Branch removals and their effects on pod and seed yields in oilseed rape (*Brassica napus L.*)

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Introduction

A close scrutiny of the basic phenology of oilseed rape indicates that the growth of the main stem and lateral branches and of their stems, flowers, pods and seeds overlap significantly (Morgan, 1986). It is clear, therefore, that there must be an intense competition between these organs for the supply of assimilates and more especially within the 2-3 weeks after anthesis. Under normal conditions of growth and development, the branches that develop in the later stages of flowering contribute very little to the final seed yield of this crop. The question, then arises whether the removal of the relatively less productive, lower positioned branches would help the development of more productive terminal inflorescence and other apically positioned and developmentally advanced branches by making more carbon assimilates available for their growth.

Experimental

Plants of spring variety Maris Haplona were grown in pots under unheated glasshouse conditions and were allocated at random to different branch removal treatments. The treatments imposed were (i) all axillaries removed, (ii) all but the uppermost two axillaries removed, (iii) all but the uppermost four axillaries removed and (iv) no axillaries removed. These treatments were carried out with as little damage as possible to the leaves at different nodes. In order to evaluate the effect of time of removal, the treatments were carried out at anthesis, one, two, and three weeks thereafter. Radiographic techniques were used to follow the development of pods at specific positions in the terminal inflorescence during crop growth (*in vivo*) and at maturity (*in vitro*).

At the time of first flower opening on the terminal inflorescence, the growth and development of branches are less advanced and this is increasingly so down the stem. Because of this, there was an 8-10 day interval between the opening of first flower on the terminal inflorescence and that on the axillary at node 5. Flowering on branches at nodes 6 and 7, if any, occurs even later. Throughout this period of flowering, the rates of stem elongation in the lower axillaries increases, thus resulting in greater competition for assimilates. The flowers and pods formed in the later stages of flowering do not contribute to the final seed yield (Table 1). It is also apparent that the weight of seed yield per unit dry weight of axillary decreases with the increasing depth in the canopy.

Results

When all but the four upper most axillaries were removed, there was a significant increase in pod and seed weights per plant. However, the increase was observed only when the treatment was carried out at anthesis and one week thereafter (Figs. 1 & 2).

Pod and seed yields per plant in oilseed rape can be broken down to various components listed in the diagram below:

Pod weight per plant → Pod number
Pod weight per plant → Weight per pod → Husk weight per pod
Weight per pod → Seed weight per pod → Seed number per pod
Seed weight per pod → Weight per seed

Seed weight per plant → Seed number per plant → Seed number per pod
Seed number per plant → Pod number per plant
Seed weight per plant → Weight per seed

The increased pod and seed yields per plant following the removal of branches below the 4th node at anthesis and one week thereafter occured because of increases in pod and seed numbers and seed weight per pod e.g. these were increased by 6, 22 and 16.7% respectively on a per plant basis after the branch removal at anthesis (Table 2). Weight per pod and weight per seed were, however, not affected significantly. Notwithstanding this, however, *in vitro* radiographs at maturity showed that similarly positioned pods in the basal and middle regions of inflorescences developed more strongly on the treated plants. A study of pod and seed characters on the different inflorescences showed that the improvements in pod and seed numbers as well as in seed weight per pod were distributed through all the inflorescences but the increases in seed weight per pod, seed number per pod and surface area per pod were greater in the terminal inflorescence and axillaries 2 and 3 (Table 3).

When branch removals were delayed until 2 or 3 weeks after anthesis, most pod and seed yield components were reduced and pod and seed numbers were significantly smaller. Pod and seed yields were also reduced significantly on a per plant basis.

Discussion

The results of this investigation showed that the removal of lower positioned and relatively unproductive branches below node 4 in single plants of spring rape at anthesis and one week after anthesis led to stronger development of the remaining inflorescences and to increased pod and seed yields per plant. This effect is probably achieved by making more carbon assimilates available to the upper inflorescences at times when important yield components (pod and seed numbers) are being determined on them (Tayo and Morgan, 1975).

Similar removal treatments performed two and three weeks after anthesis did not increase pod and seedyields and in fact, often reduced them. This is probably because pod and seed numbers had been largely determined by then in the upper inflorescences (Morgan et al. 1983) and the improvement in the supply of carbon assimilates to these inflorescences following branch removal is less than earlier because of the greater senescence of the leaves.

Conclusions

The above results are of clear practical significance to plant breeders and agronomists insofar as they demonstrate that the basally positioned inflorescences are a drain on the assimilate resources of the plant when the rates of pod and seed production on the terminal raceme and upper axillaries are very high. In the light of this, it would seem sensible to select genotypes in which there is little development of the basally positioned branches after anthesis and ones in which there are high rates of pod and seed set on the terminal inflorescence and upper axillaries. The evaluation of the effects of growth inhibitors to reduce the growth of unproductive basal axillaries is also desirable. The shift of all pod and seed bearing branches to the top of the oilseed rape could also bring about yield benefits because these are better positioned to intercept the incoming radiation and higher rates of photosynthesis in the pods, stems and leaves might be reasonably expected.

It should, however, be emphasised that the above results and conclusions are applicable to the plants of spring rape cultivar Maris Haplona grown in greenhouse conditions. In order to apply them on a wider scale, further work is necessary to test them under field conditions and for winter rape as well.

REFERENCES

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Table 1: Partitioning of dry matter and seed yield in different inflorescences at maturity in oilseed rape (Cultivar Maris Haplona)

Inflorescence	Dry weight (g)	Weight of seed (g)	Weight of seed per unit dry wt. (g)	Length of raceme (cm)
Terminal	6.92	2.59	0.37	84.0
Axillary 1	3.16	1.33	0.36	38.2
Axillary 2	3.77	1.32	0.35	46.1
Axillary 3	4.34	1.51	0.35	52.8
Axillary 4	4.55	1.36	0.30	57.7
Axillary 5	3.36	0.89	0.26	60.1
Axillary 6	1.99	0.46	0.23	47.2
Axillary 7	0.76	0.06	0.08	32.1

Table 2: Effects of branch removal treatments (a: No axillaries removed; b: all axillaries removed; c: all but the uppermost two axillaries removed; d: all but the uppermost 4 axillaries removed) on the pod and seed yield components of oilseed rape (per plant basis).

Treatments		Pod no.	Weight per pod (mg)	Seed no.	Weight per seed (mg)	Seed no. per pod	Seed Weight per pod(mg)
	a	262.3	72.4	3014.8	3.1	11.5	35.3
A	b	97.7	139.4	1227.3	5.0	12.6	62.8
(anthe-	c	197.5	98.6	2548.7	3.7	12.1	47.7
sis)	d	280.0	80.9	3677.7	3.1	13.1	41.2
	a	264.8	72.4	2965.5	3.1	11.2	35.0
A+1	b	89.2	131.0	1128.0	4.9	12.7	61.4
week	c	174.5	87.8	2191.3	3.5	12.6	43.7
	d	270.2	80.8	3386.3	3.2	12.5	40.2
	a	264.5	73.3	2973.0	3.2	11.2	35.5
A+2	b	82.8	127.2	1044.5	4.9	12.6	61.7
weeks	c	158.8	91.0	2012.7	3.6	12.7	45.3
	d	228.7	78.9	2787.7	3.2	12.2	39.9
	a	262.2	73.8	2950.5	3.2	11.3	35.9
A+3	b	64.8	104.2	705.3	4.8	10.8	52.2
weeks	c	133.0	89.5	1605.3	3.7	12.0	45.0
	d	216.7	80.0	2567.5	3.4	11.9	40.0
L.S.D.(5%)		12.22	7.80	212.82	0.25	0.92	4.10

Table 3: Compensatory gain in pod and seed yield components of different inflorescences due to removal of all but the four uppermost axillaries at anthesis (T). [C: Control (No axillaries removed)]

Parameter	Terminal		Axillary 1		Axillary 2		Axillary 3		Axillary 4	
	C	T	C	T	C	T	C	T	C	T
Pod weight	5.4	6.9	2.3	3.0	2.7	4.1	3.0	4.8	2.7	3.8
Pod number	64.7	75.5	33.5	39.7	37.5	53.2	42.2	60.5	34.8	51.2
Weight per pod (mg)	82.8	92.0	70.0	75.7	72.4	78.1	71.0	79.2	77.7	74.0
Seed weight	2.6	3.4	1.1	1.5	1.3	2.1	1.5	2.4	1.4	2.0
Seed number	781.2	1051.3	376.8	497.2	441.5	705.5	499.7	782.8	417.7	640.8
Weight per seed (mg)	3.3	3.3	3.0	3.1	3.0	3.0	3.0	3.1	3.2	3.1
Seed number per pod	12.1	13.9	11.4	12.6	11.8	13.3	11.9	13.1	12.0	12.5
Seed weight per pod(mg)	40.0	45.3	33.8	39.1	35.4	40.5	36.0	40.8	38.8	38.3

Fig.1: Effect of branch removals on pod yield in oilseed rape

Time of removal	Treatments
Anthesis (A)	No axillaries removed (a)
One week after anthesis (A+1)	All axillaries removed (b)
Two weeks after anthesis (A+2)	All but the uppermost 2 axillaries removed (c)
Three weeks after anthesis (A+3)	All but the uppermost 4 axillaries removed (d)

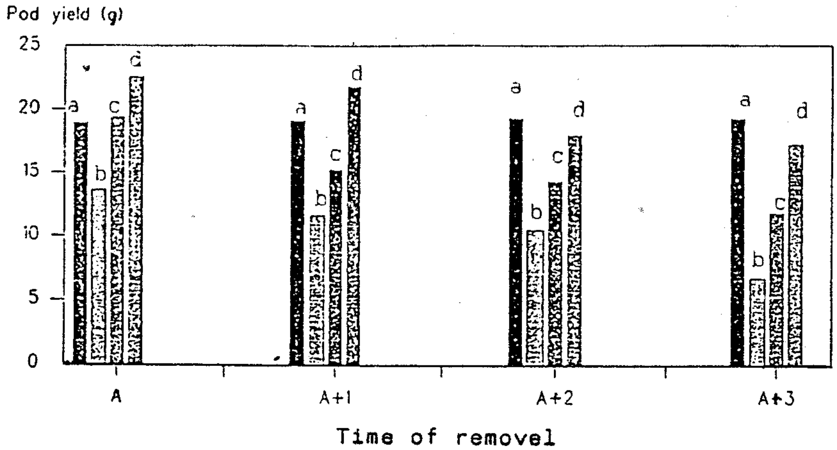

Fig.2: Effect of branch removals on seed yield in oilseed rape