AN ANALYSIS OF FACTORS AFFECTING YIELD OF WINTER OILSEED RAPE

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INTRODUCTION

To improve our understanding of those factors affecting yield and the incidence of pests and diseases, a range of agronomic inputs were compared in a five-year series of multifactorial experiments designed to assess main effects and interactions. This paper analyses the effects of sowing date, seed rate, spring nitrogen rate and timing, and applications of insecticides, fungicides and growth regulators on combine harvest yields from the single-low (low erucic acid, high glucosinolate) cultivar Bienvenu and the double-low (low erucic acid, low glucosinolate) cultivar Ariana.

MATERIALS AND METHODS

All experiments were sown on Rothamsted Experimental Station Farm, Hertfordshire, U.K., and followed winter barley. After burning the straw, the land was cultivated shallowly, 50 kg N ha^{-1} (as 'Nitram') applied to the seed bed, and seed sown at 8 kg ha^{-1} in rows 17 cm apart (except in 1988-9 when some plots were sown at 4 kg ha^{-1}). In four experiments, seven factors were tested in factorial combinations (2^7) in a half replicate design of 64 plots; in the final experiment (1988-9) only six factors were tested in a complete replicate (Table 1). The two cultivars were compared in two seasons but grown exclusively in the remainder (Table 1). Plots were 3 x 17 or 3 x 21 m. Insecticides and fungicides were applied regardless of pest and disease incidence.

RESULTS

Sowing date

Although Bienvenu consistently yielded more (0.05-0.65 t ha^{-1}) when sown in early September rather than in mid-August, the response was statistically significant in 1984-5 only (Table 2). In that year attack by *Psylliodes chrysocephala* (the cabbage stem flea beetle) larvae was severe (means of 6.2/plant on early-sown, 0.4/plant on late-sown) resulting in plant losses overwinter, particularly when sown early (31% early-sown vs 17% late-sown). Analysis of yield components showed that the later sowing had more fertile pods per unit area than the early sowing (5.97 vs 8.89 x 1000 m^2) but a smaller 1000 seed weight (4.47 vs 4.09 g). Ariana yielded slightly more from the later sowing in 1986-7 but less in 1987-8 and 1988-9; only in 1988-9 was the difference significant (Table 2).

Seed rate

There was no significant effect on yield from halving the seed rate from 8 to 4 kg ha^{-1} in 1988-9 (Table 2).

Spring nitrogen rate

Although plots of Bienvenu that received the larger rate of nitrogen yielded slightly more than plots receiving the smaller rate (0.03-0.22 t ha^{-1}) in all four years, the response was significant in 1985-6 only (Table 2). In that year early sown plots benefited more from the extra 100 kg N ha^{-1} than did later sown (0.28 v. 0.16 t ha^{-1}). Ariana also gave small but non significant increases (0.11-0.13 t ha^{-1}) in 1986-7 and 1987-8 from the extra N but in 1988-9 the larger rate of nitrogen significantly decreased yield (-0.19 t ha^{-1}) more so when the crop was sown early than later (-0.28 v. -0.10 t ha^{-1}).

Spring nitrogen timing

Plots to which nitrogen was applied one-third in mid-February to early March and two-thirds in mid March to early April, did not yield significantly more than plots receiving all their spring nitrogen at the earlier time (Table 2).

Insecticides

Combined insecticide treatment in autumn and spring significantly increased yields in only two of the five years (Table 2), in 1987-8 by 0.20 t ha^{-1} and in 1988-9 by 0.25 t ha^{-1}. The benefit was greater on early- than on later-sown plots in 1987-88 (0.34 v. 0.06 t ha^{-1}) but in 1988-9 the reverse was true (0.19 v. 0.31 t ha^{-1}). There was no yield benefit from insecticide in 1984-5, probably because much seed (mean 1.3 t ha^{-1}) was lost between desiccation and combining that year, particularly from early sown plots. However, earlier hand harvested samples showed a significant yield benefit from insecticide (0.96 t ha^{-1}) in this year, with more from early sown (1.60 t ha^{-1}) than from later-sown plots (0.32 t ha^{-1}). Analysis of yield components showed these yield improvements to be due to increases in surviving plants (61 vs 72 m^{-2}) and fertile pods per unit area (6.87 vs 7.99 x 1000 m^{-2}).

Increase in yield from applying insecticide resulted from control of *P. chrysocephala*, which exceeded threshold numbers for larvae in 1984-5, 1987-8 and 1988-9 only, causing loss of plants, particularly on early sown plots.

Fungicides

The combined spring and summer fungicide treatment gave a significant yield increase of 0.18 t ha^{-1} in one of two seasons, while the combined spring, summer and autumn fungicide treatment gave yield increases of 0.37-0.81 t ha^{-1} in all 3 seasons which were statistically significant in two. Both Ariana and Bienvenu showed similar yield responses (Table 2). Yield responses to autumn fungicide alone were small (-0.01 and -0.10 t ha^{-1}) and non significant.

Growth regulator

The triazole growth retardant, triapenthenol, applied in spring at late stem extension gave yield increases to both cultivars of 0.16 to 0.8 t ha^{-1} significant in 2 of 3 seasons, but 2-chloroethylphosphonic acid significantly decreased yield in 1984-5 by 0.15 t ha^{-1} and had no effect in 1985-86, when wet weather prevented its timely application (Table 2).

Fungicides and growth regulator

The largest increases in yield came from the application of fungicides and the triapenthenol growth regulator which resulted in an additive response when applied together (Table 3).

Table 3. Yield of rapeseed (t ha^{-1}) without and with fungicides (prochloraz in autumn and psring, plus iprodione in summer) and growth regulator (triapenthenol)

Fungicides	Tripenthenol growth regulator 1986-7		1987-8		1988-9	
	Without	With	Without	With	Without	With
Without	3.33	4.03	2.84	3.21	3.17	3.31
With	3.77	4.32	3.61	3.90	3.32	3.49
SED	0.131		0.087		0.124	

DISCUSSION AND CONCLUSIONS

The application of the growth retardant triapenthenol and of combined autumn, spring and summer fungicides gave the greatest and most consistent increase in yield from both cultivars, and when used in combination gave substantial further yield increases. Insecticide gave yield increases only in those years when the numbers of *P. chrysocephala* larvae exceeded the threshold for control, and routine use, irrespective of pest numbers cannot, therefore, be justified. Later sowings yielded slightly, if not always significantly, better than earlier sowings, possibly because they were less attacked by *P. chrysocephala*. Although little benefit was derived from increased spring nitrogen or the timing of its application, a divided application remains the preferred practice in view of concerns about nitrate leaching.

Disease control was a key component in these experiments which test the effects of various input combinations. Ariana gave consistently larger yields where fungicides were combined with either growth regulator, insecticides, extra nitrogen, divided nitrogen or the later sowing date, than when any of these were tested alone.

Table 1. Details of the factors tested and the timings and amounts of treatments in each season

		1984-5	1985-6	1986-7	1987-8	1988-9
variety Bienvenu (BV)/Ariana (A)		BV	BV	BV & A	BV & A	A
sowing date						
early		16 Aug	20 Aug	14 Aug	19 Aug	17 Aug
late		6 Sep	6 Sep	4 Sep	10 Sep	7 Sep
seed rate (kg ha^{-1})						
low		-	-	-	-	4
high		8	8	8	8	8
spring nitrogen rate (kg N ha^{-1})						
low		175	175	150	150	25 + 25
high		275	275	250	250	50 + 100
spring nirogen timing						
single		25 Feb	11 Mar	16 Feb	16 Feb	-
divided		$^1/_3$ on 25 Feb, $^2/_3$ on 25 Mar	$^1/_3$ on 11 Mar $^2/_3$ on 1 Apr	$^1/_3$ on 16 Feb, $^2/_3$ on 16 Mar	$^1/_3$ on 16 Feb, $^2/_3$ on 1 Mar	16 Feb, 28 Mar
insecticide						
without		none	none	none	none	none
with	'decis' a.i. deltamethrin +	4 Oct, 28 Nov	12 Nov	3 Oct, 20 Nov	5; 29 Oct	4 Oct, 11 Nov
	malathion + 'hostathion' a.i.	-	-	-	8; 18 Apr	12 Apr
	triazophos	17 Jun	24 Jun	15 Jun	14 Jun	5 Jun
autumn fungicide						
without		none	none	-	-	-
with	'Sportak' a.i. prochloraz	26 Nov	26 Nov	-	-	-
spring and summer fungicide						
without		none	none	-	-	-
with	'Sportak' a.i. prochloraz	4 Apr	28 Apr	-	-	-
	'Rovral Flo' a.i. iprodione	17 Jun	23 Jun	-	-	-
fungicide						
without		-	-	none	none	none
with	'Sportak' a.i. prochloraz	-	-	17 Nov, 10 Apr	27 Nov, 5 Apr	8 Nov, 21 Mar*
	'Rovral Flo' a.i. iprodione	-	-	15 Jun	14 Jun	12 Apr, 2 Jun*
growth regulator						
without		none	none	none	none	none
with	'cerone' a.i. 2-chloroethyl phosphonic acid	23*, 29 May*	12 Jun	-	-	-
	'UK 244' a.i. triapenthenol	-	-	10 Apr	8*, 18 Apr	21 Mar*, 12 Apr*

*applied to early and later sown plots respectively

Table 2. The effects of factors tested on seed yield (t ha^{-1} at 90% DM) of the winter oilseed rape cultivars Bienvenu and Ariana

	1984-5	1985-6	1986-7		1987-8		1988-9
	Bienvenu	Bienvenu	Bienvenu	Ariana	Bienvenu	Ariana	Ariana
sowing date							
early	3.63*	3.69	3.91	3.66	3.58	3.19	3.41*
late	4.28	3.75	4.10	3.78	3.63	3.16	3.23
seed rate							
low	-	-	-	-	-	-	3.30
high	-	-	-	-	-	-	3.34
spring nitrogen rate							
low	3.94	3.61*	3.90	3.65	3.57	3.12	3.42*
high	3.97	3.83	4.11	3.78	3.64	3.23	3.23
spring nitrogen timing							
single	3.97	3.70	4.07	3.67	3.65	3.12	-
divided	3.94	3.75	3.94	3.77	3.56	3.23	-
insecticide							
without	3.93	3.74	4.04	3.64*	3.48*	3.10*	3.20*
with	3.97	3.71	3.97	3.80	3.73	3.25	3.45
autumn fungicide							
without	3.96	3.67	-	-	-	-	-
with	3.95	3.77	-	-	-	-	-
spring & summer fungicide							
without	3.95	3.63*	-	-	-	-	-
with	3.95	3.81	-	-	-	-	-
fungicide							
without	-	-	3.82*	3.53*	3.20*	2.84*	3.24
with	-	-	4.19	3.90	4.01	3.51	3.40
growth regulator							
without	4.03*	3.72	3.60*	3.49*	3.48*	2.98*	3.24
with	3.88	3.72	4.40	3.94	3.74	3.37	3.40
SED	0.065	0.063	0.131	0.131	0.113	0.113	0.088

*significant at $P < 0.05$