

Organic Hop Varieties Field Lab

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

Final Report
2024



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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 primary objectives:

- Bring together key stakeholders in the organic hops supply chain including breeders, merchants, farmers 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.
- Assess hop variety characteristics and qualities for brewing through lab analysis and brewing tests
- Develop assessment tools to quantify the performance of hop varieties grown in field trials in commercial organic hop gardens
- Compare organic and conventional hop growing systems in terms of soil health, carbon and biodiversity (not achieved)

Introduction

The organic hops industry in the UK comprises two farmers and five to six breweries that are dedicated to only brewing organic beers. The small industry is the result of a decline in acreage of organic hops grown in the UK from the early 20th century. In 1966 there were 8176 hectares (ha) dedicated to all types of hop production in England (Torrens, 1967). Currently, there are only 1000 ha of hops being grown in England and the size of the industry is relatively stable (British Hop Association, 2023a). The decline over the centuries is credited to the shift from growing hops for bitterness to growing hops to add flavour; there are also challenges to growing hops in the UK (Transition Culture, 2012). This comes from the high disease and insect pressures including Damson Hop aphid, powdery and downy mildew, competition from weeds for nutrients in the soil and low nitrogen availability (British Hop Association, 2023b). Additionally, the pressures from climate change, changes in the market where hop flavour and aroma profiles typical of the US West coast hops are more fashionable, and for organic systems, the restrictions in chemical usage.

A third of the hops, organic and non-organic, used in beer production in the UK are imported, predominantly from Europe (Transition Culture, 2012). If all the hops grown in the UK were retained it would only be enough to fulfil two-thirds of the demand for beer production; there is clearly a high demand for growing more hops here (Transition Culture, 2012). The European hop growing regions such as Germany, the Czech Republic and Slovenia will experience a fall in hop yields of 4-18% by 2050 if farmers don't adapt to the hotter and drier weather caused by global heating (Mozny et al., 2023). Additionally, the alpha acid content of hops, which gives beer its distinctive taste and smell will fall by 20-31% with climate change (Mozny et al., 2023). The potential for a limited supply of hops in the future from Europe raises an opportunity for more British hop farmers. England is well situated for growing hops: the life cycle of hops is controlled by daylight rather than temperature, they grow at their best between 35 and 55 degrees latitude which covers England well (Charles Faram, 2023). Also, the high clay content soils in regions in Herefordshire, Worcestershire and Kent hold onto

water even in drought conditions, compared to the lighter soils of Germany's hops-growing region, a benefit with rising temperatures in the future.

To overcome the barriers to making a successful organic UK hop industry new hop varieties that are tolerant of disease and climatic conditions as well as suited to agricultural systems that have a positive effect on the environment are required. With milder and wetter winters and springs predicted with climate change in the UK it is important to find hop varieties that are more tolerant to these conditions (Arnell and Freeman, 2021). An increase in precipitation can lead to waterlogged soil causing root rot and diseases in hop plants (Kind and Kaiser, 2020). Milder winters disrupt the normal dormancy period of hop plants, making them more susceptible to diseases and pests. Additionally, if the chilling requirements are not met it can result in reduced yields and lower quality hops (Kind and Kaiser, 2020).

Hop farmers need better access to information on hop performance in organic systems. Hop merchants and brewers wishing to sell and use organic hops need organic farmers to help test new varieties for their adaptation to low input farming systems. This field lab is overcoming some of the challenges faced in the UK organic hops industry by using participatory variety testing to find suitable breeding lines for organic farming systems with whole supply chain collaboration. Involving all the key stakeholders in the field lab allows for a combination of expertise to be shared and collective learning (Table 1). The small organic hops industry in the UK lends itself to a field lab that requires all the actors in the supply chain to be involved. The security for the farmers and merchants that the product will be sold requires communication from the market. The market needs to be informed which varieties are compatible for brewing and this gives farmers the opportunity to test novel lines. This will open opportunities for breeders to develop new varieties. The challenge of making the industry economically viable is easier through this collaborative approach. This field lab consisted of a multi-stakeholder group that represented growers, hop merchants and brewers (Table 1).

Table 1: The participants in the organic hops field lab

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	Farmer
Tom Upton	Woodlands Farm, East Sussex	Farmer
Dominic Amos	Organic Research Centre	Crops researcher
Henny Lowth	Organic Research Centre	Crops researcher
Isabel Mackintosh	Organic Research Centre	Crops researcher

Methodology

Trial Sites

The hop varieties were tested at two farms in the predominant hop growing regions in England: the West Midlands and South East counties. Both tested different varieties of hops to suit the tall and dwarf hop systems in place.

The first farm is Tedney House Farm, farmed by John Walker, on the Herefordshire, Worcestershire border in the Teme Valley. There are 6ha of organic and 1ha of non-organic dwarf hops farmed on the clay loam soils with moderate to high fertility. The area of the farm where the hops tend to be grown is located on silty loam floodplain soils of the river Teme. The second farm, Woodlands Farm, is farmed by Tom Upton near Rye, East Sussex. They grow 2ha of organic tall hops on clay loam soils with moderate fertility.

Hop Varieties

Hop varieties were tested 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 adaptation. The varieties that were selected for the trials were chosen by the farmers in collaboration with the hop breeders.

Plants for the 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 varieties trialled at Tedney House Farm 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 and 3 summarises the varieties that were selected at each farm for testing.

Table 2: Hop varieties planted in 2019-2022 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
65/11/24	Wye Hops	Breeding line selected by farmer from Charles Faram nursery plots at CFHDP nursery
64/11/26	Wye Hops	Breeding line selected by farmer from Charles Faram nursery plots at CFHDP nursery, high alpha acid content
12/16/45	Wye Hops	Breeding line selected by farmer from Charles Faram 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. Good storage ability.

Table 3: Hop varieties planted at start of the field lab 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. Excellent all-round hop.
Harlequin	Charles Faram	CFHDP selection, new aroma variety with high alpha acid, selected for its aroma, disease resistance and yield. It is a dual purpose hop.
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 2001, 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

Assessments

Field Assessment

The qualitative visual observations on the hop varieties were recorded by the farmers throughout the growing season, some of the observations recorded are described in table 4.

Table 4: Field assessment observations

Observation	Description
Phenology	Crop stage at key timings, ripening and harvest window
Vigour	Early season vigour assessed visually as days to reach top wire
Disease resistance	In comparison to farm control varieties, identification of foliar disease symptoms and severity assessment.
Pests	In comparison to farm control varieties, identification of pest presence and damage assessment.
Weed cover	Most abundant weed species present noted
Number of hops and strength of plants	The number of hop bines that were successful and their strength
General establishment	How well established the variety is compared to the control, visual observation

Harvest Assessment

Analysis of the harvest yield, alpha acid content and olfactory analysis of each successfully established hop variety was provided by the hop merchant, Charles Faram. These varieties were assessed to determine the end use quality characteristics for brewing.

Test Brewing

Test brewing was carried by the brewer, Stroud Brewery, using the best varieties from the trial based on agronomic performance and hop quality indicators. The minimum requirement for a test brew is fifty litres requiring approximately 150g of dry hops in the brewery's small batch pilot brew kit. A yield of 300g will allow one hundred litres production and possible canning of the product.

Knowledge Exchange

Throughout the duration of the organic hops field lab there has been multiple knowledge exchange events involving all the participants in the project. These have allowed for the current challenges of the UK hops industry to be discussed from the different perspectives of the breeder, grower, merchant and brewer as well as a collaborative approach to finding solutions.

Year 1 (2021-2022)

Kick of meeting

In July 2021, a kick off meeting for the field lab took place at Charles Faram hop development nursery. Peter Glendinning gave the group a tour around the hop nursery, sharing knowledge on the complexity of growing hops organically. Some key points that were raised include a need for disease resistance in hops as the level of chemical intervention permitted in the industry is reducing; an organic setting may present reduced disease pressure due to improved soil health, reduced nitrate input and a natural predator bank. Also, organic plants require certain characteristics, for example having early vigour to be able to outcompete weeds.



Photo 1: Grower, John Walker, at CFHDP nursery inspecting a breeding line selected by him for testing. July 2021. Photo taken by Dominic Amos.

Year 2 (2022-2023)

PGhops Ltd

In July 2022, 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 2022, 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 at 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.



Photo 2: Members of the field lab inspecting the invertebrates collected from one of the hop varieties at Woodlands Farm. 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.

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.

Year 3 (2023-2024)

Tedney House Farm Visit

In September 2023, the participants of the field lab got together at Tedney House Farm in Worcestershire. John Walker gave an overview on the performance of the hop varieties that are part of the project. This was followed by a crop walk where the group discussed the prevalence of disease in the varieties, organic bio-controls that could be used and which varieties would likely produce a high yield this year. Later, future topics of interest for the organic hops field lab were discussed. This includes the environmental impact of organic hop farming compared with a conventional hop system and how to measure the differences between the two systems. This is relevant to the Scope 3 emissions reporting that many food businesses are now reporting as part of their sustainability commitments. An assessment into the current state of the organic hop industry in the UK would give insight into how valuable the work of this field lab could be. Connecting with organic European hop farmers and how they manage their systems is an interest for all the field lab members, the insights and knowledge gained from this could be applicable to both farms. The ideas that came from this meeting are further considered in the discussion section of this report.



Photo 3: Members of the field lab looking at a young hop variety at Tedney House Farm, Worcestershire. September 2023. Photo taken by Julia Cooper.

Stroud Brewery tasting

In March 2024, the participants of the field lab met at Stroud Brewery to wrap up the organic hops field lab. A tasting of the pilot brews from the third-year harvest took place. The characteristics of each pilot brew was rated for its intensity and predominance of aroma and taste. The brewing team at Stroud Brewery explained to the group about the process of doing a pilot brew and how the brews from this field lab were done. They were done with a single pale malt and single hop so the characteristics of each variety was more noticeable. The aroma of the brews wasn't adjusted for bitterness. A summary of the tasting notes that were recorded by the group is summarised in table 7.

After lunch, a preliminary version of the final report was shared. The findings and conclusions from it were communicated to the group by Isabel Mackintosh and Greg Pilley. Afterwards, both Tom Upton and John Walker discussed their experience of the field lab and the benefits it has had for their organic hop farms so far. The challenges in the organic and conventional hops industry were raised, including the market's focus on 1940s varieties of hops such as Fuggle and East Kent Goldings, which limited the opportunity to find new better suited and tastier varieties. The high labour required in organic



Photo 4: Stroud Brewery pilot brew tasting. Photo taken by Isabel Mackintosh

systems compared to conventional effects the overall profitability of organic hops, even though the premium on organic hops is higher and the artificial inputs much lower. Another challenge for the organic beer industry comes down to why consumers choose to buy organic. Often organic products are chosen for health reasons but this is not an incentive when drinking beer. The farmers also mentioned the shift in opinion from hop farmers towards growing organically throughout the duration of the field lab. Due to an increase in the cost of artificial inputs farmers are now interested in how they can grow hops with minimal inputs.

How the work of the field lab so far will be continued was also raised. Charles Faram is going to supply both farms with new breeding lines of hops to trial. A webinar with European organic hop growers to share solutions to some of the challenges faced is going to be organised. It was also suggested by the Innovative Farmers attendees that the farmers stories from this field lab would be interesting to record. If more funding is secured the carbon and environmental impact of organic hop farming and beer production would be pursued.

Results

The results of participatory varietal selection of hops at Tedney House Farm and Woodlands Farm across the three years of the field lab are summarised in tables 5 and 6. The comments and field observations were recorded by the farmers themselves and the harvest and brewing analysis results are sourced from Charles Faram hop merchants. The performance of the varieties and their suitability to organic systems are ranked by colours: green, amber and red. The green ranked varieties have been selected by the farmers as the most promising varieties, the amber ranked varieties have demonstrated at least one year of suitable harvest yields but have suffered from disease prevalence and the red ranked varieties are not suitable for organic systems due to poor performance.

Table 5: Results of hop varieties grown at Tedney House Farm, Worcestershire. The varieties have been ranked by their suitability to organic systems. Green indicates good performance and promising suitability, amber indicates moderate performance, possible suitability and red indicates not suitable due to poor performance. The varieties planted in 2023 have not been ranked as the hops aren't well established enough to determine their performance.

Variety	Year	Field observations	Harvest and brewing analysis
Planted in February 2023			
Klara	Year 3	All overtaken by weeds especially knotgrass in late August. All Klara's seem clear of aphid and should be resistant	None done
34/18/40	Year 3	Weak plants, only just clear of weeds. Odd long extension. No sign of Hop Powdery Mildew (HPM) No sign of Downy Mildew (DM)	None done

35/18/15	Year 3	Dark green colour, quite strong, look nice. No sign of HPM No sign of DM	None done
37/18/6	Year 3	DM definite signs on hop and shoot	None done
38/18/27	Year 3	Nice green colour, look nice. Hops later than rest of trial including Endeavour DM possibly on one shoot, also one hop that could be DM or HPM	None done
43/18/37	Year 3	Red bine, nice green colour, looks good. No sign of HPM No sign of DM	None done
Peter Glendinning F46	Year 3	DM and cock hops present	None done
171	Year 3	Quite yellow, cones look full of aphid No DM seen No HPM seen	None done
3957	Year 3	No HPM seen DM possibly on one shoot	None done
Endeavour	Year 3	Nice and green Hops clear of aphid and HPM DM found on a few hops but most clear	None done
Planted in 2021/22			
Endeavour	Year 1	Replaces 12/16/45 as a disease resistant dwarf type almost immune to HPM and very tolerant of wilt but may have problems with late season DM and aphids.	
	Year 2	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? 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.	
	Year 3	Slug damage early on, selected by the slugs. Very bad aphid, worse than sovereign. HPM seems pretty resistant. DM susceptible in a bad year.	13% Alpha Acid content 67kg yield.

			Tasting notes of blackcurrant, spice and lemon
12/16/45	Year 1	Wilt susceptible and discarded from the trial – deselected from the development programme due to susceptibility to wilt and HPM	
	Year 2	Wilt susceptible and discarded from the trial. Not planted.	
65/11/26	Year 1	Early signs of HPM but infection did not take hold	
	Year 2	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. Not harvested. Not very impressive.	
	Year 3	Poor to establish but stronger this year. HPM susceptible but not as bad as Merlin. Pot Bicarb has weekend plants. DM picked spike mid-summer.	6.09% Alpha Acid content 26kg yield.
65/11/24	Year 1	Promising, vigorous, generally free from disease although some late season HPM observed on some cones leading to premature ripening and some cone breakage	
	Year 2	Promising, vigorous, generally free from disease here so far. Peter has given up on them because can't control HPM even with chemicals so we will see what next year brings. These stayed clean of HPM until close to picking when we found a bit. From Peter's experience they could be much worse next year. More vigorous than the other trials, maybe too vigorous as a mature plant	A few Kg harvested
	Year 3	Vigorous and smelly. HPM susceptible but not as bad as Merlin. Treated with Pot Bicarb which has weakened plants. DM picked a bag of stunted shoots in mid-summer. Not much on cones but not heavy.	8.73% Alpha Acid content 18kg yield.

Planted in 2020/21			
W42/10	Year 1	Showed signs of HPM with low vigour	
	Year 2	Clear of HPM. Can get DM late on when in hop. This year some plants showing much better vigour so maybe worth another look. See what brewers think? These looked fantastic, they can get DM 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.	
	Year 3	Poor vigour/short plant has struggled with weeds. HPM very good resistance. Clean last year when adjacent Merlin was wiped out. DM susceptible on hops. Have been ok in dry/normal season, but not this year.	6.55% Alpha Acid content 27kg yield The taste is challenger-like, pine-floral
Planted in 2019/20			
Merlin	Year 1	Showed high levels of HPM. Debating removing. Initially planted ½ acre then added four following the season. Regretted planting the additional without a proper trial	
	Year 2	Showing high levels of HPM. 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. 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.	
	Year 3	All good except HPM Ungrowable organically Aphid resistant	None done
Sovereign	Year 1	Control	
	Year 2	Control. Have established fairly well and coming into burr. 19/July as are the other varieties in the trial. Clean of disease and pests. Didn't pick but stayed clear of disease till the end of the season. Hopefully will give a full crop next year.	

Table 6: Results of hop varieties grown at Woodlands Farms, East Sussex. The varieties have been ranked by their suitability to organic systems. Green indicates good performance and promising suitability, amber indicates moderate performance, possible suitability and red indicates not suitable due to poor performance.

Variety	Year	Field observations	Brewing analysis
Challenger	Year 1	Control	
	Year 2	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 DM 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.	840.96kg
	Year 3	A vigorous grower, coped relatively well with the wet conditions. Late season DM moved into the crop a couple of weeks out from the optimum harvest window and pegged yield back by 15%. Incremental cultural gains made growing this variety possible but it's agronomics still make this a difficult variety to grow especially organically.	8-8.5% Alpha acid content which is towards the top of achievable results for this variety
Harlequin	Year 1	Growth was moderate with 50% reaching eight foot in height. Precocious moderate crop harvested by hand from the strongest plants totalling 1kg. Disease resistance was excellent some red spider mite evident but dealt with via bio control	
	Year 2	Good showing considering the weather of the season, some cone tip blight and possibly late DM 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.	13.58kg
	Year 3	A little shy early in the season but responded well to increased temperatures.	65kg yield

		The majority of plants produced good sized bines and a respectable yield of heavy easily picked cones. Disease resistance is exceptional neither DM or HPM this season.	
Progress	Year 1	Failure of most crowns to climb up the strings suspect waterlogging of the crowns. Crop failure - cured with ditching	
	Year 2	Unpicked as the bines were too weak given the weed competition and poor training.	0kg
	Year 3	Plants suffered from early and late DM.	None done
Pilgrim	Year 1	Early season DM infection from the crown which persisted all season due to the weather some cones produced but uneconomical to harvest.	
	Year 2	Strong bine, with high quality cone, relatively heavy yield. The thickness and strength of the bine made picking difficult.	13.9kg
	Year 3	This variety suffered from DM attack throughout the season and failed to yield.	None done
404	Year 1	Early infection of DM but rapid response in growth. Very vigorous with bold cones weighing well	
	Year 2	This variety has virtually died off. Will be looking for a replacement	0kg
	Year 3	Plants died and haven't been replaced.	None done
3294	Year 1	Weak growth, poor crop. Not optimistic for its suitability but will commit to trial for three years.	
	Year 2	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 DM it rebounds very quickly upon disease pressure easing.	0.5kg
	Year 3	Vigorous, strong grower, easy training, large bold cones, relatively disease free. No sign of cone tip blight like last year. Cone hung well and didn't suffer from DM despite the wet season. Given it was harvested overripe it hung well and picked easily.	~1.5kg yield Floral, tropical fruit sweets tasting notes

The results of the pilot brew tasting at Stroud Brewery in March 2024 are shown in table 7. The intensity and predominance of the aroma and taste of each variety was recorded by the event attendees. The main use of the variety and purpose is also noted by the brewer.

Table 7: The tasting and aroma notes of the pilot brews at Stroud Brewery from the successful third year hop harvest as well as the main use and purpose of the hop varieties.

Variety	Alpha acid content	Aroma Intensity	Taste Intensity	Predominant Aroma	Predominant Taste	Main Use	Main Purpose
3294		57	51	Sweet Fruit/Melon	Melon	Dry Hop	Blend
W42/10	6.55%	12	17	Fruity	Orange	Bittering	Blend
65/11/26	6.09%	26	22	Pineapple	Tropical Fruit	Bittering	Blend
65/11/24	8.73%	25	32	Strawberry	Banana	Dry Hop	Blend
Endeavour	13%	27	34	Lemon	Zest	Dual	Blend
Harlequin		53	60	Pineapple	Pineapple	Dry Hop	Blend

Discussion

Variety Trials

The trials in the final year have been under pressure from downy mildew due to the wet growing season; there has been a yield loss for certain varieties directly from this. However, several varieties have still produced promising alpha acid results, tasting notes, good vigour and resistance to other pests and diseases.

Suitable varieties

The varieties ranked as green in tables 5 and 6 have promising suitability for organic systems due to their good performance in this field lab trials, they will continue to be grown by the farmers.

At Tedney House Farm, John Walker has decided to continue to grow and monitor Endeavour; this is the only 2022 planted variety that will be continued as well as the control, Sovereign. From the results in table 5, Endeavour showed good disease resistance in year 2 but was



Photo 5: Hop's at Tedney House Farm. September 2023. Photo taken by Julia Cooper.

susceptible to slugs, aphids, downy mildew and hop powdery mildew in year 3. Despite this a 65kg yield was obtained and a pilot brew was done. John Walker hopes that the downy mildew will be less prevalent with drier weather and in a better location too. The Endeavour planted in February 2023 has been clear of aphids and hop powdery mildew as well as having minimal downy mildew damage.

Harlequin is going to be trialled again at Woodlands Farm; Tom Upton would like to double its planted area. Table 6 shows that the variety has been relatively disease free throughout the three years and the yield reliable due to the good sized and fast-growing bines and heavy cones. Also, variety 3294 will be grown and monitored for another year with several rows planted this coming spring. Despite not looking promising at the start of the trials it recovered quickly from disease infection and was free of downy mildew in the final year despite the wet conditions. Challenger, the control, will continue to be grown but its area won't be increased due its difficult agronomics.

Potentially suitable varieties

The varieties ranked as orange in tables 5 and 6 have performed moderately well. Most have suffered heavily from disease and insect pressures which has impacted the yield of the plants. However, a yield has been taken from these varieties in at least one year of the field lab. In the third year, downy mildew significantly affected the yield of the majority of the varieties. The wet season caused an increase in downy mildew prevalence, the performance of these varieties may be different in a drier season.

Unsuitable varieties

The varieties ranked as red in tables 5 and 6 did not perform well in an organic system and are therefore determined not suitable. The varieties suffered from either wilt, downy mildew or hop powdery mildew which damaged the plants enough to produce no yield throughout the field lab.

Pilot brew tasting

The favourite hop overall was 3294 followed by one mention of 65/11/26. Some tasting notes of 3294 were 'Sharp, fresh, a bit of a false promise from aroma to taste. Sweet finish, unsure feeling on aftertaste. No off flavours identified'. This method of pilot brewing all the varieties in the same way enabled the bitterness of each to be highlighted. The beer quality slightly affected the tasting but that was to be expected given the pilot kit.

Knowledge Exchange

The six knowledge exchange events that have occurred during this field lab have established a collaborative approach between all the key stakeholders in the organic hops industry. The combination of expertise and knowledge has been crucial to achieve the results of the field lab.

During the knowledge exchange event in September 2023 held at Tedney House Farm, the field lab members discussed how they would like to continue the participatory approach to variety testing of organic hops and increase the impact it has on the organic hop market in

the UK. The topics of interest that were concluded as the most important, in addition to the participatory variety selection already been done, include:

- The environmental footprint of organic hop farming in comparison to conventional hop farming systems. This was seen as a method to improve the marketability of organic beer. Some of the metrics that would be measured are:
 - Soil health
 - Greenhouse gas emissions and sequestration
 - Water usage and surface runoff
 - Biodiversity
- A survey of organic hop production practices in the UK, the amount of hectares dedicated to organic hop production and the number of brewers that are currently using organic UK grown hops
- Looking at European organic hop growing to be able to find solutions to some of the pest and disease issues currently being faced by UK farmers.
- The end of project wrap up at Stroud Brewery in March 2024

The discussion was taken further with contributions from the wider group at the Stroud Brewery field lab wrap event in March 2024. The actions that are going to be taken forward after the field lab include:

- Continue to test hop varieties that are suitable for an organic system. The varieties will be supplied by Charles Faram Hop merchants to both Woodlands Valley Farm and Tedney House Farm.
- A webinar hosted by Innovative Farmers to bring together European organic hop growers to exchange knowledge and ideas being faced by all farmers.
- A story on the challenges of growing hops featuring the farmers in this field lab for a news article feature.



Photo 6: Greg Pilley of Stroud Brewery and John Walker of Tedney House Farm discussing the weed establishment in the hop crop. September 2023. Photo taken by Julia Cooper.

Next steps

The organic hops field lab is in its third and final year of research. The knowledge exchange event that took place in March 2024 was a wrap up of the field lab, it involved all the key stakeholders and other participants. Final discussions on the successes, challenges and legacy of the project was discussed this includes continued testing for suitable hop varieties in organic systems at Woodlands farm and Tedney House farm with support from Charles Faram Hop merchants. Engaging with European organic hop farmers to exchange knowledge and experience via a webinar hosted by Innovative Farmers. A story on the challenges of growing hops organically in the UK, this would involve the farmers sharing their experiences so far. If funding is secured the environmental and carbon footprint of organic hop farming compared to conventional will be carried out to improve the marketability of organic beer.

Conclusion

This report summarises the history of organic hops production in the UK and the barriers to the industry becoming more established. To address some of these issues the rationale for the organic hops field lab is explained. The work that has been done in the field lab over the past three years on the continued participatory varietal selection of hops that are suited to organic, low input farming systems is contributing to the aim of increasing organic hop production in the UK. This has involved the key stakeholders in the organic hops industry to use a whole supply chain approach to address issues collectively as well as expertise and learning to be shared amongst all participants. Communication between the farmers, merchants, breeder and brewer allows for the most suitable varieties to be decided on together. This ensures there is a secure output for the hops in the market and farmers are growing the right varieties for the market; involving the breeder allows for novel lines to be developed in accordance with the brewer and farmer's preferences. Additionally, lab analysis of the different varieties provided by the merchant is an insight into the most suitable varieties for brewing. The knowledge exchange events throughout the field lab brought the key stakeholders together and strengthened the motivation of the group whilst facilitating new ideas for the future of the field lab.

The results from the participatory variety trials have allowed the farmers to test varieties that are suited to low input, organic farming systems. Tom Upton of Woodlands Farm expressed that the field lab has "allowed the farm to develop a spread of varieties to make the organic hop growing enterprise to become more resilient to disease and weather pressure and increase the area planted from 2.5 to 5 acres". The farmers have both identified varieties that they would like to continue to grow and monitor next year. As well as continuing to test new varieties from the Charles Faram hop development programme to find more varieties suited to their farming systems. The process of identifying a new hop variety that is suitable for an organic system and taking it into commerce can take up to 11 years, this field lab has been a springboard into this process (British Hop Association, 2023a).

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