

The selection of stronger flavour within the UK hop breeding programme

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Flavour Hops

- Term coined by Barth-Haas 2014
- Prefer to use “High Impact Hops”
- Intense aroma
- Used for flavour, irrespective of resin
- Examples include

Nelson Sauvin (NZ), Cascade (USA),
Galaxy (Australia), Lemondrop (USA)





The logo is a circular emblem. The top half is a semi-circle with red horizontal stripes. In the center of this semi-circle is a black circle containing the word "IOWA" in white. The bottom half is a solid red semi-circle. The words "Craft Brew" are written in a large, black, cursive script across the middle, flanked by two thick black diagonal lines. The word "FESTIVAL" is written in white, bold, sans-serif capital letters on the red background. At the bottom of the red semi-circle is a white silhouette of the state of Iowa with a red star in the center, flanked by two black wheat stalks.

IOWA

Craft Brew

FESTIVAL

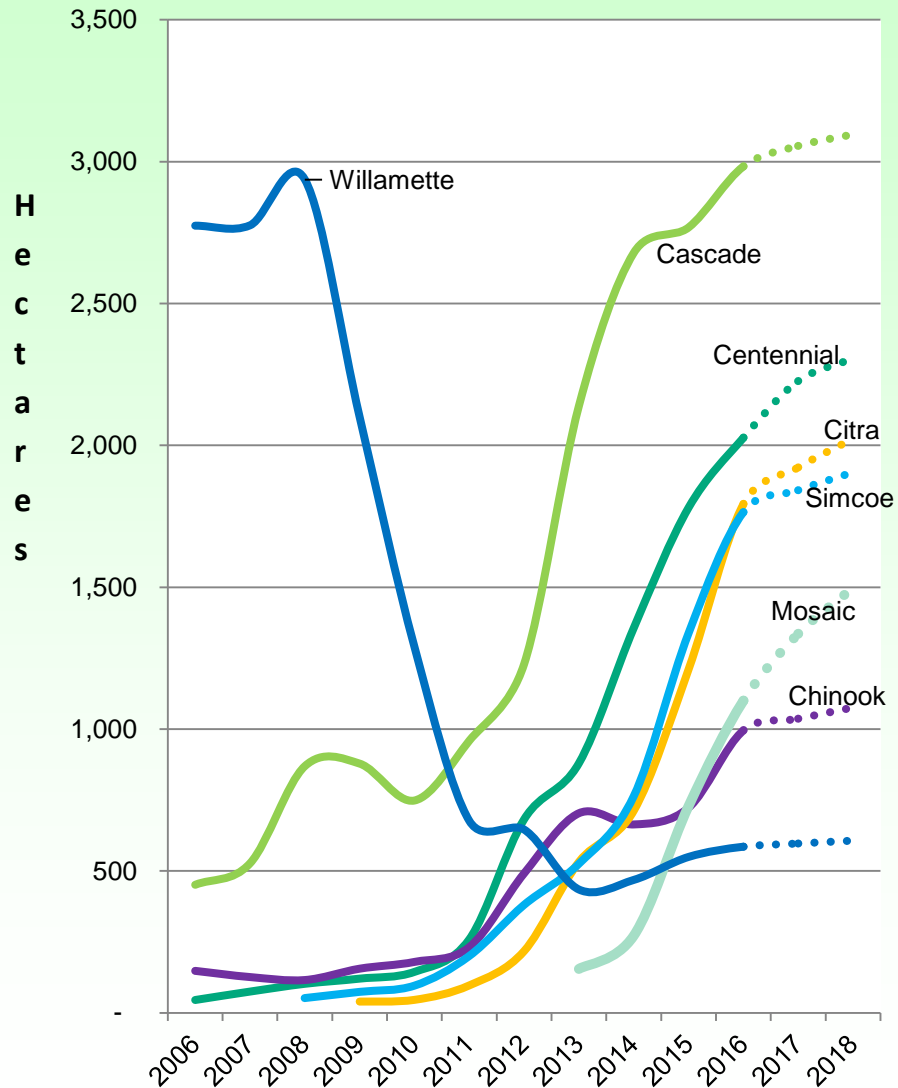


USA craft sector

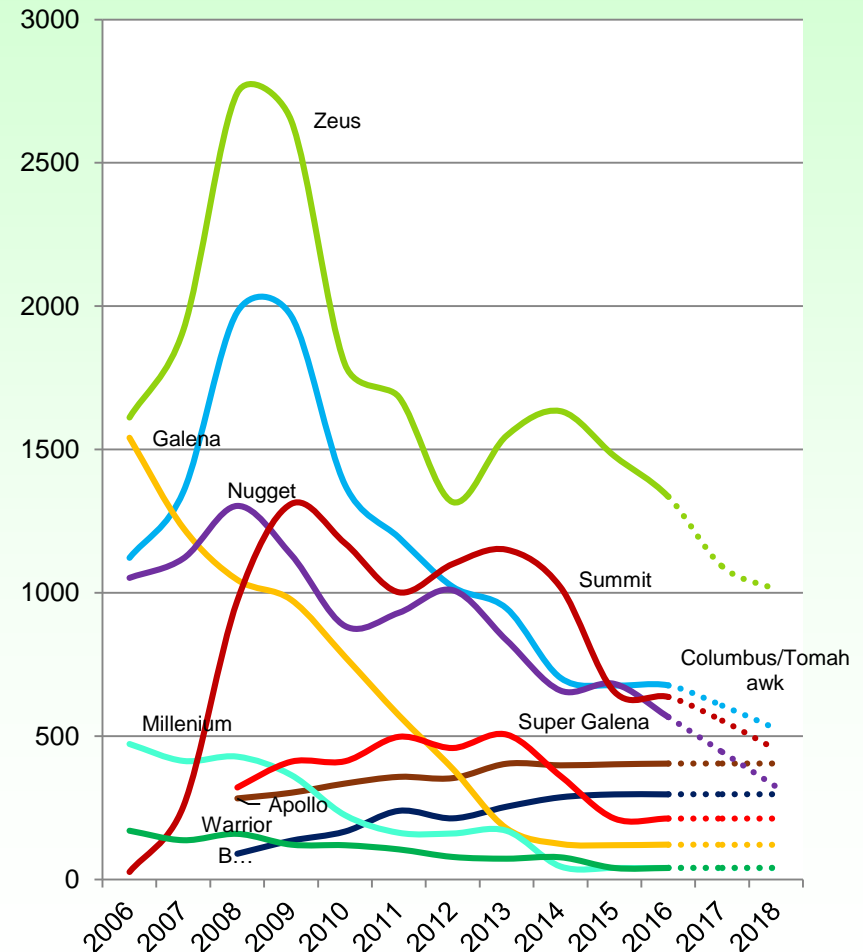
- In 2015, 12% of US beer sales
43% of US hop production



USA Aroma Acreage Development



USA Bitter Acreage Development



USA craft sector

- In 2015, 12% of US beer sales
43% of US hop production
- UK following same trend
>1500 breweries
Demanding high impact hops



Non-UK Impact Hops

- Britain 51°N vs WA, USA 46°N
Later maturity, less sunshine
- Lack resistance to UK spectrum pests and diseases esp, wilt
- Often privately owned varieties and unavailable to UK
- Need High Impact UK-grown hops



The selection of stronger flavour within the UK hop breeding programme

Objectives

- Identify intense and unusual flavours
- Select hops with commercial potential
- Select hops as parents for future
- Appraise different breeding strategies
- Find objective analytical indicators























Procedures

- Make crosses between specific parents
- Raise progeny, screen against diseases
- Establish a field population
- Select for harvest – agronomic, fresh aroma
- Dried samples
- Aroma assessment by trade panel, blind refs
- Analysis
- Take forward as new variety or parent



Procedures

- Crosses made 2011-13
 - Pedigree: Cascade, Wild USA etc
 - Specific oils: Farnesene, Selinene
 - Inbreeding: Cascade, Saaz, Fuggie



Results

From 2014 harvest (76 field selections, 39 to panel)



Sample No.	Intensity	Comments
FI81	9	Banana and floral
FI37	8	Lychees
Cascade	7	Spicy American
FJ28	7	Raspberry, orange
FK09	7	Tropical, fruity, sl ester
FZ01	7	Citrus, spicy mango
GC75	7	Earthy, sl sulphur
GE77	7	Zesty fruit
.....		
GA101	5	Soft fruits
GB53	5	Menthol
GC12	5	Spicy, nice



Results

From 2014 harvest (76 field selections, 39 to panel)

- 2 more intense than reference Cascade
 - both s. Cascade
- 5 equally intense
 - 3 s. Cascade, 1 Farnesene, 1 inbreeding
- Range of different descriptors
- No association with HPLC resin components, including cohumulone



Sample No.	Intensity	Oil	Myr	Cary	Farn	Sels
		%	%	%	%	%
FI81	9	0.75	35.1	5.8	1.1	11.6
FI37	8	1.0	32.8	10.4	1.2	1.4
Cascade	7	0.9	38.3	7.8	8.2	4.2
FJ28	7	0.7	28.6	15.5	0.3	20.8
FK09	7	1.2	27.3	14.5	2.1	2.6
FZ01	7	0.8	19.8	22.1	0.2	0.7
GC75	7	1.2	27.8	19.9	4.6	20.3
GE77	7	1.1	26.7	15.3	0.3	25.2
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GA101	5	0.3	18.4	7.4	6.4	10.0
GB53	5	0.5	24.2	5.9	2.1	34.1
GC12	5	0.3	6.8	10.5	6.7	2.5



Results

From 2014 harvest
Steam-distilled oils

- Higher aroma intensity associated with
 - Higher oil content
 - Higher Myrcene content
- High heritability for Farnesene and Selineenes
 - Not associated with aroma intensity



Results

From 2015 harvest

- 3006 seedlings for assessment in field
- 79 selected for harvest
- Samples assessed by BHA Next Generation

Group

- 29 selected for trade panel



Results

From 2015 harvest (79 field selections, 29 to panel)

Sample no.	Intensity	Comments
DM32	8	Lemon, grapefruit
DW7	8	Sweet floral
DW55	8	Geraniums, berry fruits
DY52	8	Rose
FG41	8	Cherry, floral
FJ25	8	Esters
Cascade	7	Cut grass, spicy, citrus



Results

From 2015 harvest

- 6 seedlings stronger aroma than reference Cascade, plus 9 equal to Cascade
- 7 of 15 were seedlings of Cascade. By chance would expect only 4
- None from inbreeding crosses



Results

From 2015 harvest

SPME / GC-MS oils (Twistaroma, France)

- Higher aroma intensity generally associated
 - Higher oil content
 - Higher Monoterpene content, incl Myrcene
- Not associated with volatile components of other oils eg., linalool or geraniol



Thiol analysis of oils

- Sulfur compounds
- Highly flavour-active at ppb
- Limits of detection
- Detected in beer and wine
- Distinct flavours attributed
- Only published in dry hops in April 2016 by NYSEOS, Montpellier France
- Very expensive: 15 x GC analysis



Thiol contents of selected samples (in µg/kg) analysis by NYSEOS, Montpellier, France

Variety	4MSP	C4MSP	3MH
Cascade	2.5	1.1	13.9
Sovereign	0.5	0.9	0.0

4MSP

4-methyl-4-sulfanylpentan-2-one

C4MSP

Cysteine-4-methyl-4-sulfanylpentan-2-one

3MH

3-mercaptohexan-1-ol



Thiol contents of selected samples (in µg/kg) analysis by NYSEOS, Montpellier, France

Variety	4MSP	C4MSP	3MH
Cascade	2.5	1.1	13.9
DM32	6.0	2.5	0.0
DY52	3.5	1.3	68.5
Sovereign	0.5	0.9	0.0

4MSP

4-methyl-4-sulfanylpentan-2-one

C4MSP

Cysteine-4-methyl-4-sulfanylpentan-2-one

3MH

3-mercaptohexan-1-ol



Taking forward

- 8 seedlings with aroma stronger than Cascade
- 5 of these for commercial evaluation
 - Pilot brews
- All 32 seedlings noted by panel retained as female parents
- 25 males selected as potential parents based on performance of their sisters
 - 12 of these showed field resistance to aphids or mildews



Conclusions

- Stronger aroma intensity is possible in new selections in the UK
- Pedigree breeding most consistent strategy especially with some parents (eg. Cascade)
- Association with higher oil content especially proportion monoterpenes
- Indications that alcohol thiols may be key components
- Need to see effect in brewing performance



A man wearing a dark blue t-shirt, safety glasses, and blue nitrile gloves is pouring a large quantity of green hop cones from a white plastic bucket into the top of a large, cylindrical stainless steel fermenter. The fermenter has a circular hatch with a metal rim. In the background, there are other pieces of brewery equipment, including a white hop bin and various pipes and hoses. The scene is lit by overhead fluorescent lights.

Thank you for
your attention

