

**FIELD PERFORMANCE
AND QUALITY OF
HYBRID WINTER WHEAT**

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SUMMARY

An assessment of hybrid winter wheat was carried out over three seasons to determine the commercial potential of hybrid varieties under Irish conditions. The studies examined the effects of reduced seeding rate on hybrid grain yield and quality in comparison to pure-line varieties. A comparison of the hybrid varieties available was also carried out and the higher yielding hybrids were then compared with the best pure-line varieties in terms of grain yield and quality, and response to fungicide.

The results indicated that in good sowing conditions hybrids can give greater yields than pure-line varieties at reduced seeding rates, but the effect is not large or consistent. There was generally no effect of seeding rate on the grain quality of hybrid varieties but crop lodging occurred in one season at high seeding rates.

Of the hybrid varieties examined, Mercury and Hyno Esta were the two better varieties in terms of grain yield; there was little difference between the hybrids examined in terms of grain quality.

The best hybrid varieties did not give consistently higher yields or quality than the best pure-line varieties and exhibited a similar response to fungicide application as the pure-line varieties. It is concluded that when the price differential between seed of pure-line varieties and hybrid varieties is taken into account, the winter wheat hybrid varieties currently available do not offer any economic advantages to commercial growers at the present time.

INTRODUCTION

New developments in cereal hybridising technology have resulted in hybrid wheats being introduced into the European market with the potential for higher yield and quality. Normally wheat is self-pollinated and conventional varieties come from a cross between two parents which is subsequently grown-on by breeders until it is stable and true to type. Commercial hybrid seed derives from a controlled cross pollination of parent lines. Some parental combinations exhibit hybrid vigour. This vigour is expressed in the hybrid and is lost if the hybrid seed is propagated, i.e. the hybrid does not breed true, as is the case for conventional inbred varieties.

An assessment of hybrid winter wheat was carried out over three seasons to determine the commercial potential of hybrid varieties under Irish conditions. The studies examined the effects of reduced seeding rate on hybrid grain yield and quality, in comparison to pure-line (conventional) varieties. An evaluation of the hybrid varieties available was also carried out and the highest yielding hybrids were compared with the best pure-line varieties in terms of grain yield and quality, and response to fungicide.

MATERIALS AND METHODS

Three studies examining the potential of hybrid winter wheat varieties were carried out at the Crops Research Centre, Oak Park, Carlow between 1998 and 2001.

Study 1: Effect of seeding rate on hybrid winter wheat

This compared a conventional pure-line variety and a hybrid variety at a range of seed rates over three cropping seasons. In the first season, 1998/99, Reaper (pure-line) and Hyno Seha (hybrid) were compared. Claire (pure-line) and Mercury (hybrid) were compared in the remaining two seasons. In all seasons, the range of seed rates used was 100, 150, 200, 250, 300 and 350 seeds/m². Sowing conditions in 1998 were good; in 1999, sowing conditions were acceptable, while poor conditions were encountered when sowing in the third season. Sowing dates in the three seasons were October 13, 1998, October 19, 1999 and January 12, 2001. All crops were managed for high yields with appropriate levels of agrochemical inputs.

Study 2: Hybrid variety evaluation

This compared four hybrid varieties over three cropping seasons. The four varieties were Cockpit, Mercury, Hyno Esta and Hyno Santa. Seeding rate was 300 seeds/m² in all three seasons. Sowing dates were October 15, 1998, October 19, 1999 and October 19, 2000. All crops were managed for high yields with appropriate levels of agrochemical inputs.

Study 3: Comparison of hybrid varieties with pure-line varieties

This compared hybrid varieties with conventional pure-line varieties over two cropping seasons, 1999/2000 and 2000/01, in terms of grain yield and quality and responsiveness to fungicide application (over an untreated comparison). The pure-line varieties included were Brigadier, Claire, Falstaff, Madrigal, Rialto, Savannah and Tanker. In the first season Mercury was used as the hybrid comparison; in the second season, both Mercury and Cockpit were included. All varieties in both seasons were sown at a seeding rate of 300 seeds/m². Sowing dates were October 21, 1999 and January 13, 2001. Sowing conditions were acceptable in the first season but were poor in the second season. All crops were managed for high yields with appropriate levels of agrochemical inputs. The fungicide programme used in 2000 was: T1 Unix (0.67 kg/ha) + Allegro (0.5 l/ha), T2 Allegro (0.8 l/ha), T3 Amistar (0.8 l/ha). In 2001, the fungicide programme used was: T1 Unix (0.67 kg/ha) + Allegro (0.5 l/ha), T2 Opera (1.5 l/ha).

RESULTS AND DISCUSSION

Study 1: Effect of seeding rate on hybrid winter wheat

Effects on grain yield

Grain yields of hybrid winter wheat varieties at a range of seed rates over three cropping seasons are presented in Fig. 1. High yields were achieved with the hybrid varieties in all three seasons.

The effect of seeding rate on grain yield varied with season. In 1999, when mean yield was in excess of 11 t/ha, there was no significant increase in grain yield of the hybrid Hyno Seha as seeding rate increased from 100 to 350 seeds/m². Similarly in 2000, when average grain yield was over 14.5 t/ha, hybrid grain yield was not significantly increased when seeding rate increased from 100 to 350 seeds/m². In both these seasons the crops were sown in good conditions in mid-October.

A significant effect of seed rate on hybrid grain yield was detected in 2001 when there was a statistically linear increase in yield as seed rate increased from 100 to 350 seeds/m². Unlike the previous two seasons, due to high rainfall in the autumn/winter period, sowing of this crop was delayed until January when soil conditions were poor.

These results would indicate that, with the exception of where the crop is sown into poor seedbed conditions, hybrid varieties can be sown at low seeding rates without loss of yield. When conditions are poor yield losses can occur if low seeding rates are used.

The effect of seeding rate on grain yield of the pure-line varieties included in the experiments as a comparison was similar to the effects observed with the hybrids in two of the three seasons (Fig. 1). In 1999, when sowing conditions were acceptable, the response of the pure-line variety to seed rate was not significantly different from that of the hybrid; both gave similar yields as seeding rate was reduced from 350 seeds/m² to 100 seeds/m². In 2001, when sowing conditions were poor, there was again no significant difference between the response of the pure-line and hybrid variety to reduced seeding rate; the yield of both declined as seed rate was reduced. However, the yield of the hybrid variety (Mercury) was lower than that of the pure-line variety (Claire). Examination of the components of yield indicated that the higher yield of Claire was due to a significantly higher ear density (Fig. 2). Mercury had significantly ($P = 0.05$) more grains per ear than Claire but this did not compensate for the reduced ear density. Grain weight did not differ significantly between varieties.

In 2000, there was a trend ($P = 0.0577$) towards reduced yields from the pure-line variety Claire as seed rate was reduced from 350 to 100 seeds/m², whereas yields of the hybrid Mercury were maintained over the same range of seed rates. This difference arose as a result of the greater ability of the hybrid to maintain the number of grains produced per unit area as seeding rate was reduced compared to the pure-line variety (Fig. 2). However, the magnitude of this difference was small. The difference in yield between Claire sown at 100 seeds/m² and 350 seeds/m² was 0.78 t/ha, the corresponding difference with the hybrid was 0.23 t/ha.

Crop lodging occurred in 2000. Lodging was significantly greater for the hybrid than for the pure-line variety and increased as seeding rate increased. However, this was not reflected in reduced yields. This may have been due to favourable weather, which facilitated harvesting, allowing the lodged crop to be fully harvested.

These results indicate that, while hybrids can give greater yields than pure-line varieties at reduced seeding rates, the effect is not large or consistent.

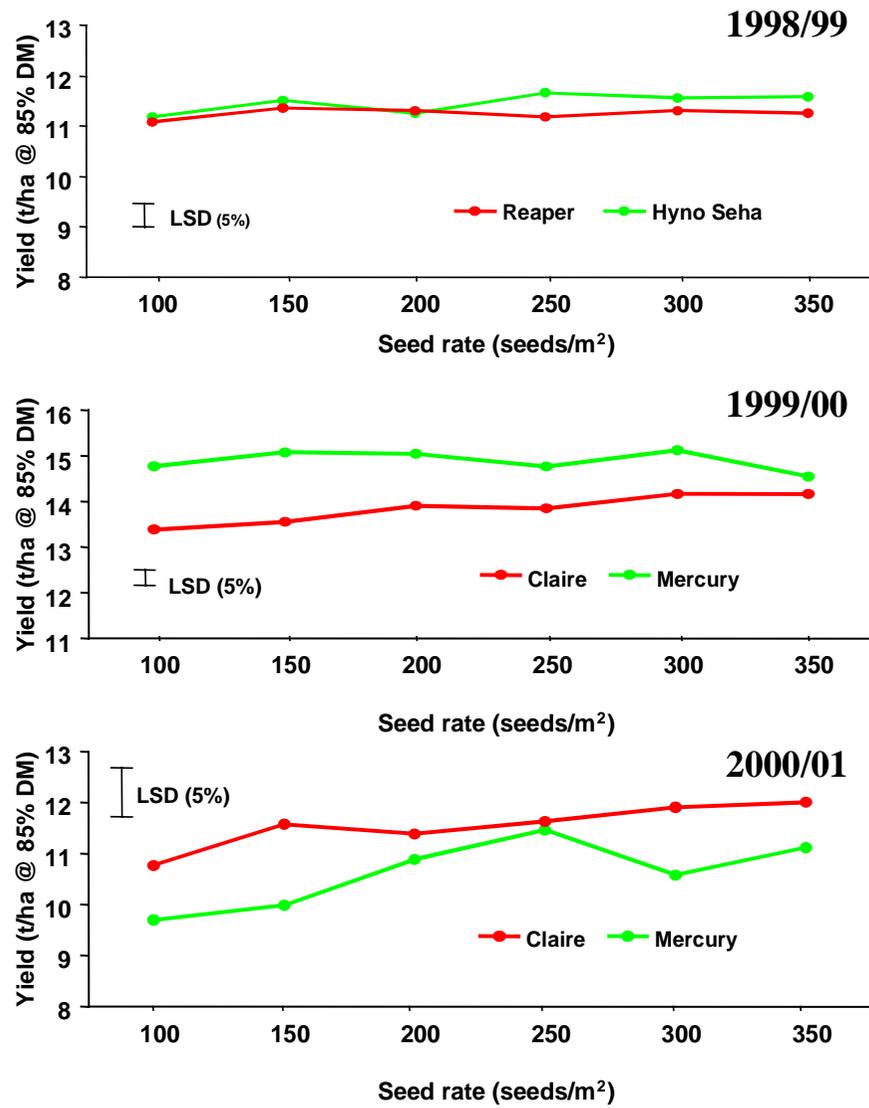


Fig. 1: Grain yield of a hybrid variety (cv. Hyno Seha, Mercury) and a pure-line variety (cv. Reaper, Claire) of winter wheat over three growing seasons

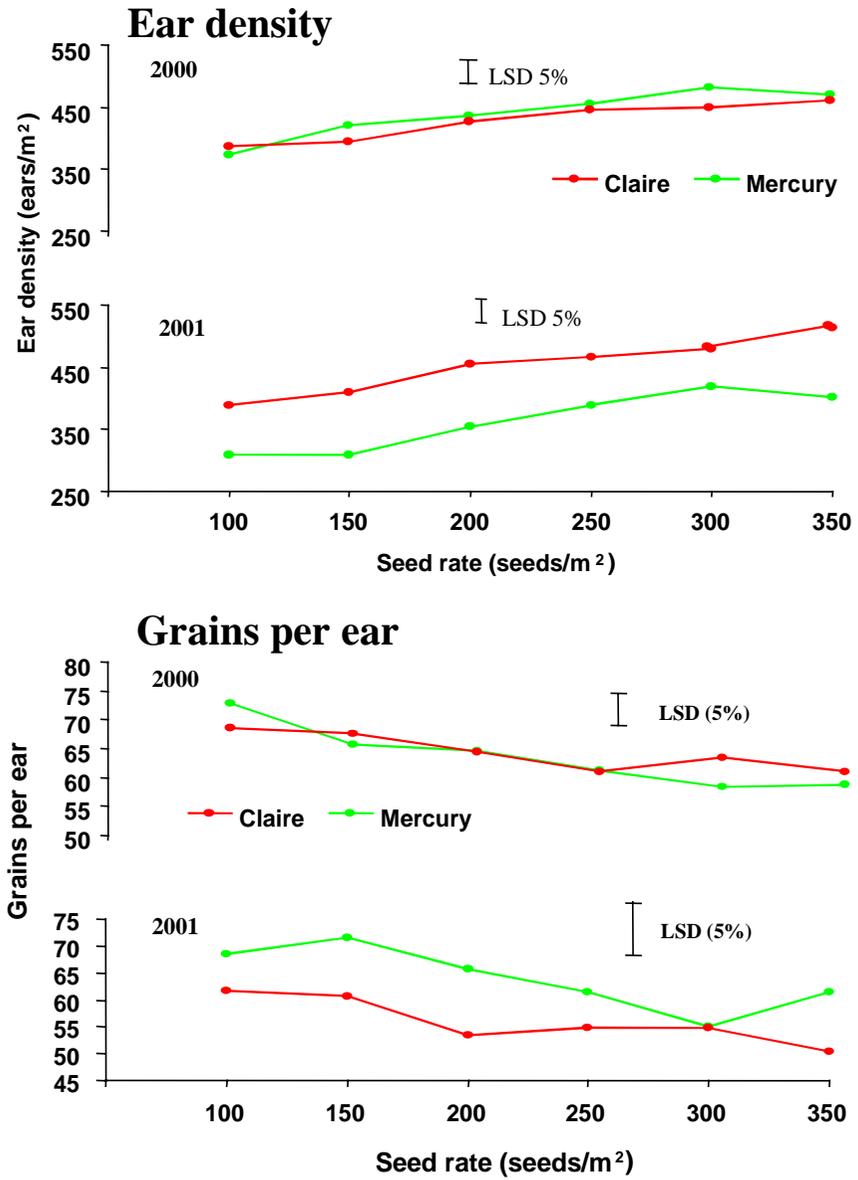


Fig. 2: Ear density and grains per ear of a pure-line (Claire) and hybrid (Mercury) variety in 2000 and 2001

Effect of seeding rate on grain quality

Hectolitre weight, 1000-grain weight and screenings were measured as indicators of grain quality (Table 1).

The effect of seeding rate on hectolitre weight in 1999 and 2000 was small. While there was a statistically significant increase in hectolitre weight as seeding rate increased, the actual increase for the hybrid was less than 1 kg/hl in both seasons. The effect of seeding rate on hectolitre weight was similar for both the pure-line and hybrid variety in both these seasons, although the hybrid variety had a significantly greater hectolitre weight than the pure-line variety in both seasons.

In 2001, the hybrid variety had a significantly lower hectolitre weight than the pure-line variety. The effect of seeding rate on hectolitre weight of the hybrid variety was greater than in the previous two seasons, increasing from 72.1 kg/hl at 100 seeds/m² to 76.7 kg/hl at 350 seeds/m². In comparison, there was little effect of seeding rate on the hectolitre weight of the pure-line variety over the same seeding rate range.

Table 1: Grain quality parameters of hybrid and pure-line winter wheat varieties over four growing seasons. Each variety was grown at six seeding rates. Data presented are means of the six seeding rates

	Hectolitre weight (kg/hl)	1000-grain weight (g)	Screenings (< 2.0 mm) (%)
1999			
Reaper	76.3	57.94	1.82
Hyno Seha	77.7	58.92	0.96
5% LSD	0.2	NS	0.21
2000			
Claire	75.9	50.96	0.63
Mercury	77.2	53.79	0.58
5% LSD	0.39	0.68	NS
2001			
Claire	76.9	46.16	2.93
Mercury	75.2	46.98	4.01
5% LSD	1.7	NS	0.69

NS – not significant

With the exception of 2000, when the hybrid Mercury had a significantly ($P < 0.01$) greater 1000-grain weight than Claire, neither variety nor seed rate had any significant effect on grain weight.

Screenings were generally low (<5%) throughout the trials. There was no significant effect of seeding rate on the level of screenings of either the pure-line or hybrid variety. In 1999, the pure-line variety had a significantly higher ($P < 0.01$) level of screenings than the hybrid variety. There was no difference between the hybrid and pure-line variety in 2000, while in 2001 the pure-line variety had significantly ($P = 0.01$) lower screenings than the hybrid variety.

These results indicate that there was generally no effect of seeding rate on the grain quality of either hybrid or pure-line varieties. Additionally, the hybrid varieties examined did not possess any consistent advantage over pure-line varieties in terms of grain quality.

Study 2: Hybrid variety evaluation

Over the three seasons, significant yield differences due to hybrid variety were detected (Fig. 3). However, no variety consistently outyielded the varieties which it was compared to. In 1999, the difference between the highest and lowest yielding variety was 0.97 t/ha. The highest yield was obtained with Hyno Esta (11.7 t/ha). Cockpit had a significantly ($P < 0.05$) lower yield than Hyno Esta.

In 2000, the difference between the highest and lowest yielding hybrids was 1.29 t/ha. Mercury had the highest yield, while Hyno Santa had the lowest, the difference between the two being statistically significant ($P < 0.05$).

In 2001, the difference between the lowest (Hyno Santa) and highest (Hyno Esta) yielding hybrid was 1.08 t/ha. There was no significant difference between hybrid varieties in 2001.

The three-year mean relative yield of the four hybrid varieties suggests that Mercury and Hyno Esta were the two best hybrid varieties, with a relative yield rating of 102 (Table 2). Cockpit had a relative yield rating of 99, followed by Hyno Santa with a rating of 96.

Hectolitre weight and the level of screenings were used as an estimate of grain quality in all three seasons (Table 3). Grain protein content and Hagberg Falling Number (HFN) were determined in 2000 and 2001 (Table 4).

There were generally only small differences in terms of hectolitre weight (<2 kg/hl) between varieties in any season. Hyno Santa had a significantly lower hectolitre weight than Mercury and Hyno Esta in 1999. It had a significantly lower hectolitre weight compared to all three other varieties in 2000 and 2001. There was little difference between Mercury and Hyno Esta in any season.

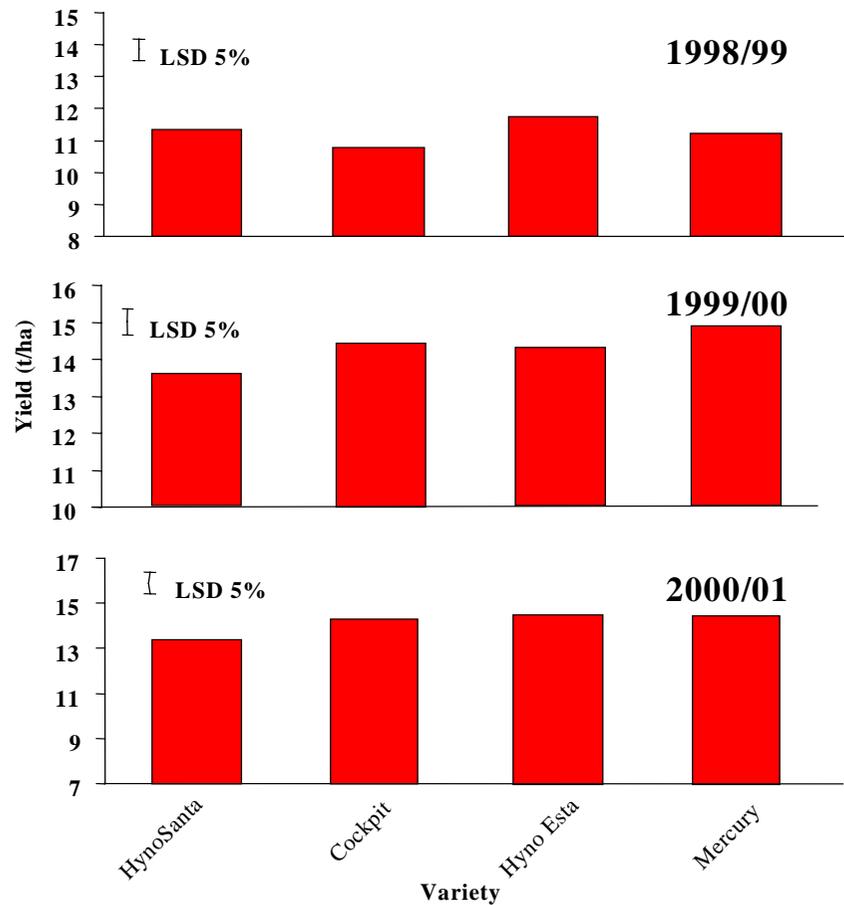


Fig. 3: Grain yield of four hybrid winter wheat varieties over three growing seasons

Table 2: Relative yields of hybrid winter wheat varieties over three growing seasons

	1999	2000	2001	3-year mean
Mercury	100	104	102	102
Hyno Esta	104	100	102	102
Cockpit	96	101	101	99
Hyno Santa	101	95	95	96
	100=11.27 t/ha	100=14.29 t/ha	100=14.17 t/ha	100=13.24 t/ha

Table 3: Grain quality of hybrid winter wheat varieties over three growing seasons. A three-year mean relative yield is also presented

	1999	2000	2001	3-year relative mean
	<i>Hectolitre weight (kg/hl)</i>			
Mercury	77.3 ^a	79.2 ^a	73.1 ^a	76.5
Hyno Esta	77.3 ^a	79.9 ^c	73.6 ^a	76.9
Cockpit	76.1 ^b	79.0 ^a	73.8 ^a	76.3
Hyno Santa	76.3 ^b	77.3 ^b	71.8 ^b	75.1
	<i>Screenings (%)</i>			
Mercury	1.38 ^a	0.77 ^a	2.10 ^a	1.4
Hyno Esta	1.50 ^a	0.92 ^a	2.22 ^a	1.5
Cockpit	1.20 ^a	0.73 ^a	2.02 ^a	1.3
Hyno Santa	0.97 ^b	0.70 ^a	1.02 ^a	0.9
	<i>1000-grain weight (g)</i>			
Mercury	54.17 ^a	54.17 ^a	50.98 ^a	53.1
Hyno Esta	58.25 ^b	58.53 ^b	56.13 ^b	57.6
Cockpit	55.83 ^{ac}	56.08 ^c	54.88 ^b	55.6
Hyno Santa	56.17 ^c	55.50 ^{ac}	50.77 ^a	54.1

Means followed by the same letter are not significantly different (P< 0.05)

The level of screenings was low (< 2.5%) for all varieties in all three seasons and there were generally no significant differences between varieties. There was no significant difference between the four hybrid varieties in either 2000 or 2001 in terms of protein content (Table 4).

Table 4: Protein content and Hagberg Falling Number of grain of hybrid winter wheat varieties over two growing seasons

	Protein content (%)		Hagberg Falling Number (sec)	
	2000	2001	2000	2001
Mercury	8.57 ^a	8.28 ^a	257 ^b	135 ^b
Hyno Esta	8.75 ^a	8.20 ^a	122 ^a	69 ^a
Cockpit	8.81 ^a	8.35 ^a	299 ^b	269 ^c
Hyno Santa	8.52 ^a	8.12 ^a	257 ^b	150 ^b

Means followed by the same letter are not significantly different ($P < 0.05$)

Hyno Esta had a significantly lower HFN than the other three varieties in both seasons. Cockpit had the highest HFN in both seasons although it was not significantly higher than Hyno Santa or Mercury in 2000 (Table 4).

These results indicate that, of the hybrids examined, Mercury and Hyno Esta were the two better varieties in terms of yield and quality, although differences in quality parameters between the four hybrids examined were generally small.

Study 3: Comparison of hybrid varieties with pure-line varieties

Yield and response to fungicide

A comparison of the hybrid variety Mercury with seven pure-line varieties in the 1999/2000 season revealed that the hybrid significantly outyielded the pure-line varieties (Table 5). The yield advantage of the hybrid over the best pure-line variety (Falstaff) was 0.65 t/ha. Yields of all varieties were in excess of 12 t/ha. Varieties differed in their response to fungicide application (over an untreated comparison). Mercury exhibited a relatively high yield response to fungicide (3.04 t/ha), similar to that achieved with Madrigal. The response to fungicide of

Mercury was significantly greater than the response achieved with the pure-line variety Claire but was not significantly different from the other varieties examined.

Table 5: Grain yield and response to fungicide application of hybrid and pure-line varieties at Oak Park in 2000 and 2001

Variety	Yield (t/ha @ 85% DM)		Response to fungicide (t/ha @ 85% DM)	
	2000	2001	2000	2001
Brigadier	12.2	11.1	3.8	0.6
Claire	12.9	11.6	1.7	0.5
Falstaff	13.3	11.2	2.7	-0.3
Madrigal	12.7	11.1	3.0	-0.2
Rialto	12.9	10.8	2.3	0.8
Savannah	13.3	10.8	3.6	1.0
Tanker	12.9	12.2	3.8	1.2
Mercury	14.0	10.8	3.0	-0.3
Cockpit	-	11.7	-	0.64
<i>LSD (5%)</i>	<i>0.58</i>	<i>0.73</i>	<i>0.97</i>	<i>n.s.</i>

In 2000/01, Mercury gave a significantly lower yield than pure-line varieties Claire and Tanker. Its yield in that season was comparable to the lowest pure-line varieties. In contrast, the hybrid Cockpit significantly outyielded Mercury and the pure-line varieties Rialto and Savannah. However, the highest yield was achieved with the pure-line variety Tanker. There was no significant difference between the hybrid and pure-line varieties in terms of their responsiveness to fungicide. Response to fungicide was low (<1 t/ha) in all varieties in 2001.

Averaged over the two seasons, the hybrid Mercury had a similar mean yield to Tanker, Claire and Falstaff.

Grain quality

In the 1999/2000 season, hectolitre weight of Mercury was significantly higher than all except two pure-line varieties, Falstaff and Rialto (Table 6). Its 1000-grain weight was similar to that of Tanker, Madrigal, Falstaff and Brigadier but significantly lower than that of Rialto and Savannah. Screenings were low for all varieties, although the hybrid had the highest screenings and significantly higher than Savannah, Tanker and Rialto. Mercury had a significantly lower protein content than Falstaff, Rialto and Tanker. Its protein content did not differ

significantly from the other varieties. HFN of Mercury was in the middle of the range recorded and was significantly lower than that of Claire and Tanker and significantly higher than that of Falstaff and Rialto (Table 7).

In the 2000/01 season, Falstaff had the highest hectolitre weight (Table 6). Hectolitre weight of Cockpit and Mercury did not differ significantly from that of Falstaff. Both hybrids had a higher, although not always significantly higher, level of screenings than the pure-line varieties. Rialto, Savannah and Tanker had a significantly higher 1000-grain weight than the two hybrids. Grain weight of the hybrids was similar to that of the remaining pure-line varieties. With the exception of Rialto, which had a significantly higher protein content than all other varieties, grain protein content of the two hybrids was generally not significantly different from the pure-line varieties. HFN of the hybrid varieties generally did not differ significantly from the pure-line varieties, with the exceptions of Falstaff and Rialto, which had significantly lower HFNs than the other varieties (Table 7). These results indicate that, while hybrid varieties can give greater yields and better grain quality than pure-line varieties, they do not give a consistent yield or quality advantage over conventional pure-line varieties.

Table 6: Grain quality of hybrid and pure-line varieties at Oak Park in 2000 and 2001

Variety	Hectolitre weight (kg/hl)		1000 grain weight (g)		Screenings (%)	
	2000	2001	2000	2001	2000	2001
Brigadier	75.2	77.9	48.7	46.1	1.8	4.1
Claire	77.2	78.5	45.1	43.3	1.6	4.1
Falstaff	78.1	79.6	48.4	43.7	1.5	4.2
Madrigal	76.2	76.1	46.9	43.1	1.8	4.0
Rialto	77.8	79.6	52.2	48.7	0.8	2.9
Savannah	75.7	74.5	53.6	51.7	1.1	2.9
Tanker	72.8	77.4	48.4	48.5	1.1	2.9
Mercury	78.9	78.7	47.8	45.7	1.9	4.7
Cockpit	-	77.2	-	43.1	-	4.8
<i>LSD (5%)</i>	<i>1.10</i>	<i>3.35</i>	<i>2.18</i>	<i>0.77</i>	<i>0.59</i>	<i>2.01</i>

Table 7: Protein content and Hagberg Falling Number of hybrid and pure-line varieties at Oak Park in 2000 and 2001

Variety	Protein (% @ 85% DM)		HFN (sec)	
	2000	2001	2000	2001
Brigadier	9.2	9.4	301	224
Claire	9.2	8.9	322	274
Falstaff	9.5	9.5	230	179
Madrigal	9.0	9.2	284	251
Rialto	9.7	10.3	189	151
Savannah	8.9	9.1	285	245
Tanker	9.6	9.4	349	266
Mercury	9.0	9.1	271	275
Cockpit	-	9.5	-	236
<i>LSD (5%)</i>	<i>0.37</i>	<i>0.43</i>	<i>32.61</i>	<i>37.93</i>

CONCLUSIONS

The results of the work presented indicate that:

- With the exception of where the crop is sown into poor seedbed conditions, hybrid varieties can be sown at low seeding rates without loss of yield. When conditions are poor, yield losses can occur if low seeding rates are used.
- In good sowing conditions, hybrids can give greater yields than pure-line varieties at reduced seeding rates. However, the effect is not large or consistent.
- There is generally no effect of seeding rate on the grain quality of hybrid varieties.
- Crop lodging can be a problem with hybrid varieties, particularly as seeding rate is increased.
- Of the hybrid varieties examined Mercury and Hyno Esta were the two better varieties in terms of grain yield.

- Differences in quality parameters between the four hybrids examined were generally small.
- Hybrid varieties exhibited a similar response to fungicide application as pure-line varieties.
- The best hybrid varieties do not necessarily give consistently higher yields or quality than the best pure-line varieties.
- Based on the results of these trials it would appear that, when the price differential between seed of pure-line varieties and hybrid varieties is taken into account, the winter wheat hybrid varieties currently available do not offer any economic advantages to commercial growers at the present time.

