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REGISTRATION

Cultivar

Registration of ‘UC-Alameda’, a California adapted, non-glycosidic nitrile-producer, two-row spring malting barley

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Abstract

The emerging malting industry in California needs adapted cultivars for a sustainable local barley production. ‘UC-Alameda’ (Reg. no. CV-381, PVP 202300263, PI 701932) is a two-row, spring malting barley (*Hordeum vulgare* L.) released by the University of California, Davis, Agricultural Experiment Station, in 2022. UC-Alameda is a highly productive cultivar with satisfactory malting quality for local craft maltsters. UC-Alameda is adapted to the California Central Valley (Sacramento and San Joaquin Valleys) and is resistant to the most common diseases present in this region (e.g., *Barley yellow dwarf virus*, *Cereal yellow dwarf virus*, stripe rust, and powdery mildew) and moderately resistant to scald and net blotch. It was evaluated in preliminary trials, as B9K62, from 2017 to 2023 at Davis, CA, and by the University of California Regional Small Grains Testing program, as UC1911, from 2018 to 2023 for late fall planting in the Central Valley. UC-Alameda is a non-glycosidic nitrile producer, which is an important trait for craft-maltsters and distillers. UC-Alameda satisfies the quality criteria of the local craft malting and brewing industry interested in sourcing locally grown malting barley.

1 | INTRODUCTION

The Central Valley of California has a Mediterranean climate with rainfall concentrated in the fall-winter months, which typically have mild temperatures. In this characteristic climate, spring cereals are sown in the fall (end of October to beginning of December) to take advantage of the fall-winter rains and of an extended growing season. Fall-sown winter cereals or spring-sown spring cereals from other states usually perform poorly in this Mediterranean environment; hence, local breeding and selection is required to develop cultivars that are well adapted to these unique Californian conditions.

Abbreviations: AMBA, American Malting Barley Association; FHB, Fusarium head blight; GN, glycosidic nitrile; UCD, University of California at Davis; YDV, *Yellow dwarf virus*.

The effort to develop malting barley (*Hordeum vulgare* L.) at the University of California, Davis (UCD) started in the early 2000s. UC-Alameda is the fourth malting barley release from UCD, following ‘UC Tahoe’ in 2016 (Hegarty et al., 2018), ‘Butta 12’ in 2019 (Gallagher et al., 2020), and ‘UC-Capay’ in 2020 (del Blanco et al., 2022). Several local malting houses have been developing recently in California, and the UCD Malting Barley Breeding Program has been working closely with this new industry since their early stages. UCD aims to produce malting barley cultivars that are well adapted to the distinctive characteristics of California and its predominant pathogens. Barley grown in the Central Valley of California requires strong resistance to stripe rust (caused by *Puccinia striiformis* Westend.) and tolerance to *Barley yellow dwarf virus* and *Cereal yellow dwarf virus*, collectively referred to here as *Yellow dwarf virus* (YDV). These cultivars need to

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have adequate malting quality to satisfy the requirements of the local California Craft Brewing Industry. The California Craft Beer Association statistics, from January 2023, report more than 1100 craft breweries in operation in California, more than any other state in the nation (CCBA, 2024).

2 | METHODS

2.1 | Early-generation population development

'UC-Alameda' (Reg. no. CV-381, PI 701932) was selected from the cross among Butta 12, 'MSel' (Madre Selva), and 'BCD-TTA-J' (a selection of Triumph/Tyra//Arupo 's'*2/Abyssinian). Butta 12 was one of the best malting quality lines at the beginning of the UCD malting barley program; 'MSel' was an entry from CIMMYT/ICARDA with resistance/tolerance to YDV (Capetini et al., 2002); BCD-TTA-J (Bar Code TTA selection J) was a re-selection of a genotype already included in the creation of Butta 12 (BU27/3/Triumph/Tyra//Arupo*2/Abyssinian). After the original cross made in 2009/2010, the F₁ generation was grown out in the 2010/2011 crop season. The progeny was self-pollinated and advanced as modified bulk from F₂ (2011/2012) to F₅ (2014/2015) generations at UCD Agron-

Core Ideas

- UC-Alameda is a new two-row spring malting barley for California.
- UC-Alameda is a non-glycoside nitrile producer.
- UC-Alameda meets the requirements of California local maltsters and brewers.
- UC-Alameda is resistant to the common barley pathogens present in the Central Valley of California.
- UC-Alameda is resistant to stripe and stem rust.

omy Field Headquarters. The F₅ was planted as head-rows; the best head-rows were selected for increases and evaluations. Evaluation started as unreplicated plots in 2016, and the final selection (B9K62) was entered into the regional trials in 2018 as UC1911. Outline of the selection process is in Appendix Table A.

Seed multiplication for all yield and quality testing as well as for breeder seed production originated from a single head-row in Davis, CA, during the 2015/2016 growing season. In May 2016, spikes were collected from the plants originated in that initial row. Spikes were threshed individually and planted as separate rows in November 2016 at Davis Agronomy Field

TABLE 1 Site locations of the experiments, and years of evaluations (all locations in California).

Experiment name	Location	Planted	Harvested
Davis Preliminary 2018 (DP18)	Yolo Co., UC Davis Agr. Farm, Davis	Nov. 7, 2017	June 5, 2018
Merced Regional 2019 (MR19)	Merced	Nov. 19, 2018	June 14, 2019
Fresno Regional 2019 (FR19)	Fresno Co., UC Westside REC, Five Points	Nov. 12, 2018	June 18, 2019
Davis Preliminary 2019 (DP19)	Yolo Co., UC Davis Agr. Farm, Davis	Dec. 11, 2018	June 10, 2019
Davis AMBA 2019 (DA19)	Yolo Co., UC Davis Agr. Farm, Davis	Dec. 11, 2018	June 10, 2019
Davis Regional 2019 (DR19)	Yolo Co., UC Davis Agr. Farm, Davis	Nov. 27, 2018	June 21, 2019
Yolo2 Regional 2019 (Y219)	Lat 38.7961, Long -122.0455	Nov. 27, 2018	June 20, 2019
Yolo3 Regional 2019 (Y319)	Lat 38.77649, Long -121.83	Jan. 4, 2019	June 21, 2019
Davis Regional 2020 (DR20)	Yolo Co., UC Davis Agr. Farm, Davis	Nov. 29, 2019	June 26, 2020
Davis Preliminary 2020 (DP20)	Yolo Co., UC Davis Agr. Farm, Davis	Nov. 21, 2019	June 11, 2020
Fresno Regional 2020 (FR20)	Fresno Co., UC Westside REC, Five Points	Nov. 26, 2019	June 17, 2020
Davis Regional 2021 (DR21)	Yolo Co., UC Davis Agr. Farm, Davis	Dec. 11, 2020	June 14, 2021
Davis Preliminary 2021 (DP21)	Yolo Co., UC Davis Agr. Farm, Davis	Nov. 24, 2020	June 14, 2021
Fresno Regional 2021 (FR21)	Fresno Co., UC Westside REC, Five Points	Nov. 18, 2020	June 10, 2021
Imperial Regional 2021 (IR21)	El Centro, Imperial Valley	Dec. 8, 2020	May 24, 2021
Yolo2 Regional 2021 (Y221)	Lat 38.7961, Long -122.0455	Dec. 10, 2020	June 3, 2021
Davis Preliminary 2022 (DP22)	Yolo Co., UC Davis Agr. Farm, Davis	Dec. 2, 2021	June 2, 2022
Fresno Regional 2022 (FR22)	Fresno Co., UC Westside REC, Five Points	Nov. 30, 2021	June 13, 2022
Davis Regional 2023 (DR23)	Yolo Co., UC Davis Agr. Farm, Davis	Nov. 22, 2022	June 15, 2023
Davis Preliminary 2023 (DP23)	Yolo Co., UC Davis Agr. Farm, Davis	Nov. 21, 2022	June 7, 2023
Fresno Regional 2023 (FR23)	Fresno Co., UC Westside REC, Five Points	Nov. 16, 2022	June 10, 2023

TABLE 2 Glycosidic nitrile genotyping: detection of epiheterodendrin (EPH)-null allele using rhAMP assay.

Genotype	EPH phenotype
Harrington	producer
Butta 12	non-producer ^a
UC-Capay	non-producer
UC Tahoe	non-producer
UC-Alameda	non-producer
LCS Odyssey	non-producer

^aNon-producers: <0.5 g glycosidic nitrile per ton.

Source: Personal communication (2020) with Aaron MacLeod (Hartwick College Center for Craft Food & Beverage, Oneonta, NY, 13820).

Station. Any row that was heterogeneous in appearance was entirely cut and discarded. In May 2017, 1000 spikes were collected, threshed individually, stored, and planted 3 years later, once the release was decided. In November 2020, at Davis Agronomy Field HQ, the 1000 spikes were planted as head-rows to produce pure breeder seed; rows looking different or mixed were discarded. UC-Alameda was evaluated in preliminary yield trials at Davis as B9K62 from 2017/2018 to 2022/2023 and entered into the California Small Grains Regional Testing Program as UC1911 for the first time in the 2018/2019 growing season, when it was planted at five locations: Davis, Fresno, Merced, Yolo2, and Yolo3 (site locations and planting/harvesting dates are presented in Table 1).

Yield, disease resistance, and agronomic data for these locations are publicly available at <https://smallgrains.ucdavis.edu/> (older data) and <http://smallgrains.ucanr.edu/Variety/> (newer data). UC1911 was evaluated for a second year at the California Small Grains Regional Testing Program in the 2019/2020 growing season at two locations (Davis and Fresno). During the 2020/2021 growing season, UC1911 was evaluated at four locations in the San Joaquin and Sacramento Valleys, including one under rain-fed conditions (water limited). During the 2021/2022 and 2022/2023 growing seasons, UC1911 was evaluated at Davis and Fresno. Malting quality was measured every subsequent year starting in 2017 (unreplicated plots) by the USDA-ARS Malting Quality Laboratory located at Madison, WI, and evaluated at the Hartwick College Center for Craft Food & Beverage, Oneonta, NY, for glycosidic nitrile (GN) production.

Breeder seed was harvested in June 2021, and 100 pounds of pure seed were delivered to the Foundation Seed Program to produce foundation seed in 0.75 acre during the 2021/2022 growing season. During 2022/2023, certified seed was produced by Adams Grain Co., Inc.

2.2 | Selection

UC-Alameda was selected in all segregating generations in the field, based on observations of disease resistance and

agronomic characteristics such as plant height and architecture and spike size and production and on phenological traits such as heading and maturity dates. In advanced generations, grain yield and malting quality were added to the selection criteria.

2.3 | Evaluation in replicated trials

Evaluation of UC-Alameda started as unreplicated plots (F_6) in 2016, and the final selection was entered into the regional trials in 2018 as UC1911. UC-Alameda was evaluated over six growing seasons, from 2017/2018 to 2022/2023, in preliminary replicated trials at Davis, in regional trials by the UCD Small-Grains Regional Testing Program from 2018/2019 to 2022/2023 in the Central Valley of California (Sacramento and San Joaquín Valleys), and in the American Malting Barley Association (AMBA) Pilot Malting from 2018/2019 to 2021/2022.

Preliminary and regional trials were organized as randomized complete block designs with four replications. The experimental units were small plots (1.5 m wide by 6 m long) with a seed density of 1 million seeds per acre. All statistical analyses were conducted using Proc GLM in SAS version 9.4 (SAS Institute, 2013).

2.4 | Disease resistance

Observation and selection for the common diseases usually present in the California Central Valley (Sacramento and San Joaquín) were conducted every year under field conditions. For stripe rust, besides the regular field observations, UCD evaluates every year the Barley Stripe Rust Screening Trial, which is also grown in Corvallis, OR, and Mount Vernon and Pullman, WA. At UCD, this nursery was inoculated with a mix of races/strains collected the previous year in the experimental field. The inoculations were done by injecting the inoculum with syringes in between the leaf sheaths and the stems and also by spraying spores on the susceptible rows of the nursery several times during the growing season. The stripe rust nurseries at Corvallis, OR, and Mount Vernon and Pullman, WA, were grown and evaluated under natural field infections.

UC-Alameda was evaluated for stem rust (caused by *Puccinia graminis*) severity during 3 years (2020–2022) at the African nurseries of Kenya and Ethiopia, locations where the race TTKSK (Ug99) is often present. UC-Alameda was also evaluated for Fusarium head blight (FHB, caused by *Fusarium graminearum*) severity under greenhouse inoculation at the University of Minnesota.

TABLE 3 Mean (SE) grain yield of UC-Alameda, compared with other University of California at Davis cultivars, in 6 years of preliminary trials at Davis, 2018–2023.

Cultivar	2017/2018	2018/2019	2019/2020	2020/2021	2021/2022	2022/2023	Average (SE)
UC-Alameda	7539	7412	8216	7058	6236	5669	6959 (378)
UC-Capay	5582	5512	8438	4756	4886	4442	5639 (595)
UC Tahoe	6303	5218	7128	5806	7250	6590	6254 (319)
Butta 12	N/A	5796	8154	7000	6510	5918	6676 (350)

Note: ANOVA, $Pr > F = 0.14$.

TABLE 4 Mean grain yield and standard errors of UC-Alameda compared with other University of California at Davis cultivars and checks (LCS Odyssey and LCS Genie) at the Sacramento and San Joaquin Valleys, Statewide, and Water-limited.

Cultivar	Regional trials—grain yield (3-yr average)					
	Sacramento Valley		San Joaquin	Statewide	Water-limited	Average (SE)
	kg ha ⁻¹					
UC-Alameda	5241	6166	5572	4498	5369 (347)	
UC-Capay	5303	4005	4547	4213	4517 (285)	
Butta 12	5040	5969	5351	4091	5113 (391)	
UC Tahoe	4767	6068	5392	4506	5183 (349)	
LCS Odyssey	4727	6048	5431	4286	5123 (388)	
LCS Genie	4780	6403	5664	4476	5331 (437)	
Mean location	4976	5777	5326	4345	5106	

Note: ANOVA, $Pr > F = 0.63$.

Data from the Smallgrains Regionals (<https://smallgrainselection.plantsciences.ucdavis.edu/>).

TABLE 5 Means for agronomic traits of UC-Alameda, compared with other University of California at Davis cultivars, from the last 6 years of preliminary trials at University of California Davis Agronomy Field HQ.

Cultivar	Days to heading ^a	Plant height	Lodging risk	Shatter risk
		in		
UC-Alameda	99	40	low	low
UC-Capay	84	43	low	low
UC Tahoe	99	37	low	low
Butta 12	98	39	medium low	low

^aFrom January 1.

TABLE 6 Means for agronomic traits of UC-Alameda, compared with other University of California at Davis cultivars and checks (LCS Odyssey and LCS Genie), from the last 3 years.

Cultivar	Regional trials—5-year average						
	Test weight	TKW	Days to heading ^a	Days to maturity ^a	Plant height	Lodging risk	Shattering risk
	lb bu ⁻¹	g	in				
UC-Alameda	46.1	53.3	106	141	31	low	low
UC-Capay	54.2	54.5	100	136	37	low	low
Butta 12	54.2	51.1	111	139	34	medium high	low
UC Tahoe	53.4	43.1	108	138	29	low	low
LCS Odyssey	51.7	43.4	112	142	30	medium low	low
LCS Genie	53.3	43.8	112	137	29	low	low

Abbreviations: TKW, 1000-kernel weight.

^aFrom January 1.

Data from the Smallgrains Regionals (<https://smallgrainselection.plantsciences.ucdavis.edu/>).

TABLE 7 Malt quality of UC-Alameda and check cultivars (ideal values for both, adjunct malt and all-malt brewing, outlined by the American Malting Barley Association, are included).

Cultivar	Location/year	KW mg	On 6/64 %	Barley color	Malt extract %	Wort color	Wort clarity	Barley protein	Wort protein	S/T	DP	α -Amylase 20°DU	β -Glucan ppm	FAN ppm
Alameda	DA17	52.6	98.8	51	80.7	2.36	1	13.9	5.3	40.0	186.6	87.0	35.4	304.2
Metcalf	DA17	34	83	73	82	2	1	11.5	4.7	45	163	114	104	253
Merit 57	DA17	38	84	63	82	2	1	12.5	4.8	40	160	117	258	260
Alameda	DA18	48.2	97.6	46	78.9	2.8	1	14.9	6.4	42.8	236	93.8	58	302
Metcalf	DA18	36	89	61	78	2	1	15.8	6.1	39.3	203	113	276	273
Merit 57	DA18	41	91	50	79	2	1	14.5	5.7	40.4	172	109	300	234
Alameda	DA19	45.1	99.0	78	82.9	2.1	1	8.8	5.2	60.0	110	82.2	72	241
Metcalf	DA19	39	96	85	81	1.5	1	12.0	5.7	50.5	159	97	157	228
Merit 57	DA19	37	92	82	82	1.4	1	12.4	5.7	49.1	173	114	169	218
Alameda	DA20	45.4	99.2	89	81.6	2.0	1	12.7	5.9	47.0	171	111.4	100	229
Metcalf	DA20	37.9	92.6	83	82.1	1.4	1	12.9	4.73	37.9	162	132.9	175	270
Merit 57	DA20	43.3	97.2	87	83.1	1.2	1	12.2	4.56	39.1	149	146.6	200	239
Alameda	DA21	37.0	85.0	79	78.5	1.8	1	15.4	6.3	42.7	237	108.1	86	275
Metcalf	DA21	38	94	88	82	1.9	1	13.3	5.9	46.1	157	101	135	250
Merit 57	DA21	42	95	86	81	1.8	1	12.9	5.9	48.5	150	106	284	243
Alameda	DA22	53.3	99.1	75.57	81.7	2.93	1	11.0	5.7	54.52	183.1	93.2	81	239.8
Genie	DA22	45.5	97.2	75	82.3	2.2	1	10.7	4.79	47.4	135	63.5	121	180
Odyssey	DA22	47.4	97.3	76	82.0	2.1	1	11.0	4.67	45.5	124	62.5	175	177
Alameda	DA23	43.3	99.0	73	80.1	1.5	1	11.7	5.51	47.1	168	82.2	98	217
Genie	DA23	39.5	91.7	80	76.2	1.2	1	11.7	4.72	41.4	148	53.1	368	122
Odyssey	DA23	48.7	99.8	71	78	1.3	1	12.0	4.94	44.3	131	62.6	45	145
AMBA	adjunct		>90		>81	1.6–2.5		≤13	4.8–5.6	40–47	>140	40–70	<100	>210
AMBA	all malt		>90		>81	1.6–2.8		≤12	<5.3	38–45	110–150	>50	<100	140–190

Note: Data from USDA-ARS, Cereal Crops Research Unit, Madison, WI.

Abbreviations: DP, diastatic power; DU, dextrinizing units; FAN, free amino nitrogen; S/T, soluble to total nitrogen.

3 | CHARACTERISTICS

3.1 | Agronomic and botanical description

UC-Alameda is a two-row, spring, early-maturing malting barley. The spike is erect, parallel, without waxiness and without hair in the rachis. The awns are rough, and the aleurone is colorless. The seed is covered. UC-Alameda is medium-tall (~3 cm taller than UC Tahoe), with stem exertion of 3–10 cm, open collar, and straight neck. Leaves are glabrous, with dropping flag leaf and without waxiness or anthocyanins in leaf sheaths. At the molecular level, UC-Alameda carries the Harrington allele (Emebiri et al., 2009) at one end of chromosome 5H (sequence GTT) between 182.8 and 194.2 cM, which improves several traits adding to malting quality, such as kernel weight, malt extract (ME), α -amylase, β -glucan, and free amino nitrogen.

UC-Alameda is a non-GN producer, as shown in Table 2, an important trait for brewers and distillers. Glycosidic nitrile is a compound present in malt resulting from the production of epiheterodendrin during the malting process (Hedley et al., 2005); epiheterodendrin is a precursor to ethyl carbamate in distilling, which is a known carcinogen regulated by some markets, such as Canada and the United Kingdom. The most recent AMBA (2021) guidelines require that All Malt Distillers' Two-Row should have <0.5 g/MT GN.

3.2 | Grain yield

UC-Alameda was evaluated during six growing seasons, from 2017/2018 to 2022/2023, in preliminary replicated trials at Davis (Table 3) and in regional trials by the UCD Small-Grains Regional Testing Program from 2018/2019 to 2022/2023 (Table 4) in the Central Valley of California (Sacramento and San Joaquín Valleys). Table 1 provides a summary of the locations and years of the replicated trials where UC-Alameda was evaluated. Means of agronomic traits are presented in Table 5 (Preliminary Trials at Davis) and Table 6 (Regional Trials, several locations). Grain yield of UC-Alameda was similar to other UCD malting barley cultivars and checks in both preliminary and regional trials.

3.3 | Malting quality

Seven years of malting quality data are summarized in Table 7. UC-Alameda has excellent malting quality compared with the malting quality checks, including the low value of β -glucans (<100, as required by USDA and AMBA) that is difficult to attain in California due to the environmental conditions (warm and dry seasons during grain filling). UC-Alameda carries a known allele for improved malting quality in chromosome 5H (the Harrington allele), associated with

TABLE 8 Resistance to stripe rust: severity scores from the barley stripe rust screening nurseries, 3 years at Davis (DA20, DA21, DA22); 1 year at Pullman, WA (PU22), Mount Vernon, WA (MV22), Central Ferry, WA (CF22); and 3 years at Corvallis (OR20, OR21, OR22).

Environment	UC-Alameda	UC Tahoe	Butta 12
	%		
DA20	0	0	30
DA21	5	5	50
DA22	1	5	30
PU22	5	0	5
MV22	5	5	40
CF22	0	5	10
OR20	7.5	2.5	45
OR21	2.5	0	0
OR22	2.5	2.5	2.5
Mean (SE)	3.2 (1.23)	2.8 (1.1)	23.6 (9.18)

Note: ANOVA, $Pr > F = 0.00007$; F -statistic = 10.32. Severity scale: resistant, 0%–9%; moderately resistant, 10%–19%; 20%–39%; moderately susceptible, 40%–49%; susceptible, 50%–100%.

improved α -amylase, β -glucan, and free amino nitrogen values (Emebiri et al., 2009). UC-Alameda was approved by AMBA in the 2019 Pilot Scale evaluation but did not pass the second year and was not recommended for Plant Scale. In our experiments (Table 7), UC-Alameda showed outstanding malting quality compared with the malting quality checks required by AMBA (Metcalfe & Merit 57 from 2017 to 2021 and LCS Genie & Odyssey over the last 2 years).

3.4 | Disease resistance

3.4.1 | Stripe rust

Besides the regular field observations, UCD evaluates every year the Barley Stripe Rust Screening Trial, which is also grown in Corvallis, OR, and Mount Vernon and Pullman, WA (Table 8). At Davis, this nursery was inoculated several times during the growing season with a mix of races/strains collected the previous year in the experimental field. The stripe rust nurseries at Corvallis, OR, and Mount Vernon and Pullman, WA, were grown and evaluated under natural field infections. UC-Alameda showed very low severity, similar to UC Tahoe and significantly lower than Butta 12, in all years and locations it was tested.

3.4.2 | Stem rust

UC-Alameda was evaluated for stem rust severity over 3 years (2020–2022) at the African nurseries of Kenya and Ethiopia, locations where the race TTKSK (Ug99) is often present

TABLE 9 Stem rust severity in nurseries at Kenya and Ethiopia.

Cultivar	2020		2021		2022		Mean (SE)
	Kenya	Ethiopia	Kenya	Ethiopia	Kenya	Ethiopia	
UC Alameda	10MRMS	20MS	10MS	20MS	10MS	30MS	17 (3.3)
UC Tahoe	15MRMS	10MS	0	20MS	5MS	20MS	12 (3.3)
Red Bobs (susceptible check)	90S	70S	80S	80S	90S	80S	82 (3.1)

Note: ANOVA, $Pr > F = 0.000$.

TABLE 10 Fusarium head blight severity and deoxynivalenol accumulation.

Cultivar	Fusarium head blight			Deoxynivalenol		
	2019	2021	Mean (SE)	2019	2021	Mean (SE)
	%			mg kg ⁻¹		
UC-Alameda	13.2	5	9.1 (4.1)	15.2	1.6	8.4 (6.8)
UC Tahoe	50.2	10	30.1 (20.1)	20.3	0.3	10.3 (10)
Susceptible checks	88.5	75	81.8 (6.7)	15.8	4.8	10.3 (5.5)

Note: ANOVA, $Pr > F = 0.05$ (Fusarium head blight); $Pr > F = 0.98$ (deoxynivalenol). Data from the FHB Nursery, University of Minnesota, 2019 and 2021.

(Table 9). Results show UC-Alameda with low disease severity, similar to UC Tahoe, compared with the susceptible check Red Bobs.

3.4.3 | Fusarium head blight

Even though FHB is not a challenge in California, UC-Alameda was evaluated for FHB severity under greenhouse inoculations at the University of Minnesota over 2 years (no evaluation was done in 2020 due to the restrictions imposed by the COVID pandemic) (Table 10). In those two evaluations UC-Alameda showed significantly lower FHB severity compared with UC Tahoe, which is considered to be of intermediate resistance and compared with the susceptible checks. No differences in deoxynivalenol accumulation were detected.

4 | CONCLUSIONS

UC-Alameda is a new two-row, spring malting barley cultivar adapted to the Central Valley of California. UC-Alameda has excellent grain yield, resistance to common diseases, and malting quality. UC-Alameda is also a non-GN producer, which is a highly valued trait in malting barley.

5 | AVAILABILITY

The UCD Foundation Seed Program (<https://fsp.ucdavis.edu/>) has maintained foundation seed since September 2022 and can produce more on request. Certified seed is available for purchase from Adams Grain in Arbutle, CA

(<http://www.adamsgrp.com/adams-grain.shtml>). Seed of UC-Alameda has been deposited into the USDA-ARS National Plant Germplasm System (PI 701932), where it will be available at the end of PVP protection. US Plant Variety Protection of UC-Alameda is PVP 202300263. Small amounts of seed (5 g) for research purposes can be requested from the corresponding author for at least 5 years.

AUTHOR CONTRIBUTIONS

Isabel del Blanco: Conceptualization; formal analysis; funding acquisition; investigation; methodology; project administration; writing—original draft. **Jorge Dubcovsky:** Conceptualization; funding acquisition; project administration; supervision; writing—review and editing.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest.

ORCID

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APPENDIX

TABLE A1 Outline of ‘UC-Alameda’ advancement.

Year(s)	Detail of stage	Selection criteria
2009/2010	F ₀	crossing in greenhouse
2010/2011	F ₁ UC Davis field	no selection
2011/2015	F ₂ to F ₅ modified bulk	agronomic type, resistance to diseases
2015/2016	single head-row selected	agronomic type, resistance to diseases
2017	1000 heads selected	homogeneity
2017/2022	preliminary trials, Davis	disease resistance, grain yield, malting quality
2018/2022	AMBA pilot malting	disease resistance, grain yield, malting quality
2018/2022	regional trials	disease resistance, grain yield, malting quality
2021	breeder seed, 100 lbs.	homogeneity
2022	foundation seed	homogeneity