Field lab: Organic Hop Varieties

A participatory approach to variety testing and evaluation including the whole supply chain

Second Year report

2022

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1 Field lab aims

The aim of the field lab is to secure and improve availability and choice of UK grown organic hops through the following set of objectives;

- Bring together key stakeholders in the organic hops supply chain including breeders, merchants, growers and brewers to address the issues collectively.
- Identify varieties and breeding lines suitable for organic production and test these in field trials in commercial organic hop gardens.
- Develop assessment tools to quantify the performance of hop varieties grown in field trials in commercial organic hop gardens.
- Identify other areas of relevant research within the sector, that can improve organic hop production

2 Background

Hops production in the UK has declined rapidly since 1962, with acreage reducing from 8,200ha to approximately 1,000ha. This is especially the case for organic hop growers, with acreage reducing to such an extent that there are now only 3 organic hop growers in the UK. Reduction in acreage is attributable to climate change, restrictions in chemical usage and changes in the market, with a move towards US grown hops. Hops are particularly difficult to grow organically due to high disease and pest pressures and competition from weeds.

Varietal resistance is crucial for the control of diseases and pests, particularly for organic farmers, where variety selection is the main way that farmers can influence the success of their crop, as external inputs and the use of agrochemicals are rarely an option to limit damage. Variety selection is becoming more important for non-organic farmers where pest and disease resistance to chemicals is increasing. In addition, with environmental sustainability of farming under increasing scrutiny, environmentally damaging fertilisers and pesticides need to be replaced with integrated approaches using less chemicals and a move towards agroecological systems (Hill & MacRae, 1996).

Previous breeding programmes have focussed on the performance of varieties under high input farming conditions. The unavailability of suitable varieties for low input systems is likely to have contributed to the reduction in organic hop acreage, despite high demand. The process of breeding new hop varieties is complex and can take up to 11 years to produce a commercial variety. Organic hop growers require better access to information on hop performance within organic systems. With the move towards agroecological processes, by evaluating varieties under organic and low-input conditions there is a wider relevance to the whole sector.

This field lab evaluates hop variety performance in organic systems to provide more relevant varietal information for organic farmers and determine their suitability for low-input environments. Small-scale organic breeding programmes are not currently economically viable, however breeding lines and varieties should be tested in organic and low-input systems to determine their suitability. The results from organic variety trials can indicate which varieties and traits may be suitable for future organic and low-input breeding.

There is still high demand for organic hops from hop merchants and brewers. This field lab was established by stakeholders from across the organic hops supply chain as listed below (Table 1). The inclusion of all members of the supply chain improves the impact of the field lab by including expertise and inputs from all stakeholders. Farmers and breeders require input from the market and end users, whilst the market needs to know which varieties are agronomically compatible. With

farmer-breeder collaboration, it gives farmers the opportunity to test novel lines, but can also open up new market opportunities for breeders.

Table 1.0 Field Lab Group membership details

Name	Organisation	Role
Greg Pilley	Stroud Brewery	Group co-ordinator and Brewer
Will Rogers	Charles Faram	Hop Merchant/Technical expert
Peter Glendinning	PGhops/Charles Faram Hop Development Programme	Research Agronomist
John Walker	Tedney House Farm, Worcestershire	Grower
Tom Upton	Woodlands Farm, East Sussex	Grower
Henny Lowth	Organic Research Centre	Crops researcher

3 Methodology and data collection

This field lab tests hop varieties directly on two organic farms, using participatory varietal selection. By testing the varieties directly on farm, it provides better information on the Genotype by Environment (GxE) and Genotype by Management (GxM) interactions to identify the best performers for the specific target environments of the farms involved, rather than standard breeding that seeks broad adaption.

One of the participating farms, Tedney House Farm, farmed by John Walker, grows 6ha of organic and 1ha non-organic dwarf hops, near Clifton upon Teme, in the Teme Valley on the Herefordshire, Worcestershire border on clay loam soils with moderate to high fertility. The area of the farm where the hops tend to be grown on the farm is located on silty loam floodplain soils of the river Teme.

The second farm, Woodlands Farm, farmed by Tom Upton, grows 2ha of organic tall hops and is located near Rye, East Sussex on clay loam soils with moderate fertility.

This growing season, the varieties trialled are listed below. Information about the agronomic qualities of the hop varieties trialled so far has been collected visually by the farmers and has been qualitative, with anecdotal evidence provided in the results section.

Plants for trial were sourced from Wye Hops Ltd and British Hop Association (BHA) breeding programme bred by Dr Peter Darby and from the Charles Faram Hop Development Programme. The numbered varieties trialled at Tedney House were all bred by Wye Hops and were selected by John Walker from the trials carried out at Dormington by Peter Glendinning for Wye Hops.

Table 2.0 Hop varieties tested at Tedney House Farm, Worcestershire

Variety	Bred By	Description

Sovereign	Wye Hops	Control – Developed by Dr Peter Darby at Wye College, a hop in the "classic English style", shows good all-round disease resistance and excellent yield potential
Merlin	Wye Hops	Trial variety from Wye Hops
42/10	Wye Hops	Trial breeding line from Wye Hops
65/2011/24	Wye Hops	Breeding line selected by grower from Charles farm nursery plots at CFHDP nursery
64/2011/26	Wye Hops	Breeding line selected by grower from Charles farm nursery plots at CFHDP nursery, high alpha acid content
12/2016/45	Wye Hops	Breeding line selected by grower from Charles farm nursery plots at CFHDP nursery, seedling of Fuggle with good aroma
Endeavour	Wye Hops	Dwarf hop from Wye breeding program, resistant to powdery mildew and tolerant of wilt

Table 3.0 Hop varieties tested at Woodlands Farm, East Sussex

Variety	**Bred By**	**Description**
Challenger	Wye Hops	Control - high yielding dual-purpose variety from Wye breeding programme released in 1972, good resistance to Downy Mildew but is susceptible to Powdery Mildew and Verticillium Wilt
Harlequin	Charles Faram	CFHDP selection, new aroma variety with high alpha acid, selected for its aroma, disease resistance and yield.
Progress	BHA	Developed by Wye as a replacement for Fuggle and has similar characteristics. A variable yielding aroma variety susceptible to Downy and Powdery Mildew but shows a high degree of tolerance to Verticillium Wilt
Pilgrim	BHA	Dual purpose hop developed at HRI Wye and released in 2000, has a vigorous growth habit and provides a high yield, with good resistance to both powdery and downy mildew, and one of the most wilt resistant varieties
404	Charles Faram	Breeding line - new CF aroma lines
3294	Charles Faram	Breeding line - new CF aroma lines

4 Knowledge Exchange

PGhops Ltd

In July, Henny Lowth met with Peter Glendinning and Will Rogers, at Peter's hops nursery in Ledbury. Peter provided an overview of the hop breeding process and provided the quantitative assessments

used to determine whether a hop variety was suitable for further breeding and commercial use. This provided an opportunity to develop an assessment tool for use on the organic variety trials, combining expertise from Peter and protocols from previous crop assessments used by ORC.

Woodlands Farm Visit

In August, all of the stakeholders, aside from John due to early Damson harvest, met at Woodlands Farm. Tom provided a short presentation covering the hop growing process as Woodlands Farm, the different processes, equipment and harvest techniques. The group then carried out a crop walk and assessment of the varieties. The group discussed the use of the crop assessment tools developed by ORC & Peter and the potential comparison of biodiversity between organic and conventional hop management. The group decided that the biodiversity assessment was outside the scope of the current project. A discussion was also initiated about permitted interventions for organic hop growing in the UK and potential further research projects to determine the feasibility of these interventions.

Figure 1. Members of the Organic Hops field lab inspecting the invertebrates collected from one of the hop varieties at Woodlands Farm. Photograph taken by Greg Pilley

Figure 2. Tom Upton, Organic Hop Farmer at Woodlands Farm, hosting a farm visit in August 2022. Photograph taken by Greg Pilley.

Great Beer Debate ORFC January 2023 – Summary provided by Greg Pilley (Stroud Brewery)

For the great beer debate at ORFC Stroud Brewery took their Oaty Ale - an all-UK Organic Pale Ale showcasing the first harvest of organic Harlequin hops from Woodlands Farm. It was very well received, and the bold fruity characteristics were well presented in the brew which utilised (the majority of) the 2022 organic crop. Conclusion for brewing characteristics - it provided bold and distinctive flavour and aroma as a UK grown hop. We (Stroud Brewery) would certainly like to see the full harvest for 2023.

The debate itself was again a great opportunity to highlight the immediate challenges faced by UK hop growers to an informed audience, including the head of standards at SA.

Oaty Ale - A smooth, juicy, fresh cask beer ABV 4.2%

In the world of new age hops and beer styles like IPAs dominating the craft market it's easy to forget how good Organic UK ingredients can be. This pale ale with all ingredients coming from within the

UK has a generous addition of oats to give a rich and smooth feel to the beer - well-balanced and bursting with flavour.

5 Results & discussion

Table 4.0 Hop variety results at Tedney House Farm, Worcestershire

Variety	Timing in Season	Comments
Sovereign	Early	Control. Have established fairly well and coming into burr. 19/July as are the other varieties in the trial. Clean of disease and pests.
	Late	Didn't pick but stayed clear of disease till the end of the season. Hopefully will give a full crop next year.
Merlin	Early	Showing high levels of powdery mildew. Will probably remove this winter. Partly because they are very hard to grow and partly to protect our other hops but mostly because they are not reliable / profitable enough.
	Late	Went from Burr to mould. Did pick but wished we hadn't grown them. They created a reservoir of disease that started to infect the older sovereign adjacent to them.
42/10	Early	Clear of powdery mildew. Can get Downey mildew late on when in hop. This year some plants showing much better vigour so maybe worth another look. See what brewers think?
	Late	These looked fantastic, they can get Downey mildew and be shy growers but the dry year seemed to suit them. Not really a big crop enough but clean in a low yielding year.
65/2011/24	Early	Promising, vigorous, generally free from disease here so far. PG has given up on them because can't control HPM even with chemicals so we will see what next year brings.
	Late	These stayed clean of Hop Powdery Mildew until close to picking when we found a bit. From Peter's experience they could be much worse next year. We did harvest a few Kg from these so look forward to hearing how they behaved in a brew. More vigorous than the other trials, maybe too vigorous as a mature plant
64/2011/26	Early	Have found a spot of HPM on these but their main issue is poor establishment. Far too many gaps, especially when compared to the other rows planted at the same time. They were uneven emerging and are still uneven. The row also contains several rogue males which came with them.
	Late	Not harvested. Not very impressive, see how next year goes.
12/2016/45	Early	Wilt susceptible and discarded from the trial. Not planted.
Endeavour	Early	Replaces 12/16/45 as a disease resistant dwarf type almost immune to powdery mildew and very tolerant of wilt but may have problems with late season downy mildew and aphids. These have established well and are free of disease and pests so far. They do not seem to tolerate the heat / lack of moisture as well as the others and their leaves look more wilted. Maybe it is a variety that irrigation would make a significant difference to?
	Late	These look much better. A good take and remained disease free. Not picked to retain vigour for next year when we are hopeful of a good crop. Apparently not the most exciting hop to brew with but will hopefully find a niche in the organic sector. We have planted more of these on a commercial scale.

Table 5.0 Hop variety results at Woodlands Farm, East Sussex

Variety	Yield Weight	Comments
Challenger	840.96	Yield down by perhaps 15-20% (primarily down to the drought) I would have expected the crop to have weighed in at 1T given its volume. High quality was undone by late season mould and downy mildew pressure 10 days prior to the allotted picking time requiring an earlier picking slot on half the garden. This compromised the weight of the cones. A delay of 8 days before picking the second half of the crop helped to increase the weight following several rain events. Bines picked well.
Progress	0	Unpicked as the bines were too weak given the weed competition and poor training.
Pilgrim	13.9kg	Strong bine, with high quality cone, relatively heavy yield. The thickness and strength of the bine made picking difficult,
Harlequin	13.58kg	Good showing considering the weather of the season, some cone tip blight and possibly late downy mildew on the cones. The bine was virtually self-training and relatively disease free making for easy growing. Given that only 90 bines out of a possible 700 were harvested and these were only 2-year-old bines, this years yield offers genuine optimism for harvest 2023. A genuine contender to mitigate against Challenger's unpredictability.
3294	.5kg	Only harvested 2 bines which yielded well due to the high oil count and bold cone. The bine grows rapidly and whilst it has had downy rebounds very quickly upon disease pressure easing.
404	0	This variety has virtually died off. Will be looking for a replacement

Following on from the assessment sheets used by Peter in his nursery, the ORC developed a field assessment sheet to assess the trial varieties in 2023 (Annex A). This will provide an opportunity in the next growing season to move forward from anecdotal evidence to provide quantitative data to determine the performance of each of the tested varieties.

The main areas to be assessed in the next growing season are:

- Growth habit
- Crop Vigour
- Pest & Disease severity
- Weed cover

It is recommended that Challenger and Sovereign, as the control varieties in the experiment, should also be assessed in nearby conventional farms to provide a benchmark for their performance in organic and conventional fields. With the accompanied assessments in non-organic systems, it is also possible to determine, to some extent, how the performance of these varieties varies in high and low input environments.

6 Further Research

As well as the importance of variety breeding and selection, the hop growers and breeders involved in the project have highlighted other key areas of research that could help to improve the production of organic hops. These key areas are listed below:

→ **Soil Health** – Key soil traits are moisture retention in July & August, drainage & high organic matter content.

- What are best practices to avoid soil compaction issues?
- Green manuring: Alternatives to winter Rye as a catch crop, whilst preventing the spread of verticillium
- Study into why some soils harbour wilt disease and others do not?
- Best practice for applying fresh organic matter (e.g., composted beef straw muck). Usually applied in the summer months, to reduce wilt risk. Best practice needs to avoid breaking strings and encouraging too many weeds.
- Soil nutrient balance: Do nitrifying organisms mobilise potassium and are there options to increase uptake of phosphates?
- Foliar feeds that don't encourage disease (e.g., ensiled fish emulsion): Are there any plant extract alternatives that might do as well?

→ **Disease Control**

- Downy mildew: Not cured fully by copper, which is not approved for use on organics currently. Could the use of potassium phosphonate or pythium oligandrum be an alternative? Potassium phosphonate is considered among the best treatments for downy mildew, however current organic regulations mean that it cannot be used by organic hop growers.
- Disease pressure: currently reduced by maintaining air circulation around the base of the plants by manually removing excess shoots, hand-stripping bines or using sheep on tall hops. What alternatives could be used? A plant-based UV defoliant?

→ **Pest Control**

- Aphid control: Varieties being tested for aphid control are currently too susceptible to hop powdery mildew. What alternatives are there - Trap cropping? Quassia sprays (Quassine in Germany)?
- Two-spotted spider mites: Current use of predatory mites is negatively affected by sulphur sprays and unsuitable conditions in the field. Could targeted pest control, with precision dropping of predatory mites, be an alternative option, as spider mites are usually detected in hot spots?

→ **Use of Fossil Fuels**

- Can hop drying be achieved without the use of fossil fuels?

7 Conclusions

This report details the second year of the field lab development as well as some background context to the state of organic and low input hop production. In 2023 we hope to see the collection of more quantitative data to compare the varieties in a more comprehensive way.

Using a Participatory Variety Selection approach involving the whole supply chain, this field lab aims to help organic and low-input hop growers find suitable varieties for organic farming showing desirable agronomic traits as well as the hop characteristics required from the market. The participatory approach enables evaluation within target environments seeking to find the most appropriate varieties for the farm rather than conventional breeding seeking broad adaption to non-organic production systems.

This report provides a basis for the required ongoing support of organic hop growers in the UK. The further research items detailed above highlight the importance of increased funding for organic hop research, not just for the research and development of novel pest and disease controls and management practices, but also for the continued selection and field testing of new hop varieties in

organic systems. As detailed earlier in the report, there is a desire for resilient hop varieties in organic brewing and a number of advanced selections can be identified. The stakeholders require continued support and funding to continue testing these varieties on Organic Hop Farms to ensure their suitability. From consultation with the participating stakeholders, there also appears to be a desire and requirement for an open dialogue with the relevant certification bodies to discuss the potential use of alternative pest and disease interventions going forward.

Annexes

Annex A: Organic Hop Assessment sheets

Hop_assessment_sheets.xlsx

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