

# Experiment Types

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## Experiment types

A network of 49 field experiments was established to investigate the effect of site variables, such as soil type and rainfall, on the biomass production of several SRC varieties (see Appendix 1).

Five experiment types were used;

- **Extensive (Pure)**  
These 28 experiments provide modellers with information on how monoclonal plots of 6 SRC varieties perform on different site types. Information collected from these sites is used to create empirical yield models for each variety.
- **Extensive (Mixture)**  
These 14 experiments investigate differences in yield between monoclonal plots of 6 SRC varieties and 'mixture' plots containing row by row mixtures of either 3 willow or 3 poplar varieties.
- **Intensive**  
These larger experiments provide information on how a broader range of SRC varieties perform on different site types. Thirty two varieties are present at the Intensive sites including the 6 used in the Extensive experiments. Data is used to adapt empirical yield models to estimate biomass production of the increased range of varieties.
- **Physiology**  
These 2 nursery experiments investigate the physiology of the 3 willow and 3 poplar SRC varieties.
- **Wishanger (spacing)**  
This experiment investigates the effect of planting density on yield and provide baseline data for the development of a non-destructive yield assessment methodology.

## Extensive (Pure)

### Objectives

To assess the effects of site factors on the dry-matter production for 6 standard varieties grown as short rotation coppice. Experimental treatments applied at each of 28 sites:

- Varieties
- Plot size
- Statistical analysis.

### Varieties

Poplars:

G - *P. x euramericana* ('Ghoy')

B - *P. x interamericana* ('Beaupré')

T - *P. trichocarpa* ('Trichobel')

Willows:

V - *S. viminalis* ('Jorunn')

G - *S. burjatica* ('Germany')

Q - *S. triandra x viminalis* ('Q83')

To reduce edge effects, poplars and willows are not randomised together but are planted in separate experiments on the same site. A fully randomised layout in each experiment (either poplar or willow) has been adopted because there are relatively few treatments, and therefore a need to maximise the number of degrees of freedom available to determine the residual. This is justified because the experiments are small and there is unlikely to be a marked trend on these relatively uniform agricultural sites. The experiments are located so as to avoid changes in site conditions across the experiment.

Thus for each experiment: 3(treatments) x 3(replicates) = 9 plots.

### Plot size

Plots are 10 trees x 10 trees with a 6 trees x 6 trees assessment plot (as in the intensive experiments).

Spacing is alternately 1.5m and 0.75m between rows, and 0.9m in the rows, to give a stocking of 10,000 cuttings/hectare.

### Statistical analysis

The experiments are intended to be analysed together. but the analysis of variance (ANOVA) for 1 site is:

- Treatments: 2
- Residual: 6
- Total: 8

### Basic Treatments

Sites are chosen on reasonably uniform arable (or improved grassland) sites. They are selected for the widest possible coverage of site types, according to the Ecological Site Classification worked out by Dr Pyatt.

The sites are:

1. Completely cleared
2. Sprayed with "Roundup" at 5 litres/hectare
3. Subsoiled to break any plough-pan or compaction
4. Ploughed and harrowed.

Deer/rabbit fencing is used.

25cm cuttings are inserted in the period January-March:

1. A spacing of alternately 1.5 and 0.75m between rows and 0.9m within the rows is applied to all varieties for comparability
2. Residual herbicide is then be applied before flushing
3. Thereafter, weeds are vigorously controlled as necessary.

In the following winter, the shoots are cut back to a single stump, 5cm above the ground (maiden cut).

### **Requirements**

1. Site area: 0.18hectare (net), 0.25hectare (gross)
2. 300 cuttings of each variety
3. Fencing
4. Herbicides.

### **Records and Assessments**

1. Plots are assessed for height and diameter at the end of the first and second year after the maiden cut, and again at harvest after three years growth.
2. Dry weight is assessed at harvest.
3. Soil data is obtained at site establishment
4. Climatic data is obtained throughout the experiment.

## Extensive (Mixed)

### Objectives

To assess the effects of site factors on the dry-matter production for 6 standard varieties grown as short rotation coppice. Experimental treatments applied at each of 16 sites:

- Varieties
- Plot size
- Statistical analysis.

### Varieties

Poplars:

G - *P. x euramericana* ('Ghoy')

B - *P. x interamericana* ('Beaupré')

T - *P. trichocarpa* ('Trichobel')

PM - A three-way mixture with equal proportions of 'G', 'B' and 'T'.

Willows:

V - *S. viminalis* ('Jorunn')

G - *S. burjatica* ('Germany')

Q - *S. triandra x viminalis* ('Q83')

WM - A three-way mixture with equal proportions of 'V', 'D' and 'Q'.

To reduce edge effects, poplars and willows are not randomised together but are planted in separate experiments on the same site. A fully randomised layout in each experiment (either poplar or willow) has been adopted because there are relatively few treatments, and therefore a need to maximise the number of degrees of freedom available to determine the residual. This is justified because the experiments are small and there is unlikely to be a marked trend on these relatively uniform agricultural sites. The experiments are located so as to avoid changes in site conditions across the experiment.

Thus for each experiment: 4(treatments) x 3(replicates) = 12 plots.

### Plot size

Single-variety plots are 10 trees x 10 trees with a 6 trees x 6 trees assessment plot (as in the intensive experiments). Mixture plots will be 10 double rows wide, and 19 "columns" deep, and so contain an assessment plot of 9 trees x 9 trees.

Spacing is alternately 1.5m and 0.75m between rows, and 0.9m in the rows, to give a stocking of 10,000 cuttings/hectare.

### Statistical analysis

The experiments are intended to be analysed together. but the analysis of variance (ANOVA) for 1 site is:

- Varieties: 15
- Blocks: 2
- Residual: 30
- Total: 47

### Basic Treatments

Sites are chosen on reasonably uniform arable (or improved grassland) sites. They are selected for the widest possible coverage of site types, according to the Ecological Site Classification worked out by Dr Pyatt.

The sites are:

1. Completely cleared
2. Sprayed with "Roundup" at 5 litres/hectare
3. Subsoiled to break any plough-pan or compaction
4. Ploughed and harrowed.

Deer/rabbit fencing is used.



25cm cuttings are inserted in the period January-March:

1. A spacing of alternately 1.5 and 0.75m between rows and 0.9m within the rows is applied to all varieties for comparability
2. Residual herbicide is then be applied before flushing
3. Thereafter, weeds are vigorously controlled as necessary.

In the following winter, the shoots are cut back to a single stump, 5cm above the ground (maiden cut).

### Requirements

1. Site area: 0.48hectare (net), 0.6hectare (gross)
2. 681 cuttings of each variety
3. Fencing
4. Herbicides.

### Records and Assessments

1. Plots are assessed for height and diameter at the end of the first and second year after the maiden cut, and again at harvest after three years growth.
2. Dry weight is assessed at harvest.
3. Soil data is obtained at site establishment
4. Climatic data is obtained throughout the experiment.

## Intensive

### Objectives

To compare the growth of 16 varieties each of poplar and willow, grown as short rotation coppice, in relation to climatic and soil variables, on 7 sites in Britain and Northern Ireland. Experimental treatments applied at each of the 7 sites:

- Varieties
- Plot size
- Statistical analysis.

### Varieties

16 each of poplar and willow, including recommended varieties and some new ones, which are close to commercialisation.

To reduce edge effects, poplars and willows are not randomised together but planted in separate experiments on the same site. A randomised block design has very little disadvantage compared with fully randomised or incomplete block designs with this number of treatments, and has the advantage that it is suitable for the varying site conditions which are likely to be encountered.

Thus for each experiment: 16(varieties) x 3(randomised blocks) = 48 plots.

### Plot size

100 trees (10 x 10) with a 36 tree (6 x 6) assessment plot.

Spacing is alternately 1.5m and 0.75m between rows, and 0.9m in the rows, to give a stocking (almost) of 10,000 cuttings/hectare.

This plot size is sufficient to provide some extra guard rows to allow for a small amount of destructive sampling, whilst minimising edge-effects.

### Statistical analysis

The degrees of freedom for each experiment are:

- Varieties: 15
- Blocks: 2
- Residual: 30
- Total: 47

Multivariate analysis is used to examine yield in relation to site factors taking all the sites together.

### Basic Treatments

Sites are chosen on reasonably uniform arable (or improved grassland) sites. They are selected for the widest possible coverage of site types, according to the Ecological Site Classification worked out by Dr Pyatt.

The sites are:

1. Completely cleared
2. Sprayed with "Roundup" at 5 litres/hectare
3. Subsoiled to break any plough-pan or compaction
4. Ploughed and harrowed.

Deer/rabbit fencing is used.

25cm cuttings are inserted in the period January-March:

1. A spacing of alternately 1.5 and 0.75m between rows and 0.9m within the rows is applied to all varieties for comparability
2. Residual herbicide is then be applied before flushing
3. Thereafter, weeds are vigorously controlled as necessary.

In the following winter, the shoots are cut back to a single stump, 5cm above the ground (maiden cut).

**Requirements**

1. 0.48hectare net (for two experiments on one site). The gross area is sufficient for an automatic weather station, access, working area etc.
2. 300 cuttings of each variety (per experiment)
3. Fencing
4. Herbicides.

**Records and Assessments**

1. Plots are assessed for height and diameter at the end of the first and second year after the maiden cut, and again at harvest after three years growth.
2. Dry weight is assessed at harvest, by weighing all assessment-plot material green, and then sampling to obtain a dry-weight conversion factor.
3. Soil data is obtained at site establishment
4. Climatic data is obtained throughout the experiment.

## Physiology

Two coppice sites were set up for the monitoring of physiological measurements of willow and poplar varieties. These are situated at:

- Headley in Hampshire (planted 1998)
- Newton in Morayshire (planted 2001)

representing different climates and soil types.

Both sites were cut after the first year's growth and Headley was cut again after a further 3 years, so that both sites are presently in the first year of the rotation.

## Varieties

Poplars:

G - *P. x euramericana* ('Ghoy')

B - *P. x interamericana* ('Beaupré')

T - *P. trichocarpa* ('Trichobel')

Willows:

V - *S. viminalis* ('Jorunn')

G - *S. burjatica* ('Germany')

Q - *S. triandra x viminalis* ('Q83')

## Plot size

At each site, four plots of each of the willow and poplar varieties are grown. The plots are 4x4 stools, planted at 1.5m square spacing. The plots are planted in a 4x6 grid of plots, within which the poplars and willows form separate 2x6 grids. There is a guard row of stools all the way around the outside of the grid.

## Treatments

The sites are both nursery sites, at which irrigation, preventative fungicide and insecticide treatments, and weeding are carried out. An automatic weather station at each site records local weather conditions.

## Wishanger

### Objective

To examine the effect of initial spacing on the yield of 2 varieties each of poplar and willow, grown as short rotation coppice.

### Varieties

Two each of poplar and willow were planted.

Poplar varieties:

- Beaupre
- Columbia River

Willow varieties:

- Dasyclados
- Bowles Hybrid

### Plot Size

Plot size was 7x7 trees to include a 1 row buffer surround, giving a 5x5 assessment plot (25 stools).

### Treatments

Each variety was planted at four spacings: 0.8m, 1.0m, 1.15m, 1.3m, 1.4m and 1.5m, in a square design, rather than the rectangular design used for the other sites.

Each spacing treatment was planted in four randomised blocks, to give a total of 24 plots for each variety. The site was kept weed free by repeated applications of contact and residual herbicides, prior to and after stumping back in January 1993.

### Planting

Both species were planted adjacent to the River Wey at Wishanger on April 1992. The willow were planted on a water meadow on an alluvial soil, whilst the poplars were planted on ex-arable land on Lower Greensand Folkestone beds. Within these areas there were still differences in the soils. The willows were planted such that block 1 closest to the poplars was on an interface between the alluvial soil and the greensand, blocks 2 and 3 were on the better alluvial soil, and block 4 was on heavier land with seasonal waterlogging. Blocks 1 and 2 of the poplar experiment were more sheltered than 3 and 4, which were exposed to cold easterly winds.

## Appendix 1. Variety parentage

Parentage of varieties of poplar and willow used in intensive and extensive trials.

### Poplar

Key to parentage:

*T* = trichocarpa; *N* = nigra; *D* = deltoides; *B* = balsamifera

Variety	Parentage	Trials
Beaupré	<i>T</i> x <i>D</i>	Intensive, Extensive, Wishanger, Physiology
Ghoy	<i>D</i> x <i>N</i>	Intensive, Extensive, Physiology
Trichobel	<i>T</i>	Intensive, Extensive, Physiology
Boelare	<i>T</i> x <i>D</i>	Intensive
Unal	<i>T</i> x <i>D</i>	Intensive
Raspalje	<i>T</i> x <i>D</i>	Intensive
Gaver	<i>D</i> x <i>N</i>	Intensive
Gibecq	<i>D</i> x <i>N</i>	Intensive
69039/4	<i>T</i> x <i>D</i>	Intensive
69038/6	<i>T</i> x <i>D</i>	Intensive
71009/1	<i>D</i> x <i>T</i>	Intensive
71015/1	<i>D</i> x <i>T</i>	Intensive
71009/2	<i>D</i> x <i>T</i>	Intensive
TT32	<i>T</i> x <i>B</i>	Intensive
Fritzi Pauley	<i>T</i>	Intensive
Columbia River	<i>T</i>	Intensive, Wishanger

### Willow

Key to parentage:

*vim* = viminalis; *tri* = triandra; *cap* = caprea; *cin* = cinerea; *aur* = aurita; *burj* = burjatica; *sch* = schwerinnii

Variety	Parentage	Trials
Jorunn	<i>vim</i> x <i>vim</i>	Intensive, Extensive, Physiology
Germany	<i>burjatica</i>	Intensive, Extensive, Physiology
Q38	<i>tri</i> x <i>vim</i>	Intensive, Extensive, Physiology
Spaethii	<i>spaethii</i>	Intensive
Dasyclados	<i>cap</i> x <i>cin</i> x <i>vim</i>	Intensive, Wishanger
ST/2481/55	<i>tri</i> x <i>vim</i>	Intensive
Delamere	<i>aur</i> x <i>cin</i> x <i>vim</i>	Intensive
Bebbiana	<i>sitchensis</i>	Intensive
V789	<i>vim</i> x <i>cap</i>	Intensive
Ing 00010	<i>burj</i> x <i>vim</i>	Intensive
Ing 00011	<i>burj</i> x <i>vim</i>	Intensive
Jorr	<i>vim</i> x <i>vim</i>	Intensive
Bjorn	<i>vim</i> x <i>sch</i>	Intensive
Tora	<i>vim</i> x <i>sch</i>	Intensive
Orm	<i>vim</i> x <i>vim</i>	Intensive
Ulv	<i>vim</i> x <i>vim</i>	Intensive
Bowles Hybrid	<i>vim</i> x <i>vim</i>	Wishanger