Field evaluation and selection of winter wheat for competitiveness against weeds

Workshop of COST860 SUSVAR Working Group1 and ECO-PB, in collaboration with COST851 Working Group 3

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Outline

- Identification of appropriate plant traits
- Development of methodologies to assist in variety selection
- EU funded project on Strategies of weed control in organic farming (WECOF)

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WECOF Work Package on ...

‘Optimising the natural competitive relationship between the crop and weeds in reducing potential weed growth and competition’

‘WECOF variety trials’

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Introduction

- Variety trials over 4 years, on an organic farm, 25 km east of Edinburgh, Scotland
- Wide range of genotypes
  - Measured crop and weeds at key growth stages
- Linked closely to the WECOF Core Trials in Germany, Poland, Spain and Scotland
  - Three genotypes, drilling direction and row width

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Plant characteristics for weed suppression

- Some genotypes have higher weed suppression than others
- But no single plant characteristic or trait determines competitive ability

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Key plant characteristics or traits

- Good establishment ability
- High tillering ability
- Plant height and internode length
- Leaf area index (LAI) through large leaves
- Leaf angle
- Ground cover (as % cover)
- Plant growth habit
- Selection for high yield potential

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Selected results from WECOF variety trials: demonstrating the importance of crop ground cover

- Effects of shoot population density, crop ground cover and light interception on weed growth (ground cover)
- Patterns of crop and weed ground cover during the season
- Yield and weed ground cover

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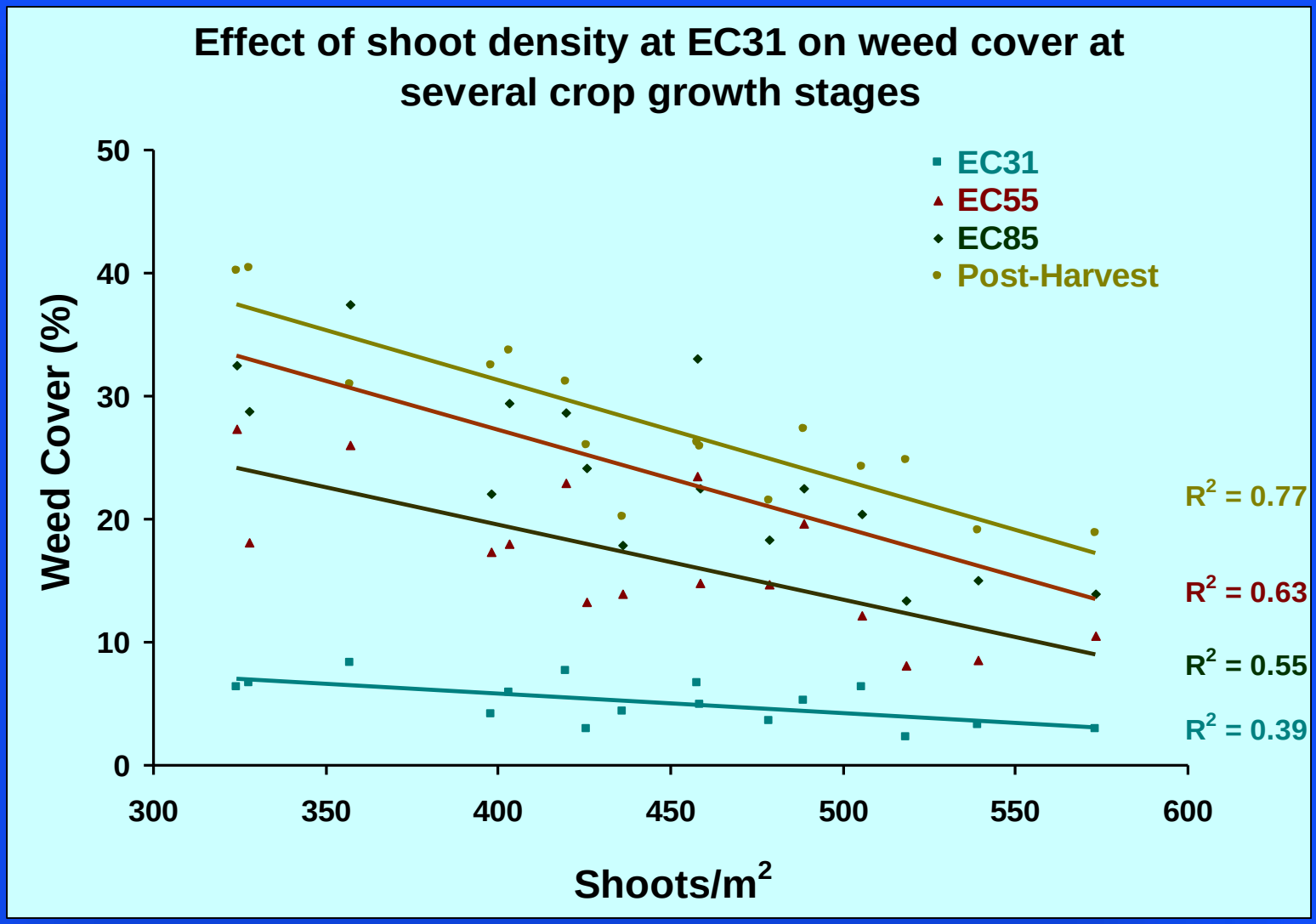

Each point represents a variety mean. Data from 2003.

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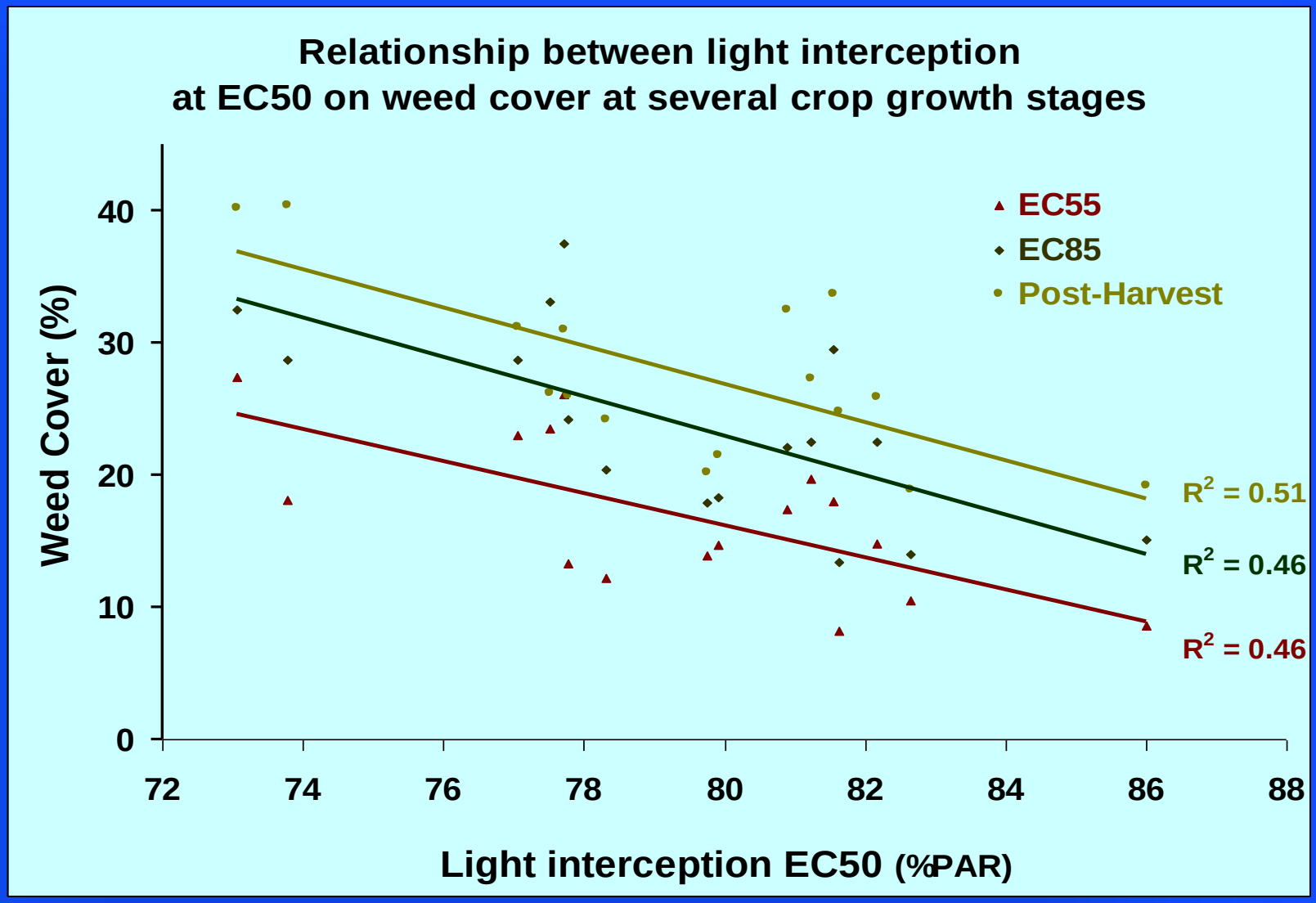

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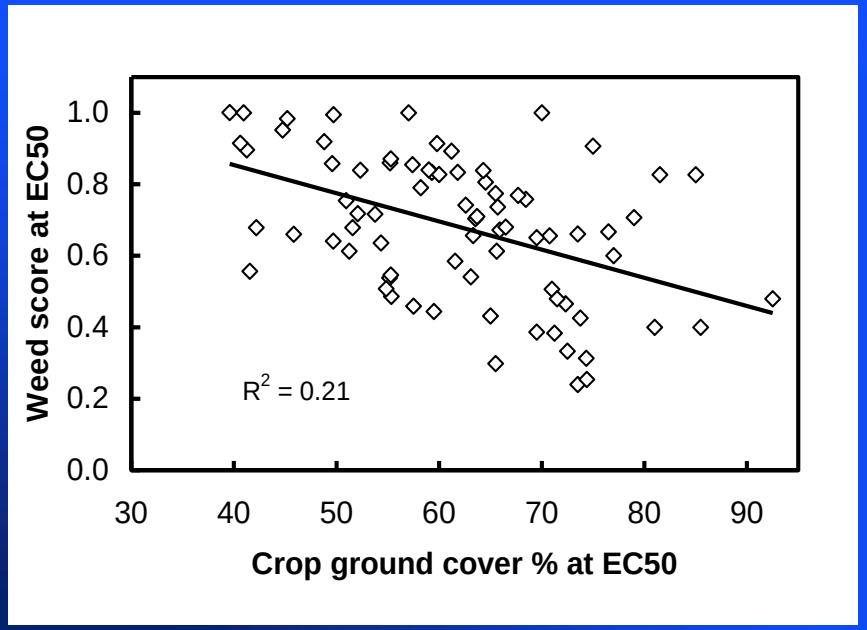
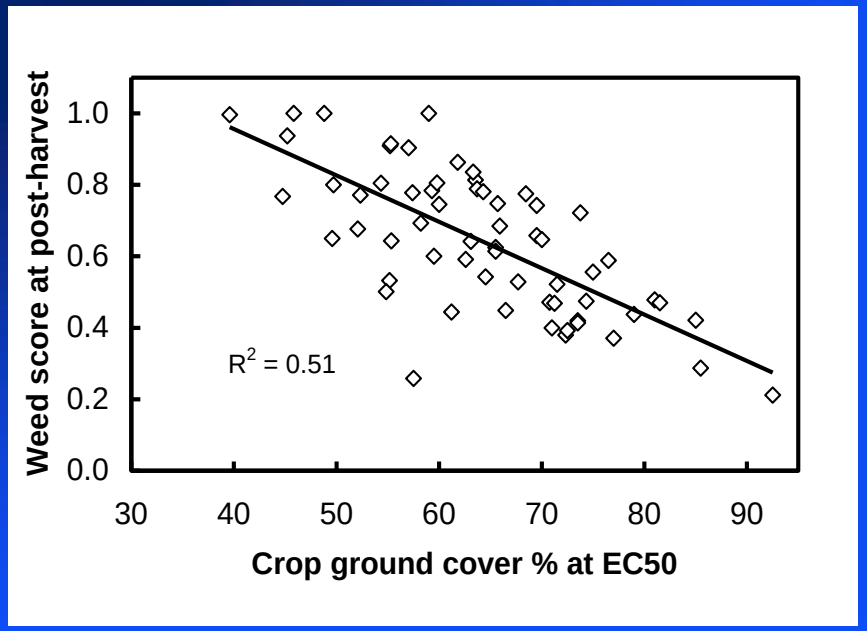
Each point represents a variety mean. Data from 2003.

Relationship between crop ground cover (at start of ear emergence) and weed ground cover (at two growth stages) across all varieties and seasons.





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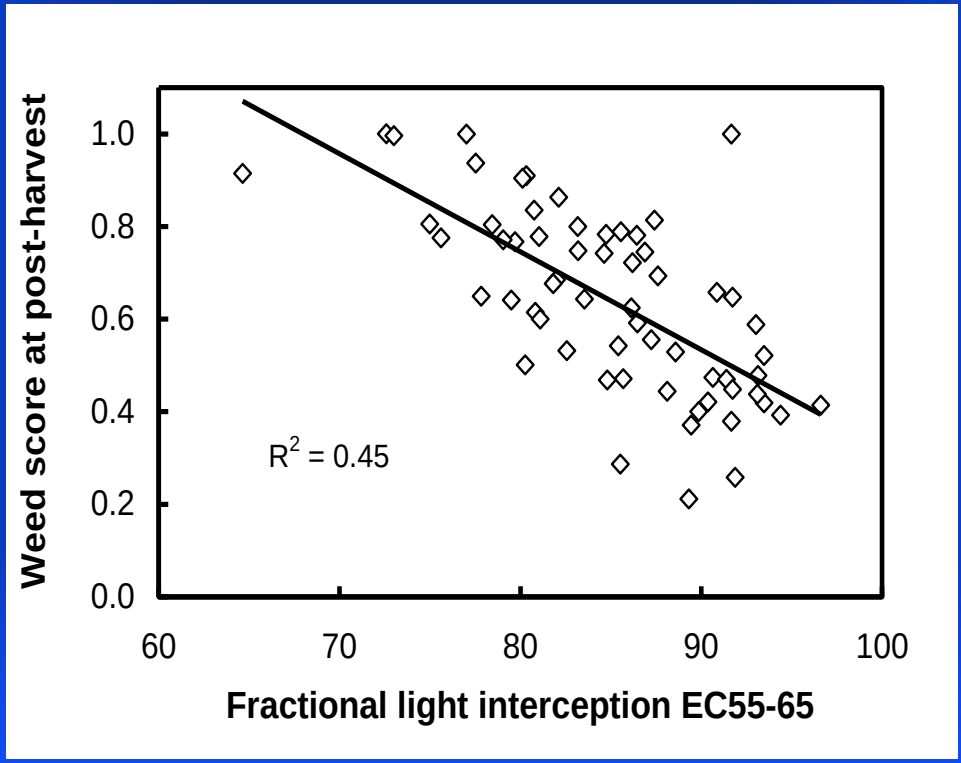
Relationship between crop fractional light interception (ear emergence to anthesis) and weed ground cover (post-harvest) across all varieties and seasons.



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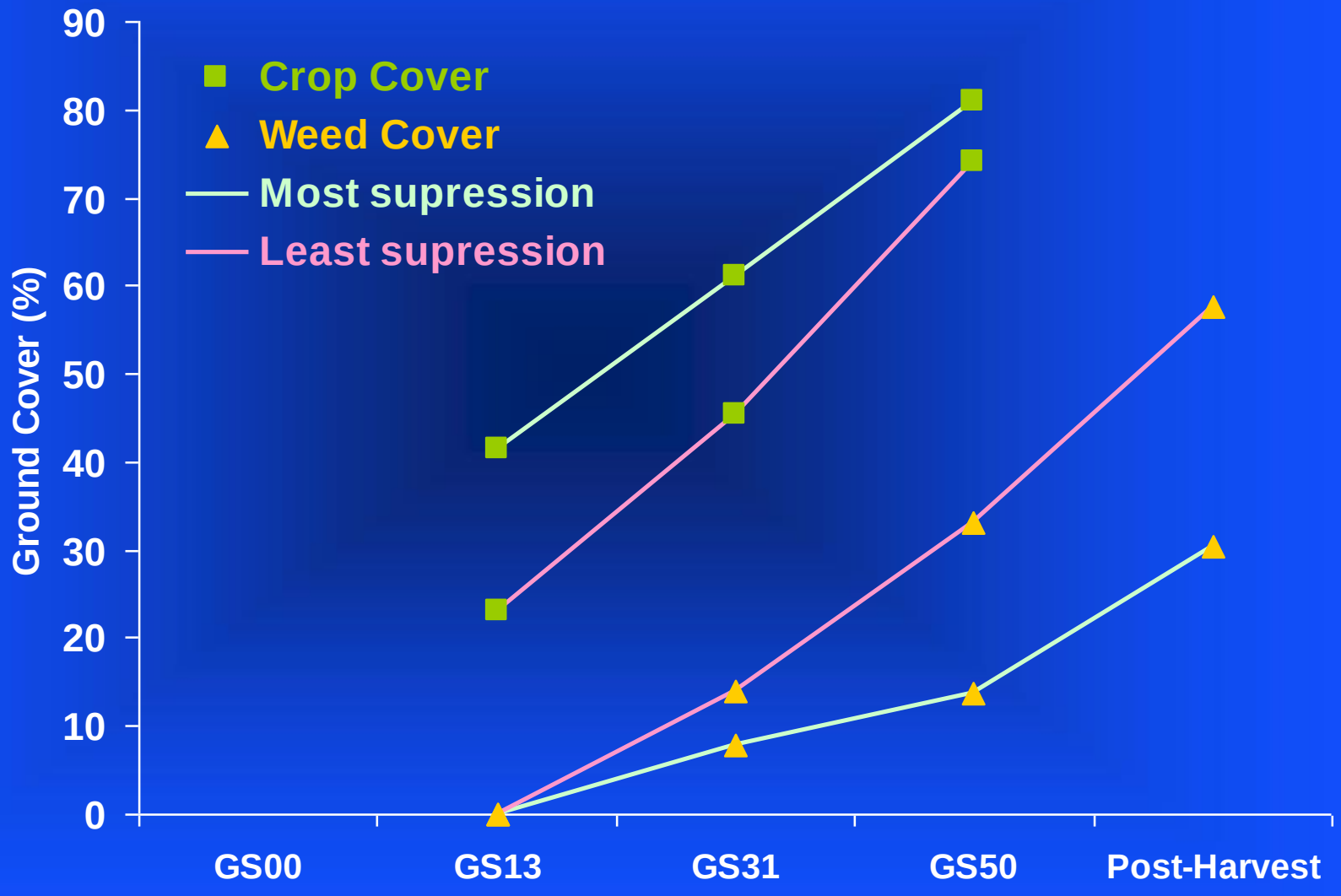
Crop and weed ground cover for varieties with most and least weed suppression, 2002



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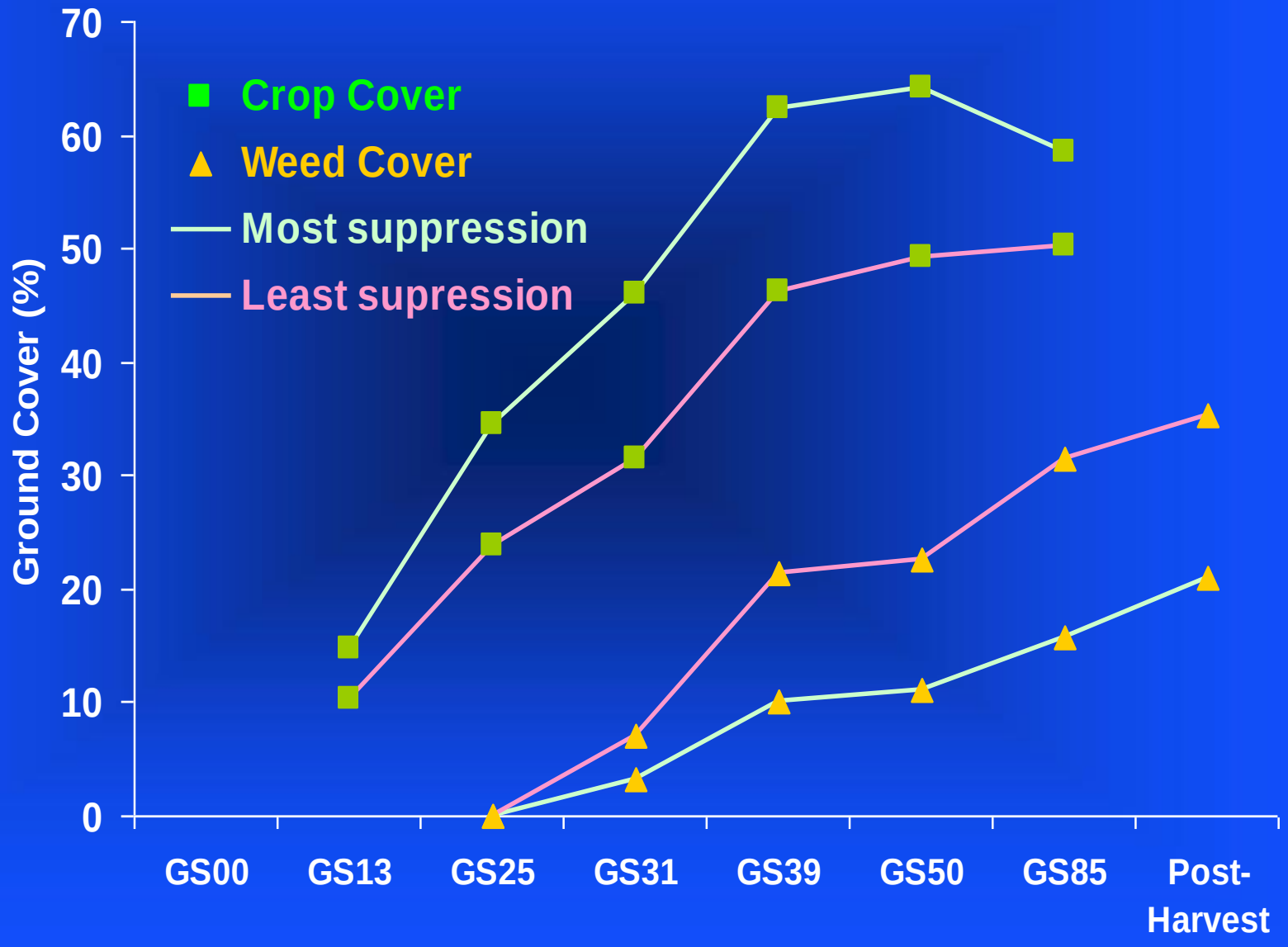
Crop and weed groundcover for varieties with most and least weed suppression, 2003



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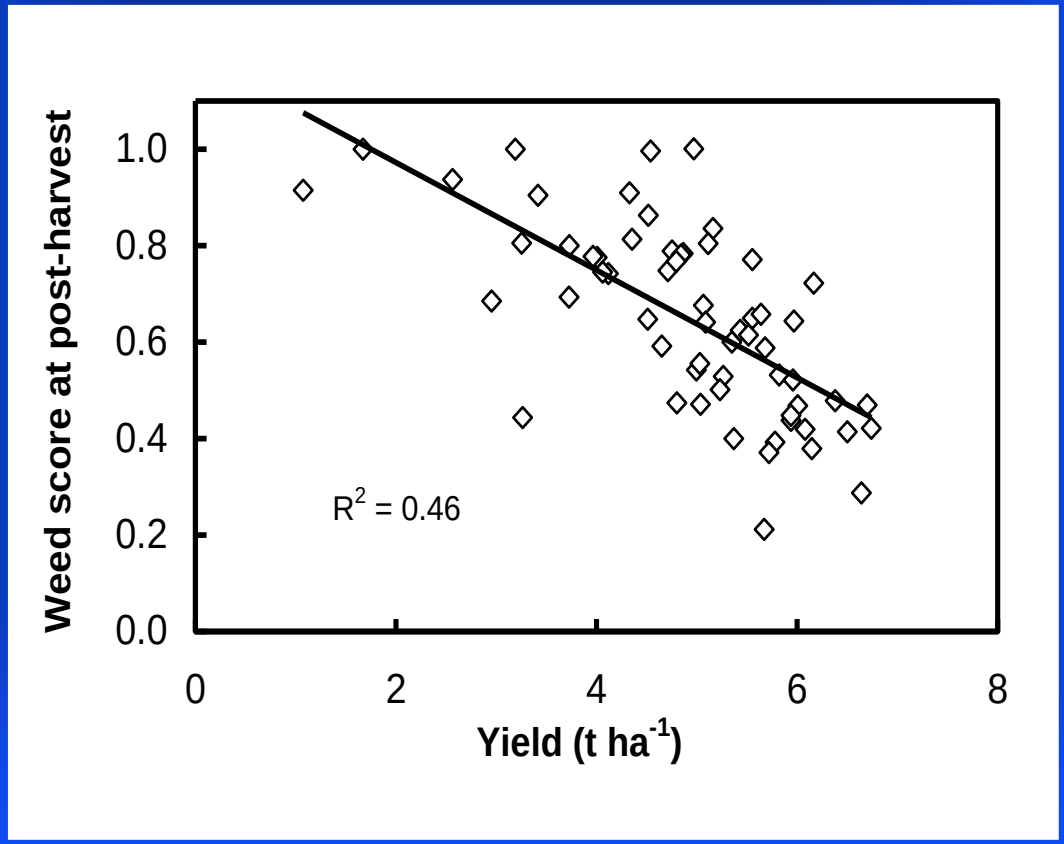
Relationship between crop grain yield and weed ground cover (post-harvest) across all varieties and seasons.



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Some key points from the WECOF variety trials

- **Good % crop establishment is important**
- **Early crop ground cover can have lasting effects on weed suppression**
- **Shoot population density:**
  - ***Below 160 plants per m^2 good tillering varieties give better weed suppression***
  - ***Above 160 plants per m^2 good shading ability gives better weed suppression***

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Some key points from the WECOF variety trials

- Crop height shows inconsistent effects on weed supression
- Extra height may benefit an erectophile growth habit
- High LAI (and shading ability) and a planophile growth habit may also have a yield benefit under organic conditions

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Describing growth habits and defining ideotypes

- From experiments on a wide range of genotypes
- Consider need for early, late or season long weed suppression and climatic region
- No single plant trait determines competitive ability

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Selection must consider climatic regions

- Cool moist climates: a wide range of sowing dates and season long weed suppression
- Continental climates: extremes of autumn/winter and summer temperatures and spring weed growth
- Mediterranean climates: need for late season moisture conservation and early or spring weed growth

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Target *robustness* in crop responses across sites and seasons

- Need to test across a range of soil and climate conditions and levels of weed competition
- Explain as much of the variation in weed competition (and yield) as possible in terms of the key plant and crop growth characteristics
- Approximately 40% of variation in ability to suppress weeds is not related to measured characteristics
    - Consider root competition and allelopathic responses

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Plant growth habits
(as defined in the WECOF project)

- Continuous planophile: clear advantage over the highly erectophile habit
- Early planophile to late erectophile: can compensate for low establishment
- Early erectophile to late planophile: must have good establishment
- Continuous erectophile: risky when weed growth is high

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Examples of different growth habits

Leaf angle (from the main stem) was measured at ear emergence and plant growth habit indicates the change from pre-tillering to post-flowering

Variety	Flag leaf	All leaves	Plant growth habit
Chablis	76	52	Continuous planophile
Maris Widgeon	55	44	Erectophile to planophile
Rialto	31	35	Planophile to erectophile
Zyta	23	26	Continuous erectophile

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Chablis
Planophile

Maris Widgeon
Erectophile to planophile

Rialto
Planophile to erectophile

Zyta
Erectophile

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Pegassos
E-P to planophile

Gerald
Winter oat: erectophile with long leaves

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Selection in plant breeding programmes: Working towards a guide for plant breeders

- Early growth habit
- High tillering capacity
- Rapid early growth to stem extension
- Plant habit
  - Leaf angle
  - Plant height
  - Assessments and scoring systems
- The role of crop ground
- Selection for yield potential

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Early growth habit

- Importance of an early prostrate habit
- Aim for moderate to high LAI through rapid leaf development or good crop establishment
- Ground cover at EC13/21 tends to be correlated with season long weed suppression
- Erectophiles must have good establishment

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High tillering capacity

- Select varieties that tiller well (production and retention of shoots)
- Shoot population density is particularly important at plant population densities below 150-160 plants per square metre
- Must consider the level of crop establishment under organic growing conditions
- Tillering capacity is particularly important in cool temperate climates

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Rapid early growth to stem extension

- To maintain high fractional light interception
- Ground cover at end of tillering is strongly related to long term weed suppression

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A guide to plant growth habit

- Leaf inclination (angle)
  - Angle of leaf from the main stem
  - Leaf curvature
  - Leaf length
- Plant height
  - Interactions with other traits
  - Implications for spread of diseases
  - Important for competing against tall or scrambling weeds

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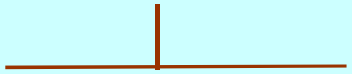
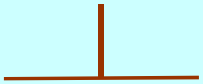
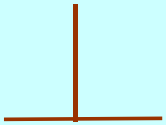
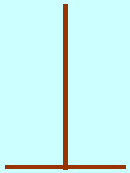
Devising scoring systems

Plant growth habit

	Description	Height to width ratio	Plant structure
1	Planophile flat > 45 ^{o} (extended)		
2	Planophile flat 45 ^{o} (compressed)		
3	P-E intermediate mixture of 2 and 4		
4	Erectophile spread		
5	Erectophile narrow		

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Importance of crop ground cover

- Function of both plant and crop characteristics
- Total LAI (or GAI) is correlated with shading ability
- Need to consider how seasonal changes in plant growth habit and ground cover affect shading ability

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Selection for yield potential

- The best weed suppressors tend to be amongst the best yielding genotypes
- Yield benefits are not lost when aiming for good weed suppression
- Must consider *vigour* or *robustness* of each genotype

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Conclusions

- Importance of planophile structure (consider other traits in relation to seasonal factors)
- Consider ground cover and tillering ability in relation to crop shading ability
- Need for robustness in crop growth, shading ability and yield across sites and seasons

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