

Bio4Ag Toolbox Indicators: emerged weeds

Background

Weeds are an important component of biodiversity, providing resources for beneficial insects and arable foodwebs, but they also represent a significant burden to crop yield. Traditional management aims at eradication, but this tends to select for highly competitive and resistant species which are difficult to control and results in declining biodiversity and loss of ecosystem function. Arable cropping makes up ca. 20% of the total UK land area and, being largely mono-cropped with little or no understorey flora, therefore represents a massive opportunity for reversing biodiversity loss and enhancing system functions at a national scale. Tolerance of some weed cover within fields is therefore essential for biodiversity conservation and the maintenance of within-field processes. The challenge is to define the optimal density and composition of the weed flora that supports a healthy agroecosystem but without detrimental impact on crop yield or product quality.



Integrated cropping strategies

At the Centre for Sustainable Cropping (CSC) long-term experiment, we combine a suite of management interventions into a single cropping system with the aim to optimise the balance between environmental protection, soil health, biodiversity and crop productivity. A primary goal for integrated weed management is to balance potential loss of yield against benefits for biodiversity by targeting competitive weeds but maintaining viable populations of beneficial species below competition threshold. This is difficult to achieve in practice and further research is required to develop reliable weed management strategies that, rather than eliminate weed cover, use a combination of cultural methods (varying the type, intensity and timing of disturbance events) to support functionally diverse weed assemblages. The integrated crop system at the CSC uses a semi-targeted approach, omitting pre-emergence herbicides and targeting post-emergence sprays only where weed burden becomes an issue, e.g. in particular fields where populations of competitive weeds are high, or in the later stages of the rotation after several years of direct drilling before cultivation for potato provides an opportunity for non-chemical control. More research is needed to identify management options that can reliably achieve low density, stable communities of functionally diverse arable weeds.



Results from the CSC

Weed species abundance was assessed in June each year (2011-2024) across all fields/treatments. Species richness and weed abundance were higher in the integrated cropping systems, though the variability in grass weed numbers resulted in a non-significant trend for this group (Fig 1). Even though weed densities were generally greater, there was no direct correlation between weed number and crop yield, suggesting that weed populations are being maintained below the competition threshold.

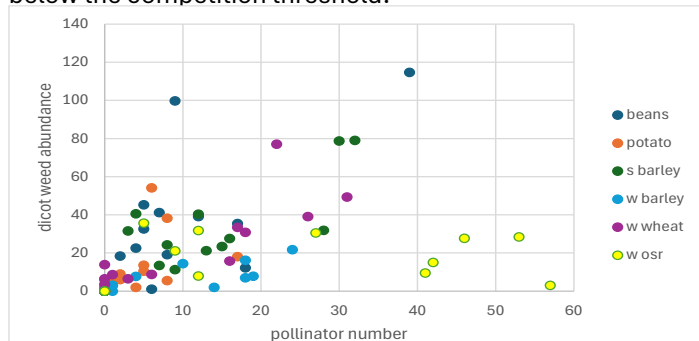


Figure 2. Mean dicot weed number against pollinator number in June each year across the 6 crops in the rotation

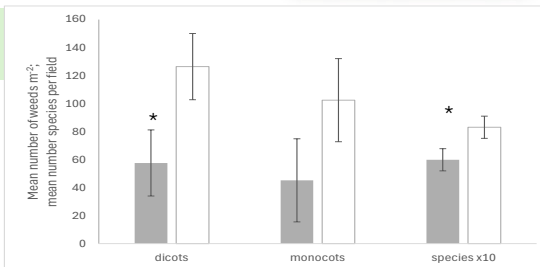


Figure 1. Mean number of broadleaved (dicot) and grass (monocot) weeds m^{-2} : species number per field (and standard errors) in conventional (open) and integrated (shaded) crop systems.

In 5 of the 6 crops, pollinator activity was positively correlated with the density of broadleaved weeds (Kendall-Rank correlation coefficient 0.68, $p < 0.001$), irrespective of cropping system (Fig 2). There was no effect of weeds on pollinators in the oilseed rape crop due to the over-riding influence of the flowering crop. In general, integrated system therefore appears to support more biodiversity and related functions without a significant effect on crop yield.

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How to measure in-field weed diversity

Counts of the number of broadleaved and grass weeds across arable fields are used to estimate the availability of resources for farmland biodiversity and assess the potential risk through the growing season to crop yield and quality. The target for management is to maintain ca.10% cover of beneficial broad-leaved species (e.g. field pansies and speedwells), that have high wildlife value (insect pollinated, large seeds), but low competitive index (low growing, shade tolerant, limited seed dispersal). Such targeted management of weed species assemblages is a major challenge in agriculture today.

Equipment: 50 x 50 cm quadrat, camera, record sheet

Timing: Survey 2-3 times a year to capture seasonal resource availability provided by understorey weeds for beneficial insects and higher trophic groups:

- spring (May, approx. 3 weeks after spring crops sown);
- summer (July, approx. 2 weeks before cereal harvests);
- autumn (Oct, at least 3 weeks after autumn sowing)

Location: Carry out assessments at about 10 locations in each field/treatment ensuring the whole field is covered either in a W pattern or along 3 equidistant transects

Procedure:

- Record date and surveyor initials on a record sheet.
- At each field, note cultivation state (plough, stubble, sown, crop).
- Place a 50 x 50 cm quadrat at each sample location.
- Within the quadrat, estimate % cover of crop, broad leaved weeds and grass weeds. The total % can add up to more than 100.
- Count the total number of broad-leaved weeds for all species present within the quadrat and take a photo of any species that you can't identify in situ.
- Record whether a species is in flower by an * next to the number entered for that species on the record form.
- Add up the total number of plants per species and rank by abundance, high to low, to compare dominant/rare species between fields and assess potential biodiversity benefit versus yield penalty risk.

Useful links

- Hawes, C., Iannetta, P.P.M., Squire, G.R. (2021) Agroecological practices for whole system sustainability. CAB Reviews, 16, no. 005. <https://doi.org/10.1079/PAVSNNR202116005>
- Hawes, C., Alexander, C.J., Begg, G.S., Iannetta, P.P.M., Karley, A.J., Squire, G.R., Young, M. (2018). Plant Responses to an Integrated Cropping System Designed to Maintain Yield Whilst Enhancing Soil Properties and Biodiversity, Agronomy, 8(10), 229. <https://doi.org/10.3390/agronomy8100229>
- <https://csc.hutton.ac.uk>
- https://csc.hutton.ac.uk/resource/Handbook_of_indicators_v1.pdf
- Weed seedling ID guides: AHDB [Weed identification pocket guide.pdf](https://media.ahdb.org.uk/media/Default/Imported%20Publication%20Docs/Weed%20identification%20pocket%20guide.pdf)
<https://media.ahdb.org.uk/media/Default/Imported%20Publication%20Docs/Weed%20identification%20pocket%20guide.pdf>
- BASF UK weed ID app <https://www.agricentre.basf.co.uk/en/Services/Mobile-Tools/Weed-ID-app/>