

2022-
2026

Summary Report – Winter Wheat Trials **LiveSeeding**

Christian Gossel (Organic Research Centre)



Introduction

Quick Facts

- Cultivar choice is one of the key management decisions for organic farmers.
- Cultivar evaluation can be resource intensive and organic testing is often overlooked in national programmes.
- Organic research and innovation across Europe has highlighted the importance of a dispersed approach to cultivar evaluation in collaboration with farmer and other stakeholders.



Participatory and Decentralised Cultivar Evaluation

In organic farming systems, where external inputs are limited or absent, informed cultivar choice is crucial for production success and for the sustainable development of the sector. In the UK at present, all cultivar evaluation occurs in fields that are managed with chemicals and are not part of an organic rotation. For example, field trials conducted by AHDB (the Agriculture and Horticulture Development Board) which contribute to the Recommended List (RL) of wheat varieties in the UK. The conditions and thus desirable traits for wheat (or other crops) grown in organic vs non-organic systems are notably different however there are limited resources available for extensive testing.

This requires innovation in cultivar evaluation methods capable of generating reliable data across diverse environments while keeping costs under control. Participatory and decentralised cultivar evaluation provides the opportunity for a more frugal approach whereby network development and management, as well as appropriate methodology, support delivery of robust and relevant data to farmers and other stakeholders at lower costs than intensive, centrally managed, plot trials.

To develop and test this approach the Organic Research Centre (ORC), in collaboration with Organic Arable, established on-farm winter wheat strip trials across the UK from 2017-2025. In total 31 farms participated with some continuing trials for the full 8 years (Figure 1). 63 varieties, blends, and populations were grown, assessed, and analysed.

Twice a year the strips were assessed by ORC researchers with some years including a complementary assessment by the participating farmers. Farmers managed all operations on farm and harvested the crop for commercial sale providing yield estimates and a grain sample at harvest.

What did we learn?

The frugal approach generated robust performance data for varieties and allowed for quantitative analysis of factors driving performance in organic arable systems. In addition, we explored how knowledge of key traits can then be utilised to formulate blends suited to organic systems.

What is LiveSeeding?

LiveSeeding - Organic seed and plant breeding to accelerate sustainable and diverse food systems in Europe - is a 4-year Innovation Action funded by the European Union, the Swiss State Secretariat for Education, Research and Innovation (SERI) and UK Research and Innovation (UKRI).

The project started in October 2022 and brings together 37 organisations operating in 16 European countries. It ends in September 2026. Within the UK, ORC is focussed on approaches to cultivar evaluation for organic food and farming systems.

The foundations of the work presented here are two previous projects. The first was another EU project, LIVESEED, which ran from 2017 – 2021 and established a group of farmers engaged in participatory winter wheat evaluation on organic farms. Following this, LiveWheat, which was funded by the UK government, continued the delivery of the on-farm trials and associated research and development until 2022.

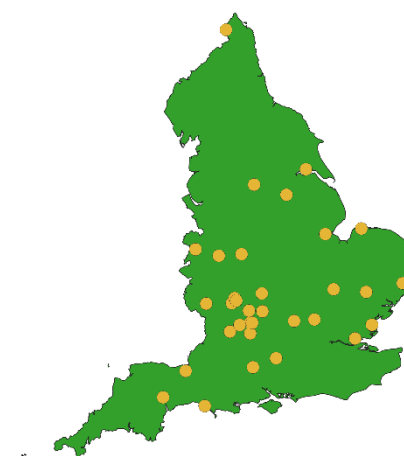


Figure 1. Map of the farm locations that have taken part in the trials from 2017 - 2025.

Results

Summary

On-farm strip trials led to the identification of wheat varieties which performed well across multiple years in organic systems. Cultivars screened were predominantly mainstream varieties that were not bred for organic systems, rather than organic varieties or populations. Improving variety choice can lead to better yield outcomes for organic winter wheat. Furthermore, which traits are drivers of grain yield in organic systems could be unpicked and feed into the design of blends and populations to ensure stable yields in an increasingly variable climate.

Evaluating the Methods

The strip trial approach undertaken in this study is not novel but had not been combined with sustained coordination across a network of sites to understand organic winter wheat performance in the UK. The method followed proved to be capable of delivering a reliable dataset which gave an indication of performance in real farming conditions. It was possible to account for variation in management, varietal preferences, and soil/environment conditions, in the experimental design.

Compared to centralised, single-field plot trials, larger strips, drilled and harvested with farm equipment, are likely to give a more accurate measure of expected performance both in-situ and more broadly across farming conditions provided enough sites are within the network. Replication of varieties across sites, with the use of a common control, is important to ensure the accuracy of results obtained. There are trade-offs between the number of sites in the network and the number of varieties (or cultivars) that can be robustly tested. The scope of the approach therefore still depends on the resource available but overall costs remain lower than extensive plot trials.

Climatic Summary

An increasingly common challenge in modern farming is variability and extremes in weather i.e. drought and heavy rainfall. This was exemplified by the conditions experienced through the years of the trial (Figure 2). The 2023/24 season was notably wet through winter and spring, while the following season was uncharacteristically dry. These were extremes during the study period with other years showing a less extreme pattern, for example 2020/21 had a particularly wet winter/spring but an average summer, while the following season saw a typically wet winter and spring with a dryer than usual summer. Overall, this highlights the increasing unpredictability of weather patterns.

This should be considered when interpreting the results from the data and highlights the important of ongoing monitoring over time. Understanding the environmental conditions driving performance can enable us to unpick what traits drive better performance under different scenarios which can feed

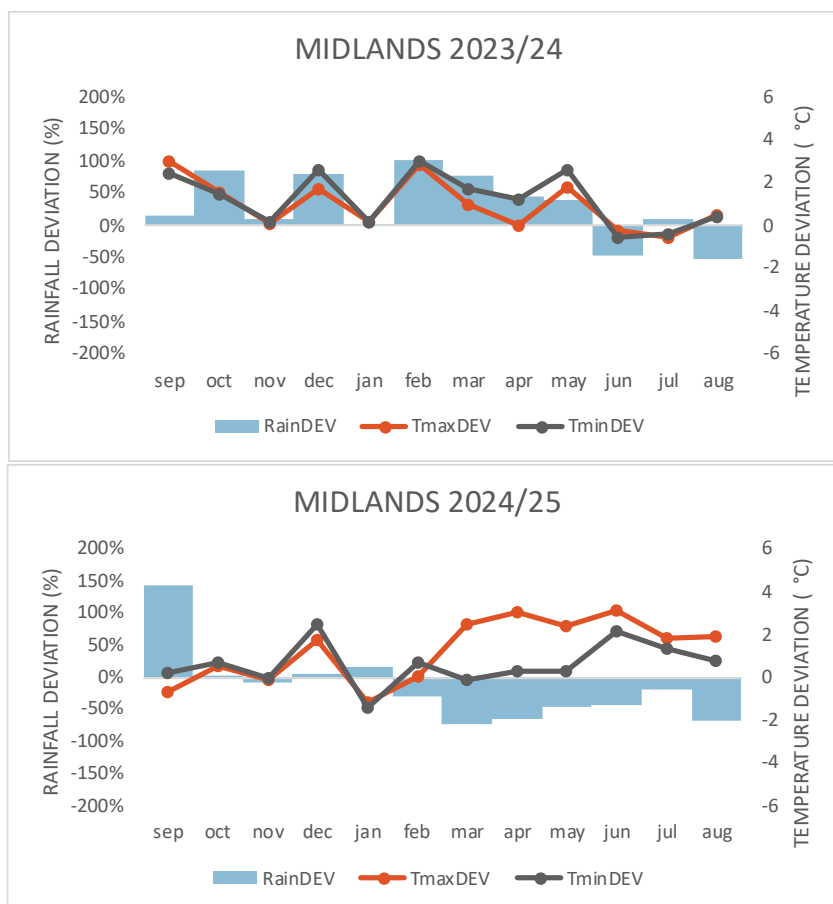


Figure 2. Deviation in monthly rainfall, maximum temperature, and minimum temperature compared to averages from 1991 to 2020. Data from Met Office.

into cultivar choice and design including blends (e.g. pairing a drought-tolerant variety and a flood-tolerant variety to ensure at least one variety yields).

Grain Yields

Farmers are paid based on volume of grain produced (yield) with some premiums for quality e.g. protein content. Different wheat varieties are classified into different end-use categories which must be taken into account when considering their average yield. For example, a milling wheat with a higher protein content (group 1) will generally yield less than a feed wheat with a lower protein content (group 4). Across the study period the top three highest yielding varieties were a blend of Mayflower and Extase, Redwald, and Mayflower, each achieving average yields of at least 4.5t/ha. The lowest three were Zyatt, Oak Farm Population, and Maris Widgeon, only achieving yields below 3.5 t/ha. Comparing the ranking of yields in different years of climatic

extremes provides some potential insights into varietal traits that drive performance. 2023/24 was wetter than usual in winter and spring, with yields generally being lower. The following year was drier with a hot summer and saw significant changes in the variety rankings.

Varietal Traits

Within organic systems the pressures on and influencers of grain yield are varied and potentially more influential than in conventional systems where chemical inputs can be used to control nutrition and competition. Through the data collected across the years we are able to identify which traits of the plant correlate with grain yield, providing an indicator of which characteristics are most important in organic winter wheat varieties.

Based on Principal Component Analysis, crop vigour and crop ground cover at flowering are strongly positively correlated with grain yield, as is, to a lesser extent, crop vigour and crop cover at stem extension (Figure 3). Weed cover and late weed cover at stem extension are negatively correlated with grain yield. Interestingly green leaf area doesn't show a strong relationship with grain yield, suggesting that disease and pest impacts were minimal.

These results suggest that the ideal variety will be one that has a high early ground cover and vigour, suppressing the weeds before they can establish. This crop cover should then continue to smother later weeds until harvest. It appears that a taller crop may not always be desirable, as crop height was found to have a less strong relationship with grain yield, and rather a wide spreading, leafy crop would be best suited to maximising yields.

Comparing the varieties based on early weed coverage the standout weed suppressors were found to be Mayflower, Maris Widgeon/Extase blend, and Evolution. Of these, however, only Mayflower was in the top ranking varieties in terms of yield, averaging 4.66 t/ha. Maris Widgeon is a milling variety, while Evolution was found to be highly variable in its yield output, rising and falling throughout the yield rankings across years.

These results highlight that weed competitiveness is not the only factor driving yield. The data obtained across the network allows us to unpick performance in more detail. For example, in 2024/25 Redwald was exceptionally high yielding compared to other varieties at 5.95 t/ha. For other years, however, its yields were relatively poor. Redwald did not score highly

on early vigour, which could explain its poorer performance some years. Indeed, it was associated with high levels of early weed coverage. Redwald's one high yielding season was unseasonably dry in spring, stunting weed growth and allowing this usually smothered-out variety to grow well. Redwald, therefore, may be suited to drought conditions or require heavy weed control.

Selecting Blends

Identifying the traits that impact grain yield the most in organic systems provides a basis for selecting varieties for blends as illustrated in Figure 4. Mayflower (shown on the left) is a potentially high yielding variety with high levels of weed suppression, although this varies depending on the climatic conditions as can be seen in the increase in the yield ranking compared to other varieties in 2023/24 and 2024/25 seasons. A reliable yielder, such as Extase (on the right), provides a suitable partner as it delivers consistent yields across years, however, suffers a little from poor early weed suppression. By combining the two the early weed suppression from Mayflower can benefit Extase, while the reliable yields from the latter provides a guaranteed minimal yield in climatically variable years. Mayflower



Figure 3. Extase (top row) and Mayflower (bottom row). The images on the left show differences in early ground coverage at stem extension and images on the right display subsequent differences in late weed coverage at flowering.

can also be paired for the same reasons with another similar variety, Siskin. When this is done the overall yield of the two varieties grown as a blend is higher than the average of each variety grown as a monoculture.

Across all of the years, growing a blend resulted in an average yield uplift of 0.27 t/ha compared to monocultures of the same varieties.

Future Work

An extensive dataset on winter wheat performance across a range of organic farm management options and environments has been collated over the course of this research. Details of weed impacts within different drilling, i.e. narrow rows vs wide rows, and subsequent weeding operations, i.e. harrowing with a comb or tine, combined with records of weed community composition have been collected over several years and indicate management does influence performance outcomes. Presently, strip trials are being conducted via an AHDB funded project alongside the implementation of weed competitiveness trait measurements within national conventional RL trials. This work will compare trait measurements in RL trials versus on farm, via the variety testing network, and hypothesises that variety performance will be influenced by the presence of weed communities with testing environment being key to determining varieties' weed competitive ability alongside identification of relevant traits.

The work completed within LiveSeeding has provided a solid foundation for understanding how a participatory and decentralised organic wheat variety testing system could operate, given insights into the key traits driving performance in organic winter wheat production, and begun preliminary research into the implementation of specific blends to suit organic growing conditions and unpredictable weather patterns due to climate change. We hope to continue this research over the coming years and believe this approach offers a viable method

to gain robust and reliable data to drive forward improved crop choice and management into the future.

- High early crop coverage
- Variable yields, high potential
- Low early crop coverage
- Reliable average yields

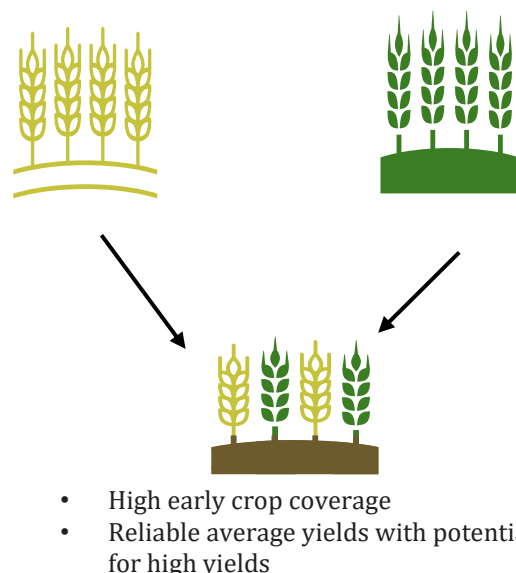


Figure 5. The concept of creating blends based on traits of different varieties to maximise productivity in organic systems.

Cold wet spring Hot dry summer	Warm spring Wet summer	Warm wet winter Warm dry spring	Cold wet winter Cold spring	Warm wet winter/spring Hot dry summer	Warm wet autumn Wet spring	Warm wet autumn/winter/spring	Wet autumn Hot dry spring/summer
2017/18	2018/19	2019/20	2020/21	2021/22	2022/23	2023/24	2024/25
•Crispin •Siskin •Evolution •Basset •Spyder •YQCCP •Montana	•Siskin •Crispin •Revelation •Evolution •Zyatt •Maris Widgeon •YQCCP •Montana •Ehogold •Extase •Skyfall	•Gleam •Crispin •Revelation •Siskin •Crusoe •Zyatt •Alabaster •YQCCP •Extase •Mortimer •Maris Widgeon •Evolution	•Crispin •Siskin/Extase •Gleam •Theodore •Saki •Hallfreda •Extase •Siskin •Graham •Crusoe •Revelation •Mortimer •Maris Widgeon •Nelson •Evolution •Mix_1 •Zyatt •Mix_2 •Costello	•Extase •Astronomer •Dawsum •Revelation •Siskin/Extase •Siskin •YQCCP •Aldiniti •Hallfreda •Mulika •Crispin •Gleam •Cranium •Maris Widgeon •Hereward •Theodore	•Extase •Mayflower •Apex •Mayflower/Siskin •Siskin/Extase •SPF •Astronomer •Champion •Nelson •Siskin •Revelation •Typhoon •Astronomer/Revelation •Aldiniti •Maris Widgeon/Extase •Maris Widgeon •YQCCP	•Mayflower/Extase •Mayflower •Astronomer •Champion •Highgrove •Typhoon •Redwald •Maris Widgeon/Extase •Nelson •Extase •YQCCP •Oak Farm Population •Marigertoba •Maris Widgeon •Miller's Choice	•Redwald/Dawsum •Redwald •Dawsum •Bamford •Mayflower/Extase •Rebellion •Palladium •Extase •Goldfinch •Mayflower •Diamond •YQCCP •Highgrove •Nelson •Astronomer •Cheer •Champion

Figure 4. Varieties grown in each season, ranked by grain yield. Above each season is a note of the climatic variation from the past 20 year average experienced in that season. Mix_1 and Mix_2 are farm-specific blends of listed varieties. YQCCP is also known as Wakelyns YQ.

ACKNOWLEDGMENTS

Production of this leaflet was funded by the European Union, the Swiss State Secretariat for Education, Research and Innovation (SERI) and UK Research and Innovation (UKRI). Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or REA, nor SERI or UKRI.



Co-funded by
the European Union



UK Research
and Innovation



Organic Research Centre, Spring Lodge, 172 Chester Road, Helsby, Cheshire, WA6 0AR, UK

01488 658 298 | hello@organicresearchcentre.com | organicresearchcentre.com

Organic Research Centre is a trading name of RSK ADAS Limited.

Registered in England no. 10486936. Registered office: Spring Lodge, 172 Chester Road, Helsby, Cheshire, WA6 0AR. RSK ADAS Limited is part of RSK Group Limited.