was not effective.

Table 1. Effect of ethrel spray (E ; 200 µL/L) and nitrogen (40, 60 and 80 Kg N ha^{-1}) on nitrate reductase (NR) activity [µ mol (NO_2) kg^{-1} (f. m) s^{-1}], leaf area index (LAI), net photosynthetic rate (P_N) [µ mol (CO_2) m^{-2} s^{-1}], dry mass [g $plant^{-1}$], 1000 seed mass [g], pods $plant^{-1}$ and seed yield [q ha^{-1}] of mustard.

Treatment	NR activity		LAI		P_N		Dry mass		1000 seed mass	Pods plant^{-1}	Seed yield
	80	100	80	100	80	100	80	100	120	120	120
N_{40}	0.39	0.30	2.93	3.14	16.42	14.50	26.70	29.80	4.26	136.98	9.61
N_{60}	0.44	0.41	3.40	3.74	19.20	17.40	28.92	32.72	4.57	144.20	11.01
N_{80}	0.56	0.50	3.88	4.42	21.68	20.15	31.74	35.25	4.55	159.35	12.51
EN_{40}	0.45	0.41	4.06	4.70	22.10	19.60	34.04	36.95	4.50	151.71	11.12
EN_{60}	0.56	0.47	4.56	5.44	25.51	23.64	35.60	40.23	4.60	163.82	13.85
EN_{80}	0.66	0.57	5.24	5.931	28.05	26.05	37.85	42.98	4.65	173.50	15.87
C.D at 5%	0.03	0.18	0.27	0.61	1.21	0.92	1.58	1.94	0.08	2.55	2.17

Nitrate reductase is the key enzyme for nitrogen metabolism as nitrate is the major N source for the plants (Campbell 1999). Enhancement of nitrate reductase activity by growth regulators has been observed by Premabatidevi (1998). However, the effect of ethrel on nitrate reductase activity has not been reported earlier. At higher application of nitrogen 80 kg N ha^{-1}, when crop produced sufficient vegetative growth, the ethrel (200 µL/L) spray has shown remarkable improvement in leaf area and LAI (Khan et al 2000). Higher leaf area results in the interception of more solar radiations so enhance photosynthetic productivity and biomass production. The dry biomass produced is efficiently translocated towards the developing pods resulting in increased seed yield. Seed yield increased by ethrel has also been reported by Joshi et al 1987; Khan, 1996; Khan, 1998 and Khan et al 2000. The correlation coefficients for LAI with dry mass were 0.975*, 0.993* at 80 and 100 DAS respectively. Dry mass accumulated in ethrel treated plants was efficiently translocated to the developing sink, evident from increased 1000 seed mass and pod number. This resulted in increase in seed yield.

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