SOURCE SINK MANIPULATION AND ITS IMPLICATIONS ON BIOMASS PRODUCTIVITY IN BRASSICA

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Abstract

The study involved a quantitative evaluation of sink capacity and demand on assimilate supply in Brassica juncea c.v. RLM 198 and B.napus cv Zellinsky. Complete defoliation during early stages of flower initiation reduced flower number, plant height, branch number, seed size and seed yield but it had no significant effect if defoliation is done at late flowering phase. Deflowering experiments demonstrated the capacity of Brassica plants to compensate for flower loss during initial stages of flowering. Continuous deflowering up to 21 days, and off side shorts led to significant increase in protein and Oil content. This was more apparent in B.juncea. Defoliation and pod shading experiments clearly demonstrated that whereas pod number was influenced by the assimilate supply of leaves, seed development within the pods was influenced by the assimilate production within pods themselves.

Introduction

The attempts at yield optimisation through genetic or cultural modification of plant canopy can succeed only if the features of plant that contribute to yield efficiency are recognised. The total dry matter production is in fact a function of the size of absorbing system, activity of this system and time during which this system functions /Stoy, 1974/. The availability and demand of assimilate varies with time and proximity of sink to source. Prior to anthesis leaves have maximum contribution of assimilates required for developing roots, stems and inflores-

cence. After anthesis, however, green pods provide a major source of assimilates towards total dry matter production /Allen and Morgan, 1972/. A number of workers have demonstrated the significance of pods /Major and Charnetski, 1976; Brar and Thies, 1977; Evans, 1984/ and leaves /Thurling, 1974; Brar and Thies, 1977; Major, 1977;Clarke, 1978/ to seed development in Brassica species. The peak flowering season of Brassica juncea and B.napus in North India is fronted with frost and insect damage, which results in yield losses. The present study was conducted to estimate the compensatory ability of these species by source sink manipulations as a consequence of various defoliation, deflowering and pod shading experiments.

Materials and methods

Two species of Brassica i.e. B.juncea cv RLM 198 and B.napus cv Zellinsky were sown in single plant randomisation with three replications. Each replication consisted of 10 rows 0.5 m long and spaced 30 cm apart. Both the species were grown separately.

Plant to plant distance was kept at 15 cm. Normal cultural practices were followed throughout the growing season. Three different experiments were executed.

/A/ DEFOLIATION: Complete defoliation of fifteen plants per plot was carried out - 7, 0, 7, 14 and 21 days before/ after the onset of flowering. Normal plants without any defoliation formed the control.

/B/ DEFLOWERING: Deflowering was done on fifteen random plants per plot at the onset of flowering. The treatments involved: /i/ complete deflowering for 7 days, /ii/ complete deflowering for 14 days, /iii/ complete deflowering for 21 days , /iv/ complete deflowering of main shoot /v/ complete deflowering of side shoots and /vi/ control /no deflowering/.

/C/ POD SHADING: This treatment involved loose wrapping of fifty random pods on five random plants of each species with aluminium foil/carbon paper. The pods were harvested at maturity and analysed for seed size, number of aborted

seeds, protein and oil. At maturity ten plants were sampled from each plot in defoliation and deflowering experiments for yield component analysis.

Results and discussion

Defoliation up to 14 days of anthesis led to reduced number of flowers per plant, plant height, branch number, seeds per pod, seed size, seed yield, oil and protein /Table 1/. Defoliation influenced both the flower initiation and blooming period. In general, leaf removal before anthesis /-7 days/ and at anthesis had the most detrimental effect on all the traits studied. Reducing the size of leaf canopy during the vegetative phase of growth limits the amount of assimilates available for developing stem and root and the assimilates stored in these organs have an important role in determining the yield potential of oilseed rape /Evans, 1984/. The absence of significant effect of defoliation treatment 21 days after anthesis can be attributed to enhanced photosynthetic rates of other plant parts, especially the pods, to compensate for leaf removal as suggested by Buttrose and May /1959/.

Deflowering resulted in greater vegetative growth and delayed senescence /Table 2/. Yield restriction was significant if deflowering was continued beyond seven days in B.juncea , while it decreased if it was continued beyond 14 days in B.napus. Reduction in protein and oil was to lesser extent. It is evident that both the species have ability to compensate for flower loss during initial stages of flowering only. This was mainly attributed to profuse side short development subsequent to deflowering /Table 2/.

The seeds /dominant sink/ exercise a controlling influence on assimilate management of source. The competition for assimilates in indeterminate crops results in reduced assimilate supply to the organs of low competing power. Thus, if dominant sink is removed, the photosynthates are more readily available to other organs, as was evident from greater side shoot development after deflowering in

the present study. Shading experiments in this study demonstrated that seed size, seed number, protein and oil percentages were greatly influenced by the assimilate production in pods /Table 3/. The defoliation experiments described earlier also demonstrated that leaves are of lesser significance as the suppliers of photosynthates to the developing seed. Similar results have also been reported in B.campestris /Thurling, 1974/. Shaded pods had a very high proportion of aborted seeds which is a clear indication of restricted assimilate supply. This was more pronounced in B.napus where broader and long pods provide greater area for photosynthesis.

The present study has demonstrated the importance of optimising the cultural conditions to maintain effective plant canopy prior to anthesis. In view of limited flower compensatory ability, there is a need to breed for genotypes having greater flower compensatory ability as a buffer against variable moisture, insect and frost damage.

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Effect of complete defoliation on yield components in Brassica

Character	Species	Defoliation days before/after anthesis					Control
		-7	0	+7	+14	+21	
Flower number	1	90.0a	105.5a	117.0a	187.5b	287.0c	310.0c
	2	141.5a	100.5a	198.5a	340.0b	456.0c	502.0c
Plant height (cm)	1	128.5a	124.2a	131.3b	139.9c	140.4c	142.6c
	2	143.7a	130.8b	141.7b	157.6c	175.7a	179.2d
Primary branches	1	4.1a	5.7ab	6.4b	7.7bc	8.8c	9.1c
	2	6.7ab	6.0b	8.6b	9.9b	13.9c	15.4c
Secondary branches	1	6.1a	6.6b	7.0b	6.9b	7.8c	7.8c
	2	7.5a	6.9a	8.1a	8.3a	11.6b	11.7b
Seeds/pod	1	8.2a	7.7a	8.6a	10.1b	12.9c	13.1c
	2	10.8a	7.8b	9.9a	13.5c	15.4cd	16.2d
Seed size (gm) (1000 seed weight)	1	2.0a	2.3b	2.5b	2.5b	2.8c	2.9c
	2	3.3a	3.1a	3.2a	3.8b	3.8b	3.8b
Seed yield/plant (gm)	1	8.2a	9.0a	9.6a	11.9b	13.2bc	13.8c
	2	15.0a	16.7a	16.5a	16.8a	20.6c	21.6c
Protein (%)	1	19.3a	20.0a	22.9b	22.0b	23.6b	23.4b
	2	21.8a	22.9b	23.6bc	23.7bc	24.5c	25.8d
Oil (%)	1	26.1 a	32.8b	33.5b	36.6c	38.0c	38.1c
	2	36.7a	38.8a	36.9b	38.3b	42.9c	43.6c

1 = B. juncea; 2 = B. napus

a-d Means within rows followed by same letter do not differ significantly according to Duncan's Multiple range test (P = 0.05)

Table 2. Effect of deflowering on plant yield components in Brassica

Character	Species	Duration of deflowering after anthesis 7	14	21	Complete de-flowering main shoot	Complete de-flowering side shoots	Control
No. of flowers (after deflowering)	1	335a	305a	332b	316a	123c	328a
	2	514a	492a	475b	467b	202c	502a
Plant height (cm)	1	148.0a	158.7b	164.7c	145.9a	152.2b	142.6a
	2	174.7a	183.7b	187.9d	179.3c	190.2d	168.5a
Primary branches	1	9.1a	11.7b	11.8b	9.7c	10.4ab	8.1a
	2	17.2a	19.7b	22.1c	16.3d	18.0ac	15.8d
Secondary branches	1	7.9a	9.7a	22.8b	12.0a	9.8a	7.8a
	2	11.9a	14.8a	21.0b	12.3a	12.2a	11.6a
Seeds/pod	1	13.0a	13.2a	11.5b	10.6b	11.0b	13.1a
	2	16.3a	15.8a	15.8a	15.0b	15.9a	16.2a
Seed size (gm) (1000 seed weight)	1	2.9a	3.1ab	3.2b	2.8ac	3.2b	2.8a
	2	4.0a	4.2b	4.3b	3.9ad	4.0a	3.8d
Yield (gm)	1	11.6a	10.9a	7.2ab	5.6ab	2.0c	12.2a
	2	17.5a	16.7a	8.8a	8.5a	6b	16.9a
Maturity	1	144.0a	153.6ab	159.0b	142.8a	1[illegible].6b	138.0a
	2	174.2a	185.4a	198.0b	178.0a	177.5a	166.0a
Protein (%)	1	22.5a	26.3b	25.9b	23.9a	26.1b	23.4a
	2	24.0a	23.6a	28.7b	26.5b	28.9b	24.3a
Oil (%)	1	38.8a	39.8a	42.9b	38.7a	42.6b	38.2a
	2	40.7a	41.7a	43.7b	41.8a	45.5b	42.0a

1 = B.juncea; 2 = B.napus

a-d - Means within row followed by same letter do not differ significantly according to Duncon's multiple range test /P=0.05/

Table 3. Effect of pod shading on seed components of Brassica

Character	Species	Pod shading by		Control
		Aluminimum foil	Black carbon paper	
Seed size (g) (500 seed wt)	1	0.9 ± 1.13	1.1 ± 0.68	2.8 ± 0.16
	2	1.3 ± 0.68	1.5 ± 0.92	3.8 ± 0.03
Aborted seeds per pod	1	6.7 ± 0.93	4.9 ± 1.17	0.9 ± 0.02
	2	9.3 ± 0.56	8.7 ± 0.26	2.1 ± 0.13
Protein (%)	1	13.2 ± 2.31	18.4 ± 0.93	23.2 ± 0.54
	2	15.4 ± 1.02	20.5 ± 0.72	25.9 ± 0.31
Oil (%)	1	21.8 ± 2.45	29.5 ± 0.47	37.9 ± 0.90
	2	20.6 ± 1.68	27.8 ± 1.25	43.8 ± 0.32

1 = Brassica juncea; 2 = B. napus