

Registration of 'Teamaker' Hop

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'Teamaker' hop (*Humulus lupulus* L.) (Reg. No. CV-28, PI 558864) was developed by the USDA-ARS as a unique, nonbittering, high beta-acids hop and was released on 26 June 2006. The defining characteristics of Teamaker are its near-zero percent alpha acids levels—a distinctive condition in the *Humulus* species (Haunold et al., 1977)—good cone production, and relatively high levels of beta acids. Due to its low level of alpha acids, the primary bittering flavor agent of hop, and high levels of beta acids, which are the primary antimicrobial active compounds in hop, the potential uses of this variety lie principally as a natural-product antimicrobial additive, replacing antibiotics in poultry feed (Cornelison et al., 2006); a bacteriostatic agent in sugar processing, replacing formaldehyde (Pollach et al., 1996); as an herbal tea; and as a "late-hopping" aroma hop addition to the brew kettle where bittering potential is of no consequence.

Teamaker descended from the cross USDA 19105/USDA 19046M and, based on analysis of pedigree, has an inbreeding level $F = 0.09375$. The female, USDA 19105, was derived from the cross 'Late Grape'/OP/3/'Fuggle'//Fuggle/OP. Both Fuggle and Late Grape are thought to have arisen during the nineteenth century from clonal selections in Great Britain (Neve, 1991), although little is known about the parentage or origin of Late Grape. The male parent, USDA 19046M, was derived from 'Late Cluster'/OP//Fuggle/OP. Genetic composition of Teamaker, based on pedigree analysis of known ancestors, is as follows: 31.25% Fuggle, 12.5% Late Grape, 12.5% Late Cluster (Neve, 1991), and the balance (43.75%) of unknown origin.

Teamaker is a fairly vigorous cultivar with a cylindrical growth type, and its hop cones are distributed fairly uniformly along the length of the bine. This variety exhibits small- to medium-sized cones that mature moderately late with harvest dates similar to the industry standard 'Nugget' (Haunold et al., 1984). Harvest dates in Oregon ranged from 30 August to 23 September, with an

average harvest date of 9 September (SD = 5.4 d). Yields in nursery test plots ranged from 267 kg ha⁻¹ during its first season to 1705 kg ha⁻¹ in subsequent years, with an average of 1031 kg ha⁻¹ (SD = 594 kg ha⁻¹). Commercial yields on 1.6-ha plots located near Mt Angel, OR, ranged from 1568 to 1904 kg ha⁻¹ with an average of 1763 kg ha⁻¹ (SD = 95 kg ha⁻¹). On the basis of the percentage of the total resins found in cones, alpha acid content on a v/v basis (alpha acids/total resins) ranged from 0.006 to 0.018% v/v, with an average concentration of 0.012 v/v (SD = 0.0023 v/v). This average alpha acids content represents the lowest alpha acids content of any hop on the market today. Storage of this hop at room temperature for 6 mo resulted in a loss of 70% of the original alpha acids content. Beta acids content (beta acids/total resins) is significantly higher ($p = 0.001$) than found in the industry standard high beta acids content hop cultivar, 'Galena' (Romanko et al., 1979), ranging from 0.054 to 0.132 v/v, with an average of 0.084 v/v (SD = 0.025 v/v). Cohumulone content (a component of the alpha acids complex) relative to total alpha acids content ranged from 0.32 to 0.67 v/v (cohumulone/alpha acids content), with an average of 0.52 v/v (SD = 0.14 v/v).

The amount of essential oil (essential oil per 100 g of hop cone tissue) present in Teamaker is similar to other "mild aroma" hops like 'Tettanager' and 'Hersbrucker' (Neve, 1991), with an average of 0.98 mL 100 g⁻¹ (SD = 0.54). Myrcene makes up the majority of the essential oils, with an average of 0.596 v/v (myrcene/total oil amount; SD = 0.08 v/v). Caryophyllene amount (caryophyllene/total oil amount) varied widely from year to year but averaged 0.124 v/v (SD = 0.16 v/v) of the essential oils, while humulene makes up 0.018 v/v (SD = 0.009 v/v) of the total oil amount. Virtually no farnesene was observed in the total oil amount.

Teamaker appears to possess high levels of general resistance to powdery mildew (caused by *Podosphaera macularis* Braun & Takamatus). Signs of powdery mildew were rarely observed on Teamaker following inoculations under optimum disease conditions. When disease was observed in growth chamber assays designed to favor powdery mildew colony development and sporulation, lesions appeared only after extended incubation (10 d vs. 5 d for susceptible check cultivar). Lesions were small (<0.1 lesion per cm²) and produced relatively few conidia compared with a susceptible check cultivar. Powdery mildew was not observed on leaves or cones in field plots in Oregon following direct inoculation of these tissues with a field population of *P. macularis* collected from hop yards in Oregon. Powdery mildew has not been reported in commercial plots of Teamaker located in Washington.

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No serious crown infections of downy mildew [caused by *Pseudoperonospora humuli* (Miy. et. Tak.) G. W. Wilson] have been observed or reported on Teamaker in any nursery or commercial plots, although disease pressure from adjacent unrelated accessions was present in all cases. Field-based inoculations followed by quantification of infected leaf area showed Teamaker having tolerance to downy mildew when compared with susceptible check Halletauer 'Mittelfrueh' (Neve, 1991). Teamaker's infected leaf area was not significantly different ($p \leq 0.05$) from the tolerant line Fuggle (Neve, 1991).

Teamaker does not appear to be highly susceptible to hop aphid [*Phorodon humuli* (Schrack)] infestation, as seen in both nursery and commercial test plots. Single sprays with appropriate insecticides have effectively controlled infestations. Finally, infestations of two-spotted spider mite (*Tetranychus urticae* Koch) have not been observed on any of the nurseries or commercial plots of Teamaker. Teamaker has not been tested in Idaho under nursery or commercial conditions.

Teamaker is not protected under U.S. Plant Variety Protection Act. This cultivar will be maintained in isolated field plots for rhizome cuttings and kept in long-term storage (via meristem storage) by the USDA-ARS National Clonal Germplasm Reposi-

tory (NCGR). Limited quantities of Teamaker will be available for research purposes, including development and commercialization of new lines and cultivars on request from the USDA-ARS NCGR, 33447 Peoria Rd., Corvallis, OR 97333. Recipients of rhizomes are asked to make appropriate recognition of the source of Teamaker if it is used in the development of a new cultivar, germplasm, parental line, or genetic stock.

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