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BRIEF COMMUNICATION

Photosynthetic rate, growth, and yield of mustard plants sprayed with 28-homobrassinolide

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Abstract

Thirty-day-old plants of mustard (*Brassica juncea* L.) were sprayed with 10^{-10}, 10^{-8}, or 10^{-6} M aqueous solution of 28-homobrassinolide (HBR). The HBR-treated plants were healthier than those treated with water and yielded more. Maximum increase over control was found in 60-d-old, 10^{-8} M-HBR-treated plants in fresh and dry mass per plant, carbonic anhydrase (CA, E.C. 4.2.1.1) activity, and net photosynthetic rate (P_N), at harvest in number of pods per plant and seed yield per plant (the respective values were 25, 30, 34, 69, 24, and 29 %). A further increase in the concentration of HBR (10^{-6} M) did not make any additional impact on the growth and yield. Increased CA activity and P_N were correlated with growth and seed yield.

Additional key words: *Brassica juncea* L.; carbonic anhydrase; dry and fresh mass; net photosynthetic rate; N, P, K contents; pod and seed number; seed mass and yield.

The photosynthetic efficiency of the plant determines its dry matter production on which depends the biological yield (Yoshida 1981). Therefore plant breeders and biotechnologists, while evolving the high yielding cultivars, give due care to the reducing power (photosynthetic efficiency) of the new cultivar, without compromising with the stature of the plant (Bennett *et al.* 1994, Yeo *et al.* 1994). Moreover, the genetic potential, in terms of photosynthesis, of the new cultivars may be exploited further by treating the plants and/or their parts with specific chemicals (Nickell 1982). A number of plant growth regulators have been successfully exploited to enhance growth and yield. There is a new class of hormones (*i.e.*, brassinosteroids) which improves the cell elongation and cell proliferation in meristems (Mandava 1988), the production of watermelon (Wang *et al.* 1994), and seed yield in groundnut (Vardhini and Rao 1998).

28-homobrassinolide (HBR) is one of the brassinosteroids. It has been used to increase the productivity of mustard (Ramraj *et al.* 1997). Here we have used it to study its impact on the activity of carbonic anhydrase and photosynthesis and to correlate them with growth pattern and seed bearing capacity of the plants.

The seeds of *Brassica juncea* L. cv. RH-30 were purchased from National Seed Corporation Ltd., New Delhi, India. The healthy seeds were surface sterilised with 0.1 % mercuric chloride solution and sown in pots (25 cm diameter), lined on its inner surface with polythene sleeves and filled with acid washed sand. These pots were placed in net house in rows. Each pot was supplied with 200 cm^3 full nutrient solution on alternate days, up to day 30. Thereafter, the quantity of nutrient solution was increased to 500 cm^3. De-ionized water (250 cm^3) was also given to each pot, daily. The aqueous solution of HBR, at the concentrations of 10^{-10}, 10^{-8}, and 10^{-6} M, was sprayed on the leaves, 30 d after sowing (DAS). Control plants were sprayed with double distilled water. Each treatment was replicated five times. Fresh and dry masses per plant, concentrations of nitrogen, phosphorus, and potassium, carbonic anhydrase (CA) activity, and net photosynthetic rate (P_N) in the leaves were determined 60 DAS. The yield characteristics were recorded at harvest. The contents of N, P, and K were estimated following the methods of Lindner (1944), Fiske and Subba Row (1925), and flame photometrically (*Associated Instrument Mfr. (I) Pvt.*, Bombay, India),

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Abbreviations: CA - carbonic anhydrase; DAS - days after sowing; HBR - 28-homobrassinolide; P_N - net photosynthetic rate.
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respectively. The procedure of Dwivedi and Randhawa (1974) was used for measuring the activity of CA. P_N in the intact leaves, that were latter on detached for the estimation of CA activity, was measured by *LI-6200* portable photosynthesis system (*LI-COR*, Lincoln, NE, USA). The results were statistically analysed following the method of Gomez and Gomez (1984).

On day 60, the plants sprayed with HBR had significantly higher fresh and dry masses and the leaves were more efficient, in terms of CA and P_N activities, as compared with the control (Table 1). The maximum response was induced by 10^{-8} M HBR where the above parameters increased by 25, 30, 34, and 69 % over the control, respectively. Naturally, these plants produced 24 and 29 % more pods and seeds per plant at harvest. However, no significant changes in concentrations of N, P, and K were recorded in the leaves. An increased concentration of HBR (10^{-6} M) made an impact very much comparable with that of 10^{-8} M.

CA catalyses the reversible interconversion of HCO_3^- and CO_2 in the leaves of higher plants where it represents 1-2 % of total soluble proteins (Okabe *et al.* 1984). Moreover, its distribution pattern is comparable with that of ribulose-1,5-bisphosphate carboxylase/oxygenase (Tsuzuki *et al.* 1985). Both these enzymes are located in stroma, suggesting a direct involvement of CA in CO_2 fixation (Sültemeyer *et al.* 1993). HBR possibly involves transcription and/or translation while elevating the level of CA enhances the rate of carboxylation (Okabe *et al.* 1980). Therefore, higher P_N was recorded in the plants treated with HBR (Table 1) or other brassinosteroids (Braun and Wild 1984). Maximum value of about 69 % higher than that of the control was recorded with 10^{-8} and 10^{-6} M of HBR. The closeness between the CA and P_N was further strengthened by the observed significant correlation (+0.997); similar results were reported by Edwards and Mohamed (1973) in *Phaseolus vulgaris* and by Ohki (1978) in *Glycine max*.

The higher photosynthetic capability generated in the HBR-treated plants of mustard was further reflected in their better vegetative growth and increased dry matter production. Therefore, the availability of the photosynthates in larger quantities during the reproductive phase significantly favoured the pod bearing capacity of these plants. This finally resulted in an increase in the seed yield at harvest (Table 1). The groundnut plants sprayed with the other steroid (24-epibrassinolide) similarly produced more seeds (Vardhini and Rao 1998).

Table 1. Effect of foliar spray of 28-homobrassinolide on growth, mineral contents, CA activity, and net photosynthetic rate (P_N) in the leaves, 60 DAS, and yield of mustard.

Characteristics	Control	28-homobrassinolide [M] 10^{-10}	10^{-8}	10^{-6}	C.D. at 5 %
Fresh mass [g plant^{-1}]	6.32	6.67	7.93	7.98	0.31
Dry mass [g plant^{-1}]	2.31	2.48	3.00	3.04	0.09
N content [%]	3.30	3.35	3.43	3.41	N.S.
P content [%]	0.36	0.38	0.39	0.38	N.S.
K content [%]	4.01	4.05	4.10	4.08	N.S.
CA activity [mol(CO_2) kg^{-1}(leaf f.m.) s^{-1}]	1.78	1.90	2.40	2.48	0.08
P_N [µmol (CO_2) m^{-2} s^{-1}]	15.65	18.38	26.45	27.18	0.93
Pod number [plant^{-1}]	217.95	234.19	270.15	275.42	9.72
Seed number [pod^{-1}]	12.65	12.61	12.58	12.70	N.S.
100 seed mass [mg]	319.45	318.45	323.30	321.50	N.S.
Seed yield [g plant^{-1}]	7.29	8.11	9.37	9.50	0.54

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