

BRIEF COMMUNICATION

Photosynthetic characteristics in *Brassica carinata* hybrids and their parents as influenced by moisture stress

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The response of *Brassica carinata* hybrids and their parents to moisture stress at different growth stages was studied. *B. carinata* 226 was found to be susceptible to stress at pre-flowering and post-flowering stages while *B. carinata* 241 at flowering stage. Neither the changes in stomatal conductance nor in chlorophyll content could fully explain the reduction in net photosynthetic rate (P_N) induced by stress. *B. carinata* 241 had higher leaf water potential (ψ_w) although, it had lower P_N compared to *B. carinata* 226. Both the parents had lower P_N as well as leaf ψ_w . The stress response of P_N in hybrids followed that in their respective female parents.

Additional key words: chlorophyll content, leaf water potential, net photosynthetic rate, stomatal conductance.

Plants tend to adapt to atmospheric and soil droughts by various morphological and biochemical means. An understanding of these adaptations and their genetic regulation is essential for breeding crops for drought resistance. Attempting to identify drought resistant *Brassica* species Katiyar *et al.* (1986) and Malik (1997) observed that *Brassica carinata* has yielded better under rainfed conditions compared to other *Brassica* species. Prakash *et al.* (1984) have synthesized hybrids between *B. carinata* and *B. nigra* or *B. oleracea* but their adaptability to stress is not known. Therefore, the objective of the present investigation is to determine the moisture stress susceptibility in these hybrids in comparison with parents.

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Abbreviations: Chl - chlorophyll; g_s - stomatal conductance; P_N - net photosynthetic rate; ψ_w - leaf water potential.

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The tetraploid hybrids, *B. carinata* 226 (with *B. nigra* cytoplasm) and *B. ca* 241 (with *B. oleracea* cytoplasm), naturally occurring *B. carinata* and the parents were grown in earthen pots with 12 kg air dry soil under the environment. Moisture stress treatment was given at pre-flowering (30 DAS), flowering (60 DAS) and post-flowering (90 DAS) stages withholding irrigation till the leaves showed wilting symptoms. The photosynthetic rate (P_N) and stomatal conductance (g_s) in the upper most expanded leaves was measured by *LI-COR 6200* (Lincoln, USA). Chlorophyll extracted from leaf discs using dimethyl sulfoxide and the absorbance was read by *Bausch and Lomb* spectrophotometer at wavelengths 665 and 649 nm. Total chlorophylls were estimated by using the equations reported by Barnes *et al.* (1970). The water potential (ψ_w) of leaves was measured by *PMS* pressure chamber (Corvallis, USA). All the parameters were determined between 10.00 and 11.00 time on clear sunny days. Plants were watered 4 to 6 after the wilting and recovery leaf ψ_w was recorded.

B. carinata hybrids responded differently to moisture stress. In *B. carinata* 226 reduction in P_N induced by stress was greater at pre-flowering and flowering stages whereas in *B. carinata* 241 at flowering stage (Table 1).

Table 1. Effect of moisture stress treatment at different growth stages on net photosynthetic rate [$\text{mmol m}^{-2} \text{s}^{-1}$] in *Brassica* genotypes.

Genotype	Pre-flowering		Flowering		Post-flowering	
	control	stress	control	stress	control	stress
<i>B. carinata</i> natural	13.69	9.57	13.81	11.95	10.30	11.1
<i>B. carinata</i> 226	18.56	12.89	30.75	26.87	22.13	17.3
<i>B. nigra</i>	14.44	11.39	12.75	10.92	12.13	10.4
<i>B. carinata</i> 241	15.34	11.86	23.06	18.13	15.54	12.8
<i>B. oleracea</i>	11.59	8.72	11.40	8.37	7.09	5.4
CD at $P = 0.05$	G	0.72		0.78		0.6
	T	1.13		1.23		1.0
	G \times T	NS		NS		1.4

Significantly greater reduction in P_N was in *B. oleracea* than in *B. nigra* in three stages. The greater P_N susceptibility in *B. oleracea* to stress was parallel to the decrease in g_s at pre-flowering and flowering stages (Table 2). At post-flowering stage the stress effect on g_s was not significant. The rate of P_N appeared to be more affected by the age. It can be noted that *B. oleracea* flowered later and experienced higher temperature during flowering.

The moisture stress induced reduction of P_N in *B. carinata* natural and 226 at flowering stage was also concomitant with a significant decrease in g_s . In these stages the stomatal components appeared to contribute more to the decreasing P_N response. This response was similar to that of the female parent, *B. nigra*. Similar transmittance responses to hybrids was observed in sorghum (Blum *et al.* 1990) and cotton

1990). In these crops, the female parent which contributed the proplastids, induce the variability in P_N . In *B. carinata* too, progenitor species *B. nigra* (Robblins Vaughan 1983, Palmer 1988) could be the source for such responses to moisture stress.

Besides stomatal component, the differential response of chlorophyll content to moisture stress in the *B. carinata* hybrids and their parents explains some of

Table 2. Effect of moisture stress treatment at different growth stages on stomatal conductance [$\text{cm}^2 \text{s}^{-1}$] in *Brassica* genotypes.

Genotype	Pre-flowering		Flowering		Post-flowering	
	control	stress	control	stress	control	stress
<i>B. carinata</i> natural	5.91	0.96	0.85	0.67	5.92	1.67
<i>B. carinata</i> 226	1.94	0.27	0.79	0.30	1.94	1.58
<i>B. nigra</i>	0.64	0.46	2.35	0.68	0.76	0.46
<i>B. carinata</i> 241	1.26	0.55	2.36	1.68	1.58	0.55
<i>B. oleracea</i>	0.53	0.29	1.58	0.62	0.56	0.53
CD at $P = 0.05$	G	0.17		0.21		0.18
	T	0.11		0.13		0.12
	G \times T	0.24		0.28		0.26

differences in responses of P_N . By the stress at pre-flowering stage chlorophyll content was decreased in *B. carinata* natural whereas in *B. carinata* 226 and 241 was not affected significantly (Table 3). However, moisture stress at flowering stage reduced more the chlorophyll content in *B. carinata* 226 compared to 241. Neither the stomatal response nor chlorophyll ratio independently could explain fully the stress response on P_N particularly in *B. carinata* 241 and its female parent. Moisture stress experiments on chloroplast and leaf ψ_w have suggested that the inhibition of P_N by water stress involved stomatal and chloroplast effects occurring simultaneously (Bourque and Naylor 1971).

Table 3. Effect of moisture stress treatment at different growth stages on total chlorophyll content [Chl [$\text{mg g}^{-1}(\text{d.m.})$]] in *Brassica* genotypes.

Genotype	Pre-flowering		Flowering		Post-flowering	
	control	stress	control	stress	control	stress
<i>B. carinata</i> natural	10.02	8.79	17.01	10.58	7.55	6.78
<i>B. carinata</i> 226	7.49	5.12	18.83	11.78	9.32	8.14
<i>B. nigra</i>	9.56	8.64	12.24	8.52	7.51	4.73
<i>B. carinata</i> 241	8.45	7.53	12.97	10.20	8.91	6.98
<i>B. oleracea</i>	7.89	6.71	8.74	7.06	4.32	2.98
CD at $P = 0.05$	G	0.30		0.55		0.24
	T	0.19		0.35		0.15
	G \times T	0.43		0.78		0.38

The stress response in P_N rate and Chl content were similar in *B. carinata* and 226 as well as in *B. nigra* (Table 1 and 3). On the other hand, no such sir in P_N and Chl content was observed between *B. carinata* 241 and its cytop parent, *B. oleracea*. However, P_N and Chl content were two fold greater in l than in their cytoplasmic parents even under moisture stress. Thus *B. c* hybrids were less susceptible to stress than their respective parents. The of adaptability may be partly due to their ability to maintain high leaf water Stress treatment at pre-flowering and post-flowering stages induced a reduction in leaf ψ_w of the hybrids compared to *B. carinata* natural. Howe flowering stage the ψ_w was largely depressed in *B. carinata* natural. Betwe hybrids, *B. carinata* 241 was affected more at post-flowering stage comp: *B. carinata* 226. The reduction in leaf ψ_w was greater in *B. nigra* at floweri post-flowering stages than that in *B. oleracea* 226 (Table 4).

Table 4. Effect of moisture stress treatment at different growth stages on leaf water poteri [-MPa] in *Brassica* genotypes.

Genotype	Pre-flowering		Flowering			Post-flowering		
	control	stress	recovery	control	stress	recovery	control	stress
<i>B. carinata</i> natural	1.00	1.75	1.07	0.80	2.03	1.35	1.20	2.12
<i>B. carinata</i> 226	0.87	2.03	0.90	0.93	2.10	1.25	1.18	2.20
<i>B. nigra</i>	0.82	2.08	1.25	0.73	2.10	1.52	0.80	1.83
<i>B. carinata</i> 241	0.73	1.72	0.88	0.97	1.93	1.31	0.97	1.90
<i>B. oleracea</i>	0.68	1.68	1.25	0.93	1.88	1.22	1.38	1.78
CD at $P = 0.05$	G		1.13			1.10		
	T		NS			NS		
	G \times T		NS			NS		

The adaptability of hybrids and parents was further tested by recovery in l It was evident that the recovery was higher in hybrids compared to both the p Within the hybrids, the recovery was higher in *B. carinata* 226 at all the stages In conclusion, *B. carinata* 241 maintained higher leaf status, although, it had : P_N than *B. carinata* 226. It was also evident that the stress response in *B. c* hybrids followed their respective female parents.

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Smith, S.E., Read, D.J.: **Mycorrhizal Symbiosis**. Second Edition. - Academic Press, San Diego - New York - Boston - Sydney - Tokyo - Toronto 1997. 605 pp., £ 65.00. ISBN 0-12-652840-3.

The second edition of the reviewed book brings three important changes of emphasis. Firstly, enormous amount of new work based on molecular phylogeny of the fungi, secondly, increased emphasis on the extraradical mycelium which is of key significance in all mycorrhizas, and finally the increased knowledge about the diversity of the structure, org and function of the mycorrhizal fungi.

The structure of both editions of this book is the same, *i.e.* four sections provide info about the main types of mycorrhiza including the vesicular-arbuscular (VA) mycorrhizas, ectomycorrhizas, mycorrhizas in the Ericales and orchid mycorrhizas. These four sections describe the identity of the symbionts, structure and development of the mycorrhizas formed by them as their function and ecological significance. The fifth section is then devoted to general themes.

The first section consists of five chapters that describe the symbionts forming VA mycorrhizas, the colonisation of roots and anatomy of VA mycorrhizas, the genetic, cellular and molecular interactions in the establishment of VA mycorrhizas, growth and carbon economy of VA mycorrhizal plants and mineral nutrition, heavy metal accumulation and water relations of mycorrhizal plants. Also the second section consists of five chapters dealing with the structure and development of ectomycorrhizal roots, the growth and carbon economy, nitrogen and phosphorus nutrition of ectomycorrhizal plants. The fifth chapter describes the ectomycorrhizas which include arbutoid mycorrhizal roots some of the structural characteristics of both ectomycorrhizas and endomycorrhizas. Two chapters of the third section describe the structure and development of arbutoid and monotropoid mycorrhizas and the anatomy, the colonisation processes and functional aspects of ericoid mycorrhizas. The chapter "Orchid mycorrhizas" of the fourth section describes the isolation, nutritional characteristics, mycorrhizal colonisation, the mechanism of the transfer of nutrients from fungus to plants, plant-fungus interactions, and the specificity and ecology of orchid mycorrhizas. This chapter has shown how a combination of conventional and molecular methods have the potential to unravel some of the complexities of plant-fungus interactions at both physiological and taxonomic levels and provide data relevant to ecological situations. The last section consists of five chapters is devoted to general themes in which ideas and information essential for understanding had been integrated. Here the uptake, translocation and transfer of nutrients in mycorrhizal symbioses is described, as well as the roles of mycorrhizas in ecosystems, mycorrhizas in agriculture and horticulture and the problem of mycorrhizas in forest environments, *i.e.* forest production, interactions with other micro-organisms and pollutants.

The nutrient transfer between the symbionts in all mycorrhizal types, the role of mycorrhizas in ecosystems, the applications of mycorrhizas in agriculture, horticulture and in forestry are discussed. The book is well illustrated with figures and electron micrographs. The book can be recommended to mycologists, plant physiologists and researchers interested in plant and fungal biology.

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