The influence of chemicals with anti-gibberellin activity on growth, development and yield of oilseed rape (B. napus L.)

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Oilseed rape trials carried out at Wye College over 5 seasons have identified several defects. The tall crop (130 cm+), is often tangled and uneven in its maturity. It usually bears the majority of its yield in the top 50 cm of the canopy which predisposes it to lodging during pod development. The stem is also a powerful sink which develops in competition with the reproductive parts.

Anti-gibberellin chemicals could theoretically reduce some of these problems. Changes in canopy structure may help to increase the present UK average yields (3 t/ha) towards the 7.5-8.5 t/ha potential proposed by Daniels et al. (1982).

Because it was difficult to economically justify specialist PGR research solely for oilseed rape, preliminary trials assessed the value of two chemicals with known anti-gibberellin activity in other crops. In trials using Chlormequat (CCC) (Table 1) no significant effects on seed yield have been demonstrated (Scarisbrick, Daniels and Noor Rawi, 1982). Terpal (Mepiquat chloride + ethephon) increased yield (NS) by approximately 10% in 2 seasons and consistently reduced plant height (Table 2) (Chapman, Scarisbrick and Daniels, 1983).

The most dramatic effects have recently been achieved using the chemically related compounds, coded PP333 and R201, from ICI. A significant reduction in plant height occurred at all times of application. It was also consistently reduced by increased concentration (Table 3). Seed yield was reduced at T2 and T3 largely due to a lower number of seeds/pod and thousand seed weight (maximum of 16 and 10% respectively). This probably occurred because the upper leaves and siliquas of the dwarfed canopies proved to be more susceptible to Alternaria brassicae. This must have reduced pod photosynthesis. R201 did not significantly affect the number of fertile branches, but the number of unproductive branches was increased. For this reason, the interaction between this PGR and plant density is currently under investigation.

A tall uniculm plant was also produced by removing all primary branches (-BR) on 4 metre squares of field grown Rafal. Other treatments carried out between 20-22 April 1982 included removal of the terminal raceme (-TR) and all but 5 primary branches (5BR). Decapitation stimulated axillary branching but in treatment 5BR only 2.91 branches per plant survived until final harvest. Surprisingly, seed yield/m^2 was not significantly affected, although the combination of yield components through which it was achieved differed markedly. -BR plants achieved a similar seed yield with 19.7 fewer plants/m^2. Numbers of pods per plant were reduced by 40 and 24% in -BR and 5BR respectively. This was compensated in the former by a 114% increase in number of seeds per pod (+9.43) and a 17% increase in 1000 seed weight. Plants in treatment -BR achieved a mean height of 182 cm (Table 4).

In a further attempt to artificially manipulate canopy structure primary branches were removed (between 11-13 May 1982) from all plants in 4 one metre square plot areas treated with R201 at 500 g ai/ha (Table 5). As in the main experiment (Table 3) seed yields were depressed by chemical applications during March. However a 39% yield advantage and a 10 cm reduction in plant height were achieved in the absence of branches in treatment T1 mainly due to an increased number of seeds per pod and seed size.

These data demonstrate that untreated plants usually produce an excess of pods which function below their full potential reproductive capacity (Table 4). However, all attempts to improve both pod and overall canopy efficiency using anti-gibberellin chemicals have not as yet been successful. Whilst it has proved possible to dramatically reduce plant stature and alter canopy structure, the extreme plasticity of the oilseed rape plant and crop hygiene problems have generally offset possible advantages resulting from these changes in plant morphology.

The manipulation experiment yield component data are particularly stimulating for they clearly demonstrate that there is little correlation between branching and crop yield. For example seed yields were similar in the presence of 4.0, 5.5 and zero primary branches (Table 4), although in the absence of a growth regulator the uniculm plant became extremely tall (182 cm). It is feasible that this type of plant may perform better at higher plant densities. This idea is supported by data in Table 5 where the highest seed yield was achieved from R201 uniculm plants (96.8 plants/m^2) which were 10 cm shorter than the controls (96.4 plants/m^2). The increase resulted largely from increased number of seeds/pod and seed weight because pods were better positioned for light interception. Light was also able to penetrate to a greater depth in the canopy.

These experiments suggest that plant breeders should attempt to reduce the rapeseed plants natural propensity to form primary and secondary branches. The crop clearly has sufficient plasticity in its yield components to compensate for their loss and other studies have shown that a high percentage of pods on the lowermost branches abort during seed development (Daniels and Scarisbrick, 1983). There is clearly much scope for further complementary studies by plant breeders and crop physiologists using PGR's to identify the ideal canopy structure for the rape crop.

References

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Table 1

The influence of CCC on combine seed yield (t/ha) of winter oilseed rape cv. Rafal

Season	Date applied	Control	kg ai/ha 1	2	4	8	SE
1979/80	10/4/80	3.44	3.48	-	3.44	3.35	0.11
1980/81	28/2/81	1.80	1.63	-	1.64	1.78	0.11
	5/4/81		1.52	-	1.74	1.53	
1981/82	6/11/81	3.94	4.28	4.55	4.51	3.99	0.26
	6/11/81 + 24/3/82	3·67	4·28	4·22	4·12	4·08	

Table 2

The influence of Terpal on combine seed yield (t/ha) of winter oilseed rape cv. Jet Neuf

Rate of application ℓ product/ha	1979/80	1980/81	1981/82
Untreated	2.37 (114)	1.67 (160)	3.39 (157)
2.5	-	1.77 (153)	3.45 (146)
3.0	2.34 (106)	-	-
4.0	2.54 (107)	-	-
5.0	2.61 (100)	1.63 (149)	3.38 (145)
7.5	-	1.67 (142)	3.53 (140)
10.0	-	1.46 (137)	3.48 (135)
LSD 5%	0.405	0.377	0.416
Significance	NS	NS	NS

[Plant height (cm) in parentheses]

Table 3

The influence of R201 on final combine seed yield of winter oilseed rape cv. Rafal (t/ha)

Rate of application g ai/ha	Date of application 5/11/81 T1	7/3/82 T2	23/3/82 T3	14/4/82 T4
Untreated	5.10 (134)	5.10 (135)	5.06 (134)	5.25 (134)
250	5.29 (133)	4.38 (89)	4.21 (101)	5.08 (127)
500	4.96 (125)	3.65 (78)	3.87 (91)	5.06 (122)
750	4.79 (121)	3.48 (72)	3.98 (80)	5.34 (120)

SED ± 0.406 CV% 12.3

[Final plant height (cm) in parentheses]

Table 4

The influence of crop manipulaiton on seed yield and its components (cv. Rafal)

	Control	-TR	5BR	-BR	SED	CV%	Sig.
Seed wt. g/m^2	426	416	351	419	55.6	16.9	NS
Plant pop./m^2	67.7	58.8	62.7	48.0	9.07	18.7	NS
*Branch No./plant	4.03	5.47	2.97	-	0.28	8.3	**
*Pod No./plant	146.4	143.3	111.3	88.5	12.02	12.0	*
*Seed No./pod	8.24	10.29	10.24	17.67	1.739	18.3	**
TSW (g)	5.261	4.824	4.939	6.164	0.417	9.7	NS
Plant height (cm)	136.0	95.2	132.4	182.1	4.73	3.9	***

TSW = Thousand seed weight * 10 plant sample

Table 5

The influence of R201 applied at 500 g ai/ha and branch removal on seed yield and its components, cv. Rafal

	Date of application of chemical						
	1981	1982					
	5/11 T1	7/3 T2	23/3 T3	14/4 T4	Control	SED	Sig.
Seed wt. g/m^2	552	274	268	338	396	59.9	**
Plant pop./m^2	96.8	77.4	77.4	79.0	96.4	6.88	*
*Pod No./plant	56.5	55.0	52.5	58.0	54.0	2.73	NS
*Seed No./pod	19.97	12.84	13.78	13.10	17.65	1.55	**
TSW (g)	5.04	5.10	4.73	5.53	4.22	0.32	*
Plant ht. (cm)	129.5	85.2	89.9	121.1	139.4	2.49	***

TSW = Thousand seed weight * 10 plant sample