Department for Environment Food & Rural Affairs

ADAS





Integrated Pest Management: Science and Practice
Disease control in cereals

Neil Paveley and Frank van den Bosch

A video series funded by Defra and produced by ADAS

www.adas.co.uk

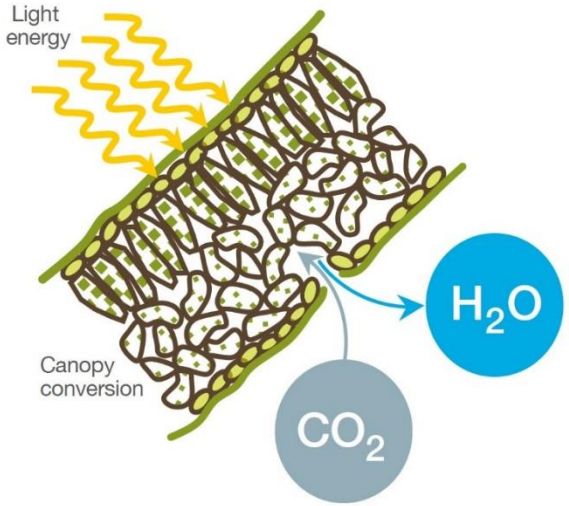
Which parts of the crop canopy need protecting and when?

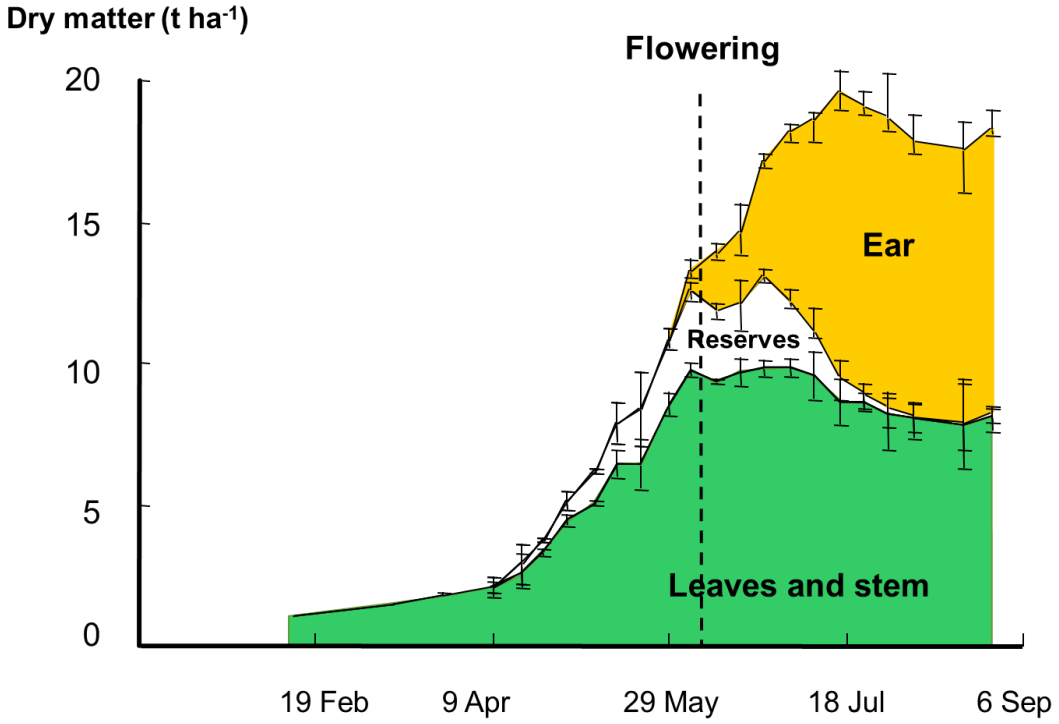
Which parts of the crop canopy need protecting and when?

What determines grain yield?

How and when does foliar disease affect yield?

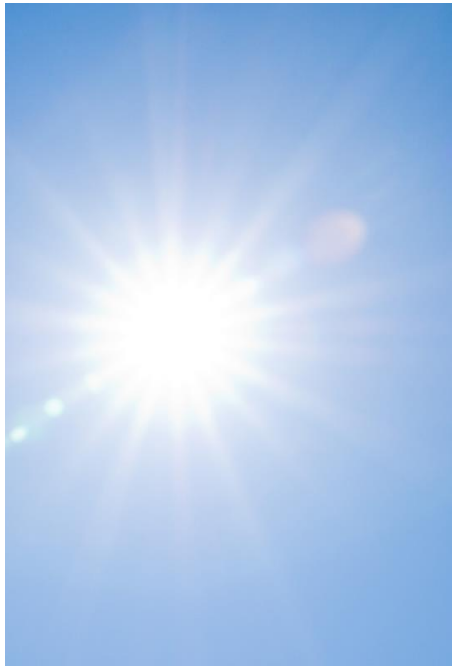
Dry matter growth and partitioning - wheat





Dry matter source and sink

Source



Sink

Source capacity =

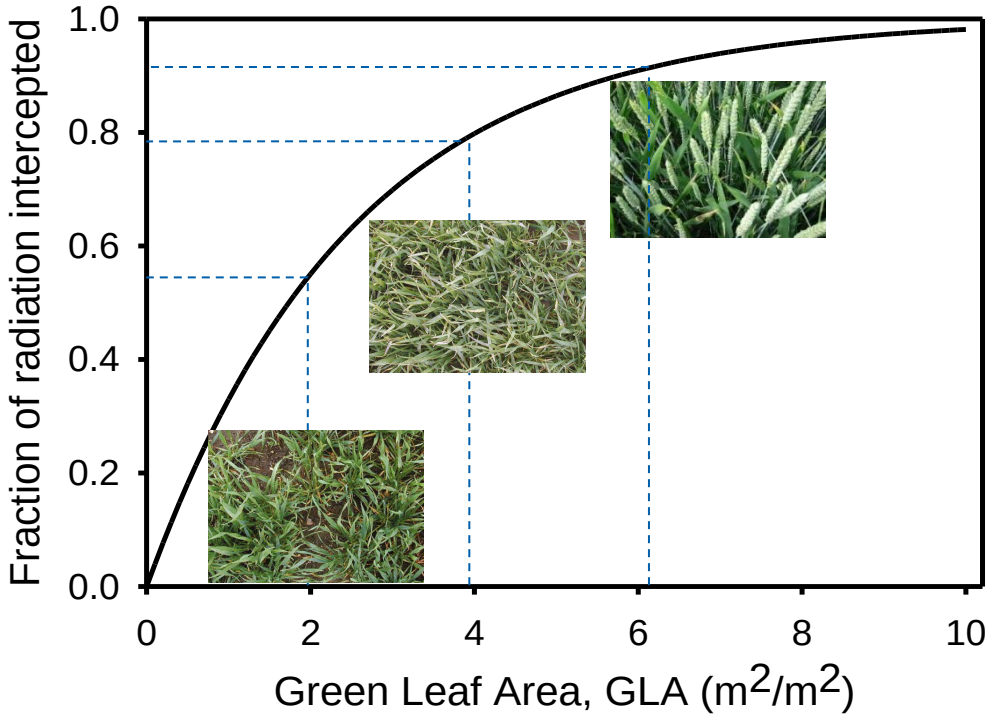
Photosynthetically active radiation intercepted by green canopy (MJ PAR)

x

Radiation use efficiency (g dry matter per MJ)

Source: AHDB Wheat Growth Guide

Source capacity (Beer's law)

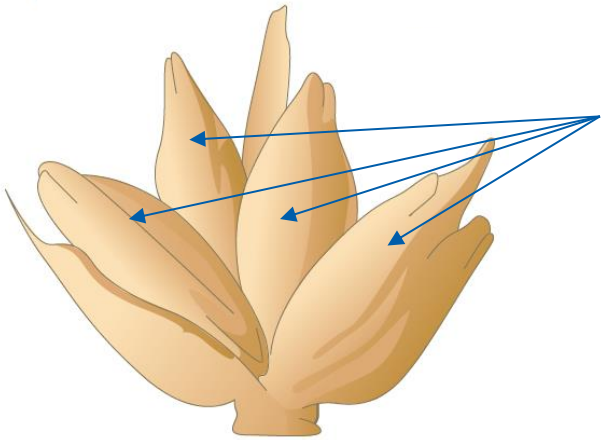


Sink capacity =

Ears per m2 x Fertile grains per ear x Potential grain weight

Wheat

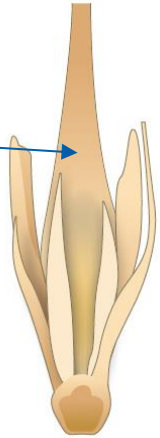
Up to 9 fertile florets per spikelet (typically 4 to 6)



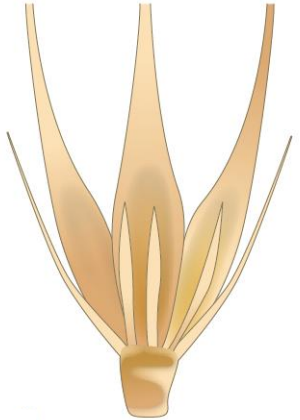
floret

Barley

One or 3 spikelets have fertile florets



Two row barley



Six row barley

Source: AHDB Barley Growth Guide

Source / Sink balance in healthy crop

	Wheat	Barley
Source:	6-7 GAI	5-6 GAI
Sink:	22,000 grains per m2	15,000 grains per m2
	Source = sink	**Source >= sink**

Source: AHDB wheat and barley growth guides

2 June

17 June

23 June

1 July

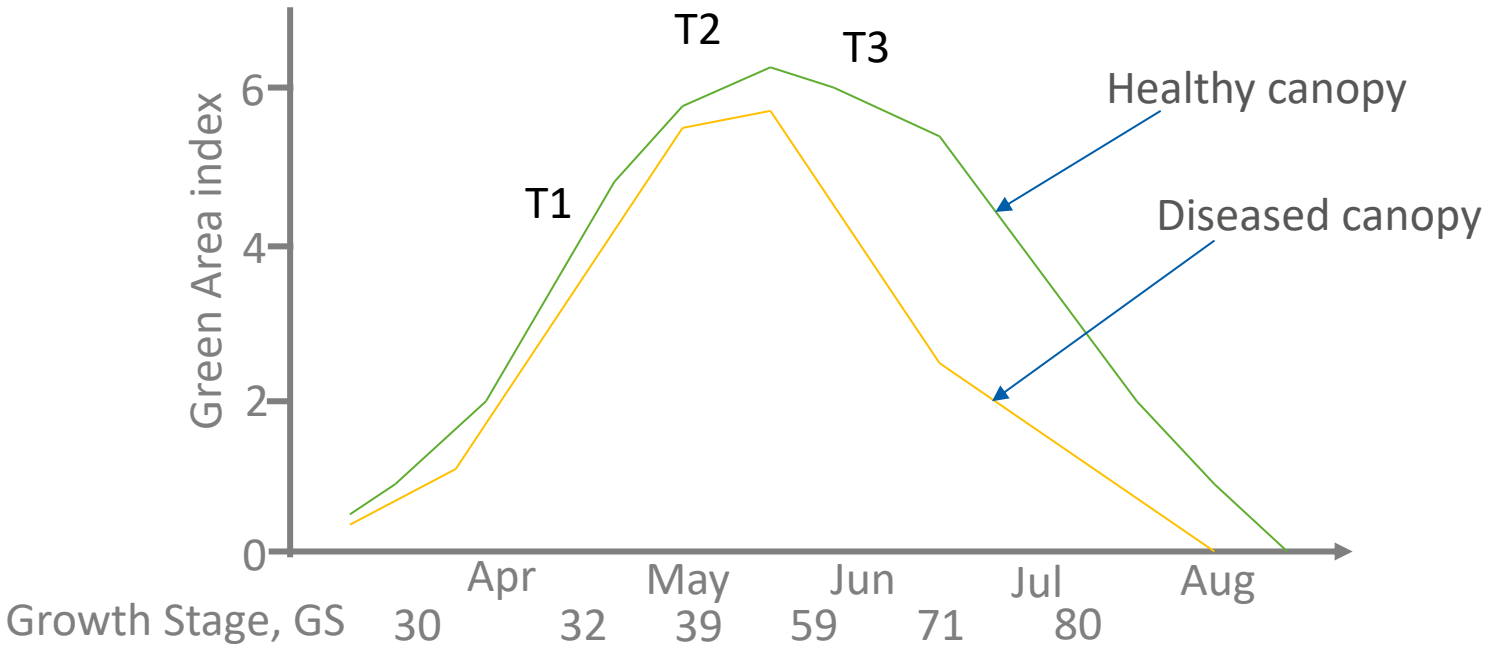
8 July

How and when does foliar disease affect yield?

Septoria tritici
ADAS Rosemuand, 2022

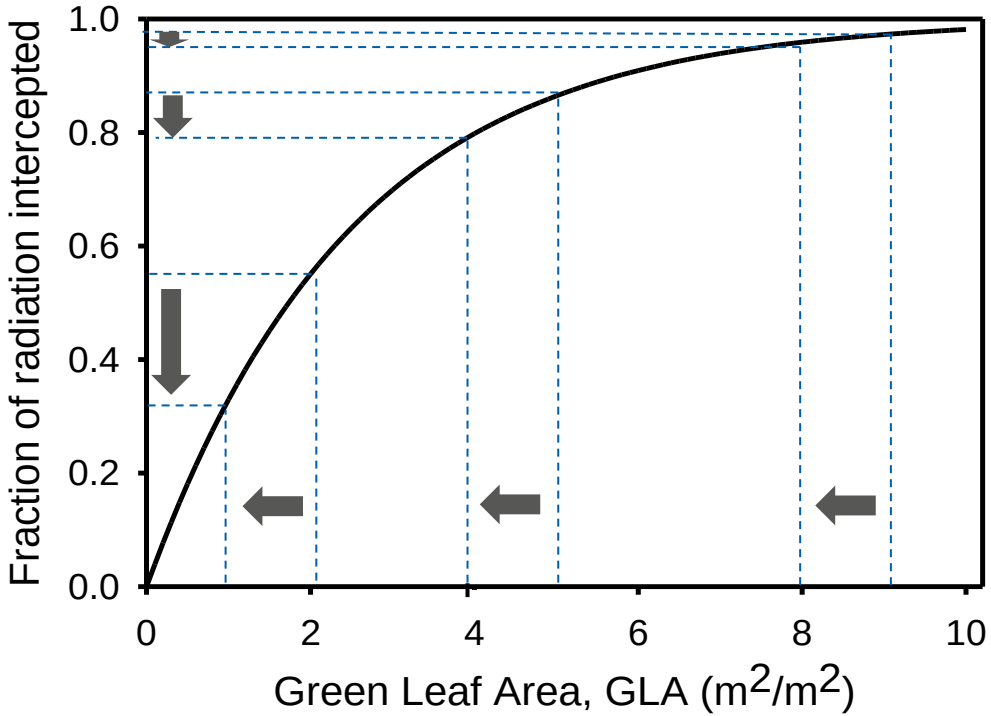
Images courtesy of Syngenta

Source capacity – effect of foliar disease



Date source: AHDB wheat and barley disease management guide

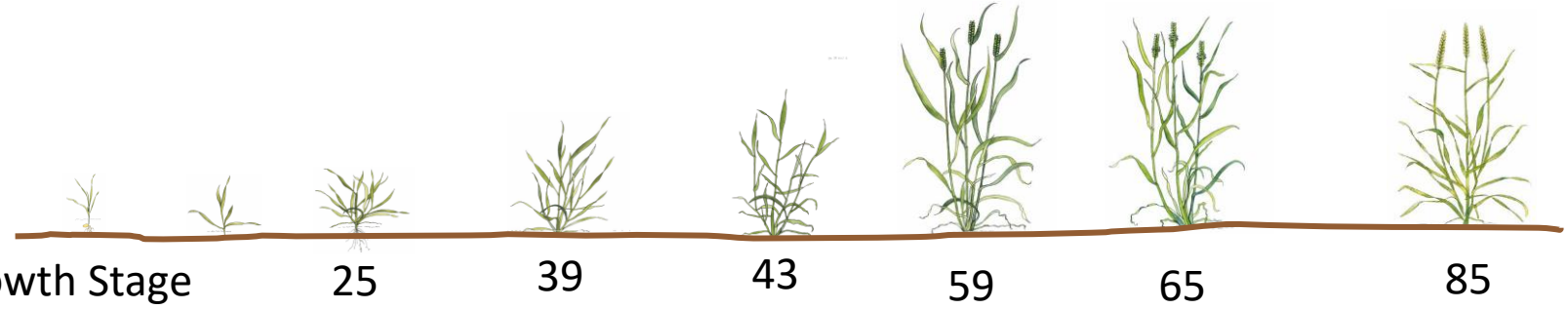
Source capacity – effect of foliar disease



Disease % severity you see does not relate directly to impact on yield

The remaining green area relates to yield

Source and sink formation – wheat and barley



Growth Stage 25 39 43 59 65 85

Canopy expansion

Canopy duration

Tillering and tiller survival (ears/m^2)

Grain filling

Spikelet/floret initiation and survival (grains/ear)

Ear growth (potential grain weight)

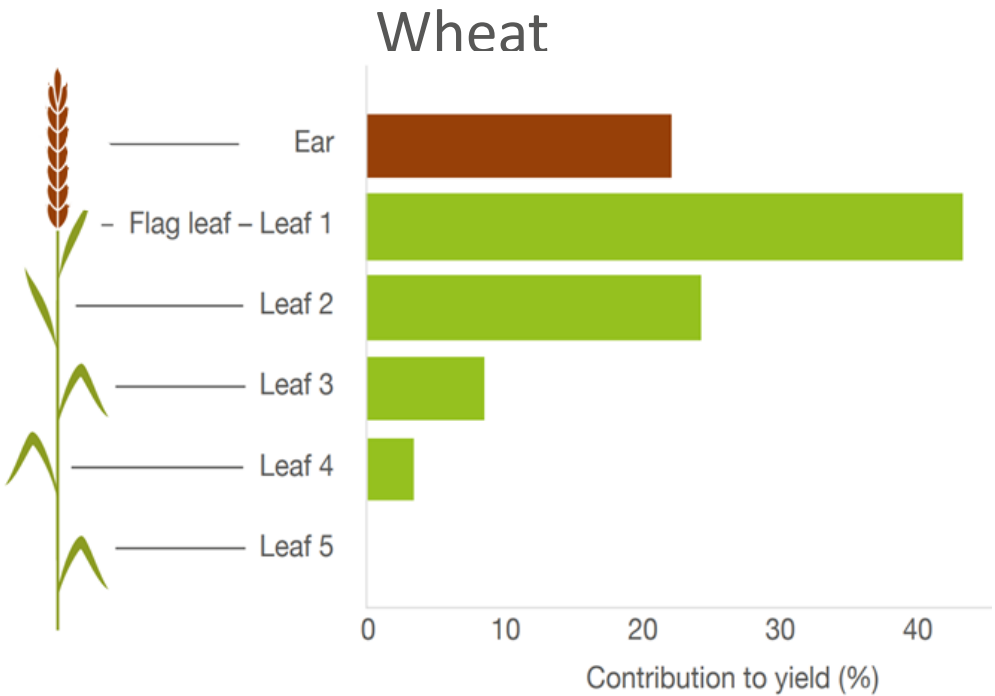
These developmental phases differ somewhat between wheat and barley

Effect of foliar disease on source and sink – wheat and barley

	Canopy expansion	Ears/m^2	Grains/ear	Canopy duration	Diseased crop
Wheat	–	–	↓	↓	Source < Sink
Barley	↓	↓	↓	↓	Source >= Sink

Source: Bingham et al. (2008) Annals Applied Biology.

Which parts of the crop canopy need protecting?



Source: AHDB wheat and barley disease management guide

Which parts of the crop canopy need protecting and when?

- Wheat disease management is to protect dry matter source
  - Protect the upper leaves from GS39 to flowering (to protect accumulation of carbohydrate stem reserves), and
  - Protect the upper leaves from flowering to natural senescence (to protect dry matter accumulation during grain filling)
- Barley disease management is mainly to protect dry matter sink formation
  - Protect tiller formation and survival, to maintain ears per m^2
  - Protect ear growth (particularly in boot), to maintain fertile florets and potential grain weight
- 2-row and 6-row barley behave similarly (6-row usually has more, but smaller, grains)
- Winter and spring barley behave similarly, but sink formation is shorter in spring crops and is sensitive to early disease

How we achieve these aims is dealt with in subsequent videos in this series

Further reading and acknowledgements

We acknowledge the help of Ian Bingham (SRUC) in producing this video

Guides

AHDB Wheat growth guide. https://ahdb.org.uk/knowledge-library/wheat-growth-guide

AHDB Barley growth guide. https://ahdb.org.uk/knowledge-library/barley-growth-guide

AHDB Wheat and barley disease management guide. https://ahdb.org.uk/knowledge-library/integrated-pest-management-ipm-of-cereal-diseases

Books

Crop physiology: case histories for major crops. Editors: Sadras VO, Calderini DF (2021). https://doi.org/10.1016/C2018-0-05018-5

Research papers by the authors on the theme of this video.

Beed, F D, Paveley, N D, Sylvester-Bradley, R (2007). Predictability of wheat growth and yield in light-limited conditions. *Journal of Agricultural Science* **145**, 63-79

Bingham I J, Young C, Bounds P, Paveley N D (2019). In sink-limited spring barley crops, light interception by green canopy does not need protection against foliar disease for the entire duration of grain filling. Field Crops Research 239:124-134.

Bingham I J, Young C, Bounds P, Gravouil C, Paveley N D (2021). Mechanisms by which fungicides increase grain sink capacity and yield of spring barley when visible disease severity is low or absent. Field Crops Research 261.

Bryson, R J, Paveley, N D, Clark, W S, Sylvester-Bradley, R and Scott, R K (1997). Use of in-field measurements of green leaf area and incident radiation to estimate the effects of yellow rust epidemics on the yield of winter wheat. *European Journal of Agronomy **7**, 53-62.*

Milne, A, Paveley, N D, Audsley, E, Livermore P (2003). A wheat canopy model for use in disease management decision support systems. *Annals of Applied Biology* **143**, 265-274.

Milne, A, Paveley, N, Audsley, E, Parsons, D (2007). A model of the effect of fungicides on disease induced yield loss, for use in wheat disease management decision support systems. *Annals of Applied Biology* **115**, 113-125

Paveley, N D, Sylvester-Bradley, R, Scott, R K, Craigon, J and Day, W (2001). Steps in predicting the relationship of yield on fungicide dose. *Phytopathology* **91**, 708-716.

Many excellent papers are available by other authors. The wheat and barley chapters in the crop physiology book listed above contain comprehensive bibliographies. If a research paper is not open-access you can request a copy by contacting authors through www.researchgate.net