

Description of bread wheat variety ‘Kern’

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Origin and Breeding History of the Variety.

KERN is a hard red spring wheat variety selected from the cross Tadorna/Inia 66//Yecora Rojo/3/Klasic (CA830182-0D-0D-2ST-4ST-1ST-3ST-1ST-3D-4ST-0D-0D-0D-0D-0D). A sibling of Tadinia (Tadorna/Inia 66) was crossed with Yecora Rojo in 1982 and the hybrid Tadorna/Inia 66//Yecora Rojo was crossed with Klasic in 1983, creating the three-way hybrid Tadorna/Inia 66//Yecora Rojo/3/Klasic (CA830182). The F₂ and F₃ seed were advanced as bulk population at Davis in 1984 and 1985. Individual heads were selected in 1985 and single F₄ rows and family head rows were evaluated in *Septoria tritici* blotch (STB) screening nurseries in subsequent generations. One row was selected from F₅ headrows on the basis of agronomic appearance and resistance to *Septoria tritici* blotch and further tested for SDS sedimentation. This line was advanced to preliminary, advanced, and multilocation elite yield trials over the next five years. In 1994, it was entered into regional testing as UC1036 (KERN). KERN was evaluated in the UC Regional Common Wheat Test Program in 1994, 1995, 1997, and 1998. Fifteen hundred F₁₅ heads were selected in 1997 at Davis and planted head-to-row at the UC Intermountain Research and Extension Center at Tulelake in April 1998. These head rows were examined for uniformity and about 1300 were harvested in bulk and designated as Breeders Seed Class.

Description of the variety

Abstract

KERN is a hard red spring wheat. It is short-statured variety with a mid-season heading time (six days later than Yecora Rojo). KERN has a mid-dense spike, fully awned with a straight peduncle. Glumes are white, glabrous with short awns and occasionally show a distinctive blackening (pseudo-black chaff). It has tendency to shattering similar to Yecora Rojo but better resistance to lodging and higher yield potential. KERN has broad adaptation to California environments and adequate levels of resistance to leaf rust, stripe rust and *Septoria tritici* blotch. It has intermediate grain protein content, excellent flour yield, intermediate to low flour water absorption, good mixing properties and loaf volume and an overall good breadmaking quality.

Statistical comparison with other California varieties

Data presented in Tables 1–4 and 6–10 were obtained from the Agronomy Progress Reports, University of California, Davis (L. Jackson et al. 1994, 1995, 1996, 1997, 1998. Regional barley, common and durum wheat, triticale, and oat performance tests in California, Agronomy Progress Report, UC Davis). For statistical analysis Year/Location combinations were used as blocks and the Year/Location * Variety interaction was used as an estimate of the error term. The California Wheat Commission Quality Laboratory, Woodland, CA, provided breadmaking quality analyses.

Agronomic characteristics

Height. The mean height of KERN is 86 cm when grown under irrigation in the Sacramento Valley and San Joaquin Valley (Table 1). KERN and Yecora Rojo are not significantly different in height but both are significantly shorter than RSI5 and Express.

Heading date. Heading time of KERN is midseason, approximately 6 days later than Yecora Rojo and 1-2 days earlier than RSI5 (Table 2).

Straw strength. KERN has good lodging resistance, equivalent to Express but better than RSI5 or Yecora Rojo (Table 3).

Shattering. KERN has good resistance to grain shattering at maturity, not significantly different from Anza but more resistant than Express and RSI5 (Table 3).

Grain characteristics. Kernels are hard, red, intermediate in length (5-7 mm), and with a short brush. Kernel weight of KERN (41 mg) was similar to Express (40 mg) and significantly lower than Yecora Rojo (43 mg) and RSI5 (46 mg) based on data from 17 Regional Performance Tests (1994-1997).

Grain yield. KERN has been extensively evaluated throughout California, but major emphasis has been placed on its performance in irrigated production in the Central Valley and Imperial Valley and to a lesser extent in rainfed areas. It was tested in regional trials in 1994, 1995, 1997, and 1998 and in strip trials in the Sacramento Valley in 1998 (Tables 4 and 5). In the Sacramento Valley grain yield for KERN was not significantly different from RSI5, Express and Anza but significantly higher than Yecora Rojo. In the San Joaquin Valley mean grain yield of KERN was lower than RSI5 and higher than Yecora Rojo. In the Imperial Valley, the mean grain yield of KERN was significantly higher than RSI5 and Express (Table 4). KERN performed well in strip trials in six locations in the Sacramento Valley in 1998 (Table 5).

Disease reactions.

Septoria tritici blotch (STB). KERN is resistant to most races of STB. However, relatively high levels of infections were observed in Colusa in 1999. Resistance to *Septoria tritici* in KERN is derived from Tadorna that carries a major dominant gene designated *Stb4*. KERN resistance to STB is similar to Express and RSI5 but significantly better than Yecora Rojo (Table 6).

Leaf rust. KERN is resistant to current races of leaf rust. Resistance is similar to Express and RSI5 but significantly better than Yecora Rojo (Table 6). Leaf rust reactions with a differential set of leaf rust races indicate that KERN has a different combination of leaf rust resistance genes than Yecora Rojo, Express and RSI5 (Table 7).

Stripe rust. KERN is resistant to stripe rust. A new virulence form of stripe rust appeared in the Sacramento valley in 1996, and was observed on Express was not on adjacent plots of KERN (Table 6).

Stem rust. Stem rust was not found in any variety during the evaluation of KERN. Occasionally, KERN shows a distinctive spike blackening (pseudo-black chaff) that has

been associated with the presence of the stem rust resistance gene *Sr2*. This important adult plant resistance gene, was reported in Inia 66, one of the progenitors of KERN.

Barley yellow dwarf virus (BYD). Available data indicates that KERN is similar to RSI5 and Yecora Rojo in BYD symptom expression but significantly better than Express (Table 6).

Quality

Bushel Weight. Mean bushel weight for KERN was very good in the Regional trials with a mean of 63.6 lbs. (28 location-years). It was significantly higher than bushel weights for the other varieties analyzed here (Table 8).

Grain Protein Content. Grain protein content of KERN is about 1 percentage unit lower than Express and Yecora Rojo, but 0.6 percentage units higher than Anza and RSI5 (Table 9).

Protein quality. High molecular weight glutenins subunits in KERN are *Glu-A1*: 1, *Glu-B1*: 13+16, *Glu-D1*: 5+10. This combination is one of the best for gluten strength and is also useful to differentiate KERN from Anza, Yecora Rojo, RSI5, Express, Klasic, Serra, Yolo, and Tadinia.

Breadmaking Quality. Flour yield of KERN is significantly higher than Yecora Rojo, Anza and Express. Differences with RSI5 were not significant (Table 10). Hardness (66.5) and water absorption values (60.5%) of KERN from regional Performance Tests were significantly lower than most of the other varieties analyzed (Table 10). However, water absorption values from the 1997 Collaborative Evaluation Program were substantially higher (CWC Quality Laboratory: 65.9%, Conagra: 62.5%, and Fisher Mills: 64.4%). Mixing peak times for KERN from farinograph analyses were not significantly different from those for Express and RSI5 but were significantly longer than those for Anza and significantly shorter than those for Yecora Rojo (Table 10). Finally, loaf volume and overall breadmaking quality scores were similar to Yecora Rojo, higher than RSI5 and Anza but significantly lower than Express.

Area of adaptation and primary use

KERN performs well agronomically in all areas where it has been evaluated in California and has good quality characteristics for breadmaking. KERN appears to be well suited for the Sacramento Valley where it combines a high yield potential with acceptable milling and baking properties. Good disease resistance is also an advantage of KERN in the Sacramento Valley. KERN also performs well in the San Joaquin Valley, where it has a yield advantage over Yecora Rojo while offering a similar breadmaking quality. KERN is also very well adapted to the Imperial Valley, where it has higher yields than most currently grown varieties (Table 4). The plant height of KERN may be too short when grown with limited moisture in some rainfed environments. *Septoria tritici* blotch resistance, stripe rust, and leaf rust resistance will provide an advantage to KERN in those areas where early planting and wet winters favor leaf diseases.

Table 1. **Plant height** in centimeters from 25 year/location combinations from the Sacramento Valley and San Joaquin Valley 1994-98.

<i>Variety</i>	<i>Year / Locations</i>	<i>Mean</i>	<i>Standard deviation</i>
Express	25	96.0 B*	9.1
RSI5	25	99.2 A	9.4
Yecora Rojo	25	84.2 C	7.0
KERN	25	86.5 C	8.3
LSD p<0.05		2.6	

* Means with the same letter are not significantly different

Table 2. **Heading date**. Days after heading of Yecora Rojo in the same experiment (10 year /location combinations analyzed 1994-98).

<i>Variety</i>	<i>Year / Locations</i>	<i>Mean</i>	<i>Standard Deviation</i>
Express	8	6.4 A*	2.0
RSI5	8	7.4 B	2.5
KERN	8	6.0 A	2.2
LSD (p<0.05)		0.9	

* Means with the same letter are not significantly different

Table 3. **Lodging and shattering** scores 1994 -98. Scale: 1= 0-3%, 2= 4-14%, 3=15-29%, 4= 30-49%.

<i>Variety</i>	<i>Shattering</i>			<i>Lodging</i>		
	<i>Year / Locations</i>	<i>Mean</i>	<i>Standard deviation</i>	<i>Year / Locations</i>	<i>Mean</i>	<i>Standard deviation</i>
Express	9	2.2 B*	1.9	28	2.40 AB	2.05
RSI5	9	2.2 B	1.6	28	2.78 B	2.21
Yecora Rojo	9	1.9 AB	1.1	28	3.76 C	2.61
Anza	9	1.7 AB	1.3	-	-	-
KERN	9	1.1 A	0.2	28	2.13 A	1.86
LSD p<0.05		0.9		0.56		

* Means with the same letter are not significantly different

Table 4. **Mean grain yield** in lbs./acre from 40 year/location experiments from Regional Performance Tests (1994-1998) grouped by production areas.

	<i>Sacramento Valley</i>	<i>San Joaquin Valley</i>	<i>Rainfed environments</i>	<i>Imperial Valley</i>
KERN	5,520 AB	5,500 B	3,010 A	8,480 A*
RSI5	5,980 A	5,940 A	3,130 A	6,580 B
Express	5,160 B	5,400 BC	2,820 AB	5,970 B
Yecora Rojo	4,120 C	5,090 C	2,540 B	7,590 A
Anza	5,140 B	5,150 BC	2,880 AB	7,610 A
LSD (p<0.05)	650	380	370	960
Number of Year/Locations	16	12	7	5

* Means with the same letter are not significantly different

Table 5. **Mean grain yield** in lbs./acre from strip trials performed in 1998 in six locations in the Sacramento Valley using four replications per location (Tom Kearney, farm advisor at Yolo County Cooperative Extension).

<i>Variety</i>	<i>Mean</i>
Bonus	5,260 A*
KERN	5,210 A
Stander	4,920 AB
RSI5	4,920 AB
Express	4,740 B
Yolo	4,150 C
Anza	3,920 C
LSD (p<0.05)	380

* Means with the same letter are not significantly different

Table 6. **Septoria Tritici Blotch, Leaf Rust, Stripe Rust, and Barley Yellow Dwarf Virus** scores from Regional Performance Tests 1994-1998. Experiments with scores 1 for all varieties were eliminated assuming absence of the disease. Rating scale for diseases (area of flag-1 leaf affected at soft dough stage): 1= 0-3%, 2= 4-14%, 3=15-29%, 4= 30-49%, 5= 50-69%, 6=70-84%, 7=85-95%, 8=96-100%.

<i>Variety</i>	<i>Barley yellow dwarf virus</i>	<i>Septoria tritici blotch</i>	<i>Leaf rust</i>	<i>Stripe rust</i>
KERN	1.2 A*	1.8 A	1.3 A	1.0 A
RSI5	1.5 AB	1.5 A	1.0 A	1.3 AB
Express	1.8 B	2.0 A	1.0 A	1.7 B
Yecora Rojo	1.2 A	6.2 B	3.3 B	1.1 AB
LSD (p<0.05)	0.3	0.7	0.5	0.5
Number of Year/Locations	18	21	22	9

* Means with the same letter are not significantly different

Table 7. **Leaf rust reactions** and resistance determined by the USDA-ARS Cereal Rust Laboratory, University of Minnesota.

<i>Variety</i>	<i>Leaf rust race</i>					
	<i>CBTB</i>	<i>MGBL</i>	<i>TDGL</i>	<i>FCDL</i>	<i>KFCL</i>	<i>TLGG</i>
KERN	2c3;	;	;	3	;	;
Yecora Rojo	;	3;	3	;	;	3
Express	;	;1c	3;	;	;	;1c
RSI5	2c	3	2c;	3;	2c;	;1c
Anza	3	3	3	3	3	3

Reaction type: 3= high infection type 2, 1, ;=low infection type c= chlorosis

Table 8. **Bushel Weight.** Pounds per bushel values from 28 year/location combinations from the Regional Performance Tests 1994-1997.

<i>Variety</i>	<i>Year / location</i>	<i>Mean (lbs)</i>	<i>Standard deviation</i>
KERN	28	63.6 A*	1.7
Yecora Rojo	28	62.5 B	1.6
RSI5	28	62.5 BC	1.7
Express	28	62.4 BC	1.9
Anza	28	62.0 C	1.7
LSD (p<0.05)		0.5	

* Means with the same letter are not significantly different

Table 9. **Grain protein content.** Percent grain protein (12% moisture basis) from 22 year/location combinations from the Regional Performance Tests 1994, 1995, and 1997 (Source: CWC Quality Laboratory).

<i>Variety</i>	<i>Year / location</i>	<i>Mean (%)</i>	<i>Standard deviation</i>
Express	22	13.2 A*	1.2
Yecora Rojo	22	12.7 B	1.4
KERN	22	11.7 C	1.1
RSI5	22	11.2 D	1.4
Anza	22	11.0 D	1.0
LSD (p<0.05)		0.4	

* Means with the same letter are not significantly different

Table 10. **Breadmaking quality.** Values from 8 year/location combinations from the Regional Performance Tests 1994, 1995, and 1997 (Source: CWC Quality Laboratory).

<i>Variety</i>	<i>Hardness (relative units)</i>	<i>Water absorption (%)</i>	<i>Flour yield (%)</i>	<i>Mixing peak (min)</i>	<i>Loaf Volume (cc)</i>	<i>Overall Score (1-5 scale)</i>
Express	89.5 A*	66.1 A	66.8 C	9.6 AB	941 A	4.2 A
Yecora Rojo	79.9 B	62.2 B	68.0 BC	12.8 A	888 B	3.5 B
KERN	66.5 D	60.5 C	70.5 A	8.5 BC	899 B	3.5 B
RSI5	72.2 C	61.7 BC	68.8 AB	5.3 CD	838 C	2.4 C
Anza	80.5 B	62.6 B	66.9 C	3.6 D	791 D	1.6 D

* Means with the same letter are not significantly different. No single LSD was available because of missing data.