

Comparative trials of elite Swedish and UK biomass willow varieties

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Summary

UK willow variety trials are planted at four sites at IACR-Long Ashton in Bristol, Markington in North Yorkshire, North Molton in Devon and Loughgall in County Armagh. The trials normally comprise between five and ten elite willow lines including two yield controls (L78183 and 'Tora'). Between 1991-95, the trial design included 10 replicates of 10 plants (double rows of five) planted at a stocking rate of 20,000 cuttings per hectare. Subsequent trials included three replicates of each variety (52 plants per plot) in a randomised plot design. Typically, the duration of a trial is 6 years comprising an establishment year followed by a two-year harvest and a three-year harvest.

'Ashton Stott' has been found to be the most productive variety with a mean yield of 15.4 oven dry tonnes per hectare per year from 16 harvests. This equates to 243% of the control clone L78183. 'Ashton Parfitt' the sibling of Stott has also yielded highly with an average of 13.9 ODT/ha/yr from 9 harvests. 'Tora' is the highest yielding variety originating from the Svalöf-Weibull breeding programme with an average yield of 12.8 ODT/ha/yr from 23 harvests. At IACR-Long Ashton, the *S. viminalis* clone Bowles Hybrid has produced high yields but its overall yield performance is low as it is severely affected by rust, particularly at the Northern Ireland sites.

In 2001, the first yield trials involving willows bred by the European Willow Breeding Partnership (EWBP) will be harvested. Early results will be exhibited at the conference.

Key words: *Salix*, short rotation coppice, biomass, yield, breeding, trials, varieties.

Introduction

Willow breeding programmes were initiated in Sweden in 1987 and the UK in 1996 (Åhman and Larsson, 1994, Lindegaard and Barker, 1997). The primary aims of these programmes are to produce high yielding disease and pest-resistant varieties with a growth habit that facilitates mechanical harvesting. The majority of the crosses made by the Swedish breeding programme at Svalöf-Weibull AB have involved *S. viminalis*, *S. dasyclados* and *S. schwerinii*. The original parental material was based on Swedish and central European collections, later supplemented by collecting expeditions to central Russia and Siberia (Larsson, 1998). The UK breeding programme based at IACR-Long Ashton (funded by the European Willow Breeding Partnership) has utilised over twenty different species held at the UK National Willows Collection. These include exotic equivalents of *S. viminalis* and *S. caprea* such as *S. rehderiana*, *S. udensis*, *S. schwerinii*, *S. discolor* and *S. aegyptiaca*.

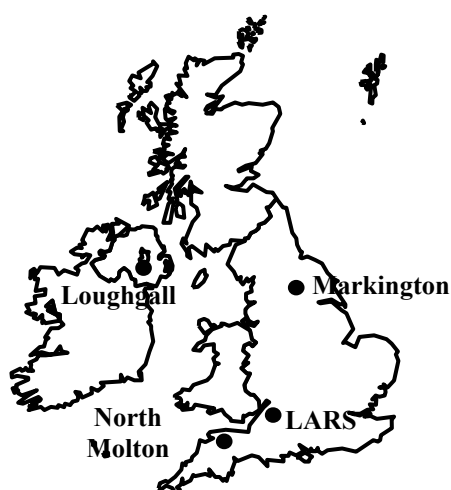
The progeny of crosses are initially raised as seedlings in a breeding nursery and subsequently as cuttings in field based observation trials. At each stage 5-10% are selected for further evaluation (Larsson and Åhman, 1994, Lindegaard and Barker, 1997). Following the second observation trial, selections are included in yield trials at four or five locations in the UK and Sweden. The breeding scheme being followed by both programmes is described in detail by Lindegaard (2002).

Materials and Methods

Sites

In the UK, yield trials are planted at four sites at IACR-Long Ashton in Bristol, Markington in North Yorkshire, Loughgall in County Armagh and North Molton in Devon (Figure 1). The first three sites have been used since 1991 whilst North Molton was added in 1994.

Figure 1: UK yield trial sites.

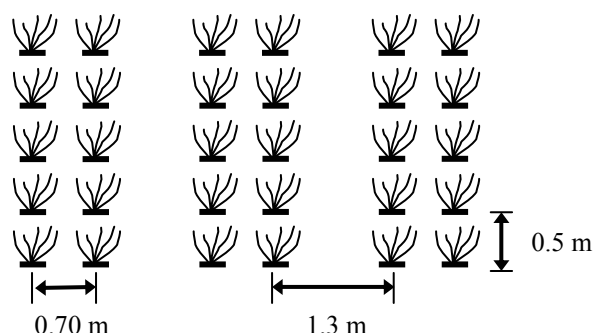


Trial design

Between 1991-95 the trial design followed International Energy Agency (IEA) protocols comprising double rows of five plants randomised in blocks. Each variety had ten replicates. Cuttings were planted with a spacing of 0.5 m within rows, 0.7 m

between each double row and 1.3 m between varieties (Figure 2). The stocking rate of each trial was 20,000 cuttings per hectare. Two reference clones were included in the trials: *S. viminalis* ‘Bowles Hybrid’ and *S. viminalis* L78183.

Figure 2: The planting design used in the yield trials (after Armstrong, 1999).



From 1996 onwards the trial design followed Forestry Commission guidelines in accordance with plant variety testing practices (Tabbush and Parfitt, 1999). These trials consist of individual plots (4 x 6m) containing 52 plants with three replicate plots of each variety. At IACR-Long Ashton, Markington and North Molton the spacings between cuttings and stocking rate were identical to the earlier trials. At the Loughgall site the spacing within the row was altered to 0.65m giving a stocking rate of 15,000 stools per hectare.

L78183 remained as the standard reference clone but ‘Bowles Hybrid’ was replaced as the high yielding reference by the variety ‘Tora’. This was due to the inconsistency of ‘Bowles Hybrid’ resulting from its susceptibility to rust, particularly at the Loughgall trials (Dawson, pers. comm.).

Planting material and trial management

UK planting material was collected from the National Willows Collection held at IACR-Long Ashton whilst Swedish planting material was provided by Svalöf Weibull AB. 60 varieties have been tested in yield trials to date and are listed in Table 1.

Hardwood cuttings, 20cm in length were planted in March-May each year. The preparation of the planting sites and establishment of the trials adhered to industry guidelines (Armstrong, 1999). Following the establishment year, the plantations were coppiced at ground level in order to promote vigorous growth from multiple stemmed stools. At IACR-Long Ashton each trial was first harvested at the end of year three having two-year old stems on three-year old roots (2S 3R). Following harvesting the trials were grown for a further three years, before a second harvest of three-year old stems (3S 6R). The trials were terminated after the second harvest. Some variations of this cropping cycle have occurred at the other sites. For instance, the Markington and North Molton sites have recently adopted a single harvest at year three (S3 R4).

Dry weight analysis

From the trials planted between 1991-95 each of the 100 plants of an individual variety were included in the yield analysis. From 1996 onwards under the new Forestry Commission protocol the central 26 stools of each replicate block were analysed. Fresh weights were measured in the field by means of a large balance mounted on a tractor-trailer. Oven dry weights were obtained by selecting three to ten

whole stool samples which were cut into 40 cm lengths and dried in an oven at 100°C for 48 hours. Oven dry weights were measured and the percentage dry matter per sample was determined by dividing the dry weight by the sample fresh weight. The mean percentage dry matter was calculated for each variety and yields estimated using the following formulas:

$$\text{Fresh weight/plot (Kg)} \times \text{Mean percentage dry matter} = \text{Oven dry weight/plot (Kg)}$$

$$\frac{\text{Oven dry weight/plot (Kg)}}{\text{Number of stools/plot}} \times \text{Stocking rate} = \text{Oven dry weight (Kg) per hectare}$$

$$\frac{\text{Oven dry weight (Kg) per hectare}}{1000} = \text{Oven dry weight (tonnes) per hectare}$$

$$\frac{\text{Oven dry weight (tonnes) per hectare}}{\text{Number of years}} = \text{Oven dry weight (tonnes) per hectare per year}$$

Table 1: Varieties tested in Yield trials planted between 1991-1998.

Pedigree	Representatives
<i>S. viminalis</i>	L78183, 810217 'Eva', 811110 'Lisa', 811208, 812509, 812518, 821624 'Hanna', 821629 'Christina', 830203, 832501 'Marie', 832502 'Anki', 832803 'Gustaf', SW870082 'Orm', SW870083 'Rapp', SW870148 'Ulv', SW880156, SW880186, SW880233, SW880514, SW880013 'Jorr', SW880205 'Jorunn', SW880435 'Astrid', 115/34 Bowles Hybrid, 115/15 Gigantea, LA960326 'Beagle'
<i>S. viminalis</i> x <i>schwerinii</i>	SW910006 'Bjorn', SW910007 'Tora', SW930387 'Olof', SW930469, SW930481, SW930527, SW930722, SW930725 'Torhild', SW930769, SW930824 'Sven', SW930935 'Asgerd', SW960299 'Tordis', SW960504 'Sherwood', SW960231 'Quest'
<i>S. dasyclados</i>	SW 'Aud', SW890129 'Loden', SW040598 'Gudrun'
<i>S. x stottii</i> (= <i>S. viminalis</i> x <i>burjatica</i>)	034/01 Stott 1, 034/02 Stott 2, 034/03 Stott 3, 034/04 Stott 4, 034/07 Stott 7, 034/08 Stott 8, 034/10 'Ashton Stott', 034/11 'Ashton Parfitt'
<i>S. viminalis</i> x <i>candida</i>	LA940009, LA940052, LA940068
<i>S. burjatica</i>	033/15 Lapin
<i>S. schwerinii</i>	'Aage', 'Hendrick', 'Stephan'
<i>S. spaethii</i>	111/01 Spaethii
<i>S. x sericans</i>	041/08

Rust assessments

An overall plot assessment was done for each willow genotype at LARS in 1997 and 2000-2001 using a categorical scoring system with 0 equalling no rust detected and 6 equalling severe infection (Hunter, pers. comm.). The central double row was

assessed visually for presence of active rust uredinia. The system was devised to give a comparative indication of rust levels at a time in the season when rust was actively developing (late August).

Results

Yields

Estimated dry weight yields for the 1991-95 trials are presented in Table 2 and the 1996-98 trials in Table 3. Trial means and variety means are shown in both. Table 4 indicates the relative mean yields for first and second rotations and presents the overall yield figures as a percentage of the control L78183. Table 5 gives the rust data for each variety from assessments made at IACR-Long Ashton.

Table 4: Summary of yield figures for UK and Swedish willow varieties. (* indicates commercially released varieties with plant variety rights).

Variety	Number of trials	Number of harvests	Mean yield (no. of harvests)		Overall mean (ODT/ha/yr)	% of L78183
			1 st rotation	2 nd rotation		
Old Varieties						
L78183	24	35	6.50 (27)	5.71 (8)	6.32	100
115/34 Bowles Hybrid	17	28	8.17 (20)	8.03	8.13	129
SW Varieties						
SW870082 'Orm' *	11	19	11.52 (12)	10.71 (7)	11.20	177
SW870083 'Rapp' *	10	18	9.53 (11)	7.90 (7)	8.90	141
SW870148 'Ulv' *	13	23	9.31 (15)	10.54 (8)	9.73	154
SW880156	6	13	10.05 (7)	8.33 (6)	9.26	147
SW880186	6	13	7.87 (7)	7.12 (6)	7.53	119
SW880233	6	13	8.02 (7)	5.49 (6)	6.85	108
SW880514	6	13	11.00 (7)	11.19 (6)	11.09	175
SW880013 'Jorr' *	11	18	9.42 (12)	10.8 (6)	9.88	156
SW880205 'Jorunn' *	14	24	9.36 (17)	8.08 (7)	8.99	142
SW880435 'Astrid' *	6	13	9.21 (7)	6.98 (6)	8.18	129
SW890129 'Loden' *	6	7	8.87 (6)	17.04 (1)	10.03	159
SW910006 'Bjorn' *	6	11	10.89 (6)	11.59 (5)	11.21	177
SW910007 'Tora' *	17	23	11.61 (18)	16.95 (5)	12.77	202
SW930387 'Olof' *	2	2	8.91	/	8.91	141
SW930469	4	4	8.16	/	8.16	129
SW930481	4	4	7.29	/	7.29	115
SW930527	4	4	9.28	/	9.28	147
SW930722	4	4	9.55	/	9.55	151
SW930725 'Torhild' *	6	6	9.46	/	9.46	150
SW930769	4	4	10.58	/	10.58	167
SW930824 'Sven' *	6	6	10.71	/	10.71	169
SW930935 'Asgerd' *	2	2	9.05	/	9.05	143
EWBP Varieties						
034/10 'Ashton Stott' *	10	16	14.56 (12)	17.84 (4)	15.38	243
034/11 'Ashton Parfitt' *	4	9	13.05 (5)	15.00 (4)	13.92	220

Rust

Disease data from the IACR-Long Ashton site over the years has shown that few willow genotypes remain completely rust free. An exception is 'Tora' from the SW

programme which has not developed rust in these UK trials. The Swedish commercial standard, L78183, was always amongst the most severely infected at all sites. 'Bowles Hybrid' has become progressively more infected at a number of the sites and because it is also susceptible to the Stem Infecting Form (SIF) of rust growth has been greatly affected. 'Ashton Stott' was assessed as having some rust development in 2001 with an apparent increase over previous years but continues to yield highly. Generally, new introductions are more rust resistant than older varieties.

Discussion

Due to time constraints the yield data has yet to be analysed statistically. However, it is possible to draw conclusions from the raw data presented in Tables 2 and 3. Although there is a great deal of variation between sites, rotations and varieties overall trends exist.

Mean percentage dry matter varied considerably within varieties, between varieties and between years and ranged between 40-50%. However, preliminary statistical analysis suggests that this has little correlation with dry matter yield (Arnold, pers. comm.).

The LARS site is generally more productive than the others with an average trial yield of 11.59 oven dry tonnes per hectare per year. This compares to 9.13 odt/ha/yr for North Molton, 8.76 odt/ha/yr for Loughgall and 7.94 odt/ha/yr for Markington. This ranking is most likely due to a number of abiotic factors that include soil and climate. The soil at the LARS site is a fertile stagnogleyic argillic brown earth (code 572) and was identified as one of the best soil types for SRC production (Armstrong *et al.*, 2000). The Loughgall sites used for the majority of the yield trials have heavy clay loams with an underlay of limestone and are situated on exposed hills. The 1995 Loughgall trial was sited on a more sheltered site with a rich soil and produced far greater yields. Markington is on a grade three loam whilst North Molton is on a light shillet soil. The LARS trials are the only ones that are fertilised, normally to a level of 60:60:60 Kg/ha unless P or K are over index 2.5. These results therefore illustrate both a relatively high and low input systems.

The LARS and Loughgall sites are generally planted in March whereas the Markington and North Molton sites are planted during May. Research conducted by Parfitt (in press) suggests that there is significant yield penalty associated with late spring planting. Without statistical analysis it is impossible to say yet whether the stocking rate employed at Loughgall has any significant effect on yield.

The initial trial design was effectively a random mixed clone planting. The newer design involves replicated monoclonal blocks. The latter has the advantage that competition effects are minimised as each variety is guarded on either side by itself. This means that the performance of a variety is not distorted by its placement next to a high or low yielding variety. Table 3 shows that the latter trial design seems to provide more consistent results but on the whole yields seem to be lower than for the earlier design. This is probably due to the removal of extremes caused by competition. Alternatively, the relatively high results of the original design might be explained by the synergistic benefits of mixtures (McCracken, Dawson and Bowden, 2001).

Recent research has indicated that the economic threshold for growing SRC willows is 10-12 ODT/ha/yr depending on input costs and the price paid for the woodchip. Of those varieties tested three have an average yield that surpasses this level. These are 'Ashton Stott' (15.4 ODT/ha/yr), 'Ashton Parfitt' (13.9 ODT/ha/yr), 'Tora' (12.8 ODT/ha/yr). 'Ashton Stott' and 'Ashton Parfitt' were bred in 1986 at

IACR-Long Ashton from an *interspecific* cross between *S. viminalis* 'Bowles Hybrid' and *S. burjatica* 'Korso' (Parfitt, 1999). They combine the desirable traits of the parents and have broad lanceolate leaves, are tall and upright and may reach basal diameters of 50mm as three-year old coppice. Although both parents have since become very susceptible to rust 'Ashton Stott' and 'Ashton Parfitt' remain largely unaffected. 'Ashton Stott' equates to 243% of the standard clone L78183.

Newly released varieties such as 'Sven' and 'Torhild' have on occasions yielded over 12 ODT/ha/yr but generally fall in the range between 10-12 ODT/ha/yr. SW930769 has produced consistent yields but is spreading in form. The performance of these clones compared to the control clone L78183 mirror Swedish results (see Larsson, this volume).

All of these cultivars are *interspecific* hybrids made by crossing individuals from different species. The performance of these varieties far exceeds the average yield of the *intraspecific* (within species) hybrids. The UK willow breeding programme has based its breeding strategy on these factors and from the 785 crosses made between 1996-2000, 404 (51.5%) were *interspecific* crosses and 215 (27.4%) were complex combinations of three and four species (Lindegaard, 2001). These types of crosses are beneficial because they maximise heterozygosity and the breeder may select specific gene combinations demonstrating heterosis. Hybrid vigour in such crosses is due to the trapping of dominant and epistatic gene action without eliminating or masking favourable recessive genes (Stettler, Zsuffa and Wu, 1996).

Of the older varieties 'Orm', 'Bjorn' and 'Jorr' have acceptable yields but generally lack quality for cutting production. 'Orm' and 'Bjorn' have wavy stems that block planting machines whilst 'Jorr' suffers from the stem infecting form of willow rust and has cankering of the stems. The yield of 'Jorunn' can suffer from being weighed down by its catkins bearing copious quantities of seed. 'Bowles Hybrid' has performed impressively at IACR-Long Ashton with an average yield of 13.5 ODT/ha/yr but at other sites, particularly Loughgall the yield has plummeted due to high susceptibility to rust. Nevertheless, there is evidence that this variety may maintain yield potential as a component of mixtures (see Hunter, this volume). With an average yield over 11 ODT/ha/yr it would seem that SW880514 is rather unlucky to have missed out on commercial release. The *S. dasyclados* variety 'Loden' is a short broad-leaved willow with an acceptable yield. It has the added benefit of adding genetic diversity to a mixture.

Table 4 indicates that the highest yielding varieties such as 'Ashton Stott' and 'Tora' increase their yield in the second rotation by between 20-40%. The older *S. viminalis* varieties generally do not share this trend in these trials. This reaction is probably a result of the mixed nature of the old trial design in which the more elite varieties tended to out compete those that were less vigorous. Swedish results (presented by Larsson, this volume) have shown yield increases in second rotation for all varieties. However, those results were all attained from the more recent trial design. The UK trials planted in 1996 (the first with the new design) will have its second rotation harvest in 2001-02 and will provide further insight into this phenomenon.

Rust resistance in bred varieties is generally very good. Table 5 shows that newer varieties have a lower level of infection than older ones. This is because new sources of resistance outside the *S. viminalis* spectrum have been used in crosses. The breeding objective is to produce resilient varieties with horizontal resistance to the rust pathogen. Crosses involving novel sources of germplasm can produce resistant progeny through additive, dominance or epistatic gene action (see Pei *et al* this volume).

The data presented in this paper suggests that ‘Ashton Stott’ and ‘Tora’ are the current industry standards. Several other newly available varieties also demonstrate very good yield prospects and excellent disease resistance. With these and planned releases over the next two to three years, the average SRC plantation yields should be raised to that of ‘Tora’. In the medium term an average yield equivalent to that of ‘Ashton Stott’ should be possible. Achieving such yield figures will greatly improve the economic sustainability of SRC willows. This will not only benefit growers but will also add greater momentum to the entire biomass industry.

Acknowledgements

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Table 3. UK yield trial data 1996-98 – new Forestry Commission design

	1996				1997				1998			1999		Mean
	LARS1 S2R3	S3R6	NI1 S2R3	Devon S3R4	LARS1 S2R3	NI1 S2R3	Yorks S2R4	Devon S3R4	LARS1 S2R3	NI1 S2R3	Yorks S2R4	LARS1 S2R3	NI1 S2R3	
Older varieties														
L78183	9.18	9.00	4.91	4.58	5.65	7.06	2.92	3.77	8.10	5.25	5.26	8.31	3.63	5.97
115/34 Bowles Hybrid	11.55	8.73		10.49										10.26
033/15 Lapin									6.53	4.58	5.16			5.42
Aage	5.04	1.79												3.42
Hendrick	4.19	2.02												3.11
Stephan	3.22	1.64												2.43
SW Varieties														
SW880013 'Jorr' *					9.48	11.73	7.13	5.45						8.45
SW880205 'Jorunn' *	10.93	8.03	8.58	4.54										8.02
SW 'Aud'	8.21	8.04	7.02	8.62										7.97
SW890129 'Loden' *	11.91	12.41	7.87	8.70			7.41							9.66
SW910007 'Tora' *	13.15	11.89	8.18	11.03	9.50	12.06	10.40	11.32	11.54	9.53	9.17	12.79	6.50	10.54
SW930387 'Olof' *									11.73	6.08	7.86	13.34	6.49	9.10
SW930469	12.53	10.96	7.38	3.82			8.92							8.72
SW930481	8.14	9.63	7.45	7.69			5.87							7.76
SW930527	11.39	9.72	7.69	8.26			9.78							9.37
SW930722					8.06	12.50	8.37	9.28						9.55
SW930725 'Torhild' *					7.65	12.37	10.22	10.06	9.98	6.45	6.74			9.07
SW930769					10.97	11.48	9.29	10.58						10.58
SW930824 'Sven' *					10.32	12.61	10.48	12.74	11.53	6.60	7.73			10.29
SW930935 'Asgerd'									10.82	7.28	7.14			8.41
SW940598 'Gudrun'												8.24	6.53	7.39
EWPB Varieties														
034/10 Ashton Stott *	15.93	15.01										12.59	4.65	12.05
LA940068												10.27	6.00	8.14
LA960231 'Quest'												9.86	5.66	7.76
LA960326 'Beagle'												11.50	6.11	8.81
Mean	9.64	8.37	7.39	7.53	8.80	11.40	8.25	9.03	10.03	6.54	7.01	10.77	5.64	8.49

* indicates commercially released varieties with plant variety rights

1 Denotes trials that will have a second rotation

Latest yields in bold

Table 5: Mean scores of rust incidence on various trials at IACR-Long Ashton in 1997, 2000 and 2001.

LARS Trial No.	205	209	212	213	214	215	216	212	213	214	215	216	217
Older Varieties													
L78183	2.00	2.33	3.61	1.79	2.96	1.50	1.00	3.78	2.21	3.21	3.61	2.22	1.72
115/34 Bowles Hybrid			1.80					1.78					
033/15 Lapin					0.00					0.00			
001/01 Shrubby willow							0.00					0.00	
041/08 S. x sericans							1.06					1.67	
SW Varieties													
SW870082 'Orm'	1.33	1.33											
SW870083 'Rapp'	1.33	1.33											
SW870148 'Ulv'	1.00	1.00											
SW880156	1.33	2.00											
SW880186	2.00	2.00											
SW880233	1.67	2.00											
SW880514	1.33	1.00											
SW880013 'Jorr'	1.33	1.67		2.12									
SW880205 'Jorunn'	1.33	1.67	0.67					1.11	1.79				
SW880435 'Astrid'	1.33	2.00											
SW890129 'Loden'			0.00					0.00					
SW 'Aud'			0.00					0.00					
SW910006 'Bjorn'													
SW910007 'Tora'			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SW930387 'Olof'					0.50	0.33				0.79	0.44		
SW930469			1.28					1.83					
SW930481			0.83					0.72					
SW930527			1.10					0.83					
SW930722				0.88					0.13				
SW930725 'Torhild'				0.04	0.00				0.75	0.13			
SW930769				0.13					0.08				
SW930824 'Sven'				0.08	0.21				0.42	0.04			
SW930935 'Asgerd'					0.00					0.00			
SW940598 'Gudrun'						0.00					0.06		
SW960299 'Tordis'							0.00					0.39	
SW960504 'Sherwood'													0.78
EWPB Varieties													
034/10 'Ashton Stott'			1.30			0.11		0.61			0.83		
LA940009							1.61					2.39	
LA940052							0.00					0.17	0.06
LA940068						0.78					0.39		
LA960231 'Quest'						0.17					0.39		
LA960326 'Beagle'						1.56					0.89		
LA980024													0.00
LA980289													0.00
LA980414													0.00
SED	0.302	0.294	0.137	0.150	0.145	0.265	0.083	0.263	0.672	0.140	0.278	0.227	0.166
df	28	32	18	18	17	13	12	18	18	17	13	12	12
LSD	0.618	0.599	0.266	0.315	0.306	0.573	0.181	0.552	1.413	0.295	0.601	0.495	0.362

Table 2. UK yield trial data 1991-95 – original IEA design

	1991						1992						1993						
	LARS		NI			Yorks	LARS		NI			Yorks	LARS		NI		Yorks		
	S2R3	S3R6	S2R3	S2R5	S3R8	S3R4	S2R3	S3R6	S2R3	S2R5	S3R8	S3R4	S3R7	S2R3	S3R6	S2R3	S3R6	S3R4	S3R7
Old Varieties																			
L78183	12.63	9.92	7.35			6.12	9.68	7.93	8.38	6.79	7.63	6.17	4.49	6.94	4.32	7.91	4.28	6.76	4.47
810217 'Eva'			7.24	7.04	7.20														
811110 'Lisa'																			
811208			9.83	8.02	9.11														
812509			9.09	6.82	8.12														
812518			7.26	5.87	6.47														
821624 'Hanna'			10.74	8.90	11.88														
821629 'Christina'			9.54	7.52	10.14														
830203			12.70	10.15	13.58														
832501 'Marie'																			
832502 'Anki'																			
832803 'Gustaf'			11.71	9.08	11.02														
115/34 Bowles Hybrid	18.15	14.78	7.53			10.34	16.36	14.62	7.47	5.64	3.81	7.78	6.67	10.39	8.50	3.64	3.11	6.83	5.58
115/15 Gigantea																			
111/01 Spaethii																			
SW Varieties																			
SW870082 'Orm' *	18.25	14.95	7.62			11.98	14.06	14.55	8.79	9.57	13.56	6.51	6.23	10.29	9.18	15.59	11.93	7.96	8.14
SW870083 'Rapp' *	14.07	11.06	7.83			9.28	11.59	10.40	8.11	7.28	7.57	7.11	6.30	8.92	6.69	11.29	6.76	8.32	6.82
SW870148 'Ulv' *	17.62	15.03	7.87			8.94	12.64	15.64	9.37	8.62	9.41	6.64	7.82	9.88	11.31	11.09	10.16	6.66	10.18
SW880156							13.22	10.53	10.44	10.82	13.99	7.75	6.28	8.55	6.97	9.65	9.35	6.76	6.04
SW880186							11.25	11.20	8.87	8.44	7.79	6.92	6.57	9.32	6.66	3.81	2.82	7.16	7.04
SW880233							11.35	9.09	8.64	5.79	6.60	6.42	4.43	7.77	4.64	8.24	4.78	7.09	4.22
SW880514							16.26	15.20	9.47	12.17	15.92	6.55	8.07	10.35	9.97	10.25	11.89	8.21	9.82
SW880013 'Jorr' *							13.37	13.20	9.05	10.14	11.28	7.56	8.31	9.86	9.95	11.22	12.13	9.19	11.07
SW880205 'Jorunn' *							16.65	10.61	9.91	10.38	11.47	6.89	5.95	10.66	6.78	12.15	11.57	5.41	6.27
SW880435 'Astrid' *							13.64	9.35	8.20	8.86	10.38	6.47	4.71	9.67	6.03	9.64	7.68	6.46	5.27
SW890129 'Loden' *																			
SW910006 'Bjorn' *														10.24	14.23	13.95	17.21	8.84	12.93
SW910007 'Tora' *														14.00	16.36	15.20	19.36	11.68	16.30
EWBP Varieties																			
034/01 Stott 1									6.24	8.35	2.76			8.15	6.01				
034/02 Stott 2									6.19	6.78	6.23								
034/03 Stott 3									8.45	7.57	5.20								
034/04 Stott 4									7.39	6.58	4.16								
034/07 Stott 7									9.54	9.89	9.76								
034/08 Stott 8							11.34	9.67	7.31	7.40	4.91	8.13	9.52						
034/10 'Ashton Stott' *							22.17	21.30	10.04	14.78	13.99	11.27	14.79	15.48	20.50				
034/11 'Ashton Parfitt' *							17.32	17.47	11.93	11.37	13.07	10.58	15.53	12.36	15.64				
Mean	16.14	13.15	8.95	7.93	9.69	9.33	14.06	12.72	8.69	8.86	8.97	7.52	7.71	10.17	9.63	10.26	9.50	7.67	8.15

Table 2. UK yield trial data 1991-95 – original IEA design (continued)

	1994						1995			Mean
	NI			Yorks	Devon		NI		Devon	
	S2R3	S2R3	S2R5	S3R5	S2R4	S3R4	S3R4	S3R6	S3R4	
Old Varieties										
L78183	4.13	3.49	5.54	4.14	9.05	4.76	6.11	7.75	3.05	6.53
810217 'Eva'				4.99						6.62
811110 'Lisa'				3.59						3.59
811208				8.19						8.79
812509				4.51						7.14
812518				5.46						6.27
821624 'Hanna'				5.20						9.18
821629 'Christina'				7.65						8.71
830203				0.60						9.26
832501 'Marie'				8.68						8.68
832502 'Anki'				5.21						5.21
832803 'Gustaf'				5.79						9.40
115/34 Bowles Hybrid	0.95	5.31	4.52	6.69	14.48	7.16	5.86	6.33	3.05	7.91
115/15 Gigantea							8.20	14.34		11.27
111/01 Spaethii							4.94	4.11	6.05	5.03
SW Varieties										
SW870082 'Orm' *					12.97	10.64				11.20
SW870083 'Rapp' *					10.73					8.90
SW870148 'Ulv' *	4.73	5.52	7.04	8.08	12.26	7.38				9.73
SW880156										9.26
SW880186										7.53
SW880233										6.85
SW880514										11.09
SW880013 'Jorr' *						7.73				10.29
SW880205 'Jorunn' *	5.38	4.97	9.86	6.55		7.67	11.01	17.55	3.94	9.13
SW880435 'Astrid' *										8.18
SW890129 'Loden' *							9.92	17.04	7.39	11.45
SW910006 'Bjorn' *	8.23	5.56	7.45	9.92		14.73				11.21
SW910007 'Tora' *	8.59	4.97	8.41	12.83		15.73	18.02	24.33	11.20	14.07
EWBP Varieties										
034/01 Stott 1					7.39					6.48
034/02 Stott 2										6.40
034/03 Stott 3										7.07
034/04 Stott 4										6.04
034/07 Stott 7										9.73
034/08 Stott 8										8.33
034/10 'Ashton Stott' *				16.71	17.54	15.80	12.07	11.34	12.35	15.34
034/11 'Ashton Parfitt' *										13.92
Mean	5.34	4.97	7.14	6.93	12.06	10.18	9.52	12.85	6.72	9.46

* indicates commercially released varieties with plant variety rights