REDUCED FUNGICIDE INPUTS IN WINTER WHEAT

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SUMMARY

Nine trials were conducted over three years at three sites to evaluate the efficacy of reduced rates of various fungicide products for their biological efficacy in controlling stem, foliar and ear diseases of winter wheat as well as their effects on yield and grain quality, and to compare the relative profitability of full and reduced rates of fungicides.

The results show that the use of half rates can give an economic benefit over that of full rates in many situations.

In circumstances where variety or seasonal factors resulted in low to moderate foliar disease pressure the use of half rates gave similar yields to that of full rates. Where foliar disease pressure was high, half rates generally gave lower yields than full rates but the amount of the reduction varied with the fungicide product used. The use of spray additives improved the yield response of the half rate treatments in most cases. Disease levels (septoria) were higher in treatments where half rates were used, compared with the corresponding full rates, but the used of spray additives improved the disease control in the half rate treatments.

The timing of spray applications is critical when half rates of fungicides are being used. Reduced rate treatments need to be applied more frequently. In these trials reduced rate treatments were applied as a three-spray programme rather than the conventional two-spray programme.

INTRODUCTION

The economic returns from cereal growing are declining. As a result, the acreage has been falling and this is threatening the long term viability of the cereal industry.

Reducing inputs while still maintaining yields can help to improve the profitability of cereal production. The application of fungicides for disease control is a major cost element in cereal production especially for winter wheat. Any reduction that can be achieved in the use of fungicides, whether by reducing the amount of active

ingredient used at each spray application or by reducing the number of spray applications, without comprising the yield potential would improve the profitability of the crop. In addition, any reduction in the overall amount of agrochemicals that are applied to crops will be beneficial to the environment.

In Denmark (Jorgensen, 1991) acceptable control of Septoria spp. was achieved using dosages in the range of one-quarter to one-half of the normal dose per treatment but in rainy seasons split doses of one-third rate each was needed for acceptable control. In the UK (Wale, 1994) good results were obtained using half doses but spray timing was shown to be critical especially in Scotland where disease pressures were higher.

METHODS

1995

The trials were carried out at three sites. The sites were located at Belgooly, Co Cork, Clonmel, Co. Tipperary and Castledermot, Co. Kildare. The cultivar at Belgooly was Hussar, at Clonmel Brigadier and at Castledermot Rialto. The same treatments were used at each site.

The fungicides used were Impact Excel and Opus plus Bravo tank mixture. These products were used at the fully recommended commercial rate and one-half of that rate. The additive Slippa was also used with a half-rate of Impact Excel. The products were applied at a number of growth stages. Full rates were applied at g.s. 39 and 59 while reduced rates were applied at g.s. 31, 37, 45 and 59. Full rate treatments were also applied at these latter growth stages as well as a treatment which consisted of full rate Impact Excel at g.s. 39, 59 and 69. Other treatments consisted of reducing the rate of Impact Excel or the rate of Bravo at the post heading (g.s. 59) spray application timing. One treatment consisted of a two-spray programme using Sportak Delta at g.s. 33/34 followed by Impact Excel at g.s.55/59. All the other treatments received Sportak (1l/ha) at g.s. 31.

Treatment details are shown in Table 1. Disease assessments were carried out in mid-July 1995. Yield, kg/hl, 1000 corn weight and screenings were recorded for all treatments.

1996

Trials were carried out at Kildalton Co. Kilkenny, Conna and Clonakilty, Co. Cork. The cultivars used were Brigadier at Kildalton and Clonakilty and Ritmo at Conna.

In these winter wheat fungicide rate trials there were four fungicide products used, Impact Excel, Opus, Opus/Bravo tank mixture and Amistar. The first three of these were used at full and half the commercially recommended rates. The products were also applied as two- and three-spray programmes. Full rate spray programmes were applied at growth stages 39 and 59 (two-spray programmes) as well as at growth stages 37, 45 and 59 (three-spray programme). The half-rate treatments were all applied at these three latter growth stages. The half-rate treatments were applied with and without the additive Slippa. Sportak was applied to all treatments at growth stage 31 with one exception. Disease assessments were carried out in mid-July 1996. Yield, kg/hl, 1000 corn weight and screenings were recorded for all treatments.

Treatment details for these trials are given in Table 2.

1997

Trials were carried out at Kildalton Co. Kilkenny, Conna and Clonakilty, Co. Cork. The cultivar used at all sites was Brigadier. There were five fungicide products used, Opus, Opus /Amistar tank mixture, Alto/Amistar tank mixture, Tilt and Impact Excel. The first three of these were used at full and half the commercially recommended rates. Full rate Opus and full rate Opus/Amistar treatments were applied as two- and as three-spray programmes. All other treatments were applied as three-spray programmes. In the two-spray programmes the fungicides were applied at growth stages 39 and 59. In the three- spray programmes they were applied at growth stages 37, 45 and 59. The half- rate spray programmes were applied with and without the additive Arma. Sportak was applied to all plots at growth stage 31/32 with the exception of one treatment at Kildalton and Clonakilty. Disease assessments were carried out in early July 1997. Yield, kg/hl, 1000 corn weight and screenings were recorded for all treatments.

Treatment details for these trials are shown in Table 3.

Table 1: Details of fungicide treatments on winter wheat (Cork, Tipperary and Kildare 1995)

Treat No.	Fungicide	Timing G.S.	Rate	Season total l/ha
1	Impact Excel	39 + 59	Full	5.0
2	Impact Excel	39 + 59 + 69	Full	7.5
3	Impact Excel	32+37+45+59	Full	5.0
4	Impact Excel	32+37+45+59	Half	2.5
5	Impact Excel +Slippa	32+37+45+59	Half	2.5
6	Impact	31	Half	0.5
	Impact Excel	39 + 59	Full	5.0
7	Impact Excel	39	Full	2.5
8	Impact Excel	39	Full	2.5
	Impact Excel	59	Half	1.25
9	Impact Excel	39	Full	2.5
	Impact Excel	59	Full	2.0
10	Impact Excel	39	Full	2.5
	Bravo	59	Half	1.0
11	Sportak Delta	33	Full	1.25
	Impact Excel	55	Full	2.5
12	Opus + Bravo	39 + 59	Full	2.0 + 2.0
13	Opus + Bravo	32+37+45+59	Half	1.0 + 1.0
14	Opus + Bravo	39 + 59	Two-thirds	1.4 + 2.0
15	Unsprayed			

Table 2: Details of fungicide treatments on winter wheat (Kilkenny and Cork {2}, 1996)

Treat. No.	Fungicide	Timing	Rate	Season total l/ha
1	Impact Excel	G.S. 39, 59	Full	5.0
2	Impact Excel	G.S. 37, 45, 59	Full	5.0
3	Impact Excel	G.S. 37, 45, 59	Half	2.5
4	Impact Excel + Slippa	G.S. 37, 45, 59	Half	2.5
5	Opus + Bravo	G.S. 37, 45, 59	Full	2.0 + 2.0
6	Opus + Bravo	G.S. 37, 45, 59	Full	2.0 + 2.0
7	Opus + Bravo	G.S. 37, 45, 59	Half	1.0 + 1.0
8	Opus + Bravo + Slippa	G.S. 37, 45, 59	Half	1.0 + 1.0
9	Opus	G.S. 39, 59	Full	2.0
10	Opus	G.S. 37, 45, 59	Full	2.0
11	Opus	G.S. 37, 45, 59	Half	1.0
12	Opus + Slippa	G.S. 37, 45, 59	Half	1.0
13	Amistar/Flutriafol	G.S. 39	Full	1.0
	Amistar	G.S. 59	Full	1.0
14	Amistar/Flutriafol	G.S. 37, 45,	Full	1.34
	Amistar	G.S. 59	Full	0.66
15	Unsprayed			

Table 3: Details of fungicide treatments on winter wheat (Kilkenny and Cork {2}, 1997)

Treat. No.	Fungicide	Timing G.S.	Rate	Season total l/ha
1	Opus	39 + 59	Full	2
2	Opus	37 + 45 + 59	Full	2
3	Opus	37 + 45 + 59	Half	1
4	Opus/Arma	37 + 45 + 59	Half	1
5	Opus	39 + 59	Full	2
6	Opus/Amistar	39	Full	0.3+0.7
	Amistar	59	Full	1
7	Opus/Amistar	37 + 45	Full	0.3+0.7
	Amistar	59	Full	1
8	Opus/Amistar	37 + 45	Half	0.15+0.35
	Amistar	59	Half	0.5
9	Opus/Amistar/Arma	37 + 45	Half	0.15+0.35
	Amistar/Arma	59	Half	0.5
10	Alto/Amistar	37 + 45 + 59	Full	0.8+1.0
11	Alto/Amistar	37 + 45 + 59	Half	0.4+0.5
12	Alto/Amistar/Arma	37 + 45 + 59	Half	0.4+0.5
13	Tilt	37 + 45 + 59	$1^1/_2$	1.5
14	Impact Excel	37 + 45 + 59	Full	5
15	Unsprayed			

In the 1996 trials, all treatments received Sportak at g.s 31/32 (1 l/ha) with the exception of Treatment 5. In 1997 at Conna all treatments received Sportak. Treatment 5 at Conna consisted of half-rate Amistar/Arma.

RESULTS

Fungicide rates trial 1995

Disease levels in general were low to moderate in 1995 because of dry weather during the growing season. The crops at all sites grew well. The crop at Belgooly was late-sown and because of the combination of late sowing and a dry summer very little disease developed on the crop. Disease levels were low to moderate at the Castledermot site and moderate at Clonmel. Yields were good at all three sites.

There was no significant yield difference between any of the treatments or between the treatments and the unsprayed control at Belgooly (Table 4). At Clonmel and Castledermot there was no significant yield difference between half rates and full rates of either the Opus + Bravo or the Impact Excel treatments. The use of the additive Slippa with half rates of Impact Excel increased the yield but not significantly so. The Opus + Bravo treatments at Clonmel and Castledermot yielded higher than the corresponding Impact Excel treatments. A single spray of Impact Excel at g.s. 39 (flag leaf) was not significantly lower yielding than any of the other Impact Excel treatments.

All treatments significantly reduced disease levels over the unsprayed control (Table 5). The lowest foliar disease levels resulted form the treatments applied at four growth stages whether half rates or full rates. There was lower disease levels in the Opus + Bravo treatments than in the Impact Excel treatments. There was no difference between any of the treatments in the control of eyespot.

Table 4: Effect of different fungicide treatments on yield, 1000 grain weight and kg/hl of winter wheat (Cork, Tipperary and Kildare 1995)
Yield and quality parameters

		Belgooly (Hussar)			Clonmel (Brigadier)			Castledermot (Ritmo)		
Treat No.	Rate	Yield t/ha@ 15 %	1000 grain wt.	kg/hl	Yield t/ha@ 15 %	1000 grain wt.	kg/hl	Yield t/ha@ 15%	1000 grain wt.	kg/hl
1	Full	9.64	53.6	71.6	11.13	48.6	76.25	12.07	48.3	80.3
2	Full	9.72	54.6	70.7	11.41	49.2	75.75	12.02	52.1	80.3
3	Full	9.78	53.3	71.3	11.20	49.6	76.17	12.06	47.9	80.0
4	Half	9.62	51.6	73.2	11.06	47.9	76.12	12.06	48.3	79.3
5	Half	9.43	53.8	73.1	11.44	44.7	76.58	12.17	49.2	79.6
6	Half Full	9.61	54.0	70.0	10.96	46.4	76.42	12.26	46.7	78.4
7	Full	9.34	49.5	74.2	11.11	46.0	76.08	11.97	46.3	79.4
8	Full Half	9.81	52.5	72.4	11.07	47.3	76.42	12.07	49.6	79.8
9	Full Full	9.69	52.7	74.1	10.87	47.3	76.50	11.86	50.0	79.7
10	Full Half	9.70	53.5	72.0	11.12	45.4	76.42	-	-	-
11	Full Full	9.80	51.8	72.6	10.72	44.7	75.92	11.87	47.5	79.5
12	Full	9.79	55.7	71.5	11.75	50.3	76.25	12.77	48.8	80.4
13	Half	9.99	55.4	71.2	12.03	51.3	76.50	12.54	49.2	79.8
14	two-thirds	9.79	52.9	70.5	11.36	48.3	76.00	12.18	50.0	80.3
15		8.97	47.8	73.4	9.81	48.4	75.75	10.92	46.3	78.1
L.S.D		**N.S.**	**N.S.**	**N.S.**	**0.69**	**N.S.**	**N.S.**	**0.64**	**N.S.**	**N.S.**

Table 5: Effects of different fungicide treatments on the incidence of Septoria and eyespot on winter wheat (Cork, Tipperary and Kildare 1995)
Disease data

	Belgooly (Hussar)		Clonmel (Brigadier)				Castledermot (Ritmo)			
Treat No.	% Septoria		% Septoria			% Eyespot	% Septoria			% Eyespot
	Flag leaf	2nd leaf	Flag leaf	2nd leaf	3rd leaf		Flag leaf	2nd leaf	3rd leaf	
1	0.3	9	4	16	63	46	1	9	43	34
2	0.1	2	8	18	59	43	1	7	49	23
3	0.1	1	1	2	14	42	0.3	2	20	31
4	0.3	5	1	8	45	41	1	8	47	25
5	0.1	1	1	5	27	43	1	8	46	21
6	0.2	2	2	12	56	43	1	5	37	29
7	0.2	10	5	15	70	46	1	11	58	28
8	0.2	6	5	20	70	44	1	8	50	28
9	0.5	5	5	23	74	46	1	8	52	19
10	0.3	3	4	20	76	40	-	-	-	-
11	1.0	2	3	16	60	47	1.4	12	52	26
12	0.1	1	1	2	25	39	1	2	18	26
13	0.1	1	1	1	4	45	1	2	9	25
14	0.1	2	1	2	30	38	1	2	16	25
15	4	23	44	84	100	63	18	72	95	40
L.S.D	**1.5**	**10**	**7.8**	**8.4**	**15**	**16**	**2.5**	**4.6**	**12**	**N.S.**

(a) Full rate treatments

Yield responses in all sprayed treatments were significantly higher than the unsprayed treatment (Table 6). The highest yielding treatments at all sites were Amistar/Flutriafol (treatment 14), Opus/Bravo (treatment 6) and Opus (treatment 10). These treatments were applied as three-spray programmes. The addition of Bravo to Opus did not increase the yield over that of straight Opus.

At the Conna site, where there was very little disease, there was no yield difference between the two-spray and three-spray programmes using either Impact Excel or Amistar/Flutriafol. At Kildalton the three-spray programmes using Impact Excel and Amistar/Flutriafol were significantly higher yielding than the corresponding two-spray programme. At Clonakilty, while the three-spray programmes using these two products were higher yielding than the two-spray programmes, they were not significantly so which can be explained by the fact that the variation at this site was very high.

Full rate Opus applied as a three-spray programme gave a significant yield increase over Opus applied as a two-spray programme only at the Conna site. These results indicate that where disease pressure was high, such as at Kildalton and Clonakilty, those products whose mode of action is mainly preventative have an improved yield when applied earlier and more frequently i.e. as three-sprays rather than two-sprays. Opus on the other hand , which is systemic and has good eradicative properties, performs equally well under either spraying regime.

The full rate three-spray programmes, while only giving a significant yield increase over the corresponding two-spray programmes in three out of the total of nine treatments, indicates that under higher disease pressure a three-spray programme has an advantage in preserving yield potential. This may be due to the disease pressure in the comparatively long period between growth stage 31 and growth stage 39.

Table 6: Effect of different full rate fungicide treatments on the yield, 1000 grain weight (Kilkenny and Cork {2}, 1996)
Yield and quality parameters

		Conna (Ritmo)		Kildalton (Brigadier)		Clonakilty (Brigadier)	
Treat No.	Spray Timings	Yield t/ha@ 15 %	1000 grain wt.	Yield t/ha@ 15%	1000 grain wt.	Yield t/ha@ 15%	1000 grain wt.
1	39,59	9.79	10.23	11.36	10.39	8.97	9.18
2	37,45,59	9.81	10.36	11.77	10.48	9.14	9.41
5	37.45,59	9.91	10.35	11.73	10.59	9.87	10.09
6	37.45,59	10.2	10.23	12.41	10.68	10.40	9.8
9	39,59	9.75	10.54	12.28	10.85	10.36	10.14
10	37.45,59	10.05	10.58	12.28	10.94	10.39	10.10
13	39,59	10.24	10.75	12.07	10.82	9.74	9.67
14	37.45,59	10.34	10.58	12.54	10.99	10.38	9.99
15		8.85	9.6	7.85	8.55	5.51	6.88
LSD		**0.25**	**0.27**	**0.29**	**0.42**	**0.84**	**0.53**

The use of Sportak at growth stage 31 with Opus/Bravo increased the yield at all sites over that of Opus/Bravo without Sportak. The average yield increase over the three sites was 0.6 t/ha. This yield increase was significant at Kildalton and Conna.

As there was very low levels of disease at Conna there was very little difference in the percentage disease between any of the treatments at this site (Table 7). At Kildalton the percentage Septoria on the flag leaf of the treated plots was low and there was no difference between the treatments. There was a significant reduction in the percentage Septoria on the second leaf in the three-spray programmes when compared with their corresponding two-spray programmes with all products. This illustrates the disease prevention effect of the earlier spray timings.

At Clonakilty this same effect of reduced disease between the three-spray and two -spray programmes can be seen for Impact Excel and Amistar on the flag leaf and for the Opus treatments on the second leaf.

At both Kildalton and Clonakilty the use of Sportak at growth stage 31 in the Opus/Bravo treatments improved the control of Septoria on the second leaf.

Table 7: Effect of different full rate fungicide treatments on the incidence of mildew and septoria (Kilkenny and Cork {2}, 1996)

		Conna (Ritmo)		Kildalton (Brigadier)		Clonakilty (Brigadier)	
		% Mildew	% Septoria	% Septoria		% Septoria	
Treat No.	Spray timings	2nd leaf	2nd leaf	Flag leaf	2nd leaf	Flag leaf	2nd leaf
1	39,59	1.2	0.6	5	49	24	99
2	37,45,59	2.8	0.5	4	24	43	97
5	37.45,59	1.0	0.5	3	32	4	56
6	37.45,59	1.0	0.1	2	13	1	30
9	39,59	0.5	0.8	2	24	1	64
10	37.45,59	1.1	0.8	2	9	1	45
13	39,59	0.6	1.7	6	52	16	90
14	37.45,59	0.5	2.1	2	10	19	88
15		4.2	63	69	100	100	100
LSD		**2**	**7**	**5**	**12**	**8**	14

(b) Reduced rate treatments

At Kildalton all the half rate fungicide treatments yielded significantly lower than the corresponding full rate fungicide treatments (Table 8). At Clonakilty and Conna there was no significant yield difference between the half rates and the full rates with the exception of Impact Excel at Clonakilty.

Half rate fungicide treatments yielded lower than the corresponding full rate treatments where disease pressure was greatest i.e. at Kildalton and Clonakilty. When the additive Slippa was used with the half rate treatments, these treatments gave similar yields to the full rate treatments at Kildalton.

The addition of the additive Slippa to the half rate fungicide treatments gave inconclusive results. It increased the yield in the Impact Excel, Opus/Bravo and Opus treatments at Kildalton (average 0.25 t/ha) and in the Impact Excel treatment at Clonakilty, gave a lower yield in the Opus treatments at Clonakilty

and had little effect on all other treatments. There was no effect of Slippa on half rate treatments at Conna.

Table 8: Effect of different half rate treatment on yield, 1000 grain weight and screenings of winter wheat (Kilkenny and Cork {2}, 1996)
Yield and quality parameters

		Conna (Ritmo)		Kildalton (Brigadier)		Clonakilty (Brigadier)	
Treat No.	Rate	Yield t/ha@ 15 %	1000 grain wt.	Yield t/ha@ 15%	1000 grain wt.	Yield t/ha@ 15%	1000 grain wt.
2	Full	9.81	73.54	11.77	10.48	9.14	9.41
3	Half	9.82	73.03	11.21	10.00	8.12	8.44
4	Half	9.89	73.75	11.48	10.14	8.49	9.10
6	Full	10.2	73.85	12.41	10.76	10.4	10.57
7	Half	9.95	73.16	11.93	10.68	9.7	9.8
8	Half	9.89	73.09	12.28	10.69	8.91	9.79
10	Full	10.05	74.0	12.28	10.94	10.39	10.10
11	Half	10.05	73.29	11.87	10.43	10.16	10.08
12	Half	10.01	73.13	12.01	10.73	9.81	10.15
15		8.85	72.33	7.85	8.55	5.51	6.88
LSD		**0.25**	**0.27**	**0.29**	**0.42**	**0.84**	**0.53**

Table 9: Effect of different half rate fungicide treatments on the incidence of septoria and mildew on winter wheat (Kilkenny and Cork {2}, 1996)
Disease measurements

		Conna (Ritmo)		Kildalton (Brigadier)		Clonakilty (Brigadier)	
		% Mildew	% Septoria	% Septoria		% Septoria	
Treat No.	Rate	2nd leaf	2nd leaf	Flag leaf	2nd leaf	Flag leaf	2nd leaf
2	Full	3	1	4	24	43	97
3	Half	2	1	10	57	58	100
4	Half	1	1	5	38	47	100
6	Full	1	1	2	13	1	30
7	Half	1	1	5	29	7	73
8	Half	2	1	2	14	4	64
10	Full	1	1	2	9	1	45
11	Half	1	1	6	25	10	83
12	Half	1	2	2	15	4	73
15		4	63	96	100	100	100
LSD		**2**	**7**	**5**	**12**	**8**	**14**

Half rates resulted in a significantly lower 1000 grain weight in all treatments at Conna, in the Impact Excel and Opus treatments at Kildalton and in the Impact Excel and Opus/Bravo treatments at Clonakilty. The use of Slippa improved the

1000 grain weight in the Impact Excel treatments at Conna and Clonakilty only. Half rates had no effect on % screenings except in the Impact Excel treatment at Clonakilty.

There was no difference between disease levels at full and half rates in Conna as would be expected given the very low incidence at this site (Table 9). At Kildalton, there was a higher level of Septoria on the flag leaf in the Impact Excel treatment with the half-rate than with the full-rate. The use of Slippa reduced this to the level of the full rate. There were higher levels of Septoria on the second leaf with all products when half rates were used and the use of Slippa reduced these levels considerably.

At Clonakilty, the half rates also had higher Septoria levels on the flag leaf than the full rates, and the use of Slippa reduced these levels. On the second leaf there was no difference between the Septoria levels in the full or reduced rate in the Impact Excel treatments but in the Opus and Opus/Bravo treatments the reduced rates had higher levels of Septoria than the full rates and the addition of Slippa to the half rates with these products made little difference. The fact that the half rate treatments were lower yielding than the full rate treatments does not mean they are less profitable.

Table 10: Effect of different full rate fungicide treatments on the yield of winter wheat (Kilkenny and Cork {2}, 1997)

Treat No.	Timing G.S.	Rate	Yield t/ha @ 15% moisture		
			Kildalton	Conna	Clonakilty
1	39, 59	Full	9.54	7.9	8.73
2	37, 45, 59	Full	9.78	8.2	8.90
5	39, 59	Full	9.07	-	8.58
6	39, 59	Full	10.88	9.5	9.02
7	37, 45, 59	Full	10.60	9.7	9.54
10	37, 45, 59	Full	10.02	9.1	9.36
13	37, 45, 59	$1^1/_2$	9.80	7.6	8.70
14	37, 45, 59	Full	9.41	8.2	9.19
15			6.49	6.0	7.57
L.S.D			**0.71**	**0.4**	**0.7**

Fungicide rates trials 1997

Full rates

The yield responses from all fungicide treatments were significantly higher than the untreated plots at each site (Table 10). There were higher responses to treatments at Kildalton and Conna than at Clonakilty which is in marked contrast to the 1996 trials. This is a reflection of the late sowing date (end Dec.) at the Clonakilty site.

The highest yielding treatments at all sites were the full rate Opus/Amistar treatments (treatments 6 and 7). These treatments were applied as both two- and three-spray programmes and were significantly higher yielding than all other treatments at both Kildalton and Conna.

In the Opus/Amistar treatments the three-spray programme outyielded the two-spray programme at Conna and Clonakilty but this increase in yield was not statistically significant.

As in 1996 full rate straight Opus applied as a three-spray programme did not significantly outyield straight Opus applied as a two-spray programme. The Alto + Amistar tank mixture outyielded the straight Opus treatments at all sites. Tilt applied at the full rate three times i.e. $1^1/_2$ times the standard recommendation gave a similar yield to that of the Opus treatments at Kildalton and Clonakilty but was lower yielding at Conna. The cost of the Tilt treatment would be approximately £20/ha lower than that of the Opus treatment. Impact Excel also gave a similar yield to that of Opus but the cost of each programme is very similar.

The use of Sportak at growth stage 31 increased the yield at Kildalton and Clonakilty over that of the treatment without Sportak (treatment 5) but the increase was not significant. In 1996 the yield difference was significant.

Table 11: Effect of different full rate fungicide treatments on the incidence of septoria (Kilkenny and Cork {2}, 1997)

			% Septoria					
			Kildalton		Conna		Clonakilty	
Treat No.	Timing G.S.	Rate	Flag leaf	2nd leaf	Flag leaf	2nd leaf	Flag leaf	2nd leaf
1	39, 59	Full	0.5	62	1.6	61	14.3	83
2	37, 45, 59	Full	1.9	52	2.9	56	11.8	87
5	39, 59	Full	1.2	65	-	-	11.6	86
6	39,59	Full	0.9	35	1.3	42	7.8	52
7	37, 45,59	Full	0.3	39	0.8	32	8.5	49
10	37, 45, 59	Full	1.0	52	1.6	46	6.7	58
13	37, 45, 59	$1^1/_2$	6.5	80	1.8	75	8.0	80
14	37, 45, 59	Full	3.1	66	1.1	45	11.1	65
15			98.3	100	40.5	96	88	98
L.S.D.			**3.9**	**11.5**	**4.0**	**11.0**	**11.5**	**10.4**

Septoria levels on the flag leaf were low and there was no significant difference between treatments (Table 11). On the second leaf the Opus + Amistar treatments gave significantly lower Septoria levels than all other treatments. At Kildalton and Conna in both the straight Opus and the Opus + Amistar tank mix there were lower levels of Septoria when the treatments were applied in three applications compared with two applications.

The Opus + Amistar half rate treatment were significantly higher yielding than any other of the half rate treatments and when the adjuvant Arma was included in the mixture were higher yielding than the full rate Opus treatments at Kildalton and Conna (Table 12). The half rate Opus treatments were slightly lower yielding than the full rate treatments but were not significantly lower. The use of the additive Arma with the half rate gave no increase over that of the half rate without the additive. The Opus + Amistar half rate treatments were also slightly lower yielding than the full rate treatments while the addition of Arma to the half rate treatment gave a slight yield increase to those treatments. There was a similar result in the Alto + Amistar treatments.

Table 12: Effect of different full and half rate fungicide treatments on the yield of winter wheat (Kilkenny and Cork {2}, 1997)

Treat. No.	Rate	Yield t/ha @ 15% moisture		
		Kildalton	Conna	Clonakilty
2	Full	9.78	8.2	8.73
3	Half	9.69	7.9	8.68
4	Half	9.60	7.9	8.47
7	Full	10.60	9.7	9.54
8	Half	10.32	9.0	9.41
9	Half	10.63	9.4	8.96
10	Full	10.02	9.1	9.36
11	Half	9.79	8.8	8.89
12	Half	9.84	9.0	9.02
5	Half	-	9.2	-
15		6.49	6.0	7.57
L.S.D.		**0.71**	**0.4**	**0.7**

At Conna, one treatment consisted of half rate Amistar with Arma applied over three applications. The yield from this treatment was similar to that of the half rate Opus + Amistar treatment at this site.

The full rate treatments had lower levels of Septoria than the corresponding half rate treatments (Table 13). These differences were significant on the second leaf in the Opus and Opus + Amistar treatments at Kildalton.

At Kildalton and Conna the Opus + Amistar treatments at both full and reduced rate gave lower Septoria levels on the both the flag and second leaves than the other treatments. The use of the adjuvant Arma with half rate treatments reduced the Septoria levels slightly in most treatments over that of the half rate without the adjuvant. This difference was significant in the case of the percentage Septoria on the second leaf in the Alto + Amistar treatment at Conna.

Table 13: Effect of different full and half-rate fungicide treatments on the incidence of septoria on winter wheat (Kilkenny and Cork {2}, 1997)

		Septoria levels					
		Kildalton		Conna		Clonakilty	
Treat No.	Rate	Flag leaf	2nd leaf	Flag leaf	2nd leaf	Flag leaf	2nd leaf
2	Full	1.9	52	2.9	56	11.8	87
3	Half	6.6	65	3.8	62	16.7	88
4	Half	1.6	62	2.8	61	15.9	82
7	Full	0.3	39	0.8	32	8.5	75
8	Half	2.8	57	1.5	38	16.4	77
9	Half	2.1	52	1.2	38	12.5	85
10	Full	1.0	52	1.6	46	6.7	75
11	Half	3.4	59	1.6	60	12.8	91
12	Half	3.3	62	2.0	43	21.3	91
5	Half	-	-	1.1	42	-	-
15		98.3	100	40.5	96.2	88	99
L.S.D.		**3.9**	**11.5**	**4.0**	**11.0**	**11.4**	**10.4**

DISCUSSION

1995 was a year of low to moderate disease pressure. Because of the low disease levels in Belgooly there was very little variation between the various treatments and only the half rate treatments would have shown a positive financial balance over fungicide costs. At both Clonmel and Castledermot there was no significant yield difference between full rates and half rates in either the Impact Excel treatments or the Opus + Bravo treatments. The Opus + Bravo treatments were higher yielding and had generally lower disease levels than the corresponding Impact Excel treatments. At Clonmel the half rate treatment of Opus + Bravo yielded significantly higher than the half rate Impact Excel treatment. The additive Slippa improved the yield of the half rate Impact Excel treatment and also reduced disease levels. In 1995 the half rate treatments at Clonmel and Castledermot were the treatments that resulted in the greatest financial return.

In 1996 there was severe septoria pressure at all three sites. However, the cultivar grown at the Conna site was Ritmo which has a high degree of resistance to this disease and as a result the yield responses to the various treatments were much lower than at the other two sites.

In 1997 disease pressure was less than in the 1996 season and varied between sites. There was low disease pressure at Clonakilty, because of the late sowing date of this crop, and medium disease pressure at the other two sites. The full rate treatments were higher yielding than the corresponding half rate treatments but not significantly so. The treatments applied over three applications were higher yielding and had less Septoria than those applied over two applications but again there was no significant difference. In terms of economic response to treatment the treatments that returned a greater profit margin were the reduced rate treatments.

A critical factor in all work on reduced fungicide doses is spray timing. In many cases where the reduced dose has performed inadequately delays in application have been identified as a major factor contributing to the poor response (Wale, 1994).

During the period that this project was being carried out a major change in the cereal fungicide market occurred. In 1995 the fungicide Opus was introduced to the market in small quantities and became freely available in 1996. This fungicide was superior to the other triazole fungicides that were being used for cereal disease control. In 1996 Amistar, a strobilurin fungicide, was released in limited quantities and became more widely available in 1997. In 1998 another new strobilurin product, Allegro, became available. The strobilurin group of fungicides are different in their mode of action to the triazoles, which have been the mainstay of cereal disease control for the past twenty years, and consequently they require a different approach when used in disease control programmes. More trials are required to establish their efficacy when used at other than the full recommended commercial rate.

While the use of half the commercially recommended rates has been reasonably successful in these trials, in many situations rates other than half, either higher or lower may be required (Volk, 1993). The concept that is currently being developed is that of appropriate dose taking into account such factors as the cultivar used, the disease pressure, the seasonal variation and the products to be used (Paveley and Lockley, 1993) The appropriate dose can range between one quarter dose and full dose. Decision support systems which take these factors and others into account and suggest spray timings and appropriate doses have been developed, or are in the course of development, in a number of countries (Secher, 1991; Secher and Bouma, 1996). These systems should be validated for their

suitability for cereal disease control in Ireland, and adapted if necessary for use under our conditions, as the resources are not available locally to carry out the major investigations required to develop these systems.

In Ireland, because of a cooler climate, there is a longer grain filling period and ripening phase than in many other European countries. Consequently the maximum retention of green leaf area after ear emergence is required to achieve high yields and fungicide programmes must be designed to take account of this. Coupled with this is the fact that the diseases that cause the main problems in Ireland are the so called wet weather diseases - Septoria in wheat, Net Blotch and Rhynchosporium in barley - whereas Mildew and Rusts tend to be more prevalent in warmer climates. The former diseases are more difficult and expensive to control so spray decision thresholds that perform well in other countries may not transfer to Irish conditions without modifications.

CONCLUSIONS

- Reduced rates of fungicides increased the gross margins from winter wheat except where disease (mainly Septoria) pressure was high.

- The efficacy of reduced rates of fungicides varied with fungicide, variety and the level of disease pressure as influenced by location and season.

- Reduced rate fungicide treatments based on Opus and Amistar performed better than treatments based on Impact Excel and Folicur.

- Efficacy of fungicides was improved by increasing the number of sprays while maintaining a standard dose rate.

- Varieties with high septoria resistance performed well with reduced rates.

- Reduced rates were most successful when disease pressure was low to moderate as influenced by location and season.

- The reliability and practical use of reduced rates would be greatly improved when used in conjunction with Decision Support Systems (DSS) which help to predict seasonal variation in disease pressure and more timely application of fungicides.

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