

Hybrid wheat - A different wheat crop?

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Summary

From 1994 to 1996, trials have been carried out in Gembloux (Belgium) to evaluate the agronomical value of hybrid wheat varieties and to determine the best adapted growing conditions for these new wheats. These experiments show that the best hybrids have a yield potential highly superior to classical varieties. In order to improve the cost-effectiveness of hybrid wheat crops, a reduction in seed rate may be possible together with changes in nitrogen fertilisation, if the results of preliminary studies are confirmed.

Key words: Hybrid wheat, seed rate, nitrogen dressing, nitrogen uptake

Introduction

Varieties of hybrid wheat obtained by chemical castration appeared on the French market nearly ten years ago. However their commercial success was limited and short-lived due to their limited performance as opposed to varieties resulting from classical selection at that time (Feyt, 1989). Since 1994, several hybrid wheats have again been added to the National French List after performing successfully in official trials. These varieties and others have since been registered for growth in other countries (eg.: Belgium and Germany).

Since the 1993-1994 season, an evaluation of hybrid varieties has taken place in Gembloux (Belgium) to study their growth and agronomic performance.

As early as the 1994-1995 season, following observations carried out during the first year, trials of seed rate, nitrogen fertilisation and crop intensification have complemented varietal trials. These experiments aim to determine whether the management of hybrid varieties should be similar to that recommended for classical varieties and if not, to propose adaptations in order to allow optimal expression of their potential. A synthesis of the results of first three years of trials is presented here and allows certain characteristics of these hybrids to be identified.

Materials and Methods

The experiments were carried out during the 1993-1994, 1994-1995 and 1995-1996 seasons in Loncée (Gembloux) as part of a series of "Cereal Trials" carried out each year by the Faculté Universitaire des Sciences Agronomiques de Gembloux and the Federal Ministry of Agriculture.

The 14 m² plots are organized in randomised blocks or in split plots with 4 to 6 replicates.

Crops were sown at the end of October or beginning of November after sugar beet or seed potatoes in loamy soils which are representative of growing conditions in the main Belgian cereal growing region.

Trials of sowing density were done with a Herriau precision driller. In the fertilisation trials, the nitrogen fertilisers were applied manually in the form of NH_4NO_3 (27 % N). In certain trials, fertiliser enriched with ^{15}N was used to determine the crop balance. The conditions of this experiment are identical to those used by Destain *et al.* (1996 and 1997). Agronomical inputs (herbicide, fungicide, insecticide and growth regulators) applied to the crops correspond to good agricultural practices advised by Seutin and Falisse (1995) and Falisse and Méeus (1996).

The hybrids used in the trials are varieties already registered or being evaluated through research by Hybritech and Hybrinova, Zeneca Seeds and New farm Crops. They are compared to varieties chosen from those that perform best in Belgium.

Results

Comparison between hybrid and classical varieties

A comparison was carried out on thirty varieties (20 hybrids and 10 classical varieties) in 1993-1994, ten varieties (4 hybrids and 6 classical) in 1994-1995 and 18 varieties (9 hybrids and 9 classical) in 1996.

Each year, half the replicates were treated with growth regulator and fungicides, the others did not receive any treatments. Seed rate and nitrogen fertilisation were as normally recommended for the conditions in the field.

Table 1 presents the yields obtained with hybrids already commercialised (Domino, Hynoprecia and Hynoseha), together with the most interesting under current evaluation and with some classical varieties such as the late cultivars Estica and Ritmo present in all three years of trials and the early cultivars Sideral and Tremie each present in two years out of three.

The results show that the hybrid varieties gave yields which were always superior to the average of the classical varieties but not always superior to the yield of the best of these varieties. Amongst all the varieties in the trial (not included in the table), certain hybrids perform less well. The hybrids Domino, Hynoprecia and Hynoseha are early-type varieties, while the others are later. A comparison can be made between varieties of same earliness because, for certain years especially the 1994 harvest, early varieties can be penalised compared to later varieties relative to their yield potential.

Examination of yield components does not allow the increase in yield to be attributed to one component. As for classical varieties, the high performing hybrid wheats can be superior due to a high thousand grain weight or to a larger number of grains resulting from more ears or to high ear fertility. The variability between varieties is similar to that between classical wheats.

Table 1. Yields in kg/ha of different classical and hybrid varieties, grown with or without protection against lodging and diseases

	1993-1994		1994-1995		1995-1996	
	Treated	Untreated	Treated	Untreated	Treated	Untreated
Classical varieties						
Estica*	10105	9927	9125	8101	10033	9220
Ritmo*	11450	10508	9909	7923	9822	8997
Sideral*	9710	8908	9137	8405	-	-
Tremie*	-	-	10146	7625	9420	8702
Mean of classical varieties*	10455	9781	9579	8013	9758	8973
Hybrid varieties						
Domino	11252	10018	10192	7848	-	-
Hynoprecia	-	-	9731	7620	10089	9531
Hynoseha	-	-	-	-	10488	9642
Hybritech 95123	-	-	-	-	10357	9276
Hybrinova 6AB	-	-	-	-	10635	10092
Hybrinova 64191	-	-	-	-	11290	10737
Zeneca 1	-	-	10328	8146	-	-
LSD ($\alpha=0,05$)	505	489	339	386	573	564

During stem elongation, growth vigour is almost always higher in the hybrids than in the classical varieties. At ear emergence, the difference is reduced.

The behaviour towards fungal diseases is very variable as shown by the yield differences between treated and untreated plots. Technological quality is also very variable: varieties such as Hynoprecia show good baking quality whereas others such as Domino should be classified as feed wheat.

Seed rate

During the two years' trials, it is clear that the behaviour of hybrid varieties is different to that of classical varieties (Table 2).

The yield of the hybrids decreases less rapidly when the seed rate is reduced with the optimal seed rate of the hybrids being lower than those of the classical varieties.

Table 2. Influence of seed rate on yield (in kg ha⁻¹)

Year	Cultivar	100 grains m ⁻²	165 grains m ⁻²	230 grains m ⁻²	300 grains m ⁻²
1994-1995	Domino	9979 b ⁽¹⁾	10419 a	10389 a	10375 a
	Soissons	9137 b	9238 b	9511 a	9545 a
1995-1996	Hyb 95123	8669 c	9282 b	9592 a	9665 a
	Rialto	7799 d	8616 c	9547 b	9926 a

⁽¹⁾ Means followed by the same letters indicate lack of significant difference at the $\alpha=0,05$ level (Newman-Keuls test)

Nitrogen dressing

The responses to nitrogen dressing of the classical variety "Pajero" and of a hybrid HA6AB were compared throughout the 1995-1996 season. Table 3 gives the yields for the 20 dressing treatments tested in the split plot trial. Yields obtained with the hybrid are greatly superior to those of the pure line.

Comparison of the yield results can be done by calculation, for each level of fungicide protection, of response surfaces where the dependant variable Y (yield) is given as a function of nitrogen dressings at each of the three fractions (X1, X2, X3) in the equation (Oger, 1994):

$$Y = a + \sum_{j=i}^3 b_i 0,99^{x_i} + \sum_{\substack{j=i \\ i < j}}^3 \sum_{j=i}^3 b_{ij} 0,99^{(x_i + x_j)} + b_{123} 0,99^{(X_1, X_2, X_3)} + \sum_{i=1}^3 d_i x_i$$

Based on this equation it is possible to calculate, with a good degree of precision (r^2 of the response surfaces for this trial= 0,81 and 0,78), the yields for all the intermediate dressing treatments within the range of fertiliser levels compared. On the basis of this, the dressings which give the yield maxima and greatest profitability, taking into account 1 kg N= 4 kg wheat, are given in Table 4.

Table 3. Influence of different splitting schedules and rates of nitrogen dressing on yield

1st application Z25	2nd application Z30	3rd application Z39	Total dose	Yield in kg.ha ⁻¹	
				Pajero (Classical)	HA6AB (Hybrid)
0 N	0 N	0 N	0 N	8049	8613
50 N	0 N	0 N	50 N	9053	10082
0 N	50 N	0 N	50 N	9135	9839
0 N	0 N	50 N	50 N	8646	10341
50 N	50 N	0 N	100 N	9616	10566
50 N	0 N	50 N	100 N	9853	10680
0 N	50 N	50 N	100 N	10115	10924
100 N	0 N	0 N	100 N	9999	10609
0 N	100 N	0 N	100 N	9991	11088
0 N	0 N	100 N	100 N	9618	10465
50 N	50 N	50 N	150 N	10258	11200
50 N	50 N	65 N	165 N	10381	11631
75 N	75 N	0 N	150 N	10133	11218
75 N	0 N	75 N	150 N	10492	11619
0 N	75 N	75 N	150 N	10178	11485
100 N	100 N	0 N	200 N	10169	11396
100 N	0 N	100 N	200 N	10472	11368
0 N	100 N	100 N	200 N	10697	11683
75 N	75 N	75 N	225 N	10332	11018
100 N	100 N	100 N	300 N	10516	10141
LSD ($\alpha=0,05$)=				466	556

Table 4. Amounts of nitrogen dressings in kg N ha⁻¹ giving the maximum yields and greatest profitability

	Pajero (pure line)				HA6AB (hybrid)			Total
	1st fraction	2nd fraction	3rd fraction	Total	1st fraction	2nd fraction	3rd fraction	
N dressing for maximum yield	0	100	100	200	0	100	60	160
N dressing for economical optimum	0	100	80	180	0	100	60	160

It appears that the "optimal" dressings are lower for the hybrids than for the "pure line" varieties.

In 1994-1995 and 1995-1996, with help of NH₄NO₃ fertiliser enriched with ¹⁵N, balances of the utilization of nitrogen fertiliser have been measured. In 1994-1995, this measurement was made on the hybrid Hynoprecia and the classical variety Torfrida, based on a dressing of 150 kg N ha⁻¹ given in three fractions of 50 kg, and in 1995-1996, on the hybrid HA6AB and the classical variety Pajero based on two dressings of 165 kg N ha⁻¹ (in three fractions: 50 kg - 50 kg - 65 kg) and of 215 kg N ha⁻¹ (in three fractions: 50 kg - 50 kg - 115 kg).

In 1994-1995, the plant recovery of N fertiliser is higher for the hybrid than for the classical variety (Table 5). In 1995-1996, the recoveries are very similar for the hybrid and the classical varieties.

Relative to the nitrogen accumulation in the aerial biomass (Table 5) observed for the same varieties in 1995, the hybrid had taken up slightly more nitrogen than the classical variety. On the other hand, in 1996, the opposite tendency was observed.

Table 5. Plant recovery of N fertiliser (%) and amounts of N exported (and their origin) by four varieties of winter wheat

Year and N dressing	Varieties	Recovery in %	N exported (kg ha ⁻¹)		total
			from fertiliser	from soil	
1995 150 kg N ha ⁻¹	Torfrida	64,4 ± 2,0	97	85	182
	Hynoprecia	68,4 ± 1,9	102	101	203
1996 165 kg N ha ⁻¹	Pajero	67,5 ± 0,7	111	155	266
	HA6AB	66,1 ± 2,6	109	124	233
1996 215 kg N ha ⁻¹	Pajero	67,8 ± 3,3	145	135	280
	HA6AB	68,7 ± 2,5	148	123	271

Discussion

The agronomical value of hybrid wheats is, as for classical varieties, very variable from one cultivar to another. Only the best of them show superiority to classical varieties for grain yield. The greatest difference observed between a hybrid and the average of the group of classical varieties taken as reference was around 16 %. On average, it is around 7 %, when crops are protected against disease and lodging. This value is similar to that mentioned by Bastergue (1995) and by Bernicot (1995) and slightly superior to that reported by Oury et al (1993) and by Morgan et al (1989).

More recent varieties, not yet marketed, seem to perform better with yield gains approaching 800 to 1000 kg.ha⁻¹, which is necessary to compensate the greater cost of the seed.

The possibility to reduce the sowing density observed during two years has also allowed the cost increase to be reduced.

The nitrogen dressing balance results for 1994-1995 and those of the fertilisation trial in 1995-1996 indicate the possibility of better nitrogen utilisation by the hybrid but are partially contradicted by the balance determined in 1995-1996. It should be noted that the difference in grain protein content of the two varieties is not negligible: 12,8 % for Pajero against 11,4 % for the hybrid with the fertilisation 50 kg - 50 kg - 65 kg.

These results should be compared with those of Oury et al (1995) who concluded that hybrids utilize nitrogen better, especially during the grain filling period.

These preliminary results show that hybrids should compete with classical varieties if improvement continues and the agronomic conditions such as seed rate and nitrogen fertilisation are optimised.

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