OPTIMISING STROBILURINE FUNGICIDE USES IN A REASONED PROTECTION OF WINTER WHEAT

P. MEEUS and B. BODSON

* Département de Phytopharmacie, Centre de Recherches Agronomiques, 11 rue du Bordia, 5030 Gembloux, Belgique

** Unité de Phytotechnie des régions tempérées, Faculté Universitaire des Sciences Agronomiques de Gembloux, 5030 Gembloux, Belgique

SUMMARY

For three years, strobilurine fungicides are applied at different growth stages of a winter wheat crop in a single application and in a programme of treatments. The trial results show the interest of these recent products for the protection of the upper organs: flag leaf and ear.

INTRODUCTION

Research in the area of wheat crop husbandry over the last 20 years has revealed the importance of the late-determined yield components: ear fertility and grain filling. Nitrogen fertilisation has been adapted to this development by postponing a large part of the fertilisation to the flag leaf stage. This shifting of part of the nitrogen fertilisation increases the disease pressure late in the growing season and therefore requires the fungicidal protection to be adapted accordingly (Bodson et al., 1997 a). The new strobilurine-based fungicides look very interesting in this respect due to their persistence and broad spectrum of activity.

Strobilurine-based products have been available to Belgian farmers since 1996 (Meeus et al., 1996). Used at the stages acknowledged as important to fungicidal protection (Bodson et al., 1997), these products do produce better results than conventional fungicides (Meeus et al., 1997). However, despite their characteristics, these new fungicides should also be applied according to the same criteria as those used in the past (Bodson et al., 1997 b).

MATERIALS AND METHODS

Most of the trials have been carried out in a loamy area on fields where good cultural practices prevail in terms of rotation, sowing dates and density, nitrogen fertilisation, herbicides and where applicable insecticides. The Lonzée experimental site (Temperate Regions Plant Husbandry Unit, Gembloux University Faculty of Agricultural Science) was the site of the research into the stages of application and the timing of application in the treatment programmes, while other trials were conducted elsewhere (Department of Crop Protection, Gembloux Agricultural Research Centre) to verify the data in space and time with respect to stages 39 (flag leaf) and 59 (heading) in the Zadocks and al. growth stage scale (1974).

The strobilurine-based products [mainly the kresoxim-methyl (125 g/l) + epoxyconazole (125 g) plus azoxystrobine (250 g/l) combination at their normal rate] were compared to various triazole-based fungicides generally used in Belgium over the last years.

Tables 1 and 2 show weather conditions over the trial period together with the average dates significant to growing.

Tables 3 to 6 show the results, expressed as the increased yield in kg/ha.

ANALYSIS OF RESULTS

1. Background

   1995 was a very favourable year for Septoria disease (*Septoria tritici*). Moderate rainfall and mild temperatures early in the year created ideal conditions for the disease to establish itself in winter wheat. The spread of the disease was nevertheless checked in May by the almost total lack of rainfall in the first half of the month and fairly low temperatures for the time of year. Subsequently, however, the disease continued to spread thanks to some heavy rain which lasted until mid-June. The disease was then halted again by over 40 days of low rainfall and very high temperatures. Other diseases (powdery mildew, rust and Fusarium) remained at insignificant levels of intensity.

   In contrast to the previous year, weather conditions in 1996 were unfavourable to the development of cereal diseases right from the beginning. Low rainfall in March, April, June and July to a great extent prevented Septoria disease, and only powdery mildew (*Erysiphe graminis*) developed to any significant extent, though this was limited by cold weather in the first half of May.

   At the end of the 1995-1996 growing season, the inoculum potential for most diseases was thus not very high due to the low level of infection of crop residues. This low potential was further diminished by a relatively cold winter. Despite mild temperatures in March and April, low rainfall prevented the diseases from spreading rapidly. Heavy rain between May and July (about 60 days of rain) nevertheless allowed Septoria disease to develop. As a result of these favourable weather conditions for diseases, all stages of the plant were ultimately attacked by Septoria disease and the ears were also affected by Fusarium infection and other secondary cryptogams. Due to very high temperatures in early August, the harvest was nevertheless earlier than expected.

2. Effect of stage of application on yield

   During the three trial years, the effect of the strobilurine-based fungicide treatments on yield was greater than the effect of triazole-based treatments, irrespective of stage of application (Table 3), treatment programme or trial site (Table 5). The increased yield in relation to an untreated control is always cost-effective in the case of a single application, whether this takes place at the flag leaf or heading stage (Table 4). This is especially true in years of high disease pressure such as 1995 or 1997, though also in 1996. In the case of 1997, fairly close to a normal year as far as growing conditions and weather conditions in May, June and July are concerned, in the case of a single application, stage 59 proves to be the most effective on average (Tables 3 and 4). In 1995 and 1996, very dry or hot weather after 15th June prevented the development of ear disease. The incidence of fungicide thus mainly benefits the upper leaves. This accounts for the significant effect of treatment carried out between stages 37 and 45 on yields and the lower predominance of ear treatments (stage 59) in these two slightly unusual years from the point of view of weather after heading.

As far as strobilurines are concerned, it appears in 1997 (Tables 3 and 4) that despite the persistence of these fungicides, too early an application makes it impossible to keep a proper check on the state of health of the parts of the plant not present at the time of application. In the field, plots treated when ears are present could be clearly distinguished by their appearance from untreated at that stage, whichever fungicide was used but especially in the case of strobilurines; the greyish discoloration in untreated plots was due to the usual diseases (Septoria, Fusarium) developing on the ears and also secondary fungi. This therefore showed a lack of or insufficient distribution to the ear of the fungicides applied at the flag leaf stage.

In the case of two applications (Tables 3 and 4), the yield differences in 1995 and 1997, between the double and the single application, are significant and yield levels are higher in the case of strobilurine-based products. The treatment programme comprising applications at stages 39 and 59 confirms its suitability for fungicide treatment of winter wheat in Belgium, although a double strobilurine application is at the limit of cost-effectiveness (Table 4).

3. Positioning of strobilurines in the treatment programmes

Given that a double application of strobilurines does not always prove cost-effective, it is important to cut the cost of fungicide treatment by possibly using a triazole at either of the two stages of fungicide protection. As strobilurines are characterised by a broad spectrum of activity, high persistence and action in the early stages of fungal development (Godwin et al., 1997), it appears more effective to apply them at stage 59, especially if the health situation has been good until then.

In view of their treatment potential, triazoles appear to fill a position of choice at stage 39. If applied at that stage, triazoles offer a means of attacking disease at the incubation stage in the upper leaves and so paving the way for strobilurine, which can then be optimally used: for prevention in the case of the ear, to strengthen the fungicide protection for the upper leaves and for persistence at all stages of the cereal. The results in Tables 5 and 6 illustrate this approach to reasoned disease control, specifically showing the importance of applying strobilurine at stage 59.

CONCLUSION

The trials conducted between 1995 and 1997 show the economic benefits of using strobilurine-based fungicides to control diseases of winter wheat. Bearing in mind that due to the crop protection practices used in Belgium these diseases mainly have a detrimental effect on yield after the flag leaf stage, applications carried out after that stage are important and in particular applications at heading.

To make fungicide protection cost-effective and optimise strobilurine applications at heading, triazoles have a part to play in connection with applications at stage 39.

REFERENCES

Bodson B. et Meeus P. (1997). a - Influence de l'évolution de la phytotechnie du blé sur le raisonnement de la protection fongicide. Cinquième Conf. sur les maladies des plantes. Tours: 3-4-5 décembre 1997 - (1): 305-311.

Bodson B. et Meeus P. (1997). b - Intérêt et positionnement d'un traitement fongicide avant le stade épiaison sur froment d'hiver dans les conditions culturales de la Belgique. Med. Fac. Landbouww. Rijksuniv. Gent, 62/3b: 1009 - 1115.

Godwin J.R., Bartlett D.W., Heaney S.P. (1997). Azoxystrobin: implications of biochemical mode of action, pharmacokineties and resistance management for spray programmes against septoria diseases of wheat 15th Long Ashton Int. Symp. - « in Press ».

Meeus P. et Bodson B. (1996). Résultats de trois années d'essais fongicides dans les céréales en Belgique avec les strobilurines. Med. Fac. Landbouww. Rijksuniv. Gent, 61/2a: 395-404.

Meeus P. et Bodson B. (1997). Protection fongicide du froment d'hiver en Belgique: incidence des strobilurines en fonction du stade d'application. Med. Fac. Landbouww. Rijksuniv. Gent, 62/3b: 1117-1127.

Zadoks J-C., Chang T.I., Konzak C.F. (1974). A decimal code for the growth stage of cerals - Weed Research, 14: 415-420.

Year	Month	Rainfall				Temperature			
		Ten-day period			Month	Ten-day period			Month
		1	2	3		1	2	3	
1995	May	0.2^{-}	18	52.8^{++}	71	13.5^{++}	8.7^{-}	15^{+}	12.5
	June	31.9	40.8^{+}	0^{--}	72.7	11.6^{-}	13.1^{-}	17.8^{+}	14.2
	July	21.1	26	4.5^{-}	51.6^{-}	18.5^{+}	20.1^{++}	20.5^{++}	19.8^{++}
	August	0^{---}	0^{--}	25	25^{--}	20.7^{++}	20.2^{++}	17.5^{+}	19.4^{+++}
1996	May	22.5	7.6	26.4	56.5	7.3 --	9.2 -	12.8	9.9^{--}
	June	8.8^{-}	0.7^{--}	19.6	29.1^{-}	17.8^{++}	14.7	12.4^{---}	14.9
	July	29.5	0.2^{--}	0.7^{---}	30.4^{--}	13.8^{-}	16.6	17.7^{+}	16.1
	August	0.9^{---}	64.8^{++}	178.3^{++}	244.0^{+++}	16.9	17.9	16	16.9
1997	May	45^{++}	27.4	22.7	95.1^{+}	11.3	14.8^{++}	11.1^{-}	12.4
	June	7^{-}	46.8^{+}	37.9	91.7	17.5^{++}	15.3	13.6^{-}	15.5
	July	27	41.6^{+}	7.7^{-}	76.3	15.2^{-}	17.6^{+}	17	16.6
	August	15.6	0^{--}	26.6	42.2^{-}	19.7^{++}	20.5^{++}	20.3^{+++}	20.2^{+++}

Occurrence of events
+++ or --- $^{(x)}$ rare (not recorded between 1950 and 1989)
++ or -- $^{(x)}$ fairly rare (recurs within 10 to 40 years)
+ or - $^{(x)}$ more frequent (recurs within 4 to 10 years)
No sign = frequent (recurs in under 4 years)
$^{(x)}$ + or - signs denote values above or below normal

Table 1: **Agro-climatic data from May to August in the three years of the trials (Ernage weather station)**

Year	FUNGICIDE TREATMENT			HARVEST	
	Stage 39 – Average dates (variations)	Stage 59 - Average dates (variations)	Difference in days between 2 treatments (variations)	Average dates (variations)	Difference in days between stage 59 and harvest
1984-1994	25/5	11/6	17	15/8	66
1995	20/5 (12/5 - 26/5)	7/6 (31/5-19/6)	18 (13 to 25)	3/8 (31/7 - 7/8)	57
1996	30/5 (28/5 - 2/6)	12/6 (10/6-14/6)	12 (9 to 14)	23/8 (7/8 - 26/8)	72
1997	22/5 (16/5-26/5)	9/6 (3/6 - 16/6)	18 (14 to 24)	11/8 (7/8 - 14/8)	63

Table 2: **Average dates of fungicide treatments and harvest dates: averages from 1984 to 1994 and in 1995, 1996 and 1997**

STAGE					1995			1996			1997		
32	**37**	**39**	**45**	**59**	**EF**	**KE**	**A**	**EF**	**KE**	**A**	**EF**	**KE**	**A**
x					428	586	300	490	814	733	-	-	-
	x				726	826	533	217	693	407	1085	768	802
		x			862	877	634	358	727	458	753	893	699
			x		790	1083	771	120	680	316	766	845	931
				x	534	767	826	324	818	644	717	1237	1058
x			x		1202	1551	1152	496	714	641	-	-	-
x				x	1127	1386	1193	565	709	796	-	-	-
		x		x	989	1494	1251	776	944	457	1162	1792	1411
Average					832	1071	832	418	762	556	897	1107	980
Control (kg/ha)					8288			11755			8854		
F					10.67			3.01			7.21		
CV					2.95 %			2.22 %			3.13 %		
ppds 0.05					340 kg			384 kg			434 kg		
Ppds 0.01					449 kg			509 kg			575 kg		

EF : EC at 250 g/l fenpropimorphe and 84 g/l epoxyconazole (1.5 l/ha)
KE : SC at 125 g/l kresoxim-methyl and 125 g/l epoxyconazole (1 l/ha)
A : SC at 125 g/l azoxystrobine (1 l/ha)
M : average

Table 3: Yield increase in kg/ha compared to controls for various fungicide treatments - Lonzée experimental site

STAGE	1995 (6 trials)	1996 (4 trials)	1997 (9 trials)
39	1261	750	1319
59	1076	746	1413
39 and 59	1645	944	1865

Table 4: **Yield increase in kg/ha compared to untreated controls for various treatments with strobilurine-based fungicides**

STAGE	1995 (6 trials)	1996 (3 trials)	1997 (5 trials)
39	359	389	116
59	149	364	288
39 and 59	345	279	499

Tableu 5: **Yield increase due to stobilurines treatments in kg/ha compared to a triazole-based fungicide applied in the same conditions**

Stage 39	Stage 59	Trial I FH 97.03	Trial II FH 97.37	Trial III FH 97.38	Average
	Strobilurine	1282	908	1073	1088
Strobilurine	Triazole	1644	591	531	922
Triazole	Strobilurine	2072	1146	1543	1587
Strobilurine	Strobilurine	2084	1200	1309	1531

Table 6: **Winter wheat in 1997 – Time of application of strobilurines in treatment programmes - yield in kg/ha compared to the control**