

Data for Apollo, Bravo, Delta, and Super Galena was provided by S. S. Steiner, Inc. Data for Amarillo® was provided by Virgil Gamache Farms, Inc. Data for Ahtanum™, Palisade®, Simcoe®, and Warrior® was provided by Yakima Chief, Inc. Data for Summit was provided by the American Dwarf Hop Association. Data for US Brewer's Gold, Crystal, US Fuggle, US Hallertau, US Magnum, US Northern Brewer, US Perle, US Saaz, Santiam, and US Tettnang was obtained from the Hopunion CBS, LLC Directory of Hop Data. The "Barth-Haas Hops Companion" (Copyright © 2009 by John I. Haas, Inc.) was used to obtain data for Cascade, Centennial, Chelan, Chinook, Citra, Cluster, CTZ, Galena, Glacier, US Golding, Horizon, Liberty, Millennium, Mt. Hood, Newport, Nugget, Sterling, Tillicum, Ultra, Vanguard, and Willamette. The Hop Growers of America would like to thank these companies for their support.

INTRODUCTION

From the sun-soaked volcanic soil of Washington's Yakima Valley and Idaho's Treasure Valley, to the lush landscape of Oregon's Willamette Valley, U.S. hop growers produce a wide range of aroma, bittering, and super-alpha hops. This manual details 41 hop varieties that are grown in Washington, Oregon, and Idaho—including some American-grown European varieties. These 41 varieties make up approximately 99% of the commercially available acreage in the U.S. The quality, consistency, and versatility of American-grown hops are unmatched, and we are proud that our hops can be found in beer styles throughout the world. The Hop Growers of America encourages you to sample the diverse selection of premium hops grown in the United States. Please refer to the buyers guide on the last page to see a list of companies that sell American hops.

AMERICAN-GROWN HOP VARIETIES ARRANGED BY ALPHA ACIDS (AVERAGE RANGE)

Ultra	2.0 – 3.5%
Saaz (U.S.)	3.0 – 4.5%
Liberty	3.0 – 5.0%
Tettnang (U.S.)	4.0 – 5.0%
Crystal	3.5 – 5.5%
Hallertau (U.S.)	3.5 – 5.5%
Fuggle (U.S.)	4.0 – 5.5%
Glacier	5.5 – 5.5%
Golding (U.S.)	4.0 – 6.0%
Willamette	4.0 – 6.0%
Vanguard	5.5 – 6.0%
Ahtanum™	5.7 – 6.3%
Mt. Hood	4.0 – 7.0%
Cascade	4.5 – 7.0%
Santiam	5.0 – 7.0%
Delta	5.5 – 7.0%
Cluster	5.5 – 8.5%
Sterling	6.0 – 9.0%
Palisade®	5.5 – 9.5%
Perle (U.S.)	7.0 – 9.5%
Brewer's Gold (U.S.)	8.0 – 10.0%
Northern Brewer (U.S.)	8.0 – 10.0%
Amarillo®	8.0 – 11.0%
Centennial	9.5 – 11.5%
Citra	11.0 – 13.0%
Horizon	11.0 – 13.0%
Galena	11.5 – 13.5%
Nugget	11.5 – 14.0%
Chinook	12.0 – 14.0%

Magnum (U.S.)	12.0 – 14.0%
Simcoe®	12.0 – 14.0%
Chelan	12.0 – 14.5%
Tillicum	12.0 – 14.5%
Super Galena	13.0 – 16.0%
Columbus/Tomahawk®/Zeus	14.5 – 16.5%
Millennium	14.5 – 16.5%
Newport	13.5 – 17.0%
Bravo	14.0 – 17.0%
Warrior®	15.0 – 18.0%
Summit	16.0 – 18.0%
Apollo	15.0 – 19.0%

AMERICAN-GROWN HOP VARIETIES ARRANGED BY TOTAL OILS* (AVERAGE RANGE)

*ml/100g

Cluster	0.4 – 0.8
Tettnang (U.S.)	0.4 – 0.8
Perle (U.S.)	0.7 – 0.9
Saaz (U.S.)	0.5 – 1.0
Ultra	0.5 – 1.0
Hallertau (U.S.)	0.6 – 1.0
Golding (U.S.)	0.7 – 1.0
Delta	0.5 – 1.1
Liberty	0.6 – 1.2
Fuggle (U.S.)	0.7 – 1.2
Ahtanum™	0.8 – 1.2
Vanguard	0.9 – 1.2
Galena	0.9 – 1.3
Cascade	0.7 – 1.4
Crystal	1.0 – 1.5
Willamette	1.0 – 1.5
Santiam	1.3 – 1.5
Glacier	0.7 – 1.6
Palisade®	1.4 – 1.6
Mt. Hood	1.2 – 1.7
Sterling	1.3 – 1.9
Amarillo®	1.5 – 1.9
Chelan	1.5 – 1.9
Tillicum	1.5 – 1.9
Warrior®	1.0 – 2.0
Horizon	1.5 – 2.0
Northern Brewer (U.S.)	1.5 – 2.0
Millennium	1.8 – 2.2
Nugget	1.8 – 2.2
Centennial	1.5 – 2.3
Magnum (U.S.)	1.9 – 2.3
Bravo	1.6 – 2.4
Brewer's Gold (U.S.)	2.0 – 2.4
Apollo	1.5 – 2.5
Summit	1.5 – 2.5
Super Galena	1.5 – 2.5
Simcoe®	2.0 – 2.5
Chinook	1.7 – 2.7

Citra	2.2 – 2.8
Columbus/Tomahawk®/Zeus	2.0 – 3.0
Newport	1.6 – 3.4

Ahtanum™

Ahtanum™ (YCR 1 cv.) is an aroma-type cultivar bred by Yakima Chief Ranches. It is used for its aromatic properties and moderate bittering. The variety is named after the location where Charles Carpenter established the first hop farm in the Yakima Valley in 1869.

Yield (kilos per hectare)	2050 – 2250
Yield (lbs per acre)	1775 – 1950
Alpha Acids	5.7 – 6.3%
Beta Acids	5.0 – 6.5%
Cohumulone (% of alpha acids):	30 – 35%
Total Oils (Mls. per 100 grams dried hops)	0.8 – 1.2
Myrcene (as % of total oils)	50 – 55%
Caryophyllene (as % of total oils)	9.0 – 12%
Humulene (as % of total oils)	16 – 20%
Farnesene (as % of total oils)	0.0%
Storage (% alpha acids remaining after 6 months storage at 20° C)	Fair to Good
Possible Substitutions	Cascade

Amarillo®

Amarillo® (VGXP01 cv.) is an aroma variety of recent origin, discovered and introduced by Vigil Gamache Farms Inc. in Washington State. It is most often used as a late kettle or dry hop addition to American style Pale Ales and IPA's due to its signature aroma characteristics.

Yield (kilos per hectare)	1350 – 1800
Yield (lbs per acre)	1200 – 1600
Alpha Acids	8.0 – 11%
Beta Acids	6.0 – 7.0%
Cohumulone (% of alpha acids):	21 – 24%
Total Oils (Mls. per 100 grams dried hops)	1.5 – 1.9
Myrcene (as % of total oils)	68 – 70%
Caryophyllene (as % of total oils)	2.0 – 4.0%
Humulene (as % of total oils)	9.0 – 11%
Farnesene (as % of total oils)	2.0 – 4.0%
Storage (% alpha acids remaining after 6 months storage at 20° C)	Good (above average %)
Possible Substitutions	Cascade, Centennial

Apollo

Apollo (Hopsteiner 0151) is a super high alpha variety was developed by the Hopsteiner Breeding Program and released in 2006. It is resistant to powdery and downy mildew. The very high alpha, good storage stability and low cohumulone ratio makes it an excellent choice for bittering. Added late into the boil it provides a strong grapefruit and hoppy note.

Yield (kilos per hectare)	2900 – 3350
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Yield (lbs per acre)	2600 – 3000
Alpha Acids	15.0 – 19%
Beta Acids	5.5 – 8.0%
Cohumulone (% of alpha acids):	24 – 28%
Total Oils (Mls. per 100 grams dried hops)	1.5 – 2.5
Myrcene (as % of other oils)	30.0 – 55%
Caryophyllene (as % of other oils)	14.0 – 20%
Humulene (as % of other oils)	20.0 – 35%
Farnesene (as % of other oils)	< 1.0%
Storage(% alpha acids remaining after 6 months storage at 20° C)	80 – 90%
Possible Substitutions	Nugget, CTZ

Bravo

Bravo (Hopsteiner 0146) is a second generation super high alpha variety that was developed by the Hopsteiner Breeding Program and released in 2006. It has good resistance to powdery mildew. Bravo is an excellent bittering hop that provides pleasant fruity and floral aroma characteristics.

Yield (kilos per hectare)	3000 – 3470
Yield (lbs per acre)	2700 – 3100
Alpha Acids	14 – 17%
Beta Acids	3.0 – 5.0%
Cohumulone (% of alpha acids):	29 – 34%
Total Oils (Mls. per 100 grams dried hops)	1.6 – 2.4
Myrcene (as % of other oils)	25 – 50%
Caryophyllene (as % of other oils)	10 – 12%
Humulene (as % of other oils)	18 – 20%
Farnesene (as % of other oils)	< 1.0%
Storage (% alpha acids remaining after 6 months storage at 20° C)	60 – 70%
Possible Substitutions	CTZ

Brewer's Gold (USA Grown)

Brewer's Gold is an English variety that is primarily used as a bittering hop. It is a descendent of Bullion and has many of the same varietal attributes. American-grown Brewer's Gold has a higher percentage of alpha acids than its counterpart in England.

Yield (kilos per hectare)	2750
Yield (lbs per acre)	2400
Alpha Acids	8.0 – 10%
Beta Acids	3.5 – 4.5%
Cohumulone (% of alpha acids):	40 – 48%
Total Oils (Mls. per 100 grams dried hops)	2.0 – 2.4
Myrcene (as % of total oils)	37 – 40%
Caryophyllene (as % of total oils)	7.0 – 7.5%
Humulene (as % of total oils)	29 – 31%
Farnesene (as % of total oils)	< 1.0%

Storage (% alpha acids remaining after 6 months storage at 20° C)	Poor
Possible Substitutions	UK Brewer's Gold, Galena, Northern Brewer

Cascade

Cascade is an aroma hop that was developed by the U.S.D.A. breeding program in Oregon and released in 1972. It contains low amounts of alpha acids. The aroma is of medium strength and provides a unique floral/spicy character with well balanced bittering potential. It is the most popular hop with the U.S. craft brewing industry.

Yield (kilos per hectare)	1792 – 2240
Yield (lbs per acre)	1600 – 2000
Alpha Acids	4.5 – 7.0%
Beta Acids	4.8 – 7.0%
Cohumulone (% of alpha acids):	33 – 40%
Total Oils (Mls. per 100 grams dried hops)	0.7 – 1.4
Myrcene (as % of total oils)	45 – 60%
Caryophyllene (as % of total oils)	3.5 – 5.5%
Humulene (as % of total oils)	8.0 – 13%
Farnesene (as % of total oils)	3.0 – 7.0%
Storage (% alpha acids remaining after 6 months storage at 20° C)	48 – 52%
Possible Substitutions	Centennial, Amarillo

Centennial

Centennial is an aroma variety that was released in 1990. It was derived from three-quarters Brewer's Gold with minor contributions from Fuggle, East Kent Golding and others. It is among the most popular varieties for U.S. craft brewers and is sometimes referred to as a super Cascade.

Yield (kilos per hectare)	1700 – 2000
Yield (lbs per acre)	1500 – 1750
Alpha Acids	9.5 – 11.5%
Beta Acids	3.5 – 4.5%
Cohumulone (% of alpha acids):	29 – 30%
Total Oils (Mls. per 100 grams dried hops)	1.5 – 2.3
Myrcene (as % of total oils)	45 – 55%
Caryophyllene (as % of total oils)	5.0 – 8.0%
Humulene (as % of total oils)	10 – 18%
Farnesene (as % of total oils)	< 1.0%
Storage (% alpha acids remaining after 6 months storage at 20° C)	60 – 65%
Possible Substitutions	Cascade, Amarillo

Chelan

Chelan is a high alpha variety with a very high percentage of beta acids. The variety was developed through the John I. Haas, Inc., breeding program and released in 1994. It is a daughter of Galena and therefore has analytical data similar to Galena.

Yield (kilos per hectare)	2240 – 2688
Yield (lbs per acre)	2000 – 2400
Alpha Acids	12.0 – 14.5%
Beta Acids	8.5 – 9.8%
Cohumulone (% of alpha acids):	33 – 35%
Total Oils (Mls. per 100 grams dried hops)	1.5 – 1.9
Myrcene (as % of total oils)	45 – 55%
Caryophyllene (as % of total oils)	9.0 – 12%
Humulene (as % of total oils)	12 – 15%
Farnesene (as % of total oils)	< 1.0%
Storage (% alpha acids remaining after 6 months storage at 20° C)	80%
Possible Substitutions	Galena

Chinook

Chinook was developed by the U.S.D.A. breeding program in Washington State and released in 1985 as a high alpha variety. It has a highly acceptable beer aroma profile with smooth bitterness and full flavor.

Yield (kilos per hectare)	1904 – 2352
Yield (lbs per acre)	1700 – 2100
Alpha Acids	12 – 14%
Beta Acids	3.0 – 4.0%
Cohumulone (% of alpha acids):	29 – 35%
Total Oils (Mls. per 100 grams dried hops)	1.7 – 2.7
Myrcene (as % of total oils)	35 – 40%
Caryophyllene (as % of total oils)	9.0 – 11%
Humulene (as % of total oils)	18 – 23%
Farnesene (as % of total oils)	< 1.0%
Storage (% alpha acids remaining after 6 months storage at 20° C)	68%
Possible Substitutions	Nugget, CTZ, Galena

Citra

Citra (HBC 394) is an aroma variety that was released in 2007 by Hop Breeding Co. Ltd., a joint venture between John I. Haas, Inc. and Yakima Chief Inc. Citra has fairly high alpha acids and total oils, and it imparts a distinctive citrus character to beer.

Yield (kilos per hectare)	1600 – 1800
Yield (lbs per acre)	1400 – 1600
Alpha Acids	11 – 13%
Beta Acids	3.5 – 4.5%
Cohumulone (% of alpha acids):	22 – 24%
Total Oils (Mls. per 100 grams dried hops)	2.2 – 2.8
Myrcene (as % of total oils)	60 – 65%
Caryophyllene (as % of total oils)	6.0 – 8.0%
Humulene (as % of total oils)	11 – 13%
Farnesene (as % of total oils)	0%
Storage (% alpha acids remaining after 6 months storage at 20° C)	65 – 75%
Possible Substitutions	

Cluster

Cluster is the oldest hop variety grown in the U.S. Until the late 1970's, Cluster was one of only a few varieties growing in the U.S. and accounted for most of the country's hop acreage. It is an excellent general purpose hop with well-balanced bittering potential and aroma properties. The storage stability of its alpha acids is among the best in the world.

Yield (kilos per hectare)	1904 – 2352
Yield (lbs per acre)	1700 – 2100
Alpha Acids	5.5 – 8.5%
Beta Acids	4.5 – 5.5%
Cohumulone (% of alpha acids):	37 – 43%
Total Oils (Mls. per 100 grams dried hops)	0.4 – 0.8
Myrcene (as % of total oils)	45 – 55%
Caryophyllene (as % of total oils)	6.0 – 7.0%
Humulene (as % of total oils)	15 – 18%
Farnesene (as % of total oils)	< 1.0%
Storage (% alpha acids remaining after 6 months storage at 20° C)	84%
Possible Substitutions	Galena

Columbus/Tomahawk®/Zeus (CTZ)

These three super high alpha varieties are often grouped together and referred to as CTZ. Each of these varieties has alpha acid content of between 14.5-16.5% and share the same female parent as Nugget. Originally bred for their high alpha value, they have also become popular for their oil profile.

Yield (kilos per hectare)	2800 – 3249
Yield (lbs per acre)	2500 – 2900
Alpha Acids	14.5 – 16.5%
Beta Acids	4.0 – 5.0%
Cohumulone (% of alpha acids):	28 – 32%
Total Oils (Mls. per 100 grams dried hops)	2.0 – 3.0
Myrcene (as % of total oils)	40 – 50%
Caryophyllene (as % of total oils)	9.0 – 11%
Humulene (as % of total oils)	12 – 18%
Farnesene (as % of total oils)	< 1.0%
Storage (% alpha acids remaining after 6 months storage at 20° C)	52%
Possible Substitutions	Galena, Chinook, Nugget

Crystal

Crystal is a triploid variety that was bred by U.S.D.A. from Hallertau mf, Cascade, Northern Brewer, and Early Green. It is perceived as the most pungent of the triploid Hallertau family of hops, and is increasingly popular among U.S. craft brewers. It is a versatile variety that is used in Pilsners and Lagers, as well as in ESB's and American and Belgian-style Ales. Crystal is primarily grown in Oregon.

Yield (kilos per hectare)	1350 – 2250
Yield (lbs per acre)	1200 – 2000

Alpha Acids	3.5 – 5.5%
Beta Acids	4.5 – 6.5%
Cohumulone (% of alpha acids):	20 – 26%
Total Oils (Mls. per 100 grams dried hops)	1.0 – 1.5
Myrcene (as % of total oils)	40 – 65%
Caryophyllene (as % of total oils)	4.0 – 8.0%
Humulene (as % of total oils)	18 – 24%
Farnesene (as % of total oils)	< 1.0%
Storage (% alpha acids remaining after 6 months storage at 20° C)	50%
Possible Substitutions	Mt. Hood, Liberty

Delta

Delta (Hopsteiner 04188) is a new aroma variety that was developed by the Hopsteiner Breeding Program and released in 2009. It is a cross between Fuggie and a male variety derived from Cascade. It shows good tolerance to downy mildew and is resistant to strains of powdery mildew. Delta has a mild and pleasant aroma that is slightly spicy with a hint of citrus.

Yield (kilos per hectare)	1600 – 2000
Yield (lbs per acre)	1400 – 1800
Alpha Acids	5.5 – 7.0%
Beta Acids	5.5 – 7.0%
Cohumulone (% of alpha acids):	22 – 24%
Total Oils (Mls. per 100 grams dried hops)	0.5 – 1.1
Myrcene (as % of total oils)	25 – 40%
Caryophyllene (as % of total oils)	9.0 – 15%
Humulene (as % of total oils)	16 – 20%
Farnesene (as % of total oils)	< 1.0%
Storage (% alpha acids remaining after 6 months storage at 20° C)	80 – 90%
Possible Substitutions	Fuggie, Willamette

Fuggie (USA Grown)

This classic English aroma variety has long been grown in both Oregon and Washington. It has a typical English aroma and contributes a balanced bitterness. Fuggie is very suitable for English and American-style Ales.

Yield (kilos per hectare)	1200 – 1800
Yield (lbs per acre)	1070 – 1600
Alpha Acids	4.0 – 5.5%
Beta Acids	1.5 – 2.0%
Cohumulone (% of alpha acids):	25 – 32%
Total Oils (Mls. per 100 grams dried hops)	0.7 – 1.2
Myrcene (as % of total oils)	40 – 50%
Caryophyllene (as % of total oils)	6.0 – 10%
Humulene (as % of total oils)	20 – 26%
Farnesene (as % of total oils)	4.0 – 5.0%
Storage (% alpha acids remaining after 6 months storage at 20° C)	60 – 65%
Possible Substitutions	English Fuggie, Styrian Golding, Willamette

Galena

Galena is a high alpha variety that was developed in the Idaho state breeding program in 1978. It has balanced bittering properties combined with an agreeable aroma profile. Galena's storage stability is excellent. It has often used in both English and American-style Ales.

Yield (kilos per hectare)	1904 – 2352
Yield (lbs per acre)	1700 – 2100
Alpha Acids	11.5 – 13.5%
Beta Acids	7.2 – 8.7%
Cohumulone (% of alpha acids):	36 – 40%
Total Oils (Mls. per 100 grams dried hops)	0.9 – 1.3
Myrcene (as % of total oils)	55 – 60%
Caryophyllene (as % of total oils)	4.5 – 5.5%
Humulene (as % of total oils)	10 – 13%
Farnesene (as % of total oils)	< 1.0%
Storage (% alpha acids remaining after 6 months storage at 20° C)	79%
Possible Substitutions	Nugget, CTZ

Glacier

Glacier is a dual-purpose hop with well balanced bittering properties and a pleasant aroma profile. It was released in 2000 from the Washington State University breeding program. It is commonly used in beer styles such as Pale Ale, ESB, Bitter, English-Style Pale Ale, Porter, and Stout.

Yield (kilos per hectare)	2750 – 2900
Yield (lbs per acre)	2400 – 2600
Alpha Acids	5.5%
Beta Acids	8.2%
Cohumulone (% of alpha acids):	11 – 13%
Total Oils (Mls. per 100 grams dried hops)	0.7 – 1.6
Myrcene (as % of total oils)	33 – 62%
Caryophyllene (as % of total oils)	6.5 – 10%
Humulene (as % of total oils)	24 – 36%
Farnesene (as % of total oils)	< 1.0%
Storage (% alpha acids remaining after 6 months storage at 20° C)	72%
Possible Substitutions	Willamette

Golding (USA Grown)

Golding hops consist of a group of traditional English aroma varieties which have been cultivated since 1790. Several selections now exist including Cobbs, Early Bird, East Well, Bramling, Canterbury and Mathon, some of which are now being grown in the U.S. All Goldings are recognized as having a most typical English aroma.

Yield (kilos per hectare)	1344 – 1680
Yield (lbs per acre)	1200 – 1500
Alpha Acids	4.0 – 6.0%
Beta Acids	2.0 – 3.0%

Cohumulone (% of alpha acids):	23 – 28%
Total Oils (Mls. per 100 grams dried hops)	0.7 – 1.0
Myrcene (as % of total oils)	25 – 35%
Caryophyllene (as % of total oils)	13 – 16%
Humulene (as % of total oils)	35 – 45%
Farnesene (as % of total oils)	< 1.0%
Storage (% alpha acids remaining after 6 months storage at 20° C)	66%
Possible Substitutions	Fuggle, Styrian Golding, East Kent Golding, Willamette

Hallertau (USA Grown)

This traditional German land-race variety has limited acreage in the U.S. Its noble aroma character is considered mild, pleasant, and slightly flowery.

Yield (kilos per hectare)	900 – 1400
Yield (lbs per acre)	800 – 1250
Alpha Acids	3.5 – 5.5%
Beta Acids	3.5 – 5.5%
Cohumulone (% of alpha acids):	18 – 24%
Total Oils (Mls. per 100 grams dried hops)	0.6 – 1.0
Myrcene (as % of total oils)	35 – 44%
Caryophyllene (as % of total oils)	10 – 12%
Humulene (as % of total oils)	30 – 38%
Farnesene (as % of total oils)	< 1.0%
Storage (% alpha acids remaining after 6 months storage at 20° C)	52 – 58%
Possible Substitutions	German Hallertau mf, Hallertau Tradition, Liberty, Mt. Hood

Horizon

Horizon is a half-sister to Nugget. It is generally considered a dual purpose hop with medium alpha and good aroma. Horizon's low cohumulone results in a clean tasting beer.

Yield (kilos per hectare)	2100 – 2300
Yield (lbs per acre)	1900 – 2000
Alpha Acids	11 – 13%
Beta Acids	6.5 – 8.5%
Cohumulone (% of alpha acids):	16 – 19%
Total Oils (Mls. per 100 grams dried hops)	1.5 – 2.0
Myrcene (as % of total oils)	55 – 65%
Caryophyllene (as % of total oils)	7.5 – 9.0%
Humulene (as % of total oils)	11 – 13%
Farnesene (as % of total oils)	2.5 – 3.5%
Storage (% alpha acids remaining after 6 months storage at 20° C)	Average to Good
Possible Substitutions	Magnum

Liberty

Liberty is a triploid Hallertau variety that was bred by U.S.D.A. Of the four Hallertau mf varieties released by U.S.D.A., Liberty most closely resembles the Hallertau mf cultivar. It is typically used in Lager, Pilsner, Bock, US Wheat, and Kölsch beers.

Yield (kilos per hectare)	1100 – 1900
Yield (lbs per acre)	1000 – 1700
Alpha Acids	3.0 – 5.0%
Beta Acids	3.0 – 4.0%
Cohumulone (% of alpha acids):	24 – 30%
Total Oils (Mls. per 100 grams dried hops)	0.6 – 1.2
Myrcene (as % of total oils)	20 – 40%
Caryophyllene (as % of total oils)	9.0 – 12%
Humulene (as % of total oils)	35 – 40%
Farnesene (as % of total oils)	< 1.0%
Storage (% alpha acids remaining after 6 months storage at 20° C)	35 – 40%
Possible Substitutions	Hallertau, Mt. Hood

Magnum (USA Grown)

Magnum is a high alpha variety that was developed at the Hop Research Center in Huell, Germany. It is widely grown in the Hallertau region of Germany, and is also grown in the U.S. Magnum is a good bittering hop for Ales and Lagers.

Yield (kilos per hectare)	1900 – 2000
Yield (lbs per acre)	1340 – 1700
Alpha Acids	12 – 14%
Beta Acids	4.5 – 6.0%
Cohumulone (% of alpha acids):	24 – 28%
Total Oils (Mls. per 100 grams dried hops)	1.9 – 2.3
Myrcene (as % of total oils)	30 – 35%
Caryophyllene (as % of total oils)	8.0 – 12%
Humulene (as % of total oils)	34 – 40%
Farnesene (as % of total oils)	< 1.0%
Storage (% alpha acids remaining after 6 months storage at 20° C)	Very Good
Possible Substitutions	German Magnum, CTZ, Nugget

Millennium

Millennium is a high alpha variety bred in the John I. Haas, Inc. breeding program and released in 2000. Its brewing profile is comparable to Nugget and Columbus, being used primarily as a bittering hop with strong alpha potential.

Yield (kilos per hectare)	2464 – 2913
Yield (lbs per acre)	2200 – 2600
Alpha Acids	14.5 – 16.5%
Beta Acids	4.3 – 5.3%
Cohumulone (% of alpha acids):	28 – 32%
Total Oils (Mls. per 100 grams dried hops)	1.8 – 2.2

Myrcene (as % of total oils)	30 – 40%
Caryophyllene (as % of total oils)	9.0 – 12%
Humulene (as % of total oils)	23 – 27%
Farnesene (as % of total oils)	< 1.0%
Storage (% alpha acids remaining after 6 months storage at 20° C)	76%
Possible Substitutions	Nugget, CTZ

Mt. Hood

Named after the famous Oregon volcano, Mt. Hood is an aroma variety that was bred from the German Hallertauer variety and released in 1989 from the U.S.D.A. breeding program in Oregon. It has clear similarities to German Hallertauer and Hersbrucker, and is typically used in Lagers, Pilsners, Bocks, Wheat, Alt, and Helles beers.

Yield (kilos per hectare)	1624 – 1960
Yield (lbs per acre)	1450 – 1750
Alpha Acids	4.0 – 7.0%
Beta Acids	5.0 – 8.0%
Cohumulone (% of alpha acids):	21 – 23%
Total Oils (Mls. per 100 grams dried hops)	1.2 – 1.7
Myrcene (as % of total oils)	30 – 40%
Caryophyllene (as % of total oils)	13 – 16%
Humulene (as % of total oils)	30 – 38%
Farnesene (as % of total oils)	< 1.0%
Storage (% alpha acids remaining after 6 months storage at 20° C)	55%
Possible Substitutions	Strisselspalt, Hersbrucker, Hallertauer

Newport

A high-alpha hop developed by the U.S.D.A. breeding program at Oregon State University using Hallertau Magnum as its mother. Newport has excellent yields and is resistant to both powdery and downy mildews.

Yield (kilos per hectare)	2300 – 2840
Yield (lbs per acre)	1990 – 2550
Alpha Acids	13.5 – 17%
Beta Acids	7.2 – 9.1%
Cohumulone (% of alpha acids):	36 – 38%
Total Oils (Mls. per 100 grams dried hops)	1.6 – 3.4
Myrcene (as % of total oils)	47 – 54%
Caryophyllene (as % of total oils)	4.5 – 7.0%
Humulene (as % of total oils)	9.0 – 14%
Farnesene (as % of total oils)	< 1.0%
Storage (% alpha acids remaining after 6 months storage at 20° C)	60%
Possible Substitutions	Magnum, Galena, Nugget

Northern Brewer (USA Grown)

Northern Brewer was bred in England in 1934 from a female American hop and an English male. It is a dual purpose hop with moderate alpha and a good aroma profile. Northern Brewer's acreage has declined in England, but is still widely grown in Germany. It is also grown in the U.S.

Yield (kilos per hectare)	1200 – 1600
Yield (lbs per acre)	1000 – 1400
Alpha Acids	8.0 – 10%
Beta Acids	3.0 – 5.0%
Cohumulone (% of alpha acids):	20 – 30%
Total Oils (Mls. per 100 grams dried hops)	1.5 – 2.0
Myrcene (as % of total oils)	50 – 60%
Caryophyllene (as % of total oils)	5.0 – 10%
Humulene (as % of total oils)	20 – 30%
Farnesene (as % of total oils)	< 1.0%
Storage (% alpha acids remaining after 6 months storage at 20° C)	70 – 85%
Possible Substitutions	German Northern Brewer, Chinook, Galena, Magnum

Nugget

Nugget is a high alpha variety released in 1983 from the U.S.D.A. breeding program in Oregon. It is characterized by a mild herbal aroma, a low proportion of cohumulone, and good storage stability. It is used by brewers both for bittering and for its aroma profile. Nugget is one of the most widely grown varieties in Oregon and also has significant acreage in Washington State.

Yield (kilos per hectare)	2016 – 2464
Yield (lbs per acre)	1800 – 2200
Alpha Acids	11.5 – 14%
Beta Acids	3.0 – 5.8%
Cohumulone (% of alpha acids):	22 – 30%
Total Oils (Mls. per 100 grams dried hops)	1.8 – 2.2
Myrcene (as % of total oils)	48 – 55%
Caryophyllene (as % of total oils)	7.0 – 10%
Humulene (as % of total oils)	16 – 19%
Farnesene (as % of total oils)	< 1.0%
Storage (% alpha acids remaining after 6 months storage at 20° C)	76%
Possible Substitutions	Galena, CTZ, Magnum

Palisade®

Palisade® (YCR 4 cv.) is an aroma variety bred by Yakima Chief Ranches, which has low susceptibility to downy mildew. It is used by brewers for its aromatic properties and moderate bittering.

Yield (kilos per hectare)	2400 – 3400
Yield (lbs per acre)	2200 – 3000
Alpha Acids	5.5 – 9.5%
Beta Acids	6.0 – 8.0%
Cohumulone (% of alpha acids):	24 – 29%

Total Oils (Mls. per 100 grams dried hops)	1.4 – 1.6
Myrcene (as % of total oils)	9.0 – 10%
Caryophyllene (as % of total oils)	16 – 18%
Humulene (as % of total oils)	19 – 22%
Farnesene (as % of total oils)	0%
Storage (% alpha acids remaining after 6 months storage at 20° C)	Good (above average %)
Possible Substitutions	Willamette

Perle (USA Grown)

Perle was bred from Northern Brewer at the Hop Research Center in Huell, Germany. It is well established in Germany and is also grown in both Oregon and Washington. Perle is a dual purpose variety with moderate alpha levels and a nice aroma profile. It is popular with growers due to its high yields and resistance to downy mildew and wilt.

Yield (kilos per hectare)	1300 – 1800
Yield (lbs per acre)	1160 – 1600
Alpha Acids	7.0 – 9.5%
Beta Acids	4.0 – 5.0%
Cohumulone (% of alpha acids):	27 – 32%
Total Oils (Mls. per 100 grams dried hops)	0.7 – 0.9
Myrcene (as % of total oils)	45 – 55%
Caryophyllene (as % of total oils)	10 – 12%
Humulene (as % of total oils)	28 – 33%
Farnesene (as % of total oils)	< 1.0%
Storage (% alpha acids remaining after 6 months storage at 20° C)	80 – 85%
Possible Substitutions	German Perle, Northern Brewer

Saaz (USA Grown)

This traditional variety from the Czech Republic is grown on a limited basis in the U.S. It has a classic noble aroma that is famously used in Pilsners.

Yield (kilos per hectare)	650 – 1150
Yield (lbs per acre)	600 – 1000
Alpha Acids	3.0 – 4.5%
Beta Acids	3.0 – 4.5%
Cohumulone (% of alpha acids):	24 – 28%
Total Oils (Mls. per 100 grams dried hops)	0.5 – 1.0
Myrcene (as % of total oils)	25 – 30%
Caryophyllene (as % of total oils)	9.0 – 11%
Humulene (as % of total oils)	35 – 40%
Farnesene (as % of total oils)	9.0 – 13%
Storage (% alpha acids remaining after 6 months storage at 20° C)	45 – 55%
Possible Substitutions	Czech Saaz, Polish Lublin, Sterling

Santiam

Released in 1997, Santiam was bred from Tettngang, Hallertau, and a cultivar derived from Cascade. Its resin, oil, and flavor profile are similar to Tettngang, but it has the lower CoH of Hallertau.

Yield (kilos per hectare)	1600 – 2350
Yield (lbs per acre)	1400 – 2100
Alpha Acids	5.0 – 7.0%
Beta Acids	6.0 – 8.0%
Cohumulone (% of alpha acids):	22 – 24%
Total Oils (Mls. per 100 grams dried hops)	1.3 – 1.5
Myrcene (as % of total oils)	27 – 36%
Caryophyllene (as % of total oils)	7.0 – 8.0%
Humulene (as % of total oils)	23 – 26%
Farnesene (as % of total oils)	13 – 16%
Storage (% alpha acids remaining after 6 months storage at 20° C)	Average
Possible Substitutions	Tettngang, Spalt, Spalt Select

Simcoe®

Simcoe® (YCR 14 cv.) is a bittering/aroma variety bred by Yakima Chief Ranches and released in 2000. It is used for its bittering properties and aroma qualities that impart a unique, pine-like aroma. It is very popular in American style Ales.

Yield (kilos per hectare)	1905 – 2240
Yield (lbs per acre)	1700 – 2000
Alpha Acids	12 – 14%
Beta Acids	4.0 – 5.0%
Cohumulone (% of alpha acids):	15 – 20%
Total Oils (Mls. per 100 grams dried hops)	2.0 – 2.5
Myrcene (as % of total oils)	60 – 65%
Caryophyllene (as % of total oils)	5.0 – 8.0%
Humulene (as % of total oils)	10 – 15%
Farnesene (as % of total oils)	0%
Storage (% alpha acids remaining after 6 months storage at 20° C)	Good (above average %)
Possible Substitutions	Summit, Magnum

Sterling

Sterling is an aroma variety that was bred from Saaz and a number of other varieties. It has herbal and spicy aroma notes with a hint of floral and citrus. Sterling is perceived to be similar to a combination of Saaz and Mt. Hood, and many brewers use it as a replacement for Saaz. It is typically used in Pilsners and Lagers, as well as Belgian-style Ales.

Yield (kilos per hectare)	1650 – 1860
Yield (lbs per acre)	1400 – 1600
Alpha Acids	6.0 – 9.0%
Beta Acids	4.0 – 6.0%
Cohumulone (% of alpha acids):	22 – 28%
Total Oils (Mls. per 100 grams dried hops)	1.3 – 1.9

Myrcene (as % of total oils)	44 – 48%
Caryophyllene (as % of total oils)	5.0 – 7.0%
Humulene (as % of total oils)	19 – 23%
Farnesene (as % of total oils)	11 – 17%
Storage (% alpha acids remaining after 6 months storage at 20° C)	60 – 75%
Possible Substitutions	Saaz, Polish Lublin

Summit

Summit is a high alpha variety of recent origin that was bred by the American Dwarf Hop Association. It is the first U.S. high alpha variety that can be grown commercially on low and high trellis. The variety exhibits unusually high alpha acids content, high alpha/beta ratios, excellent storage-stability and powdery mildew resistance. Summit has a strong aroma profile that includes citrus and grapefruit notes.

Yield (kilos per hectare)	2500 – 3100
Yield (lbs per acre)	2200 – 2700
Alpha Acids	16 – 18%
Beta Acids	4.0 – 6.0%
Cohumulone (% of alpha acids):	26 – 33%
Total Oils (Mls. per 100 grams dried hops)	1.5 – 2.5
Myrcene (as % of total oils)	30 – 50%
Caryophyllene (as % of total oils)	10 – 15%
Humulene (as % of total oils)	15 – 25%
Farnesene (as % of total oils)	< 1.0%
Storage (% alpha acids remaining after 6 months storage at 20° C)	85%
Possible Substitutions	CTZ, Warrior, Millennium, Simcoe

Super Galena

Super Galena (Hopsteiner 9908) is a super high alpha variety developed by the Hopsteiner breeding program and released in 2006. It has relatively high contents of both alpha and beta acids, making it a good bittering hop with pleasant aroma. Super Galena is comparable to Galena in its aroma and bitterness profile, but offers a substantially higher yield and complete resistance to all current hop powdery mildew strains found in the U.S.

Yield (kilos per hectare)	2800 – 3100
Yield (lbs per acre)	2500 – 2800
Alpha Acids	13 – 16%
Beta Acids	8.0 – 10%
Cohumulone (% of alpha acids):	35 – 40%
Total Oils (Mls. per 100 grams dried hops)	1.5 – 2.5
Myrcene (as % of total oils)	45 – 60%
Caryophyllene (as % of total oils)	6.0 – 14%
Humulene (as % of total oils)	19 – 24%
Farnesene (as % of total oils)	< 1.0%
Storage (% alpha acids remaining after 6 months storage at 20° C)	75 – 80%
Possible Substitutions	Galena

Tettnang (USA Grown)

Tettnang is a traditional German land-race variety known for its noble aroma that is pleasant and slightly spicy. It remains well established in the Tettnang growing region of Germany, and is also grown in Oregon and Washington. American-grown Tettnang is reported to have slightly higher myrcene levels than its German counterpart.

Yield (kilos per hectare)	1000 – 1500
Yield (lbs per acre)	900 – 1340
Alpha Acids	4.0 – 5.0%
Beta Acids	3.0 – 4.0%
Cohumulone (% of alpha acids):	20 – 25%
Total Oils (Mls. per 100 grams dried hops)	0.4 – 0.8
Myrcene (as % of total oils)	36 – 45%
Caryophyllene (as % of total oils)	6.0 – 7.0%
Humulene (as % of total oils)	18 – 23%
Farnesene (as % of total oils)	5.0 – 8.0%
Storage (% alpha acids remaining after 6 months storage at 20° C)	55 – 60%
Possible Substitutions	German Tettnang, Spalt, Spalt Select, Santiam

Tillicum

Tillicum is a high alpha variety with a very high content of beta acids. The variety was developed through the John I. Haas, Inc. breeding program and released in 1995. It is a daughter of Galena and a full sister to Chelan and therefore has analytical data similar to both varieties.

Yield (kilos per hectare)	2016 – 2464
Yield (lbs per acre)	1800 – 2200
Alpha Acids	12.0 – 14.5%
Beta Acids	9.3 – 10.5%
Cohumulone (% of alpha acids):	31 – 38%
Total Oils (Mls. per 100 grams dried hops)	1.5 – 1.9
Myrcene (as % of total oils)	45 – 55%
Caryophyllene (as % of total oils)	6.8 – 8.0%
Humulene (as % of total oils)	13 – 16%
Farnesene (as % of total oils)	< 1.0%
Storage (% alpha acids remaining after 6 months storage at 20° C)	80%
Possible Substitutions	Galena, Chelan

Ultra

Ultra was bred by U.S.D.A. from a tetraploid Hallertau mf cultivar and a Saazer-type male diploid genotype. It is a half-sister to Mt. Hood, Liberty, and Crystal. Ultra has a mild and pleasant Saaz-like aroma. It has very low alpha acids compared to most U.S. aroma varieties.

Yield (kilos per hectare)	1800 – 2000
Yield (lbs per acre)	1600 – 1800
Alpha Acids	2.0 – 3.5%
Beta Acids	3.0 – 4.5%
Cohumulone (% of alpha acids):	23 – 38%

Total Oils (Mls. per 100 grams dried hops)	0.5 – 1.0
Myrcene (as % of total oils)	15 – 25%
Caryophyllene (as % of total oils)	10 – 15%
Humulene (as % of total oils)	35 – 50%
Farnesene (as % of total oils)	< 1.0%
Storage (% alpha acids remaining after 6 months storage at 20° C)	Good to very good
Possible Substitutions	Mt. Hood, Liberty, Crystal

Vanguard

Vanguard was the last of the Hallertau varieties to be released from the U.S.D.A. breeding program. It has a reputation of having a very close chemistry and aroma to Hallertau mf. Vanguard is typically used in Lager, Pilsner, Bock, Kölsch, Wheat, Munich, Helles, and Belgian-style Ales.

Yield (kilos per hectare)	1500 – 1650
Yield (lbs per acre)	1350 – 1475
Alpha Acids	5.5 – 6.0%
Beta Acids	6.0 – 7.0%
Cohumulone (% of alpha acids):	14 – 16%
Total Oils (Mls. per 100 grams dried hops)	0.9 – 1.2
Myrcene (as % of total oils)	20 – 25%
Caryophyllene (as % of total oils)	12 – 14%
Humulene (as % of total oils)	45 – 50%
Farnesene (as % of total oils)	< 1.0%
Storage (% alpha acids remaining after 6 months storage at 20° C)	75 – 80%
Possible Substitutions	Hallertau, Hersbrucker, Mt. Hood, Liberty

Warrior®

Warrior® (YCR 5 cv.) is a high alpha variety of recent origin developed by Yakima Chief Ranches. It is used both for its aromatic properties and especially for its bittering properties, due to its low cohumulone content.

Yield (kilos per hectare)	2750 – 3000
Yield (lbs per acre)	2400 – 2600
Alpha Acids	15 – 18%
Beta Acids	4.5 – 5.5%
Cohumulone (% of alpha acids):	24%
Total Oils (Mls. per 100 grams dried hops)	1.0 – 2.0
Myrcene (as % of total oils)	40 – 50%
Caryophyllene (as % of total oils)	8.0 – 10%
Humulene (as % of total oils)	15 – 20%
Farnesene (as % of total oils)	< 1.0%
Storage (% alpha acids remaining after 6 months storage at 20° C)	76%
Possible Substitutions	Nugget, Columbus, Magnum

Willamette

Named after Oregon's Willamette River, which runs through that state's hop growing region, Willamette was released in 1976 from the U.S.D.A. breeding program. It is a daughter of the classic English variety, Fuggle, and is characterized by a low alpha content and mild aroma. Willamette is the most widely grown U.S. aroma hop. It imparts a mild, slightly spicy, and pleasant aroma in beer.

Yield (kilos per hectare)	1500 – 1900
Yield (lbs per acre)	1300 – 1700
Alpha Acids	4.0 – 6.0%
Beta Acids	3.0 – 4.5%
Cohumulone (% of alpha acids):	30 – 35%
Total Oils (Mls. per 100 grams dried hops)	1.0 – 1.5
Myrcene (as % of total oils)	30 – 40%
Caryophyllene (as % of total oils)	6.5 – 8.2%
Humulene (as % of total oils)	20 – 27%
Farnesene (as % of total oils)	5.0 – 6.0%
Storage (% alpha acids remaining after 6 months storage at 20° C)	60 – 65%
Possible Substitutions	Fuggle, Tettnang, Styrian Golding

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