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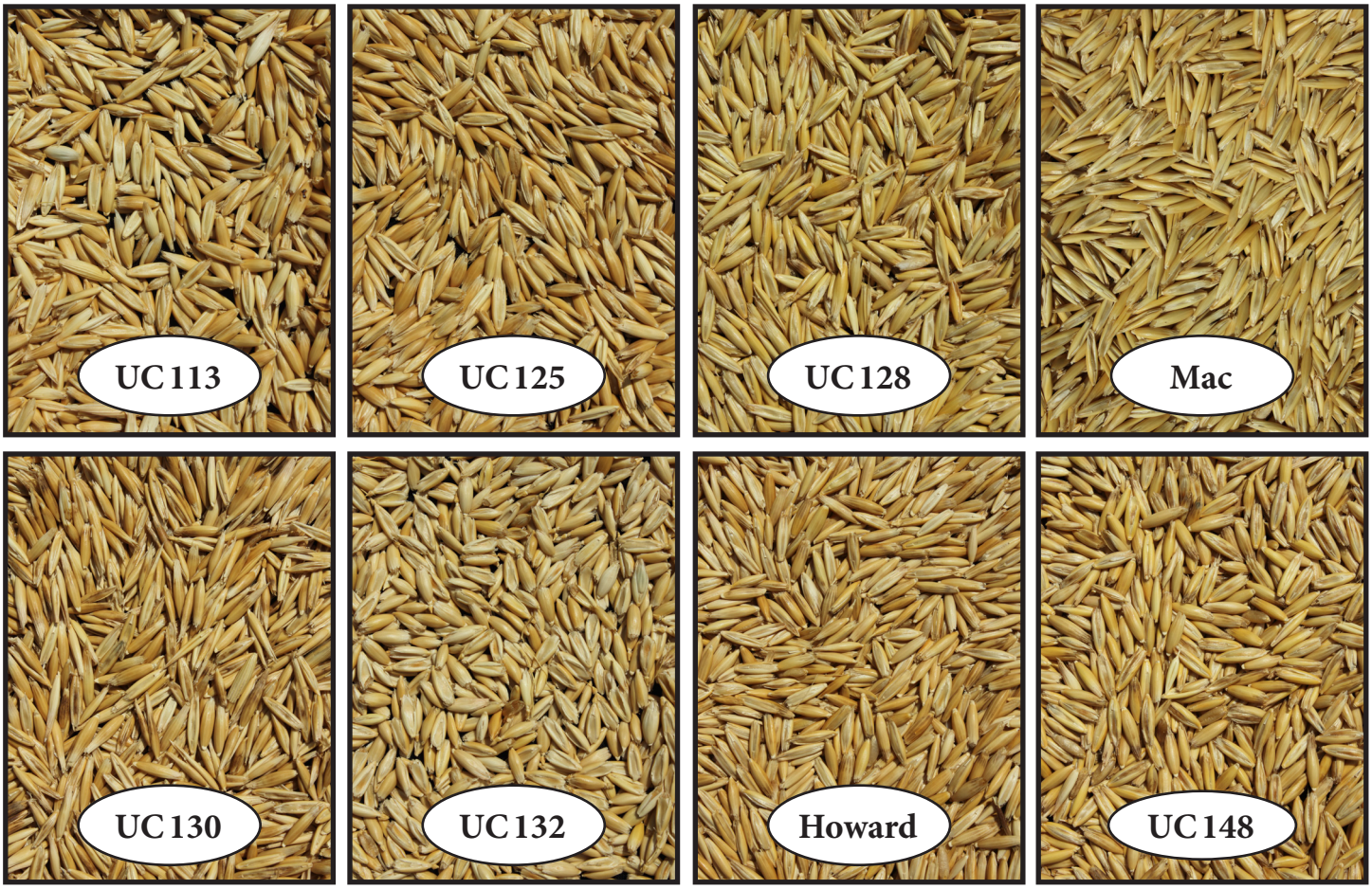

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Enhancing Diversity and Productivity of the California Oat Crop: Eight New Varieties[1]

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Abstract. Eight oat varieties were bred and/or selected at UC Davis during the period 1983 to 2007 and were released in 2007 by the California Agricultural Experiment Station and the Department of Plant Sciences, University of California, Davis. These varieties provide growers with diversity in oat variety selection for their various needs. The new varieties have shown up to 50% higher grain yield, about 10 to 30% higher forage yield, and better disease resistance than the current most popular varieties, Montezuma and California Red. Since most oat acreage in California is not harvested for grain, there is often a shortage of planting seed. The new varieties are prolific seed producers that should make seed production and distribution a profitable enterprise and the growers will receive the benefits of the advances in agronomic type and disease reactions of the new varieties. This report presents the breeding history, morphologic and agronomic traits, and agronomic performance for grain and forage production of the new varieties (UC 113, UC 125, UC 128, UC 130, UC 132, UC 148, Howard, and Mac). Seed is available from licensed seed handlers or the Foundation Seed Program, Department of Plant Sciences, University of California, Davis.

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Introduction and Background

Oat (*Avena sativa* L.) is a minor crop in the California agricultural scene, but it is grown throughout the state. Often relegated to marginal, rainfed production sites, the statewide annual yields are far below the biological potential for biomass production. Oat has diverse uses, including grain for food and feed, dried and green forage for livestock, and to a limited extent, as a cover crop. Oat is grown as a rotation crop with other more profitable ones. Planted acreage was reported to be about 250,000 in 2007 with only about 10% of the acres harvested for grain and the remainder harvested for forage or abandoned. Often the seed supply of locally grown oat is limited and seed is imported from other states, mostly from Oregon or Washington.

California oat varieties have been bred or introduced since early in the 20th century, but the activity has been limited and sporadic. An early introduction, California Red, is basically a landrace that has had minimal improvement, but is still grown throughout the state. Suneson et al.[1] (1959) discussed the oat varieties extant in the 1950s, including Kanota, Palestine, Ventura, Indio, and Coast Black. C.A. Suneson, a USDA scientist located at UC Davis (retired in 1968), bred several varieties which improved the general oat variety picture for California growers. In 1958, he introduced Curt[2], the first short-statured cereal crop released in the US. Later, he exploited hybrids of cultivated *Avena sativa* varieties with wild oat, *A. fatua*, and released the varieties Sierra[3] (1961) and Montezuma[4] (1968). Varieties, such as Ogle, have been introduced from the Midwest US, Cayuse from the Pacific Northwest, and Swan from Australia. Zwer et al.[5] (1984) reviewed the oat production and improvement situation in California and suggested the need for more aggressive oat breeding in California.

California Red and Montezuma are still the mainstay varieties grown in California. Both are fraught with foliar diseases and agronomic deficiencies that limit productivity and reduce grain and forage quality. A new short-statured plant type was introduced from the oat breeding program in Western Australia and released in California in 1994 with the name Pert[6]. Pert had measured grain yields up to 50% higher than California Red or Montezuma, but it matures later and this was seen as a disadvantage to some growers. Its acceptance by some growers was minimal because the variety had thick culms and was believed

[1]Suneson, C.A., M.D. Miller, and B.R. Houston. 1959. Oats for grain and forage. Circular 481. Division of Agricultural Sciences, University of California, California Agricultural Experiment Station.

[2]Murphy, H.C. 1960. Registration of oat varieties, XXII. *Agron J* **52**:663-665.

[3]Suneson, C.A. 1967. Registration of Sierra oats. *Crop Sci* 7:168.

[4]Suneson, C.A. 1969. Registration of Montezuma oats. *Crop Sci* **9**:848; Suneson, C.A., C.O. Qualset, J.D. Prato, J.T. Feather, and W.H. Isom. 1969. High test weight featured in Montezuma oats. *Calif Agric* **23**(**2**):6-7.

[5]Zwer, P., C.O. Qualset, H.E. Vogt, and L.F. Jackson. 1984. Oat improvement in California. University of California, Davis, Agronomy Progress Report No. 146.

[6]Qualset, C.O., H.E. Vogt, P.K. Zwer, J.H. Heaton, L.C. Federizzi, L.F. Jackson, R. McLean, P. Portman, and A.L. McKendry. 1994. Pert and Bates-89: Two oat varieties released for grain and forage production in California. University of California, Davis, Agronomy Progress Report No. 246.

not to be acceptable to the horse hay market. The variety was not publicized or marketed aggressively. Bates-89 was introduced from Missouri because of its BYD tolerance and desirable forage traits, unfortunately, Bates-89 tends to lodge and its grain yield is lower and affected by propensity for shattering.

UC Davis has conducted a limited-scale oat breeding program under the leadership of Cal Qualset since 1968, the year of the retirement of C.A. Suneson. Initially, emphasis was placed on identifying sources of resistance to the barley yellow dwarf virus from the USDA world oat collection. Limited success was recorded in this effort, but USDA and University of Illinois workers achieved measurable success and several of their breeding lines were introduced to the California breeding program. Ogle was a popular variety with BYD resistance from the Illinois program that has been useful in California. The Quaker Oat Company sponsored the International Oat Nursery that included breeding lines from oat breeding programs from the US and South America. Quaker Oats provided small grants to the California oat breeding program during the years 1987 to 1993 in exchange for conducting BYD screening of the entries in the international nursery. All lines in that nursery are available for use by breeders, upon agreement with the clauses of the Code of Ethics for oat breeders. One of the varieties released now, Mac (UC129), was selected from the International Oat Nursery. It was developed at Texas A&M University by the late Milton McDaniel. In 1992, Northrup-King & Company donated a collection of lines to the USDA National Plant Germplasm System (NPGS) that were developed by Coker's Pedigreed Seed Company that Northrup-King had purchased. These lines were made available by the USDA National Small Grains Collection to breeders and the collection of some 200 lines were evaluated at UC Davis for several years beginning in 1993.

Pamela Zwer, who provided leadership under the guidance of Qualset for the oat breeding program while she was a graduate student at UC Davis, used the Western Australian short-statured lines in crosses with California and Illinois varieties and breeding lines. Luiz Federizzi, oat breeder at the University of Rio Grande do Sul in Brazil, studied the genetics of plant height reduction in oat at UC Davis. He studied several sources of dwarfness, including a mutant from the variety Palestine, called Palestine Dwarf, and OT 207, a short-statured mutant derived after gamma ray irradiation of seeds at the Agriculture Canada oat program at Ottawa, Ontario. One of the new varieties, UC132, resulted from this cross. Pamela Zwer (until 1986), John Heaton (until 1995), Herb Vogt, and Cal Qualset, carried out the selection and evaluation of lines that eventually resulted in the varieties being released in 2007.

Thus, the UC oat breeding program utilized germplasm from several sources: Western Australia, Canada, Texas A&M University, University of Illinois, University of Missouri, and the USDA National Small Grains Collection. The program was conducted in the facilities of the Department of Agronomy and Range Science (*cum* Plant Sciences Department) and the UC Genetic Resources Conservation Program during the period 1968 to 2007. Over the years of the program, financial support was received from the Quaker Oats Company, 1982 to 1993, and the California Crop Improvement Association Cereal Research Fund, 1984 to 1993.

The goals of the breeding program were:

- To expand the genetic diversity of the California oat crop by introducing several divergent variety types to California growers.
- To breed and distribute oat varieties with disease resistance, good agronomic traits, high grain and forage yield and acceptable end-use quality, especially forages for livestock uses.
- To innovate and implement a system of seed multiplication and distribution to insure that new varieties would be widely available to California growers.

The breeding program was successful in all of its goals. The eight new varieties greatly enhance the options for California growers when they consider oat in their farming systems. Descriptive and performance data are summarized in Tables 1 to 9 and information on origin, adaptation, and performance is summarized for each variety in separate sections.

Field Evaluations and Data Collected

The UC Division of Agriculture and Natural Resources test agreement process (Administrative Manual, DANR, Section 485) was used to explore the potential of seven of the eight varieties for seed production performance and adaptation on growers fields. Since it was a goal of the breeding program to structure the evaluations in such a way that seed companies could determine whether the varieties meet a market niche that could be exploited by aggressive advertisement and marketing, all of the major oat seed marketing companies were provided a letter of opportunity to participate in the test program. Three seed companies responded and arranged for field-scale production of the varieties with growers. The production tests were conducted during 2005 to 2007 by Baglietto Seed Company (UC 113, UC 128, and UC 148), Resource Seeds, Inc. (UC 125, UC 130, and Howard), and Mezger Bros. Seed (Mac). Each of these companies was supplied by the breeder with Breeders Seed for the test plantings. Westbred LLC did not arrange for test production of a new variety, but based on test data, expressed interest in UC 132. None of the varieties was requested by more than one company. After the results of the test plantings, the companies expressed interest in entering a marketing arrangement with the University of California that would provide them exclusive marketing of the varieties that they had tested. This is desirable because the companies will have assurance that their marketing efforts will not be exploited by others. By this means, the varieties will become known to the growers through marketing efforts that have not been applied in the past by the UC Foundation Seed Program or UC research and extension specialists. Other states have been confronted with similar situations and have devised mechanisms, through Plant Variety Protection, for granting the exclusive marketing agreements with seed companies of new varieties released by public plant breeding programs.

Public Release, Ownership, Plant Variety Protection, and Licensing

Oat varieties and other small grain crops will not provide a substantial source of royalty income to the University of California if protected by the USDA Plant Variety Protection Act (PVP) and licensed because of (1) the relatively high cost of the PVP process, (2) the low volume of seed sales, and (3) the legal provision allowing grower self-saving of planting seed of PVP-protected varieties. On the other hand, PVP allows advertisement and marketing that should encourage wide distribution of the varieties.

UC breeding efforts have identified varieties that have been developed by others that have merit for California growers. Thus, UC cannot claim ownership of those varieties, but may have approval for release of the varieties from the original developer. This was the case when Pert (Western Australia) and Bates 89 (University of Missouri) were released. Mac (UC 129) and Howard (UC 142) fall into this category and do not have PVP certificates.

To accomplish the marketing and distribution goals outlined earlier, the UC Davis Office of Technology Transfer (OTT) applied for and received USDA PVP certificates on six of the eight released varieties. (UC 113, UC 125, UC 132, UC 130, UC 128, and UC 148). Mac (UC 129) was developed by Texas A & M University. Marketing of this variety should be coordinated with the University. Howard (UC 142) is regarded as a public variety and is available without licensing from the Foundation Seed Program, Department of Plant Sciences, University of California, Davis.

OTT issued licenses for marketing of four of the six varieties by two companies. The licenses provide due-diligence clauses and are subject to review and renewal.

Variety Descriptions and Performance Characteristics

UC 113

1. Taxonomic and Variety Designation
Poaceae: *Avena sativa* L.; Experimental designation UC 113

2. Name of Breeder and Variety Development Team
Breeding and selection team: **Pamela Zwer**, **Cal Qualset**, **John Heaton**, and **Herb Vogt**
Evaluation team: **John Heaton**, **Herb Vogt**, **Cal Qualset**, **Lee Jackson**, **Dan Putnam**, **Marsha Mathews**, **Tom Kearney**, **Kent Brittan**, **Mick Canevari**, **Harry Carlson**, **Don Kirby**, **Sergio Garcia**, **Zak Mousli**, **Carl Wick**, and **Bob Baglietto**
Breeders and foundation seed development team: **Cal Qualset**, **Herb Vogt**, and **Baglietto Seed Company**

3. Ownership
Regents of the University of California, USDA Plant Variety Protection Certificate 200800357

4. Origin, Breeding History, and Pedigree
UC 113 was bred and selected at UC Davis from a hybrid CA 850837 made by **Pamela Zwer** in 1985. She hybridized a Coker's Pedigreed Seed line from the cross 77-22/77-23, with an advanced line, 75Q036-22, received from the Western Australia Department of Agriculture. Coker 77-22 was selected from the hybrid Ora//CI 7762/CI 7922/3/TAM 301. Coker 77-23 was selected from Coker 234/Coker 75-27, both developed by Howard Harrison at Coker's Pedigreed Seed.

The Western Australia line was derived from the hybrid OT 207/Swan that was produced in the oat breeding program at Perth. 75Q036-22 is a sib of Pert, a variety released jointly by the California Agricultural Experiment Station and the Western Australia Department of Agriculture. Pedigree and bulk selection was used in the development of UC 113.

The parentage and selection history are represented in the following designations:
Hybrid CA 850837: 77-22/77-23//75Q036-22
Selection: CA 850837-(1-4)D-1D-78D-4D-0D-0D-(1-16)D-(1-104)D-0D

'D' indicates that the selections in each generation, F_2 to F_9, were done at the Agronomy Farm at UC Davis during the period 1987 to 1994. In 1994, after the final selection for uniformity, seeds from 104 single-plant-derived progeny rows were bulked. In subsequent years UC 113 was advanced by bulk harvest from the original bulk made in 1994. To assure seed purity and uniformity panicle-row selection was done, followed by bulking on two occasions, in 2000 at Davis and in 2005 at the UC Intermountain Research and Extension Center at Tulelake, CA.

UC 113 has undergone extensive and intensive evaluation during its development. It appeared in replicated breeders trials at Davis each year from 1989 to 1997; in the UC CE Regional trial at Davis from 1991 to 2002; in numerous County trials under supervision of UC CE County Advisors; and in trials at the UC Desert Research and Extension Center and UC Intermountain Research and Extension Center. Evaluations included grain and forage yield performance, agronomic performance traits, and disease reactions. On-farm plantings were made under UC Experimental Use Agreements in 2005 to 2007 to judge farmer acceptance and seed production.

5. Adaptation and Use
UC 113 is well adapted for fall planting in the Central Valley, Imperial Valley, and Central Coastal areas for both grain and forage production. It performs well with April to early May plantings in northern intermountain areas, such as Tulelake. Being late maturing and short statured, it is favored by irrigation, but has performed well in rainfed environments.

6. Botanical Characteristics

Growth habit: Spring type, erect early growth habit

Panicles: Long, lax, with long rachis and branch internodes; glumes are light red; lemma awns absent

Heading and maturity: Late, 15 to 20 days later than Montezuma

Height: Short, 4 to 5 inches shorter than Montezuma; uniform, without presence of tall types; peduncle length short, about 18 cm shorter than Montezuma

Culms: Culms slightly thicker than Montezuma (5.0 vs. 4.8 mm); 5 to 6 internodes; culms and panicles are waxy compared to glossy of Montezuma

Straw strength: Excellent, lodging only in highly productive environments, much less lodging than Montezuma

Shatter resistance: Excellent

Kernel characteristics: Light red; mid-long, and plump; test weight and kernel weight good (35 to 40 lb/bu, 35 to 40 mg/kernel), higher than Montezuma; rachilla shorter than Montezuma; basal floret hairs present and shorter than Montezuma

7. Pest and Disease Reactions

Barley yellow dwarf virus	*Crown rust*	*Stem rust*
moderately susceptible under severe infection conditions, tolerant in most environments	susceptible	resistant

8. Field Performance

The accompanying tables provide data regarding identity and performance characteristics. These results provide comparison information of UC 113 with Montezuma, California Red, and some other varieties that are or were important in California oat production. Yield performance and other data were summarized over a series of experiments as indicated in the tables. Statistical analysis of results, when appropriate, were conducted on individual year/site data, but not on multiple year and site information. Grain and forage yields are expressed on an acre basis and as percentage of performance of Montezuma, the most widely grown oat variety in California.

Key field performance information for this variety can be found in the tables as follows:

Trait	Table
Diagnostic and other descriptors	1, 2
Grain yield	3, 5, 6
Agronomic and disease traits	4
Forage (hay) yield	5, 6, 7, 8, 9
Forage quality	6, 7, 8

Grain yield: UC 113 yield was 145% of Montezuma in 14 location/years in Cooperative Extension and Intermountain Research and Extension Center trials; similar results (153%) were found in a three-year, large-plot study at the UCD Agronomy Farm.

Forage yield: Forage yield and quality are dependent on stage of growth at time of harvest, but a general indicator of yield potential is given by mean yields over harvest stages. UC 113 had mean forage yield compared to Montezuma of 111, 107, and 89% in trials at Davis and two other sites. Forage yield of UC 113 was higher than California Red and less than Bates-89 in a two-year study in Yolo County. In a Kings County trial where Curt was the standard of comparison, UC 113 was 9% higher than Curt and about 15% higher than Bates-89 and it had about the same yield as obtained by Ogle and Sierra.

Forage quality: In a Yolo County farmer's trial and at UC Davis in 1999, UC 113 had higher crude protein percentage and lower acid and neutral detergent fiber pewrcentages than Montezuma, favoring UC 113 in these three quality parameters. Other comparisons can be seen in Tables 6, 7, and 8.

9. Method and Responsibility for Maintenance

Breeders seed source can be produced from samples maintained at the USDA National Small Grains Collection at Aberdeen, ID and at UC Davis for the duration of active oat breeding research. Foundation Seed will be produced from Breeders Seed or Foundation Seed from panicle-row multiplication by the breeder, UC Foundation Seed Program, or under supervision by UC Davis by a designated seed company.

UC 125

1. Taxonomic and Variety Designation
Poaceae: *Avena sativa* L.; Experimental designation UC 125

2. Name of Breeder and Variety Development Team
Breeding and selection team: **Pamela Zwer**, **Cal Qualset**, **John Heaton**, and **Herb Vogt**
Evaluation team: **John Heaton**, **Herb Vogt**, **Cal Qualset**, **Lee Jackson**, **Dan Putnam**, **Marsha Mathews**, **Tom Kearney**, **Kent Brittan**, **Mick Canevari**, **Harry Carlson**, **Don Kirby**, **Sergio Garcia**, **Zak Mousli**, **Carl Wick**, and **Gene Aksland**
Breeders and foundation seed development team: **Cal Qualset**, **Herb Vogt**, and **Resource Seeds, Inc**.

3. Ownership
Regents of the University of California, USDA Plant Variety Protection Certificate 200800358

4. Origin, Breeding History, and Pedigree
UC 125 was bred and selected at UC Davis from a hybrid CA 850838 made by **Pamela Zwer** in 1985. She hybridized an advanced line from Coker's Pedigreed Seed, Coker 234/Coker 227, with an advanced line, 75Q036-83-1D, received from the Western Australia Department of Agriculture. The Coker line is a selection from the hybrid of two Coker released varieties. The Western Australia line was derived from the hybrid OT 207/Swan that was produced in the oat breeding program at Perth. 75Q036-83-1D was later released as the variety Pert jointly by the California Agricultural Experiment Station and the Western Australia Department of Agriculture.

Pedigree and bulk selection was used in the development of UC 125. The parentage and selection history are represented in the following designations:

Hybrid CA 850838: Coker 234/Coker 227//75Q036-83-1D
Selection: CA 850838-1D-0D-2D-2D-3D-2D-0D-0D

'D' indicates that the selections in each generation, F_2 to F_9, were done at the Agronomy Farm at UC Davis during the period 1987 to 1997. In 1997, after the final selection for uniformity, seed from 200 single-plant-derived progeny rows were bulked. In subsequent years, UC 125 was advanced by bulk harvest from the original bulk made in 1994. To assure seed purity and uniformity panicle-rows were grown and harvested in bulk in 2000 at Davis and in 2005 at the UC Intermountain Research and Extension Center at Tulelake, CA.

UC 125 has undergone extensive and intensive evaluation during its development. It appeared in replicated breeders trials at Davis each year from 1993 to 1997; in the UC CE Regional trial at Davis from 1997 to 2002; in numerous County trials under supervision of UC CE County Advisors; and in trials at the UC Desert Research and Extension Center and UC Intermountain Research and Extension Center. More than 30 replicated trials were conducted in the evaluation of performance and adaptation of UC 125 for grain and forage yield potential and agronomic and disease traits. On-farm plantings were made under UC Experimental Use Agreements in 2005 to 2007 to judge farmer acceptance and seed production.

5. Adaptation and Use
UC 125 is well adapted for fall planting in the Central Valley, Imperial Valley, and Central Coastal areas for both grain and forage production. It performs well with April to early May plantings in northern intermountain areas, such as Tulelake. Being late maturing and short statured, it is favored by irrigation, but has performed well in rainfed environments.

6. Botanical Characteristics
Growth habit: Spring type, erect early growth habit
Panicles: Long, lax, with long rachis and branch internodes; glumes are light red; lemma awns absent
Heading and maturity: Late, 15 to 20 days later than Montezuma

Height: Short, 4 to 5 inches shorter than Montezuma; uniform, without presence of tall types; peduncle length short, about 18 cm shorter than Montezuma

Culms: Culms slightly thicker than Montezuma (4.0 vs. 4.8 mm); 5 to 6 internodes; culms and panicles are waxy compared to glossy of Montezuma

Straw strength: Excellent, lodging only in highly productive environments; much less lodging than Montezuma

Shatter resistance: Excellent

Kernel characteristics: Light red; mid-long, and plump; test weight and kernel weight good (35 to 40 lb/bu, 35 to 40 mg/kernel), higher than Montezuma; rachilla shorter than Montezuma; basal floret hairs present and shorter than Montezuma

7. Pest and Disease Reactions

Barley yellow dwarf virus	*Crown rust*	*Stem rust*
moderately susceptible under severe infection conditions, tolerant in most environments	susceptible	resistant

8. Field Performance

The accompanying tables provide the data regarding identity and performance characteristics. These results provide comparison information of the new variety with Montezuma, California Red, and some other varieties that are or were important in California oat production. Yield performance and other data were summarized over a series of experiments as indicated in the tables. Statistical analysis of results, when appropriate, were conducted on individual year/site data, but not on multiple year and site information. Grain and forage yields are expressed on an acre basis and as percentage of performance of Montezuma, the most widely grown oat variety in California.

Key field performance information for this variety can be found in the tables as follows:

Trait	Table
Diagnostic and other descriptors	1, 2
Grain yield	3, 5, 6
Agronomic and disease traits	4
Forage (hay) yield	5, 6, 7, 8, 9
Forage quality	6, 7, 8

Grain yield: UC 125 yield was 128% of Montezuma in 11 location/years in Cooperative Extension and Intermountain Research and Extension Center trials; similar results (166%) were found in a three-year, large-plot study at the UCD Agronomy Farm.

Forage yield: Forage yield and quality are dependent on stage of growth at time of harvest, but a general indicator of yield potential is given by mean yields over harvest stages. UC 125 had mean forage yield compared to Montezuma of 114, 109, and 97% in trials at Davis and two other sites. Forage yield of UC 125 was 11% higher than California Red and 19% lower than Bates-89 in a two-year study in Yolo County. In a Kings County trial where Curt was the standard of comparison, UC 125 was equal to Curt and Bates-89, but while it had about the same yield as Ogle and Sierra, it had lower forage yields.

Forage quality: In a Yolo County farmer's trial and at UC Davis in 1999, compared to Montezuma, UC 125 had higher crude protein percentage and comparable acid and neutral detergent fiber percentages. Other comparisons can be seen in Tables 6, 7, and 8.

9. Method and Responsibility for Maintenance

Breeders seed source can be produced from samples maintained at the USDA National Small Grains Collection at Aberdeen, ID and at UC Davis for the duration of active oat breeding research. Foundation Seed will be produced from Breeders Seed or Foundation Seed from panicle-row multiplication by the breeder, UC Foundation Seed Program, or under supervision by UC Davis by a designated seed company.

UC 128

1. Taxonomic and Variety Designation
Poaceae: *Avena sativa* L.; Experimental designations UC 128 and UCD 94-408

2. Name of Breeder and Variety Development Team
Breeding and selection team: **Pamela Zwer**, **Cal Qualset**, **John Heaton**, and **Herb Vogt**
Evaluation team: **John Heaton**, **Herb Vogt**, **Cal Qualset**, **Lee Jackson**, **Dan Putnam**, **Marsha Mathews**, **Tom Kearney**, **Kent Brittan**, **Mick Canevari**, **Harry Carlson**, **Don Kirby, Sergio Garcia**, **Zak Mousli**, **Carl Wick**, and **Bob Baglietto**
Breeders and foundation seed development team: **Cal Qualset**, **Herb Vogt**, and **Baglietto Seed Company**

3. Ownership
Regents of the University of California, USDA Plant Variety Protection Certificate 200800361

4. Origin, Breeding History, and Pedigree
UC 128 was bred and selected at UC Davis from hybrid CA 830616 made by **Pamela Zwer** in 1983. She hybridized an advanced line derived from the hybrid Albion 20//5068/6975 produced at the University of Illinois with Montezuma, a popular California variety.

The parentage and selection history of UC 128 are represented in the following designations:
Hybrid CA 830616: Albion 20//5068/6975/3/Montezuma
Selection: CA 830616-0DH-0DH-0DL-1YD-3D-2D-3D-1D-(1-216)D

'0D' indicates that a bulked population from the F_2 generation was advanced and mass-selected for high (H) or low (L) seed density for three generations at the Agronomy Farm at UC Davis during the period 1987 to 1989. Subsequent generations were advanced by single-plant selection in the F_5 through F_{11}. In 1997, after the final selection for uniformity, seed from 216 single-plant-derived F_{11} progeny rows were bulked. In subsequent years UC 128 was advanced by bulk harvest from the original bulk made in 1997. To assure seed purity and uniformity panicle-row selection was done, followed by bulking on two occasions, in 2000 at Davis and in 2005 at the UC Intermountain Research and Extension Center at Tulelake, CA.

UC 128 has undergone extensive and intensive evaluation in more than 30 replicated trials during its development. It appeared in replicated breeders trials at Davis each year from 1991 to 1997; in the UC CE Regional trial at Davis from 1994 to 2002; in numerous county trials under supervision of UC CE County Advisors; and in trials at the UC Desert Research and Extension Center and UC Intermountain Research and Extension Center. Evaluations included grain and forage yield performance, agronomic performance traits, and disease reactions. On-farm plantings were made under UC Experimental Use Agreements in 2005 to 2007 to judge farmer acceptance and seed production.

5. Adaptation and Use
UC 128 is well adapted for fall planting in the Central Valley, Imperial Valley, and Central Coastal areas for both grain and forage production. It performs very well with April to early May plantings in northern intermountain areas, such as Tulelake. Being late maturing, it is favored by irrigation, but has performed well in rainfed environments. Because of its tall stature, a reduced planting rate is suggested to decrease incidence of lodging.

6. Botanical Characteristics
Growth habit: Spring type, erect early growth habit
Panicles: Long, lax, with long rachis and branch internodes; glumes are white; lemma awns present, but variable in expression
Heading and maturity: Late, 15 to 20 days later than Montezuma
Height: Very tall, uniform; 8 to 10 inches taller than Montezuma; peduncle length mid-long, 10 to 15 cm longer than Montezuma

Culms: Culms thick, about 1 mm thicker than Montezuma (5.0 vs. 4.8 mm), less thick in dense plantings; 7 culm internodes, compared to 5 for Montezuma; culms and panicles are waxy compared to glossy of Montezuma

Straw strength: Excellent, lodging evident in thick stands in highly productive environments; much less lodging than Montezuma

Shatter resistance: Excellent

Kernel characteristics: Yellow-white; long, and slender; test weight good (35 to 38 lb/bu); light kernel weight, about 30 mg, lower than Montezuma (35 to 40 mg/kernel); rachilla shorter than Montezuma; basal floret hairs absent or sparse, basal floret rachilla length about 1 mm, shorter than Montezuma

7. Pest and Disease Reactions

Barley yellow dwarf virus
moderately resistant under severe infection conditions, resistant in most environments

Crown rust
moderately resistant

Stem rust
moderately resistant

8. Field Performance

The accompanying tables provide the data regarding identity and performance characteristics. These results provide comparison information of the new variety with Montezuma, California Red, and some other varieties that are or were important in California oat production. Yield performance and other data were summarized over a series of experiments as indicated in the tables. Statistical analysis of results, when appropriate, were conducted on individual year/site data, but not on multiple year and site information. Grain and forage yields are expressed on an acre basis and as percentage of performance of Montezuma, the most widely grown oat variety in California.

Key field performance information for this variety can be found in the tables as follows:

Trait	Table
Diagnostic and other descriptors	1, 2
Grain yield	3, 5, 6
Agronomic and disease traits	4
Forage (hay) yield	5, 6, 7, 8, 9
Forage quality	6, 7, 8

Grain yield: The grain yield of UC 128 was 127% of Montezuma in 11 location/years in Cooperative Extension and Intermountain Research and Extension Center trials; similar results (127%) were found in a three-year, large-plot study at the UCD Agronomy Farm.

Forage yield: Forage yield and quality are dependent on stage of growth at time of harvest, but a general indicator of yield potential is given by mean yields over harvest stages. UC 128 had mean forage yield compared to Montezuma of 132, 128, and 123% in trials at Davis and two other sites. Forage yield of UC 128 was 34% higher than California Red and equal to Bates-89 in a two-year study in Yolo County. In a Kings County trial where Curt was the standard of comparison, UC 128 was 8% higher than Curt and Bates-89 while forage yields of UC 128 were about the same as Ogle and Sierra.

Forage quality: In a Yolo County farmer's trial and at UC Davis in 1999, compared to Montezuma, UC 128 had higher crude protein percentage, comparable acid detergent fiber percentage, but higher neutral detergent fiber percentage. The later is an undesirable quality attribute. Other comparisons can be seen in Tables 6, 7, and 8.

9. Method and Responsibility for Maintenance

Breeders seed source can be produced from samples maintained at the USDA National Small Grains Collection at Aberdeen, ID and at UC Davis for the duration of active oat breeding research. Foundation Seed will be produced from Breeders Seed or Foundation Seed from panicle-row multiplication by the breeder, UC Foundation Seed Program, or under supervision by UC Davis by a designated seed company.

Mac

1. Taxonomic and Variety Designation
Poaceae: *Avena sativa* L.; Experimental designations UC 129, UCD 94-409, and A890068.

2. Name of Breeder and Variety Development Team
Lead breeder: **Milton McDaniel** (deceased) and **Rex Herrington**, Texas A & M University
Breeding and selection team at UC Davis: **Cal Qualset**, **John Heaton**, and **Herb Vogt**
Evaluation team: **John Heaton**, **Herb Vogt**, **Cal Qualset**, **Lee Jackson**, **Dan Putnam**, **Marsha Mathews**, **Tom Kearney**, **Kent Brittan**, **Mick Canevari**, **Harry Carlson**, **Don Kirby**, **Sergio Garcia**, **Zak Mousli**, **Carl Wick**, and **Mark Mezger**
Breeders and foundation seed development team: **Cal Qualset**, **Herb Vogt**, **Don Kirby**, and **Mark Mezger**

3. Ownership
Mac was developed by Texas A & M University.

4. Origin, Breeding History, and Pedigree
Mac was bred and selected at the Texas A & M University by Milton McDaniel and entered as Entry 49 (seed source identification 86SA92) in the 1987 Quaker Oats International Nursery. This nursery was evaluated for resistance to the barley yellow dwarf virus and Entry 49 exhibited tolerance in both the 1987 and 1989 Quaker Oats International Nurseries grown at UC Davis. This line was accessioned in the UCD oat breeding nursery as A890068 and advanced by selection for uniformity and agronomic traits by single-plant progeny rows for seven generations from 1990 to 1996.

The parentage and selection history of Mac are represented in the following designations:
Hybrid: Cortez*5/Pendak//ME1563
Selection: 1563-1D-4D-7D-(1-240)D

In 1996, 240 panicles were selected for progeny row seed multiplication in 1997. These panicle rows were evaluated for uniformity and harvested in bulk. To assure seed purity and uniformity, panicle-row selection was done, followed by bulking on two occasions, in 2000 at Davis and in 2005 at the UC Intermountain Research and Extension Center at Tulelake, CA.

Mac has undergone extensive and intensive evaluation during its development. It appeared in more than 30 replicated experiments, including breeder's trials at Davis each year from 1991 to 1997; in the UC CE Regional trial at Davis from 1994 to 2002; in numerous county trials under supervision of UC CE County Advisors; and in trials at the UC Desert Research and Extension Center and UC Intermountain Research and Extension Center. Evaluations included grain and forage yield performance, agronomic performance traits, and disease reactions. On-farm plantings were made under UC Experimental Use Agreements in 2005 to 2007 to judge farmer acceptance and seed production.

5. Adaptation and Use
Mac is well adapted for fall planting in the Central Valley, Imperial Valley, and Central Coastal areas for both grain and forage production. It performs very well with April to early May plantings in northern intermountain areas, such as Tulelake. Being late maturing, it is favored by irrigation, but has performed well in rainfed environments. Because of its tall stature, a reduced planting rate is suggested to decrease incidence of lodging.

6. Botanical Characteristics
Growth habit: Spring type, erect early growth habit
Panicles: Long, lax, with long rachis and branch internodes; glumes are white; lemma awns present, but variable in expression
Heading and maturity: Late, 15 to 20 days later than Montezuma
Height: Very tall, uniform; 8 to 10 inches taller than Montezuma; peduncle length mid-long, 10 to 15 cm

longer than Montezuma

Culms: Culms thick, about 1 mm thicker than Montezuma (5.0 vs. 4.8 mm), less thick in dense plantings; 7 culm internodes, compared to 5 for Montezuma; culms and panicles are waxy compared to glossy of Montezuma

Straw strength: Excellent, lodging evident in thick stands in highly productive environments; much less lodging than Montezuma

Shatter resistance: Excellent

Kernel characteristics: Yellow-white; long, and slender; test weight good (35 to 38 lb/bu); light kernel weight, about 30 mg, lower than Montezuma (35 to 40 mg/kernel); rachilla shorter than Montezuma; basal floret hairs absent or sparse, basal floret rachilla length about 1 mm, shorter than Montezuma

7. Pest and Disease Reactions

Barley yellow dwarf virus	*Crown rust*	*Stem rust*
moderately susceptible under severe infection conditions, resistant in most environments	moderately resistant	moderately resistant

8. Field Performance

The accompanying tables provide the data regarding identity and performance characteristics. These results provide comparison information of the new variety with Montezuma, California Red, and some other varieties that are or were important in California oat production. Yield performance and other data were summarized over a series of experiments as indicated in the tables. Statistical analysis of results, when appropriate, were conducted on individual year/site data, but not on multiple year and site information. Grain and forage yields are expressed on an acre basis and as percentage of performance of Montezuma, the most widely grown oat variety in California.

Key field performance information for this variety can be found in the tables as follows:

Trait	Table
Diagnostic and other descriptors	1, 2
Grain yield	3, 5, 6
Agronomic and disease traits	4
Forage (hay) yield	5, 6, 7, 8, 9
Forage quality	6, 7, 8

Grain yield: The grain yield of Mac was 129% of Montezuma in 11 location/years in Cooperative Extension and Intermountain Research and Extension Center trials; similar results (128%) were found in a three-year, large-plot study at the UCD Agronomy Farm.

Forage yield: Forage yield and quality are dependent on stage of growth at time of harvest, but a general indicator of yield potential is given by mean yields over harvest stages. Mac had mean forage yield compared to Montezuma of 128, 119, and 130% in trials at Davis and two other sites. Forage yield of Mac was 23% higher than California Red and 9% lower than Bates-89 in a two-year study in Yolo County. In a Kings County trial where Curt was the standard of comparison, Mac was equal to Curt and Bates-89 while forage yields of Mac were lower than Ogle and Sierra.

Forage quality: In a Yolo County farmer's trial and at UC Davis in 1999, compared to Montezuma, Mac had higher crude protein percentage and comparable acid and neutral detergent fiber percentages. Other comparisons can be seen in Tables 6, 7, and 8.

9. Method and Responsibility for Maintenance

Breeders seed source can be produced from samples maintained at the USDA National Small Grains Collection at Aberdeen, ID and at UC Davis for the duration of active oat breeding research. Foundation Seed will be produced from Breeders Seed or Foundation Seed from panicle-row multiplication by the breeder, UC Foundation Seed Program, or under supervision by UC Davis by a designated seed company.

UC 130

1. Taxonomic and Variety Designation
Poaceae: *Avena sativa* L.; Experimental designations UC 130 and UCD 94-401

2. Name of Breeder and Variety Development Team
Breeding and selection team: **Pamela Zwer**, **Cal Qualset**, **John Heaton**, and **Herb Vogt**
Evaluation team: **John Heaton**, **Herb Vogt**, **Cal Qualset**, **Lee Jackson**, **Dan Putnam**, **Marsha Mathews**, **Tom Kearney**, **Kent Brittan**, **Mick Canevari**, **Harry Carlson**, **Don Kirby**, **Sergio Garcia**, **Zak Mousli**, **Carl Wick**, and **Gene Aksland**
Breeders and foundation seed development team: **Cal Qualset**, **Herb Vogt**, and **Resource Seeds, Inc.**

3. Ownership
Regents of the University of California, USDA Plant Variety Protection Certificate 200800360

4. Origin, Breeding History, and Pedigree
UC 130 was bred and selected at UC Davis from a hybrid CA 830607 made by **Pamela Zwer** in 1983. She hybridized a line designated as BYDV Resistant with Swan. The parentage of BYDV Resistant is unknown. It was identified as having resistance to barley yellow dwarf virus in evaluation trials at UC Davis. Swan is a variety bred and released in Western Australia. Swan was introduced to California and is still in commercial production in the northern San Joaquin Valley.

The parentage and selection history of UC 130 are represented in the following designations:
Hybrid CA 830607: BYDV Resistant/Swan
Selection: CA 830607-0DH-0DL-0DL-2YD-2D-2D-1D-1D-0D-0D-(1-336)D

'0D' indicates that a bulked population from the F_2 generation was advanced and mass-selected for high (H) or low (L) seed density for three generations at the Agronomy Farm at UC Davis during the period 1987 to 1989. Subsequent selection generations were advanced by single-plant selection in the F_5 through F_{11}. In 1996, after the final selection for uniformity, 336 panicles were selected for progeny rows in 1997. After inspection for uniformity the seed from the progeny rows was harvested in bulk. In subsequent years UC 130 was advanced by bulk harvest from the original bulk made in 1997. Panicle-row seed increase was also done in 2000 at Davis and in 2005 at the UC Intermountain Research and Extension Center at Tulelake, CA to ensure that high quality seed was used in evaluation trials and to establish Breeders Seed.

UC 130 has undergone extensive and intensive evaluation in more than 30 replicated trials during its development. It appeared in replicated breeders trials at Davis each year from 1991 to 1997; in the UC CE Regional trial at Davis from 1994 to 2002; in numerous county trials under supervision of UC CE County Advisors; and in trials at the UC Desert Research and Extension Center and UC Intermountain Research and Extension Center. Evaluations included grain and forage yield performance, agronomic performance traits, and disease reactions. On-farm plantings were made under UC Experimental Use Agreements in 2005 to 2007 to judge farmer acceptance and seed production.

5. Adaptation and Use
UC 130 is well adapted for fall planting in the Central Valley, Imperial Valley, and Central Coastal areas for both grain and forage production. It performs very well with April to early May plantings in northern intermountain areas, such as Tulelake. Being late maturing and short statured, it is favored by irrigation, but has performed well in rainfed environments.

6. Botanical Characteristics
Growth habit: Spring type, erect early growth habit
Panicles: Short, about 3 cm shorter than Montezuma; dense, panicle internode length shorter than Montezuma (3.38 vs. 3.60 cm/internode); glumes are white; lemma awns absent; panicle node number 5.2 vs. 5.8 for Montezuma

Heading and maturity: Late, 15 to 20 days later than Montezuma

Height: Short, 4 to 6 inches shorter than Montezuma; uniform; peduncle length mid-long, 20 to 24 cm shorter than Montezuma; variants 4 to 6 inches taller than the general population of UC 130 plants may be found at 0.01% frequency or less in seed production fields

Culms: Culms thick, about 1 mm thicker than Montezuma (5.2 vs. 4.8 mm), less thick in dense plantings; 6 culm internodes, compared to 5 for Montezuma; culms and panicles are glossy, similar to Montezuma

Straw strength: Very good, lodging evident in thick stands in highly productive environments; much less lodging than Montezuma

Shatter resistance: Excellent

Kernel characteristics: Light red; long, and slender; test weight good, comparable to Montezuma (34 lb/bu); light kernel weight, about 30 mg, lower than Montezuma (35 to 40 mg/kernel); rachilla about 1 mm, shorter than Montezuma (>1.0); basal floret hairs absent or sparse

7. Pest and Disease Reactions

Barley yellow dwarf virus	*Crown rust*	*Stem rust*
moderately susceptible under severe infection conditions, resistant in most environments	resistant	moderately resistant

8. Field Performance

The accompanying tables provide the data regarding identity and performance characteristics. These results provide comparison information of the new variety with Montezuma, California Red, and some other varieties that are or were important in California oat production. Yield performance and other data were summarized over a series of experiments as indicated in the tables. Statistical analysis of results, when appropriate, were conducted on individual year/site data, but not on multiple year and site information. Grain and forage yields are expressed on an acre basis and as percentage of performance of Montezuma, the most widely grown oat variety in California.

Key field performance information for this variety can be found in the tables as follows:

Trait	Table
Diagnostic and other descriptors	1, 2
Grain yield	3, 5, 6
Agronomic and disease traits	4
Forage (hay) yield	5, 6, 7, 8, 9
Forage quality	6, 7, 8

Grain yield: The grain yield of UC 130 was 127% of Montezuma in 11 location/years in Cooperative Extension and Intermountain Research and Extension Center trials and performed similarly (131%) in a three-year, large-plot study at the UCD Agronomy Farm.

Forage yield: Forage yield and quality are dependent on stage of growth at time of harvest, but a general indicator of yield potential is given by mean yields over harvest stages. UC 130 had mean forage yield compared to Montezuma of 111, 93, and 101% in trials at Davis and two other sites. Forage yield of UC 130 was 9% higher than California Red and 14% lower than Bates-89 in a two-year study in Yolo County. In a Kings County trial where Curt was the standard of comparison, UC 130 was 11% higher than Curt and Bates-89 while forage yields of UC 130 were equivalent to Ogle and Sierra.

Forage quality: In a Yolo County farmer's trial and at UC Davis in 1999, compared to Montezuma, UC 130 had higher crude protein percentage, comparable acid detergent fiber percentage, and higher neutral detergent fiber percentage, the latter being undesirable. Other comparisons can be seen in Tables 6, 7, and 8.

9. Method and Responsibility for Maintenance

Breeders seed source can be produced from samples maintained at the USDA National Small Grains Collection at Aberdeen, ID and at UC Davis for the duration of active oat breeding research. Foundation Seed will be produced from Breeders Seed or Foundation Seed from panicle-row multiplication by the breeder, UC Foundation Seed Program, or under supervision by UC Davis by a designated seed company.

UC 132

1. Taxonomic and Variety Designation

Poaceae: *Avena sativa* L.; Experimental designations UC 132 and UCD 94-403.

2. Name of Breeder and Variety Development Team

Breeding and selection team: **Luiz Federizzi**, **Cal Qualset**, **John Heaton**, and **Herb Vogt**

Evaluation team: **John Heaton**, **Herb Vogt**, **Cal Qualset**, **Lee Jackson**, **Dan Putnam**, **Marsha Mathews**, **Tom Kearney**, **Kent Brittan**, **Mick Canevari**, **Harry Carlson**, **Don Kirby**, **Sergio Garcia**, **Zak Mousli**, and **Carl Wick**

Breeders and foundation seed development team: **Cal Qualset** and **Herb Vogt**

3. Ownership

Regents of the University of California, USDA Plant Variety Protection Certificate 200800362

4. Origin, Breeding History, and Pedigree

UC 132 was bred and selected at UC Davis from hybrid CA 830833 made by Luiz Federizzi in 1983. He hybridized Palestine Dwarf, a spontaneous short-statured mutant found in the variety Palestine, with OT 207, a gamma irradiation-derived mutant from Ottawa, Ontario, Canada.

The parentage and selection history of UC 132 are represented in the following designations:

Hybrid CA 830833: Palestine Dwarf/OT 207

Selection: CA 830833-17D-2D-2D-0D-0D-1D-1D-3D-3D-2D-0D-(1-4)D-(1-96)D-0D-0D-(1-96)D-4(0D)-(1-150)TL

Generations were advanced by single-plant selection in the F_5 through F_{13}. In 1997, after the final selection for uniformity, seed from 96 single-plant-derived F_{13} progeny rows were bulked. In subsequent years UC 132 was advanced by bulk harvest from the original bulk made in 1997. To assure seed purity and uniformity panicle-row selection was done, followed by bulking on two occasions, in 2000 at Davis and in 2005 at the UC Intermountain Research and Extension Center at Tulelake, CA. A one-acre planting from the Tulelake panicle-row seed production was made at Davis in 2007 for foundation seed production.

UC 132 has undergone extensive and intensive evaluation in more than 30 replicated trials during its development. It appeared in replicated breeders trials at Davis each year from 1991 to 1997; in the UC CE Regional trial at Davis from 1994 to 2002; in numerous county trials under supervision of UC CE County Advisors; and in trials at the UC Desert Research and Extension Center and UC Intermountain Research and Extension Center. Evaluations included grain and forage yield performance, agronomic performance traits, and disease reactions.

5. Adaptation and Use

UC 132 is well adapted for fall planting in the Central Valley, Imperial Valley, and Central Coastal areas for both grain and forage production. It performs well with April to early May plantings in northern intermountain areas, such as Tulelake. UC 132 has extremely strong straw and may perform very well at high seeding rates and high soil fertility. Because of its short stature and late maturity, UC 132 may not perform well in rainfed sites.

6. Botanical Characteristics

Growth habit: Spring type, erect early growth habit

Panicles: Short, comparable to Montezuma; mid-dense, panicle internode length shorter than Montezuma (2.40 vs. 3.60 cm/internode); glumes are white; lemma awns absent; panicle node number 5.8, comparable to Montezuma

Heading and maturity: Moderately late, about 14 days later than Montezuma

Height: Very short, 5 to 8 inches shorter than Montezuma; height variants 6 to 8 inches taller than the general population are found at about 0.02% frequency; peduncle length short, about 25 cm shorter than Montezuma

Culms: Culms moderately thick, about 0.5 mm thicker than Montezuma (5.2 vs. 4.8 mm), less thick in dense plantings; 6 culm internodes, compared to 5 for Montezuma; culms and panicles are waxy, in contrast to glossy for Montezuma

Straw strength: Excellent limited lodging evident in thick stands in highly productive environments; much less lodging than Montezuma

Shatter resistance: Excellent

Kernel characteristics: White; short and plump; test weight very good, comparable to Montezuma (34 lb/bu); kernel weight, relatively light, about 30 mg, compared to Montezuma (35 to 40 mg/kernel); rachilla about <0.5 mm, shorter than Montezuma (>1.0); basal floret hairs absent or sparse

7. Pest and Disease Reactions

Barley yellow dwarf virus	*Crown rust*	*Stem rust*
moderately susceptible under severe infection conditions, resistant in most environments	resistant	susceptible

8. Field Performance

The accompanying tables provide the data regarding identity and performance characteristics. These results provide comparison information of the new variety with Montezuma, California Red, and some other varieties that are or were important in California oat production. Yield performance and other data were summarized over a series of experiments as indicated in the tables. Statistical analysis of results, when appropriate, were conducted on individual year/site data, but not on multiple year and site information. Grain and forage yields are expressed on an acre basis and as percentage of performance of Montezuma, the most widely grown oat variety in California.

Key field performance information for this variety can be found in the tables as follows:

Trait	Table
Diagnostic and other descriptors	1, 2
Grain yield	3, 5, 6
Agronomic and disease traits	4
Forage (hay) yield	5, 6, 7, 8, 9
Forage quality	6, 7, 8

Grain yield: The grain yield of UC 132 was 116% of Montezuma in 11 location/years in Cooperative Extension and Intermountain Research and Extension Center trials; but UC 132 performed relatively better (144%) in a three-year, large-plot study at the UCD Agronomy Farm.

Forage yield: Forage yield and quality are dependent on stage of growth at time of harvest, but a general indicator of yield potential is given by mean yields over harvest stages. UC 132 had mean forage yield compared to Montezuma of 112, 102, and 112% in trials at Davis and two other sites. Forage yield of UC 132 was 18% higher than California Red and 5% lower than Bates-89 in a one-year study in Yolo County. In a Kings County trial where Curt was the standard of comparison, UC 132 was equal to Curt and Bates-89 while forage yields of UC 132 were lower than Ogle and Sierra.

Forage quality: In a Yolo County farmer's trial and at UC Davis in 1999, compared to Montezuma, UC 132 had higher crude protein percentage and comparable acid and neutral detergent fiber percentages. Other comparisons can be seen in Tables 6, 7, and 8.

9. Method and Responsibility for Maintenance

Breeders seed source can be produced from samples maintained at the USDA National Small Grains Collection at Aberdeen, ID and at UC Davis for the duration of active oat breeding research. Foundation Seed will be produced from Breeders Seed or Foundation Seed from panicle-row multiplication by the breeder, UC Foundation Seed Program, or under supervision by UC Davis by a designated seed company.

Howard

1. Taxonomic and Variety Designation

Poaceae: *Avena sativa* L.; Experimental designations Coker A-99, UC 142, UCD 96-406, and Coker 342-1-B-2-2-1-2-1.

UC 142 was named Howard in honor of **Howard Harrison**, its breeder, for his substantial contributions to oat variety development in the US.

2. Name of Breeder and Variety Development Team

Lead breeder: **Howard Harrison** (deceased), Coker's Pedigreed Seeds

Breeding and selection team at UCD: **Cal Qualset**, **John Heaton**, and **Herb Vogt**

Evaluation: **John Heaton**, **Herb Vogt**, **Cal Qualset**, **Lee Jackson**, **Dan Putnam**, **Marsha Mathews**, **Tom Kearney**, **Kent Brittan**, **Mick Canevari**, **Harry Carlson**, **Don Kirby**, **Sergio Garcia**, **Zak Mousli**, **Carl Wick**, and **Gene Aksland**

Breeders and Foundation Seed Development: **Cal Qualset**, **Herb Vogt**, and **Resource Seeds, Inc.**

3. Ownership

Howard was developed by Coker's Pedigreed Seed and appeared among the lines donated by Northrup-King & Company to the USDA National Plant Germplasm System, receiving the designation PI 605485. Howard is in the public domain and is under release and marketing by UC Davis.

4. Origin, Breeding History, and Pedigree

Howard was selected from Coker 342-1-B-2-2-1-2-1, from Coker 75-28/Coker 74-21//Coker 76-16*2/3/Coker 76-19/CI 9221, a hybrid produced by Howard Harrison, oat breeder at Coker's Pedigreed Seed Co., South Carolina.

Selection: Coker A-99-2D-1D-(1-24)D-4(0D)-(1-150)D-0D

This line was included in a collection of more than 200 lines that were donated by Northrup-King & Company to the USDA National Small Grains Collection after it had purchased Coker's Pedigreed Seed Co. and had discontinued oat variety development and marketing. The lines were distributed by the NSGC to breeders as public germplasm. This collection of lines was received at Davis in 1992 and first grown at Davis in the 1992 to 1993 crop cycle.

The breeders designation was Coker A-99 and this designation was retained during pedigree selection at Davis, resulting in the pedigree Coker A-99-2D-1D-(1-24)D representing four generations of selection and visual evaluation in panicle-row progenies. This line was entered in the UC CE Regional trial in 1997 with the breeder's designation UCD 96-406 and the regional trial entry number UC 142. The initial bulk seed of Howard was obtained from seed of 24 panicle rows in 1997. Bulk seed increase from this source was produced in subsequent years for replicated trials. To assure seed purity and uniformity panicle-row selection and bulk harvest was done at Davis in 2000 and at Tulelake in 2005.

Howard was evaluated in more than 20 replicated trials as follows: Breeders trials at Davis in 1994 to 1997; UC CE Regional trial at Davis 1997 to 1998, 2002 to 2003; seven county-based trials in 1999, 2001, 2001, and 2004; Intermountain Research and Extension Center, Tulelake, 2000, 2002, 2004, and 2005, and 1999 to 2001 for forage and grain yield evaluation at Davis. On-farm plantings were made under UC Experimental Use Agreements in 2005 to 2007 to judge farmer acceptance and seed production.

5. Adaptation and Use

Howard is well adapted for fall planting in the Central Valley, Imperial Valley, and Central Coastal areas for both grain and forage production. Grain yield performance is comparable or higher than old California varieties, but its thin culms are favored for hay production. It performs very well with April to early May plantings in northern intermountain areas, such as Tulelake. Howard is favored by irrigation, and because of its very short stature, it may not perform well in rainfed, moisture-stressed sites. Early growth of Howard is prostrate. Howard may be considered as a suitable cover and green manure crop alone or in mixtures

with other species in vineyards. At the time of its release Howard has excellent resistance to crown and stem rusts, and generally good tolerance to BYDV.

6. Botanical Characteristics

Growth habit: Spring type, prostrate early growth habit

Panicles: Short, about 7 cm shorter than Montezuma; dense, panicle internode length shorter than Montezuma (2.40 vs. 3.60 cm/internode); glumes are white; lemma awns present; panicle node number 5.8 similar to Montezuma

Heading and maturity: Moderately early, 10 to 12 days later than Montezuma

Height: Short, about 8 inches shorter than Montezuma; uniform; peduncle length mid-long, about 7 cm shorter than Montezuma

Culms: Culms thin, about 1 mm thinner than Montezuma (4.0 vs. 4.8 mm); 5 culm internodes, comparable to Montezuma; culms and panicles are glossy, similar to Montezuma

Straw strength: Good, lodging evident in thick stands in highly productive environments; much less lodging than Montezuma

Shatter resistance: Excellent

Kernel characteristics: Light red; slender; test weight good, 36 lb/bu, greater than Montezuma (34 lb/bu); kernel weight, about 26 mg, less than Montezuma (35 to 40 mg/kernel); rachilla about <1 mm, shorter than Montezuma (>1.0); basal floret hairs absent or sparse

7. Pest and Disease Reactions

Barley yellow dwarf virus	*Crown rust*	*Stem rust*
moderately resistant	resistant	resistant

8. Field Performance

The accompanying tables provide the data regarding identity and performance characteristics. These results provide comparison information of the new variety with Montezuma, California Red, and some other varieties that are or were important in California oat production. Yield performance and other data were summarized over a series of experiments as indicated in the tables. Statistical analysis of results, when appropriate, were conducted on individual year/site data, but not on multiple year and site information. Grain and forage yields are expressed on an acre basis and as percentage of performance of Montezuma, the most widely grown oat variety in California.

Key field performance information for this variety can be found in the tables as follows:

Trait	Table
Diagnostic and other descriptors	1, 2
Grain yield	3, 5, 6
Agronomic and disease traits	4
Forage (hay) yield	5, 6, 7, 8, 9
Forage quality	6, 7, 8

Grain yield: The grain yield of Howard was 96% of Montezuma in 11 location/years in Cooperative Extension and Intermountain Research and Extension Center trials, but Howard performed relatively better (136%) in a three-year, large-plot study at the UCD Agronomy Farm.

Forage yield: Forage yield and quality are dependent on stage of growth at time of harvest, but a general indicator of yield potential is given by mean yields over harvest stages. Howard had mean forage yield compared to Montezuma of 96, 94, and 100% in trials at Davis and two other sites. Forage yield of Howard was 10% higher than California Red and 13% lower than Bates-89 in a one-year study in Yolo County. In a Kings County trial where Curt was the standard of comparison, Howard was equal to Curt and Bates-89 while forage yields of Howard were about 8% lower than Ogle and Sierra.

Forage quality: In a Yolo County farmer's trial and at UC Davis in 1999, compared to Montezuma, Howard had higher crude protein percentage, comparable acid detergent fiber precentage, and higher neutral detergent acid percentage. The later is undesirable. The thin culms of Howard appear to be desirable as a dried fodder for horses and dairy cattle, but insufficient data have been obtained. The nonfeed use as a cover crop because of its early prostrate growth but rapid heading and maturity appear to be desirable attributes. Other comparisons can be seen in Tables 6, 7, and 8.

9. Method and Responsibility for Maintenance
Breeders seed source can be produced from samples maintained at the USDA National Small Grains Collection at Aberdeen, ID and at UC Davis for the duration of active oat breeding research. Foundation Seed will be produced from Breeders Seed or Foundation Seed from panicle-row multiplication by the breeder, UC Foundation Seed Program, or under supervision by UC Davis by a designated seed company.

UC 148

1. Taxonomic and Variety Designation
Poaceae: *Avena sativa* L.; Experimental designations UC 148 and UCD 96-412

2. Name of Breeder and Variety Development Team
Breeding and selection team: **Pamela Zwer**, **Cal Qualset**, John Heaton, and **Herb Vogt**
Evaluation team: **John Heaton**, **Herb Vogt**, **Cal Qualset**, **Lee Jackson**, **Dan Putnam**, **Marsha Mathews**, **Tom Kearney**, **Kent Brittan**, **Mick Canevari**, **Harry Carlson**, **Don Kirby**, **Sergio Garcia**, **Zak Mousli**, **Carl Wick**, and **Bob Baglietto**
Breeders and foundation seed development team: **Cal Qualset**, **Herb Vogt**, and **Baglietto Seed Co.**

3. Ownership
Regents of the University of California, USDA Plant Variety Protection Certificate 200800359

4. Origin, Breeding History, and Pedigree
UC 148 was bred and selected at UC Davis from a hybrid CA 830607 made by **Pamela Zwer** in 1983. She hybridized a line designated as BYDV Resistant with Swan. The parentage of BYDV Resistant is unknown. It was identified as having resistance to barley yellow dwarf virus in evaluation trials at UC Davis. Swan is a variety bred and released in Western Australia. Swan was introduced to California and remains in commercial production in the northern San Joaquin Valley.

The parentage and selection history of UC 148 are represented in the following designations:
Hybrid CA 830607: BYDV Resistant/Swan
Selection: CA 830607-0DH-0DL-0DL-1YD-0YD-3YD-1D-2D-1D-1D-4(0D)-(1-200)D

'0D' indicates that a bulked population from the F_2 generation was advanced and mass-selected for high (H) or low (L) seed density for three generations at the Agronomy Farm at UC Davis during the period 1987 to 1989. Subsequent selection generations were advanced by single-plant selection in the F_5 through F_{13}. In 1996, after the final selection for uniformity, 200 panicles were selected for progeny rows in 1997. After inspection for uniformity the seed from the progeny rows was harvested in bulk. In subsequent years UC 148 was advanced by bulk harvest from the original bulk made in 1997. Panicle-row seed increase was also done in 2000 at Davis and in 2005 at the UC Intermountain Research and Extension Center at Tulelake, CA to ensure that high quality seed was used in evaluation trials and to establish Breeders Seed.

UC 148 has undergone extensive and intensive evaluation in more than 30 replicated trials during its development. It appeared in replicated breeders trials at Davis each year from 1991 to 1997; in the UC CE Regional trial at Davis from 1994 to 2002; in numerous county trials under supervision of UC CE County Advisors; and in trials at the UC Desert Research and Extension Center and UC Intermountain Research and Extension Center. Evaluations included grain and forage yield performance, agronomic performance traits, and disease reactions. On-farm plantings were made under UC Experimental Use Agreements in 2005 to 2007 to judge farmer acceptance and seed production.

5. Adaptation and Use
UC 148 is well adapted for fall planting in the Central Valley, Imperial Valley, and Central Coastal areas for both grain and forage production. It performs well with April to early May plantings in northern inter-

mountain areas, such as Tulelake. Being late maturing, it is favored by irrigation, but has performed well in rainfed environments. Lodging has been observed in some instances, such as during and after irrigation with high winds. High severity of stem rust infection has been observed in one season at Tulelake and, while stem rust is not usually present, UC 148 would not be the favored variety for that region.

6. Botanical Characteristics

Growth habit: Spring type, erect early growth habit

Panicles: Short, about 3 cm shorter than Montezuma; dense, panicle internode length shorter than Montezuma (3.10 vs. 3.60 cm/internode); glumes are white; lemma awns absent; panicle node number 5.6 vs. 5.8 for Montezuma

Heading and maturity: Moderately late, 10 to 12 days later than Montezuma

Height: Tall, about 3 inches taller than Montezuma; uniform; peduncle length mid-long, about 10 cm shorter than Montezuma

Culms: Culms thick, about 1 mm thicker than Montezuma (5.5 vs. 4.8 mm), less thick in dense plantings; 6 culm internodes, compared to 5 for Montezuma; culms and panicles are glossy, similar to Montezuma

Straw strength: Good, lodging evident in thick stands in highly productive environments; much less lodging than Montezuma

Shatter resistance: Excellent

Kernel characteristics: Light red; plump; test weight very good, 38 lb/bu greater than Montezuma (34 lb/bu); kernel weight, about 36 mg, comparable to Montezuma (35 to 40 mg/kernel); rachilla about 1 mm, shorter than Montezuma (>1.0); basal floret hairs absent or sparse

7. Pest and Disease Reactions

Barley yellow dwarf virus	*Crown rust*	*Stem rust*
moderately susceptible under severe infection conditions, resistant in most environments	resistant	susceptible

8. Field Performance

The accompanying tables provide the data regarding identity and performance characteristics. These results provide comparison information of the new variety with Montezuma, California Red, and some other varieties that are or were important in California oat production. Yield performance and other data were summarized over a series of experiments as indicated in the tables. Statistical analysis of results, when appropriate, were conducted on individual year/site data, but not on multiple year and site information. Grain and forage yields are expressed on an acre basis and as percentage of performance of Montezuma, the most widely grown oat variety in California.

Key field performance information for this variety can be found in the tables as follows:

Trait	Table
Diagnostic and other descriptors	1, 2
Grain yield	3, 5, 6
Agronomic and disease traits	4
Forage (hay) yield	5, 6, 7, 8, 9
Forage quality	6, 7, 8

Grain yield: The grain yield of UC 148 was 114% of Montezuma in 11 location/years in Cooperative Extension and Intermountain Research and Extension Center trials and performed relatively better (139%) in a three-year, large-plot study at the UCD Agronomy Farm.

Forage yield: Forage yield and quality are dependent on stage of growth at time of harvest, but a general indicator of yield potential is given by mean yields over harvest stages. UC 148 had mean forage yield compared to Montezuma of 115, 99, and 102% in trials at Davis and three other sites. Forage yield of UC 148 was 10% higher than California Red and 8% lower than Bates-89 in a two-year study in Yolo County. In a Kings County trial where Curt was the standard of comparison, UC 148 was 14% higher than Curt and Bates-89 while forage yields of UC 148 were slightly higher than Ogle and Sierra.

Forage quality: In a Yolo County farmer's trial and at UC Davis in 1999, compared to Montezuma, UC 148 had higher crude protein percentage, comparable acid detergent fiber percentage, and higher neutral fiber percentage, the latter being undesirable. Other comparisons can be seen in Tables 6, 7, and 8.

9. Method and Responsibility for Maintenance

Breeders seed source can be produced from samples maintained at the USDA National Small Grains Collection at Aberdeen, ID and at UC Davis for the duration of active oat breeding research. Foundation Seed will be produced from Breeders Seed or Foundation Seed from panicle-row multiplication by the breeder, UC Foundation Seed Program, or under supervision by UC Davis by a designated seed company.

Field Performance Tables

Table 1a Descriptors for the eight new oat varieties with Montezuma and California Red as comparison varieties

Variety	Kernel color	Kernel shape	Basal floret hairs	Awns	Rachilla length (mm)	Panicle length	Panicle density[a]	Panicle exsertion
UC 113	lt red	plump	yes	no	<0.5	long	lax	full
UC 125	lt red	plump	yes	no	<0.5	long	lax	full
UC 128	y-white	slend	no	yes	1.0	long	lax	full
Mac	y-white	slend	no	yes	1.0	long	lax	full
UC 130	lt red	slend	no	no	1.0	short	dense	full
UC 132	white	sh plump	no	no	<0.5	short	mid dense	partial-full
Howard	lt red	slend	no	yes	0.5-1.0	short	dense	full
UC 148	lt red	plump	no	no	1.0	short	dense	full
Montezuma	red	plump	yes	yes	1.0+	long	mid dense	full
California Red[b]	red	plump	yes	yes	1.0	long	dense	full

[a]Panicle density in cm/panicle internode: dense=2.8 to 3.5, mid-dense=3.6 to 3.9, lax=4.9 to 5.1
[b]Straw color often red
Abbreviations: lt=light, mod=moderately, sh=short, slend=slender, y=yellow

Table 1b Descriptors for the eight new oat varieties with Montezuma and California Red as comparison varieties

Variety	Growth habit	Maturity	Lodging resistance	Height	Culm thickness	Waxy or glossy	BYD	CR	SR
UC 113	erect	late	good	short	thick	wx	MS	MR	R
UC 125	erect	late	good	short	thick	wx	MS	MR	R
UC 128	erect	mod late	good	v tall	thick	wx	MR	MR	MR
Mac	erect	mod late	good	v tall	thick	wx	MS	MR	MR
UC 130	erect	late	good	short	thick	gl	MS	MR	MR
UC 132	erect	late	mod	tall	thick	gl	MS	R	S
Howard	erect	late	good	v short	thick	wx	MS	R	S
UC 148	prostrate	mod early	fair	short	thin	wx	MR	R	R
Montezuma	erect	v early	poor	tall	mod thin	gl	VS	VS	VS
California Red[a]	mod erect	mod early	v poor	tall	thin	wx	VS	R	VS

[a]Straw color often red
Abbreviations: v=very, mod=moderately, wx=waxy culm, gl=glossy culm, BYD=Barley yellow dwarf virus, CR=Crown rust, SR=Stem rust, R=resistant, MR=moderately resistant, S=susceptible, MS=moderately susceptible, VS=very susceptible

Table 2 Mean culm and panicle traits for the eight new oat varieties with Montezuma and California Red as comparison varieties as measured during the years 2000, 2003, and 2006 at Davis; length measurements are in centimeters (cm) and millimeters (mm)

	Plant	Peduncle		Panicle			Culm	
Variety	height (cm)	length (cm)	length (% plt. ht.)	length (cm)	node number	internode length (cm)	node number	diameter (mm)
UC 113	119	30.6	29.1	25.7	6.8	3.84	5.5	5.0
UC 125	123	30.1	24.8	25.5	6.5	3.94	5.8	4.9
UC 128	156	37.9	30.0	30.5	7.0	4.65	7.0	6.0
Mac	157	34.8	25.5	30.8	8.2	3.82	7.1	5.7
UC 130	114	26.2	27.3	17.6	5.2	3.38	6.0	5.2
UC 132	105	25.7	25.7	21.0	7.2	3.00	6.2	5.2
Howard	102	34.2	32.9	13.6	5.8	2.40	5.0	4.0
UC 148	131	39.3	30.0	17.0	5.6	3.10	6.0	5.5
Montezuma	128	48.2	42.3	20.8	5.8	3.60	5.0	4.8
California Red	146	38.3	30.3	22.1	7.0	3.14	7.0	3.8
Pert	118	27.7	25.6	23.7	6.6	3.65	5.8	5.0
Bates-89	159	35.2	29.0	24.4	7.2	3.41	6.6	4.2
Curt	114	34.5	37.2	20.1	5.4	3.47	4.8	3.6
Years evaluated	2000	2000	2000	2000	2000	2000		2000
	2003	2003	2003	2002	2003	2003	2003	
	2006	2006	2006	2006	2006	2006	2006	2006

Abbreviations: plt. ht.=plant height

Table 3 Grain yields as pounds per acre (lb/ac) and as a percentage of Montezuma (%Mz) over years at five locations, all of which were UC Cooperative Extension trials, except Tulelake

	Davis		Santa Clara		Butte		San Benito		Tulelake		All locs.	No.
	(lb/ac)	(%Mz)	(lb/ac)	(%Mz)	(lb/ac)	(%Mz)	(lb/ac)	(%Mz)	(lb/ac)	(%Mz)	(%Mz)	loc-yr
UC 113	3900	152	3580	129	4950	198	3060	106	6260	113	145	14
UC 125	3765	147	3320	120			3120	108	6210	112	128	11
UC 128	3340	131	4100	148			2820	98	6460	117	127	11
Mac	2920	114	4340	157			3320	115	6360	115	129	11
UC 130	3240	127	3970	144			3280	114	5580	101	127	11
UC 132	3170	124	3690	133			2140	74	5560	100	116	11
Howard	2665	104	3090	112			2400	83	4670	84	96	11
UC 148	3290	129	3920	142			2640	92	5120	92	114	11
Montezuma	2560	100	2760	100	2500	100	2880	100	5540	100	100	14
Bates-89	1920	75	1740	63	3080	123	2320	80	5640	102	91	14
Pert	3670	143	3060	111	4770	191	2960	103	5990	108	135	14
Sierra	2740	107	3470	125	3610	145					125	9
Years evaluated	1997		2001		1991		2004		2000			
	1998		2002		1992				2002			
	2001				1993				2004			
	2002								2005			

Abbreviations: locs.=locations, no.=number, loc-yr=location-years

Table 4 Agronomic and disease data from UC Cooperative Extension trials at Davis for the years 1997, 1998, 2001, and 2002; means over years are presented, with the number of years indicated for each trait; test weight is given as pounds per bushel (lb/bu), kernel weight in milligrams (mg), plant height in inches (in), and heading and maturity as days from March 1

Variety	Test weight (lb/bu)	Kernel weight (mg)	Height (in)	Lodging score	Heading	Maturity	Crown rust score	Powdery mildew score	Leaf blotch score	BYD
UC 113	36.9	37.4	41	3.4	68	109	1.9	2.5	1.5	3.4
UC 125	36.8	35.8	44	3.5	67	108	2.2	2.5	2.0	3.2
UC 128	35.8	30.2	58	4.9	66	96	1.0	1.0	1.0	1.9
Mac	36.2	29.9	54	5.3	67	96	1.0	1.0	1.0	1.6
UC 130	34.6	30.0	44	4.8	65	95	1.5	1.4	1.3	1.2
UC 132	34.6	30.2	40	3.4	64	91	1.0	1.0	3.8	2.3
Howard	36.0	26.2	37	4.6	61	93	1.0	1.0	1.0	1.6
UC 148	38.3	35.7	48	6.0	60	101	1.0	1.0	1.3	1.5
Montezuma	34.8	36.8	45	7.0	48	88	6.6	1.0	1.0	2.6
Bates-89	37.7	26.3	59	5.9	67	96	1.8	1.2	1.0	1.8
Pert	36.5	36.4	44	3.9	68	109	2.6	3.0	1.5	2.6
Sierra	31.7	35.9	48	6.8	56	91	5.3	1.0	4.0	2.9
Kanota	36.2	29.0	52	7.4	53	89	4.8	1.2	1.0	3.2
Swan	37.4	43.4	54	5.6	50	93	4.9	1.5	2.5	3.1
No. years	4	4	3	4	4	2	2	2	1	2

Code for disease (visual estimated area affect of flag leaf – 1, penultimate leaf) scores and lodging: 1=0 to 3, 2=4 to 14, 3=0=15 to 29, 4=30 to 49, 5=50 to 69, 6=70 to 84, 7=85 to 95, 8=96 to 100% for the expression of the trait. BYD was scored using the above scale as the visually estimated percentage of plants showing foliar symptoms. Fungal diseases were generally scored at soft dough stage of kernel development; BYD generally scored post-heading.

Table 5 Three-year (1999, 2000, 2001) mean forage yield as tons per acre (t/ac) and as percent of Montezuma (%Mz) at 15% moisture at three harvest stages (Feekes scale*) at Davis and grain yield as pounds per acre (lb/ac)

	Forage					Grain	
Variety	10.6-7 (t/ac)	10.7-8 (t/ac)	10.8-9 (t/ac)	mean (t/ac)	mean (%Mz)	yield (lb/ac)	yield (%Mz)
UC 113	8.65	8.30	8.81	8.59	111	5170	153
UC 125	8.12	9.00	9.65	8.92	114	5600	166
UC 128	9.72	10.61	10.35	10.23	132	4270	127
Mac	8.53	10.56	10.47	9.85	127	4300	128
UC 130	7.65	8.86	9.27	8.59	111	4420	131
UC 132	8.83	8.91	8.37	8.71	112	4850	144
Howard	6.23	8.38	7.65	7.42	96	4590	136
UC 148	8.85	8.72	9.64	9.07	115	4690	139
Montezuma	8.52	7.39	7.34	7.75	100	3370	100
California Red	7.93	7.63	8.17	7.91	102	2120	63
Pert	8.19	9.29	9.65	9.05	117	5170	153

*Feekes scale: 10.1 to 10.9 are post-heading stages, with kernels in hard dough stage at 10.8.

Table 6 Forage yield as tons per acre (t/ac) and as percent of Montezuma (%Mz) on a 15% moisture basis and quality at Davis in 1999 at three harvest stages (Feekes scale, see Table 5) and grain yield as pounds per acre (lb/ac) and percent of Montezuma (%Mz)

	Harvest	Forage		Crude	ADF	NDF	Grain yield	
Variety	stage	(t/ac)	(%Mz)	protein (%)	(%)	(%)	(lb/ac)	(%Mz)
UC 113	10.6	7.58	97	8.0	39.9	62.9		
	10.7	8.15	125	7.0	39.1	60.8		
	10.8	9.62	138	6.1	39.1	54.7		
	Mean	*8.45*	*120*	*7.0*	*39.4*	*59.5*	*6300*	*211*
UC 125	10.4	6.78	87	8.0	39.9	62.9		
	10.7	8.82	136	7.2	38.8	60.2		
	10.8	8.70	125	8.8	40.5	62.7		
	Mean	*8.10*	*116*	*8.0*	*39.7*	*61.9*	*6680*	*224*
UC 128	10.6	7.10	91	7.7	44.4	66.7		
	10.6	7.60	111	7.4	44.7	66.1		
	10.8	9.10	131	5.6	44.9	65.8		
	Mean	*7.93*	*113*	*6.9*	*44.7*	*66.2*	*4780*	*160*
Mac	10.5	7.40	95	6.6	44.6	66.2		
	10.7	8.40	129	5.8	42.9	64.2		
	10.8	9.58	137	4.9	41.7	61.7		
	Mean	*8.46*	*119*	*5.8*	*43.1*	*64.0*	*5000*	*168*
UC 130	10.6	7.10	91	7.9	43.8	66.3		
	10.7	8.12	125	7.0	41.0	63.0		
	10.8	8.82	127	5.4	40.8	61.0		
	Mean	*8.01*	*114*	*6.8*	*41.9*	*63.4*	*4980*	*167*
UC 132	10.6	7.20	92	7.6	41.3	62.8		
	10.7	7.70	119	6.0	41.3	62.8		
	10.8	8.52	122	6.0	39.2	58.4		
	Mean	*7.81*	*111*	*6.5*	*40.6*	*61.3*	*5320*	*178*
Howard	10.6	6.28	80	8.1	40.3	64.9		
	10.7	6.67	103	7.2	37.6	61.0		
	10.9	7.80	112	5.4	38.6	59.8		
	Mean	*6.92*	*98*	*6.9*	*38.8*	*61.9*	*5050*	*169*
UC 148	10.5	7.32	94	7.2	42.2	65.3		
	10.7	8.45	130	6.9	41.7	63.2		
	10.8	9.22	132	5.2	42.6	62.0		
	Mean	*8.33*	*118*	*6.4*	*42.2*	*63.5*	*5520*	*185*
Montezuma	10.7	7.80	100	6.6	38.3	59.7		
	10.8	6.50	100	5.8	41.0	61.7		
	10.9	6.97	100	5.4	41.2	61.1		
	Mean	*7.10*	*100*	*5.9*	*40.2*	*60.8*	*2980*	*100*
California Red	10.5	6.57	84	7.4	41.6	62.3		
	10.6	5.77	89	6.3	43.6	63.5		
	10.8	7.63	109	5.9	40.8	61.3		
	Mean	*6.66*	*94*	*6.5*	*42.0*	*62.4*	*1960*	*66*
Ogle	10.6	7.42	95	7.6	43.5	64.9		
	10.7	7.68	118	6.2	44.8	66.8		
	10.8	8.90	128	4.9	43.3	63.9		
	Mean	*8.00*	*113*	*6.2*	*43.9*	*65.2*	*4350*	*145*
Sierra	10.7	7.75	99	6.4	41.0	61.9		
	10.7	8.48	130	5.4	37.4	56.2		
	10.9	7.52	108	5.8	37.2	55.3		
	Mean	*7.92*	*112*	*5.8*	*38.5*	*57.8*	*4350*	*145*
Pert	10.6	7.75	99	7.6	38.1	60.1		
	10.7	8.28	127	6.3	38.1	59.6		
	10.8	8.92	128	4.8	38.8	59.3		
	Mean	*8.25*	*118*	*6.2*	*38.3*	*59.7*	*6630*	*222*

Abbreviations: ADF=acid detergent fiber, NDF=neutral detergent fiber

Table 7 Forage yield as tons per acre (t/ac) and percent of Montezuma (%Mz) at 15% moisture and quality at two harvests (May 6: Feekes 10.6 to 10.8; May 13: Feekes 10.7 to 10.8; see Table 5) in 1999 and one harvest date in 2005 at Chamberlain farm in Yolo County in 2005

	Harvest	1999 forage		2005 forage		2-year mean forage		Crude	ADF	NDF
Variety	stage	(t/ac)	(%Mz)	(t/ac)	(%Mz)	(t/ac)	(%Mz)	protein (%)	(%)	(%)
UC 113	10.7	6.07	104					7.8	38.1	60.8
	10.8	6.00	82					7.4	38.9	59.9
	Mean	6.04	92	8.80	121	7.42	107	7.6	38.5	60.3
UC 125	10.7	5.57	95					7.8	36.8	58.5
	10.8	6.40	88					7.5	38.0	58.8
	Mean	5.98	91	9.20	126	7.59	109	7.6	37.4	58.6
UC 128	10.7	6.20	106					7.4	40.7	62.0
	10.8	6.55	90					7.1	40.7	62.4
	Mean	6.38	97	11.40	156	8.89	128	7.2	40.7	62.2
Mac	10.7	6.15	105					7.0	39.3	60.2
	10.8	7.00	96					7.5	39.0	59.2
	Mean	6.58	100	10.00	137	8.29	119	7.2	39.2	59.7
UC 130	10.6	5.15	88					7.8	39.2	61.8
	10.7	7.10	97					8.3	37.6	59.4
	Mean	6.12	93	5.40	74	5.76	83	8.0	38.4	60.6
UC 132	10.7	6.40	109					6.6	37.9	59.1
	10.7	7.08	97					6.6	37.4	59.0
	Mean	6.74	102					6.6	37.6	59.0
Howard	10.7	5.70	94					8.7	37.3	62.1
	10.8	6.65	91					7.4	38.3	63.1
	Mean	6.18	94					8.0	37.8	62.6
UC 148	10.8	5.68	97					7.4	38.3	59.9
	10.8	7.32	100					7.2	37.8	59.2
	Mean	6.50	99	10.80	148	8.65	125	7.3	38.0	59.6
Montezuma	10.8	5.85	100					6.5	36.6	55.5
	10.9	7.30	100					6.5	39.2	60.2
	Mean	6.58	100	7.30	100	6.94	100	6.5	39.9	57.8
California Red	10.6	5.30	91					7.8	39.7	60.2
	10.8	5.72	98					7.0	39.3	59.0
	Mean	5.51	84	7.80	107	6.66	96	7.4	39.5	59.6
Ogle	10.8	5.95	102					7.4	39.4	61.5
	10.8	6.62	91					7.6	39.5	61.1
	Mean	6.28	95					7.5	39.4	61.3
Sierra	10.8	5.48	94					10.7	38.5	58.8
	10.8	7.20	99					7.0	36.5	57.0
	Mean	6.34	96					8.8	37.5	57.9
Pert	10.8	5.77	99					7.2	38.0	59.7
	10.9	6.82	93					7.0	36.2	57.5
	Mean	6.30	96					7.1	37.1	58.6
Bates-89	10.6	6.55	112					7.0	42.1	65.8
	10.8	7.50	103					7.2	41.8	64.0
	Mean	7.02	107	10.80	148	8.91	128	7.1	42.0	64.9
CV, %		11.1								
SE, t/ac		0.36								

Abbreviations: ADF=acid detergent fiber, NDF=neutral detergent fiber

Table 8 Forage yield as tons per acre (t/ac) and as percent of Curt (%C) at 15% moisture and quality at two harvest dates (April 29: Feekes 10.4 to 10.6; May 7: Feekes 10.6 to10.7; see Table 5) in 1999 near Lemoore, Kings County

	Harvest	Forage		Crude	ADF	NDF
Variety	stage	(t/ac)	(%C)	protein (%)	(%)	(%)
UC 113	10.4	5.80	107	10.8	40.7	61.0
	10.6	6.28	111	9.6	43.9	66.2
	Mean	6.03	109	10.2	42.3	63.6
UC 125	10.5	5.50	102	10.4	40.8	61.4
	10.6	5.48	97	9.6	42.5	64.5
	Mean	5.49	99	10.0	41.6	63.0
UC 128	10.4	5.38	100	10.4	40.8	61.4
	10.6	6.60	116	9.6	42.5	64.5
	Mean	5.99	108	10.0	41.6	63.0
Mac	10.5	4.72	87	10.2	43.1	64.1
	10.6	6.40	113	8.3	46.9	68.8
	Mean	5.56	101	9.2	45.0	66.4
UC 130	10.4	5.87	109	10.6	42.3	62.2
	10.6	6.40	113	9.1	45.2	68.7
	Mean	6.14	111	9.8	43.8	65.4
UC 132	10.5	5.30	98	10.7	41.3	63.9
	10.6	6.10	108	10.2	42.1	64.9
	Mean	5.70	103	10.4	41.6	64.4
Howard	10.5	4.75	88	10.6	42.2	67.7
	10.7	6.27	111	9.5	42.9	68.4
	Mean	5.51	100	10.0	42.6	68.0
UC 148	10.4	6.33	117	10.1	43.2	64.9
	10.6	6.30	114	8.7	44.9	67.9
	Mean	6.30	114	9.4	44.0	66.4
Curt	10.6	5.40	100	9.2	43.4	66.5
	10.7	5.67	100	9.5	40.8	62.1
	Mean	5.53	100	9.4	42.1	64.3
Pert	10.4	4.33	80	11.4	39.1	58.3
	10.6	6.02	106	8.6	43.2	65.4
	Mean	5.18	94	10.0	41.2	61.8
Ogle	10.5	6.12	102	9.8	44.0	64.4
	10.6	5.77	102	8.7	45.7	66.7
	Mean	5.94	107	9.2	44.8	65.6
Bates-89	10.4	4.90	91	9.2	44.4	67.2
	10.6	6.08	107	9.7	42.7	65.0
	Mean	5.49	99	9.4	43.6	66.1
Sierra	10.4	5.20	96	9.5	42.7	66.5
	10.6	6.80	120	9.2	42.7	65.3
	Mean	6.00	108	9.4	42.7	65.9
Mean	10.4 to 10.6	5.35		10.2	42.2	63.8
	10.6 to 10.7	6.16		9.3	43.5	65.6
	Mean	5.76		9.8	42.8	64.7
CV, %		12.2				
SE, t/ac		0.12				

Abbreviations: ADF=acid detergent fiber, NDF=neutral detergent fiber

Table 9 Forage yield as tons per acre (t/ac) and percent of Montezuma (%Mz), lodging as percent of plot lodged as of May 22, and plant height at maturity in inches (in) from one-acre strip plots, Robinson Farms, San Joaquin County, 2006; forage yield estimated from weights of three bales per plot × number of bales

	Forage		Lodging	Height
Variety	(t/ac)	(%Mz)	(%)	(in)
UC 113	5.33	89	85	42
UC 125	5.82	97	80	48
UC 128	7.44	123	75	69
Mac	7.83	130	45	60
UC 130	6.08	101	90	48
UC 132	6.77	112	10	48
Howard	6.06	100	90	48
UC 148	6.18	102	70	60
Montezuma	6.03	100	90	54
CV, %	8.7			
SE, t/ac	0.19			
LSD (0.05)	0.39			