

**PROJECT TITLE:**

2017 STATEWIDE DURUM VARIETY TRIALS

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**OBJECTIVE:**

To test advanced durum lines for agronomic and quality traits relative to currently grown varieties under Montana growing conditions.

**METHODS:**

In 2017, twelve experimental durum lines and twelve elite durum varieties were tested at six Montana Agricultural Experiment Stations and one location maintained by Northern Seed, LLC. (Table 1). This year's trial includes the addition of 11 new experimental lines developed at Montana State University-Bozeman that carry genetic markers associated with reduced cadmium accumulation and/or a licensed gene that increases pasta firmness, one experimental line developed by Dr. Joyce Eckhoff (MSU-EARC) with reduced cadmium accumulation, as well as the addition of four recent varieties from the Canadian Crop Development Center, University of Saskatchewan. Rainfed experiments were grown in Bozeman, MT (MSU-Post Agronomy Farm), Havre, MT (MSU-NARC), Sidney, MT (MSU-EARC), Conrad, MT (MSU-WTARC and Northern Seed, LLC), and Moccasin, MT (MSU-CARC). Irrigated trials were grown in Bozeman, MT (MSU-Post Agronomy Farm) and Sidney, MT (MSU-EARC). There were three replicates of each line/variety grown at each location grown in a randomized complete block design. Seed was treated with CruiserMaxx Vibrance for Cereals® (Syngenta) (5 fl oz/100 lb), and Mountrail was considered the check variety. The individual research centers/cooperators provided agronomic data and grain sub-samples from the three replicates per line per location were bulked and submitted to Dr. Linda Dykes (USDA-ARS, Fargo, ND) for analysis of seed traits, milling and semolina quality, and mixing strength. Overall statewide agronomic performance can be found in Table 2 with agronomic performance separated by irrigation environment (irrigated or rainfed) presented in Tables 3 and 4. Agronomic data for each individual location is in Tables 5-13 with overall quality data summarized in Tables 14 and 15 and individual location quality data in Tables 16-33. Supplemental information for off-station variety trials grown in the north central and north-eastern part of Montana can be found at the end of this report (Tables 34-37). All the off-station trials in north central Montana were conducted and data summarized by Peggy Lamb (MSU-NARC) and all the off-station trials in north-eastern Montana were conducted, and data summarized by Dr. Chengci Chen (MSU-EARC).

**AGRONOMIC RESULTS SUMMARY:**

Across nine locations in 2017, MTD16007 (65.4 bu/ac) was the highest yielding line followed by MTD16004 (65.1 bu/ac). Both yielded significantly more than the check Mountrail (61.6 bu/ac) (Table 2). Line MT112219 had the largest test weight (61.0 bu/ac) overall but had the second lowest protein content (14.1%) after line MTD16003 (13.8%) (Table 2). All four CDC varieties had the highest protein

content (averaged 15.8%) and overall had significantly higher protein than 18 of the other lines/varieties tested (Table 2). Line MTD16009 had the highest protein content of the experimental lines (15.8%) but also had the second lowest yield (57.9 bu/ac) and lowest test weight (56.3 lbs/bu) in the trial (Table 2). Lines MTD16010 (15.2%) and MTD16011 (15.2%) also had significantly higher protein than the check Mountrail (14.8%) (Table 2). The shortest line was MT112219 (25.8 in.) followed by Alzada (28.1 in.), which are both semi-dwarfs, while the tallest line was Tioga (34.9 in.) followed by MTD16002 (34.3 in.) (Table 2). Alzada and MT112219 also had a significantly earlier heading date (-4 days) compared to Mountrail (Table 2).

Under irrigated conditions, MTD16004 was the top yielding line (123.6 bu/ac), though not significantly, and had the highest test weight (62.8 lbs/bu) which was significantly higher than Mountrail (Table 3). MTD16009 had the lowest test weight (57.7 lbs/ac) and was the third lowest (108.4 bu/ac) yielding line following Alzada (103.1 bu/ac) (Table 3). No significant differences existed for protein in irrigated trials but numerically CDC-Fortitude (13.9%) was the highest followed by MTD16009, CDC-Dynamic, and CDC-Vivid. Lines MTD16003 and MT112219 numerically had the lowest protein (12.1%) followed by Joppa (12.3%) (Table 3).

In rainfed trials, MTD16007 (49.8 bu/ac) was the highest yielding line, but not significantly more than Mountrail (47.5 bu/ac) (Table 4). Line MT112219 had the highest test weight (60.6 bu/ac) and was the shortest (24.6 in.) but had the second lowest protein content (14.8%) after MTD16003 (14.3%) (Table 4). The four CDC varieties and MTD16011 had the highest protein (average 16.2%) of the lines while MTD16003 (14.3%) had significantly lower protein than Mountrail (15.2%) (Table 4).

### **QUALITY RESULTS SUMMARY:**

Grain quality results from USDA-ARS showed significant differences for all traits measured (Tables 14, 15). The line with the highest test weight was MT112219 (61.9 bu/ac), whereas Alzada had the largest individual seed weight (42.2 mg), individual kernel diameter (2.9 mm), and percent large kernels (66.9 %). Line MTD16009 had the lowest test weight (56.4 bu/ac) but the highest grain protein (15.9%) along with Dynamic (15.9%). Mountrail had the lowest percent of large kernels (23.6 %) and MTD16003 had the lowest grain protein (13.5%).

Due to its large test weight MT112219 had the highest milling yield (62.6%) followed by Alzada (62.5%) while MTD16009 had the lowest milling yield (57.9%). Semolina protein results reflected the grain results with Dynamic and MTD16009 having the highest protein content (14.8%) and MTD16003 had the lowest (12.4%). The CDC lines Dynamic, Fortitude, and Precision had the highest grain ash

content (1.47%) and Alzada had the highest semolina ash content (0.64%). MTD16003 had the lowest grain ash content (1.30%), lowest semolina ash content (0.55%), and lowest falling number (417 sec.). The lines with the highest falling numbers were Alzada, Precision, and MT16010 at 450 seconds.

Though significant differences existed for semolina whiteness ( $L^*$ ) the range was very small (1.5 units), with the whitest line being Mountrail (84.8) and the least white line being CDC-Vivid (83.3). The significant differences for semolina yellowness had a larger range (11 units) with Precision being the most yellow (33.0) and MTD16007 being the least yellow (22.2), which was significantly lower than Mountrail (26.0). The range for yellowness in the MSU experimental lines ranged from 22.2 to 29.1. As measured by mixograph, Alzada had the strongest gluten strength with a mixograph pattern of 7.3 while Mountrail had the weakest gluten with a mixograph pattern of 3.0. The MSU experimental lines had mixograph patterns that ranged from 3.9 to 5.8. Quality data for individual locations can be found in Tables 16-21.

**Table 1. 2017 site information for testing sites across Montana.**

	<b>Bozeman</b>	<b>Bozeman (I)</b>	<b>SARC</b>	<b>NS- Conrad</b>	<b>CARC</b>
Latitude	45° 41'	45° 41'	45° 35'	48° 06'	47° 03'
Longitude	111° 00'	111° 00'	108° 13'	112° 02'	109° 57'
Planting Date	5/6/2017	5/4/2017	3/27/2017	4/20/2017	4/18/2017
Harvest Date	8/22/2017	9/1/2017	7/27/2017	8/7/2017	8/9/2017
Crop Year Precipitation	17.4"	17.4"	19.7"	11.6"	10.9"
Growing Season Precipitation	5.2"	5.2"	5.6"	4.8"	6.2"
Irrigation	-	4"	-	-	-
Herbicide	Huskey (15 oz/ac); Parity (10.6 oz/ac)	Huskey (15 oz/ac)	Bromac (16 oz/ac); Advanced Affinity (0.5 oz/ac); 1 lbs AMS.	NA	Base Camp; RT3; Brimstone
Soil Fertility	N(0-48") 148 lbs/ac, PKS 10-219 ppm, S(0-24")-32 lbs/ac	N(0-48") 166 lbs/ac, PK 33-407 ppm, S(0-24")-54 lbs/ac	N(0-48") 256 lbs/ac, PK 12-456 ppm, S (0-24")-122 lbs/ac	NA	N(0-24")33 lbs/ac, P-22 ppm, S(0-24") 36 lbs/ac
Fertilizer applied	300 lbs/acre 46-0-0 top dress	435 lbs/acre 46-0-0 top dress	NPKS 6-26-0-0 in furrow	NA	50 lbs/ac NPKS 20-30-20-10 at planting plus 95 lbs/ac 46-0-0 on 5/23/17
Previous Crop	Fallow	Fallow	Fallow	Fallow	Fallow

**Table 1 cont. 2017 site information for testing sites across Montana.**

	<b>NARC</b>	<b>EARC</b>	<b>EARC (I)</b>	<b>WTARC</b>
Latitude	48° 29'	47° 46'	47° 46'	48° 18'
Longitude	109° 48'	104° 14'	104° 14'	111° 55'
Planting Date	4/13/2017	4/19/2017	4/20/2017	4/19/2017
Harvest Date	8/3/2017	8/7/2017	8/17/2017	8/14/2017
Crop Year Precipitation	9.5"	3.9"	4.1"	11.6"
Growing season Precipitation	2.3"	2.4"	2.6"	4.8"
Irrigation	-	-	4.7"	-
Herbicide	Brox-M, (24oz/ac)	NA	NA	Huskey (15 oz/ac); Axial XL (16.4 oz/ac)
Soil Fertility	N (0-36")-57 lbs/ac	N-57.5 lbs/ac	N-7.5 lbs/ac	NA
Fertilizer applied	NPKS 125-20-10-10 banded	55 lbs/ac 46-0-0	NP 11-52 100 lb/ac + 300 lbs/ac 46-0-0	NPK 208-22.5-20 lbs/ac
Previous Crop	Fallow	Fallow	Fallow	Fallow

**Table 2. Agronomic means from 2017 intrastate durum trials all locations (n=9) and conditions.**

Line	Source <sup>1</sup>	Release Year	Heading (Julian) <sup>2</sup>	Height (in.)	Yield (bu/ac) <sup>3</sup>	Test weight (lbs/bu)	Protein (%) <sup>4</sup>
Mountrail	NDSU	1998	168.3	32.6	61.6	59.2	14.8
Divide	NDSU	2005	168.4	33.5	63.5	59.7	14.9
Alkabo	NDSU	2005	167.0	31.4	61.7	59.9	14.5
Grenora	NDSU	2005	166.9	30.7	63.9	59.6	14.6
Tioga	NDSU	2010	168.8	<b>34.9</b>	62.0	59.4	15.4
Carpio	NDSU	2012	169.6	32.6	63.7	58.8	14.9
Joppa	NDSU	2013	167.4	33.6	61.4	60.2	14.5
Alzada	WestBred	2004	<u>163.8</u>	28.1	<u>58.0</u>	60.3	14.8
Dynamic <sup>+</sup>	CDC	2016	169.3	32.5	60.5	59.3	<b>16.0</b>
Fortitude <sup>+</sup>	CDC	2015	168.6	31.6	59.7	59.5	15.8
Precision <sup>+</sup>	CDC	2016	167.2	32.5	61.7	60.0	15.6
Vivid <sup>+</sup>	CDC	2013	168.5	32.9	59.9	59.7	15.7
MT112219 <sup>+</sup>	MSU		164.9	<u>25.8</u>	61.7	<b>61.0</b>	14.1
MTD16001*	MSU		168.6	32.8	63.1	58.4	14.8
MTD16002**	MSU		<b>170.5</b>	34.4	62.7	59.2	15.0
MTD16003	MSU		167.5	32.8	63.5	59.7	<u>13.8</u>
MTD16004*	MSU		168.0	32.3	65.1	60.5	14.5
MTD16005**	MSU		168.7	33.2	62.4	58.7	15.0
MTD16006 <sup>+</sup>	MSU		168.1	34.3	63.0	59.7	14.7
MTD16007 <sup>+</sup>	MSU		168.6	32.8	<b>65.4</b>	60.0	15.0
MTD16008**	MSU		168.0	33.9	59.4	58.5	14.9
MTD16009	MSU		169.9	33.3	58.9	<u>56.3</u>	15.8
MTD16010*	MSU		168.8	33.3	61.9	59.8	15.2
MTD16011**	MSU		169.0	33.3	63.3	59.0	15.2
Mean			168.1	32.5	62.0	59.4	15.0
CV (%)			2.6	4.5	6.0	1.3	3.3
LSD (0.05)			3.1	1.3	3.5	0.7	0.5
F < Prob			0.019	<0.001	0.001	<0.001	<0.001

<sup>+</sup>Low cadmium accumulation gene is present

<sup>\*</sup>Contain a licensed pasta firmness gene

<sup>1</sup>NDSU-North Dakota State University, CDC-University of Saskatchewan Crop Development Center, MSU-Montana State University

<sup>2</sup>Data for five locations

<sup>3</sup>Reported on a 13% moisture basis

<sup>4</sup>Reported on a 12% moisture basis

Underline/Bold = Highest values, underline = lowest

**Table 3. Agronomic means from 2017 intrastate durum trials conducted under irrigated conditions (n=2).**

Line	Height (in.)	Yield (bu/ac) <sup>1</sup>	Test weight (lbs/bu)	Protein (%) <sup>2</sup>
Mountrail	40.0	110.7	61.3	12.7
Divide	40.8	117.6	61.3	13.1
Alkabo	38.1	114.4	61.5	12.9
Grenora	37.4	113.6	60.9	13.1
Tioga	41.9	113.1	61.2	13.2
Carpio	40.3	120.7	61.7	12.9
Joppa	41.0	113.0	62.0	12.3
Alzada	30.2	<u>103.1</u>	62.0	12.8
Dynamic	39.2	112.3	61.6	13.7
Fortitude	37.6	110.2	61.1	<b>13.9</b>
Precision	40.6	111.1	61.9	13.5
Vivid	39.1	109.0	61.9	13.4
MT112219	<u>29.3</u>	109.7	61.9	<u>12.1</u>
MTD16001	40.1	116.4	59.8	12.8
MTD16002	<b>43.2</b>	117.3	61.4	13.0
MTD16003	39.8	120.1	61.8	<u>12.1</u>
MTD16004	39.3	<b>123.6</b>	<b>62.8</b>	13.1
MTD16005	39.9	113.4	60.7	13.0
MTD16006	41.9	115.2	61.7	12.8
MTD16007	39.1	120.0	62.2	12.8
MTD16008	40.1	106.9	60.0	12.5
MTD16009	40.1	108.4	<u>57.7</u>	13.7
MTD16010	41.3	112.2	61.8	13.1
MTD16011	40.8	118.2	61.1	12.9
Mean	39.2	113.8	61.3	13.0
CV (%)	2.4	5.4	1.1	5.3
LSD (0.05)	1.9	NS	1.5	NS
F > Prob	<0.001	0.333	<0.001	0.577

<sup>1</sup>Reported on a 13% moisture basis

<sup>2</sup>Reported on a 12% moisture basis

NS = No significant difference based on ANOVA  $p < 0.05$

Underline/Bold = Highest values, underline = lowest

**Table 4. Agronomic means from 2017 intrastate durum trials conducted under rainfed conditions (n=7).**

Line	Heading (Julian) <sup>1</sup>	Height (in.)	Yield (bu/ac) <sup>2</sup>	Test weight (lbs/bu)	Protein (%) <sup>3</sup>
Mountrail	172.1	30.3	47.5	58.2	15.2
Divide	172.2	31.3	48.0	59.0	15.4
Alkabo	171.2	29.4	46.6	59.2	14.8
Grenora	170.6	28.7	49.7	58.9	15.0
Tioga	172.9	<b>32.9</b>	47.4	58.4	15.7
Carpio	173.5	30.3	47.4	57.7	15.3
Joppa	171.3	31.3	46.6	59.4	15.1
Alzada	<u>168.0</u>	26.4	46.2	59.7	15.3
Dynamic	173.4	30.5	45.7	58.4	<b>16.5</b>
Fortitude	172.5	29.8	45.2	58.7	16.2
Precision	171.3	30.1	47.6	59.0	16.2
Vivid	172.3	30.9	45.9	58.7	16.3
MT112219	168.7	<u>24.6</u>	48.0	<b>60.6</b>	14.8
MTD16001	172.6	30.5	47.9	57.6	15.1
MTD16002	<b>174.3</b>	31.8	47.1	58.2	15.4
MTD16003	171.2	30.7	47.3	58.9	<u>14.3</u>
MTD16004	171.8	30.1	48.4	59.5	14.8
MTD16005	172.5	31.1	47.8	57.8	15.4
MTD16006	171.9	31.9	48.1	58.8	15.2
MTD16007	172.7	30.7	<b>49.8</b>	59.0	15.4
MTD16008	171.6	31.8	45.9	57.7	15.3
MTD16009	173.9	31.1	<u>44.8</u>	<u>55.6</u>	16.2
MTD16010	172.7	30.8	47.5	58.9	15.6
MTD16011	172.8	31.0	47.6	58.0	15.8
Mean	167.8	30.4	47.3	58.9	15.4
CV (%)	0.5	4.8	5.0	1.0	2.9
LSD (0.05)	1.1	1.6	2.8	0.7	0.5
F > Prob	<0.001	<0.001	<0.001	<0.001	<0.001

<sup>1</sup>Data for four locations

<sup>2</sup>Reported on a 13% moisture basis

<sup>3</sup>Data for six locations, reported on a 12% moisture basis

Underline/Bold = Highest values, underline = lowest



**Table 5. Agronomic means from 2017 irrigated intrastate durum trial conducted by Giroux/Hogg at the Post Agronomy Farm in Bozeman, MT.**

Line	Flowering (Julian)	Plant Height (in.)	Yield (bu/ac) <sup>1</sup>	Test weight (lbs/bu)	Protein (%) <sup>2</sup>	Maturity (Julian)
Mountrail	188.3	38.7	103.8	59.5	13.5	222.7
Divide	188.3	39.8	113.4	60.3	14.6	223.7
Alkabo	187.7	38.8	106.5	60.0	12.8	224.7
Grenora	188.0	36.4	106.2	59.8	13.7	223.7
Tioga	188.7	41.7	111.6	59.9	14.4	225.0
Carpio	<u>189.7</u>	39.2	118.2	59.8	13.8	225.7
Joppa	188.3	40.0	110.4	60.8	13.1	223.0
Alzada	<u>186.0</u>	29.1	<u>100.6</u>	<b>61.3</b>	13.7	224.7
Dynamic	189.3	39.1	115.8	60.0	14.3	224.7
Fortitude	188.7	38.3	107.4	59.1	14.9	224.7
Precision	189.0	39.6	111.0	60.5	14.7	225.3
Vivid	188.3	39.4	112.2	60.2	14.4	224.3
MT112219	186.0	<u>28.3</u>	103.7	59.9	13.3	<u>221.7</u>
MTD16001	189.0	40.0	113.0	57.9	13.9	224.3
MTD16002	189.3	<b>42.4</b>	115.0	59.9	14.6	<b>226.3</b>
MTD16003	188.3	39.5	104.5	60.1	<u>12.7</u>	222.7
MTD16004	188.7	39.1	114.6	62.1	13.8	224.0
MTD16005	189.0	39.1	108.5	59.5	14.5	223.3
MTD16006	188.7	42.0	114.1	60.7	13.9	225.3
MTD16007	189.0	38.5	<b>118.3</b>	61.1	14.2	224.3
MTD16008	188.3	39.9	106.1	57.6	14.5	224.0
MTD16009	<u>189.7</u>	41.1	105.6	<u>55.5</u>	<b>15.6</b>	224.3
MTD16010	189.0	40.2	104.1	59.4	14.0	223.3
MTD16011	<u>189.7</u>	39.8	105.9	60.1	14.6	223.3
Mean	188.5	38.8	109.6	59.8	14.1	224.1
CV (%)	0.3	2.1	5.5	1.7	2.1	0.4
LSD (0.05)	0.8	1.3	9.9	1.7	0.5	1.6
Prob > F	<0.001	<0.001	0.018	<0.001	<0.001	<0.001

<sup>1</sup>Reported on a 13% moisture basis

<sup>2</sup>Reported on a 12% moisture basis

Underline/Bold = Highest values, underline = lowest

**Table 6. Agronomic means from 2017 rainfed intrastate durum trial conducted by Giroux/Hogg at the Post Agronomy Farm in Bozeman, MT.**

Line	Flowering (Julian)	Plant Height (in.)	Yield (bu/ac) <sup>1</sup>	Protein (%) <sup>2</sup>	Test weight (lbs/bu)	Maturity (Julian)
Mountrail	188.7	36.4	65.6	14.0	60.8	215.3
Divide	188.7	37.3	67.4	14.7	60.9	217.7
Alkabo	188.7	35.7	68.3	13.4	61.3	218.3
Grenora	187.3	33.7	68.0	13.6	61.3	218.0
Tioga	189.3	38.7	69.2	14.1	<b>62.0</b>	218.3
Carpio	189.3	36.0	68.4	13.9	60.2	218.3
Joppa	188.0	38.6	67.8	13.6	61.4	217.0
Alzada	<u>186.0</u>	28.1	<u>56.4</u>	14.7	60.1	<u>214.0</u>
Dynamic	189.7	35.3	62.5	<b>16.0</b>	60.0	216.3
Fortitude	188.7	34.4	63.9	15.4	60.9	218.0
Precision	189.0	35.4	66.7	15.1	61.6	219.0
Vivid	188.0	37.1	67.5	15.0	61.2	217.3
MT112219	<u>186.0</u>	<u>26.1</u>	62.2	13.7	61.9	215.7
MTD16001	189.0	37.3	71.5	14.0	60.0	218.3
MTD16002	<b>190.0</b>	37.8	71.0	14.6	60.7	<b>219.3</b>
MTD16003	187.0	36.0	69.2	<u>12.7</u>	60.6	217.3
MTD16004	187.7	35.6	68.7	14.0	<b>62.0</b>	216.7
MTD16005	188.7	36.5	67.7	14.4	60.5	217.7
MTD16006	188.3	<b>39.4</b>	69.9	14.5	61.4	217.7
MTD16007	189.0	37.0	<b>74.0</b>	14.5	61.5	217.7
MTD16008	188.0	37.5	67.6	14.2	60.2	218.0
MTD16009	189.7	36.4	65.0	15.1	<u>58.2</u>	218.3
MTD16010	188.7	37.0	63.9	14.5	61.3	218.7
MTD16011	189.0	37.1	68.0	14.8	60.5	216.3
Mean	188.4	35.8	67.1	14.4	60.9	217.5
CV (%)	0.3	2.8	7.0	2.4	1.1	0.3
LSD (0.05)	1.1	1.7	7.7	0.6	1.1	1.2
Prob > F	<0.001	<0.001	0.055	<0.001	<0.001	<0.001

<sup>1</sup>Reported on a 13% moisture basis

<sup>2</sup>Reported on a 12% moisture basis

NS = No significant difference based on ANOVA  $p < 0.05$

Underline/Bold = Highest values, underline = lowest

**Table 7. Agronomic means from 2017 rainfed intrastate durum trial conducted at Southern Agricultural Research Center Huntley, MT.**

Line/Variety	Heading (Julian)	Height (in.)	Yield (bu/ac) <sup>1</sup>	Test Weight (lbs/bu)	Protein (%) <sup>2</sup>	Rust <sup>3</sup>
Mountrail	163.0	44.0	77.3	61.7	13.4	5.0
Divide	161.7	44.3	78.7	62.2	14.2	3.7
Alkabo	161.0	42.1	73.3	<b>63.3</b>	13.3	7.0
Grenora	160.3	41.8	79.2	62.2	13.9	5.3
Tioga	163.0	<b>47.1</b>	76.8	61.9	14.8	5.7
Carpio	163.7	44.1	80.2	61.1	14.6	3.7
Joppa	160.7	44.9	76.6	62.4	13.7	7.7
Alzada	<u>157.7</u>	35.5	<b>82.0</b>	61.8	14.0	2.0
Dynamic	163.0	43.7	74.1	60.7	<b>15.8</b>	3.7
Fortitude	162.7	42.9	74.4	61.9	15.0	3.7
Precision	161.7	44.1	79.3	61.7	15.3	5.7
Vivid	162.7	44.0	74.7	61.9	15.3	4.7
MT112219	158.3	<u>33.3</u>	81.6	63.1	13.4	7.0
MTD16001	163.0	44.7	79.2	60.8	14.0	2.0
MTD16002	<b>164.0</b>	46.0	77.4	61.3	14.6	4.0
MTD16003	162.0	44.1	74.9	62.0	<u>13.2</u>	3.3
MTD16004	162.3	43.1	81.9	63.2	13.7	1.3
MTD16005	162.7	45.1	77.1	61.2	14.5	5.3
MTD16006	163.0	46.5	81.0	62.1	14.4	2.3
MTD16007	163.0	42.5	78.4	62.2	14.4	<u>0.7</u>
MTD16008	162.0	46.6	78.4	60.9	14.3	3.7
MTD16009	163.7	43.8	<u>71.5</u>	<u>58.7</u>	15.2	5.0
MTD16010	162.7	44.1	76.5	62.3	14.1	3.3
MTD16011	163.7	45.1	75.3	61.4	14.6	<b>9.7</b>
Mean	162.1	43.5	77.5	61.8	14.3	3.9
CV (%)	0.3	2.0	5.5	0.6	1.7	41.3
LSD (0.05)	0.9	1.4	NS	0.6	0.4	1.7
Prob > F	< 0.001	< 0.001	0.216	< 0.001	< 0.001	0.033

<sup>1</sup>Reported on a 13% moisture basis

<sup>2</sup>Reported on a 12% moisture basis

<sup>3</sup>Percent flag leaves infected by stripe rust (*Puccinia striiformis* Westend.) visually estimated on June 21<sup>st</sup>. Observations transformed by arcsine of the square root prior to analysis.

NS = No significant difference based on ANOVA  $p < 0.05$

Underline/Bold = Highest values, underline = lowest

**Table 8. Agronomic means from 2017 irrigated intrastate durum trial conducted at Eastern Agricultural Research Center Sidney, MT.**

Line	Heading (Julian)	Height (in.)	Yield (bu/ac)	Test weight (lbs/bu)	Protein (%)
Mountrail	169.5	41.3	117.7	63.2	11.9
Divide	170.0	41.9	121.7	62.4	11.5
Alkabo	167.5	37.4	122.2	63.0	12.9
Grenora	169.0	38.4	121.0	62.0	12.5
Tioga	169.0	42.1	114.6	62.4	12.0
Carpio	170.0	41.3	123.2	63.7	12.0
Joppa	169.0	41.9	115.5	63.2	11.5
Alzada	<u>165.5</u>	31.3	<u>105.6</u>	62.7	11.9
Dynamic	169.0	39.2	108.8	63.2	<b>13.2</b>
Fortitude	169.5	36.8	113.0	63.2	12.9
Precision	169.0	41.5	111.2	63.3	12.2
Vivid	170.0	38.8	105.8	63.6	12.4
MT112219	167.5	<u>30.3</u>	115.8	63.9	10.8
MTD16001	169.5	40.2	119.8	61.8	11.7
MTD16002	<b>171.5</b>	<b>44.1</b>	119.5	63.0	11.4
MTD16003	168.5	40.0	<b>135.7</b>	63.6	11.5
MTD16004	168.5	39.4	132.5	63.5	12.3
MTD16005	169.0	40.6	118.2	61.8	11.5
MTD16006	170.0	41.9	116.4	62.8	11.8
MTD16007	169.0	39.8	121.6	63.4	11.4
MTD16008	170.5	40.4	107.8	62.3	<u>10.4</u>
MTD16009	169.5	39.2	111.2	<u>59.9</u>	11.7
MTD16010	169.5	42.5	120.4	<b>64.3</b>	12.3
MTD16011	170.0	41.9	130.4	62.1	11.1
Mean	169.2	39.7	117.9	62.8	11.8
CV (%)	0.6	3.3	7.28	0.7	7.3
LSD (0.05)	1.9	2.7	NS	0.8	NS
F > Prob	0.006	<0.001	0.119	<0.001	0.340

<sup>1</sup>Reported on a 13% moisture basis

<sup>2</sup>Reported on a 12% moisture basis

Rep 1 was excluded from analysis

NS = No significant difference based on ANOVA  $p < 0.05$

Underline/Bold = Highest values, underline = lowest

**Table 9. Agronomic means from 2017 rainfed intrastate durum trial conducted at Eastern Agricultural Research Center Sidney, MT.**

Line	Heading (Julian)	Height (in.)	Yield (bu/ac) <sup>1</sup>	Test		
				weight (lbs/bu)	Protein (%) <sup>2</sup>	Emergence (%) <sup>3</sup>
Mountrail	169.3	22.6	44.6	61.1	13.5	73.3
Divide	171.3	24.3	<u>40.4</u>	60.9	13.7	66.7
Alkabo	168.3	23.0	45.8	61.8	13.0	73.3
Grenora	168.7	22.4	46.4	60.0	13.6	73.3
Tioga	170.0	25.7	45.3	60.6	14.1	66.7
Carpio	170.3	23.2	42.5	60.1	13.6	70.0
Joppa	169.7	25.3	40.8	60.7	14.1	63.3
Alzada	<u>165.0</u>	21.7	42.7	61.4	13.6	70.0
Dynamic	<b>172.0</b>	24.3	44.2	60.2	<b>15.4</b>	70.0
Fortitude	170.3	23.8	41.6	60.4	14.9	<u>56.7</u>
Precision	170.0	23.2	42.4	60.7	14.9	66.7
Vivid	171.0	25.5	44.8	61.1	14.9	73.3
MT112219	<u>165.0</u>	<u>19.7</u>	41.5	<b>63.2</b>	13.3	66.7
MTD16001	169.3	25.2	45.3	59.9	13.5	73.3
MTD16002	<b>172.0</b>	24.9	45.5	60.7	13.3	<b>76.7</b>
MTD16003	169.7	23.5	44.3	60.9	<u>12.2</u>	70.0
MTD16004	170.7	21.8	46.3	62.0	13.3	70.0
MTD16005	171.0	23.1	42.9	59.8	13.5	70.0
MTD16006	170.0	24.4	42.8	61.1	13.7	63.3
MTD16007	171.0	24.1	45.3	61.4	14.3	73.3
MTD16008	169.7	23.9	42.2	60.6	13.8	70.0
MTD16009	171.0	25.1	41.7	<u>57.0</u>	15.0	73.3
MTD16010	170.3	24.8	<b>48.3</b>	60.9	14.8	<b>76.7</b>
MTD16011	171.0	<b>26.0</b>	48.1	59.9	14.1	73.3
Mean	169.9	23.8	44.0	60.7	13.9	70.0
CV (%)	0.5	5.4	6.1	0.9	4.2	7.8
LSD (0.05)	1.3	2.1	4.4	0.9	1.0	8.9
F > Prob	< 0.001	< 0.001	0.022	< 0.001	< 0.001	0.013

<sup>1</sup>Reported on a 13% moisture basis

<sup>2</sup>Reported on a 12% moisture basis

<sup>3</sup>Stand counts performed at 2-3 leaf stage and converted to percentage

Underline/Bold = Highest values, underline = lowest

**Table 10. Agronomic means from 2017 rainfed intrastate durum trial at Central Agricultural Research Center in Moccasin, MT**

Line	Height (in.)	Yield (bu/ac) <sup>1</sup>	Test weight (lbs/bu)	Protein (%) <sup>1</sup>
Mountrail	26.0	26.7	55.8	18.8
Divide	25.7	27.6	55.6	18.6
Alkabo	25.0	25.4	55.7	19.4
Grenora	<u>24.3</u>	26.6	56.6	18.2
Tioga	26.0	24.6	55.1	19.7
Carpio	26.3	25.1	55.7	18.9
Joppa	24.7	25.1	56.5	18.3
Alzada	27.0	25.9	55.4	17.9
Dynamic	26.0	<u>20.9</u>	56.1	<b>19.9</b>
Fortitude	25.7	23.1	56.9	18.4
Precision	24.7	25.3	56.5	18.6
Vivid	25.3	23.8	55.5	19.3
MT112219	<u>24.3</u>	26.7	56.0	18.0
MTD16001	25.3	27.8	56.5	18.3
MTD16002	25.7	26.5	56.9	18.6
MTD16003	26.7	26.6	55.8	18.7
MTD16004	25.7	27.5	56.4	18.6
MTD16005	<b>27.7</b>	29.0	55.7	18.0
MTD16006	27.0	<b>30.7</b>	<b>57.5</b>	<u>17.7</u>
MTD16007	26.0	28.1	56.6	<u>17.7</u>
MTD16008	27.0	25.8	56.5	18.3
MTD16009	25.7	25.1	<u>55.0</u>	19.0
MTD16010	25.3	23.9	55.6	19.2
MTD16011	<u>24.3</u>	25.4	56.4	18.6
Mean	25.7	26.0	56.1	18.6
CV (%)	7.9	11.5	2.1	5.0
LSD (0.05)	NS	NS	NS	NS
F > Prob	0.906	0.159	0.733	0.325

<sup>1</sup>Reported on a 12% moisture basis

NS = No significant difference based on ANOVA  $p < 0.05$

Underline/Bold = Highest values, underline = lowest

**Table 11. Agronomic means from 2017 rainfed intrastate durum trial at Northern Agricultural Research Center in Havre, MT.**

Line	Stand (%)	Height (in.)	Heading (Julian)	Yield (bu/ac) <sup>1</sup>	Test weight (lbs/bu)	Protein (%) <sup>2</sup>	Falling Number (sec)
Mountrail	94.8	22.6	165.3	28.2	58.6	16.6	360
Divide	93.5	25.6	165.0	27.4	58.7	16.3	362
Alkabo	94.5	22.3	165.0	27.0	59.4	15.8	362
Grenora	96.1	22.5	164.3	30.8	58.4	16.3	377
Tioga	97.4	<b>26.9</b>	166.3	30.8	58.3	16.4	360
Carpio	91.5	23.6	<b>168.0</b>	26.7	56.2	16.3	354
Joppa	92.5	25.5	164.7	28.0	58.6	16.6	369
Alzada	96.7	22.1	<u>160.0</u>	<u>24.1</u>	59.4	16.3	<b>416</b>
Dynamic	97.1	25.3	167.7	28.1	57.6	<b>17.8</b>	351
Fortitude	91.9	23.8	166.0	27.6	58.3	17.2	377
Precision	91.8	23.7	163.7	29.7	58.5	17.2	389
Vivid	<u>89.2</u>	24.1	166.0	24.5	58.6	17.3	378
MT112219	97.1	<u>20.6</u>	163.3	27.1	<b>60.3</b>	15.7	387
MTD16001	96.4	23.2	167.3	26.8	57.6	15.8	363
MTD16002	99.3	25.2	<b>168.0</b>	29.1	57.8	16.1	366
MTD16003	98.7	25.8	165.0	29.5	59.2	<u>14.8</u>	373
MTD16004	99.0	24.3	165.0	30.1	59.3	15.8	<u>348</u>
MTD16005	94.5	24.1	167.0	27.2	57.9	16.7	376
MTD16006	<b>100.0</b>	24.4	165.0	30.9	58.6	16.0	362
MTD16007	98.7	25.0	166.0	<b>31.3</b>	58.9	16.8	370
MTD16008	95.4	25.2	164.0	30.1	57.9	16.1	362
MTD16009	95.4	25.1	<b>168.0</b>	27.4	<u>55.0</u>	17.1	351
MTD16010	99.0	22.3	167.0	28.0	58.5	16.4	365
MTD16011	98.4	22.9	166.7	30.5	58.1	16.6	377
Mean	95.8	24.0	165.6	28.4	58.3	16.4	369
CV (%)	4.2	4.6	0.7	5.9	0.6	1.6	1.7
LSD (0.05)	NS	1.8	2.0	2.8	0.6	0.4	10.3
F>Prob	0.104	>0.001	>0.001	>0.001	>0.001	>0.001	>0.001

<sup>1</sup>Reported on a 13% moisture basis

<sup>2</sup>Reported on a 12% moisture basis

Underline/Bold = Highest values, underline = lowest

**Table 12. Agronomic means from 2017 rainfed intrastate durum trial at Western Triangle Agricultural Research Center in Conrad, MT.**

Row Labels	Heading (Julian)	Height (in.)	Lodge (%)	Yield (bu/ac) <sup>1</sup>	Test weight (lbs/bu)	Protein (%) <sup>2</sup>
Mountrail	174.3	28.7	10.0	48.3	58.5	14.8
Divide	174.3	28.7	5.0	55.7	61.0	14.6
Alkabo	173.0	26.0	8.3	49.0	60.1	14.3
Grenora	172.3	25.7	6.7	53.1	59.9	14.4
Tioga	175.7	<b>31.7</b>	6.7	50.5	60.5	15.3
Carpio	176.0	27.0	5.7	51.6	59.9	14.2
Joppa	173.3	26.7	11.7	47.3	60.9	14.1
Alzada	171.3	24.0	10.0	46.1	60.4	15.1
Dynamic	174.7	26.3	9.0	48.3	60.2	14.3
Fortitude	175.0	26.0	<u>3.0</u>	46.1	58.9	<b>16.3</b>
Precision	172.0	26.7	8.3	49.0	60.0	15.8
Vivid	173.7	27.0	4.0	<u>43.8</u>	59.6	15.9
MT112219	<u>171.0</u>	<u>22.7</u>	4.0	49.5	<b>61.4</b>	14.5
MTD16001	174.3	26.0	5.0	49.6	58.0	15.3
MTD16002	<b>177.3</b>	29.3	6.7	46.3	58.6	15.3
MTD16003	172.3	26.7	10.0	49.2	59.8	14.0
MTD16004	173.3	27.7	11.7	49.0	61.0	<u>13.3</u>
MTD16005	173.3	27.7	8.3	52.9	59.4	15.1
MTD16006	173.0	27.3	6.7	46.1	59.2	14.8
MTD16007	174.3	27.0	10.0	<b>56.1</b>	60.9	14.7
MTD16008	174.3	27.7	6.7	45.6	58.4	15.1
MTD16009	177.0	27.3	6.7	47.6	<u>56.2</u>	15.9
MTD16010	175.0	29.0	11.7	54.0	61.3	14.9
MTD16011	173.7	27.3	<b>16.7</b>	47.6	58.6	15.9
Mean	173.9	27.1	8.0	49.3	59.7	14.9
CV (%)	0.5	4.1	47.5	10.3	1.7	5.8
LSD (0.05)	1.3	1.8	6.3	NS	1.7	1.4
F > Prob	>0.001	>0.001	0.022	0.277	>0.001	0.016

<sup>1</sup>Reported on a 13% moisture basis

<sup>2</sup>Reported on a 12% moisture basis

NS = No significant difference based on ANOVA  $p < 0.05$

Underline/Bold = Highest values, underline = lowest



**Table 13. Agronomic means from 2017 rainfed intrastate durum trial conducted by Northern Seed, LLC., Conrad, MT.**

Line	Height (in.)	Yield (bu/ac) <sup>1</sup>	Test weight (lbs/bu)
Mountrail	33.0	41.8	53.7
Divide	34.5	38.9	55.3
Alkabo	32.5	37.6	54.7
Grenora	31.0	43.5	56.3
Tioga	34.5	34.4	53.9
Carpio	33.0	37.1	52.9
Joppa	34.5	40.9	56.9
Dynamic	33.5	41.8	55.3
Fortitude	33.0	39.9	55.6
Precision	34.0	40.9	56.9
Vivid	34.5	42.2	55.7
MT112219	<u>26.5</u>	<b>47.6</b>	<b>59.4</b>
MTD16001	33.0	35.1	52.8
MTD16002	34.5	34.2	53.8
MTD16003	33.0	37.4	55.7
MTD16004	34.0	35.3	55.1
MTD16005	35.0	37.8	52.8
MTD16006	35.5	35.6	54.2
MTD16007	35.0	35.1	54.0
MTD16008	<b>36.5</b>	<u>31.1</u>	51.7
MTD16009	36.0	35.1	<u>51.5</u>
MTD16010	34.5	38.1	55.0
MTD16011	35.5	38.4	53.9
Mean	33.8	38.3	54.7
CV (%)	4.2	9.7	2.8
LSD (0.05)	3.0	6.1	2.5
F > Prob	0.001	0.002	>0.001

<sup>1</sup>Reported on a 13% moisture basis

Underline/Bold = Highest values, underline = lowest

No Alzada was planted in this trial

Table 14. USDA-ARS seed quality means from all locations for 2017 intrastate durum trial.

Line	Test Weight (lbs/bu)	Kernel Weight (mg)	Kernel Diameter (mm)	Large Kernels (%)	Small Kernels (%)	Hardness	Wheat Protein (%) <sup>1</sup>
Mountrail	59.3	37.0	2.7	<u>29.7</u>	<b>23.6</b>	75.1	14.9
Divide	60.2	37.9	2.7	44.1	17.3	75.1	15.0
Alkabo	60.6	37.9	2.7	42.7	16.0	76.6	14.5
Grenora	59.7	38.2	2.7	42.9	16.7	77.2	14.6
Tioga	59.7	37.7	2.7	47.4	16.3	74.7	15.4
Carpio	59.1	36.5	2.7	47.9	15.3	74.4	14.6
Joppa	60.2	37.9	2.7	43.3	17.4	76.2	14.6
Alzada	60.2	<b>42.2</b>	<b>2.9</b>	<b>66.9</b>	<u>6.9</u>	75.1	14.6
Dynamic	59.5	35.9	2.6	33.6	18.9	80.4	<b>15.9</b>
Fortitude	59.5	34.6	2.7	44.9	16.6	82.1	15.7
Precision	60.2	35.2	2.6	42.0	15.7	82.5	15.4
Vivid	60.1	36.4	2.6	49.9	13.8	79.9	15.7
MT112219	<b>61.7</b>	37.3	2.7	49.7	15.0	78.2	14.1
MTD16001	58.6	36.3	2.6	32.6	22.4	76.5	14.7
MTD16002	59.3	34.3	<u>2.6</u>	30.4	23.4	82.1	15.0
MTD16003	60.2	35.0	2.6	39.4	18.9	79.0	<u>13.5</u>
MTD16004	61.2	37.1	2.7	54.2	13.2	80.2	14.3
MTD16005	59.1	37.6	2.7	35.2	18.8	74.6	15.2
MTD16006	60.1	40.0	2.8	54.6	13.8	75.6	14.7
MTD16007	60.3	36.3	2.7	41.7	16.8	77.3	15.1
MTD16008	58.9	39.5	2.7	53.8	12.9	<u>73.7</u>	15.0
MTD16009	<u>56.4</u>	34.4	2.6	32.4	20.2	74.9	<b>15.9</b>
MTD16010	60.6	<u>34.2</u>	2.6	36.6	19.8	<b>83.5</b>	15.3
MTD16011	59.0	36.8	2.6	31.1	20.0	74.2	15.2
Mean	59.7	36.9	2.7	42.7	17.1	77.5	14.9
CV (%)	1.0	3.9	2.1	16.5	24.5	3.1	3.3
LSD (0.05)	0.6	1.4	0.05	6.6	3.9	2.2	0.5
F > Prob	>0.001	>0.001	>0.001	>0.001	>0.001	>0.001	>0.001

<sup>1</sup>Reported on a 12% moisture basis

Underline/Bold = Highest values, underline = lowest

Table 15. USDA-ARS semolina quality means from all locations for 2017 intrastate durum trial.

Line	Milling Yield (%) <sup>1</sup>	Semolina L*	Semolina b*	Mixograph Pattern	Grain Ash (%)	Falling Number (sec)	Semolina Protein (%) <sup>2</sup>	Semolina Ash (%)
Mountrail	61.6	<b>84.8</b>	26.0	<u>3.0</u>	1.39	443.7	13.9	0.61
Divide	61.6	84.6	27.2	5.1	1.34	425.1	13.6	0.58
Alkabo	61.2	84.7	29.9	4.7	1.39	439.3	13.2	0.58
Grenora	60.4	84.6	29.2	4.4	1.42	431.7	13.4	0.61
Tioga	61.8	84.5	29.6	6.6	1.42	438.2	14.2	0.60
Carpio	60.5	84.5	30.4	7.0	1.37	439.7	13.6	0.57
Joppa	61.7	84.6	29.6	6.2	1.39	438.9	13.4	0.57
Alzada	62.5	83.9	30.9	<b>7.3</b>	1.44	<b>450.0</b>	13.6	<b>0.64</b>
Dynamic	60.7	83.9	31.5	5.9	<b>1.47</b>	424.4	<b>14.8</b>	0.60
Fortitude	58.8	84.0	31.6	6.4	<b>1.47</b>	436.9	14.4	0.62
Precision	59.3	84.0	<b>33.0</b>	6.4	<b>1.47</b>	<b>450.0</b>	14.3	0.62
Vivid	60.7	<u>83.3</u>	31.2	6.2	1.41	429.9	14.4	0.62
MT112219	<b>62.6</b>	83.8	27.8	5.8	1.42	447.1	13.1	0.62
MTD16001	61.3	84.4	28.2	5.1	1.37	430.8	13.6	0.58
MTD16002	60.6	84.2	27.3	4.0	1.33	449.9	14.0	0.56
MTD16003	62.1	<b>84.8</b>	26.4	3.9	<u>1.30</u>	427.9	<u>12.4</u>	<u>0.55</u>
MTD16004	60.8	84.3	24.9	4.6	1.36	443.7	13.4	0.57
MTD16005	61.2	84.2	28.4	4.9	1.36	432.4	14.1	0.57
MTD16006	61.2	84.6	25.3	4.8	1.39	434.1	13.8	0.59
MTD16007	60.6	84.7	<u>22.2</u>	5.0	1.38	423.2	13.8	0.59
MTD16008	60.6	83.5	26.4	4.4	1.42	442.7	13.8	0.61
MTD16009	<u>57.9</u>	84.3	25.2	4.9	1.42	<u>417.7</u>	<b>14.8</b>	0.60
MTD16010	61.2	84.4	26.5	4.7	1.42	<b>450.0</b>	14.3	0.56
MTD16011	60.8	84.2	29.1	5.0	1.34	442.6	14.2	0.58
Mean	60.9	84.3	28.2	5.3	1.4	437.0	13.8	0.6
CV (%)	1.5	0.4	2.8	13.3	4.6	3.2	3.4	5.7
LSD (0.05)	0.8	0.3	0.7	0.6	0.06	12.8	0.4	0.03
F > Prob	>0.001	>0.001	>0.001	>0.001	>0.001	>0.001	>0.001	>0.001

<sup>1</sup>Reported on a 14% moisture basis

<sup>2</sup>Reported on a 12% moisture basis

Underline/Bold = Highest values, underline = lowest

**Table 16. USDA-ARS seed quality traits for 2017 irrigated location at Post Agronomy Farm in Bozeman, MT.**

Line	Test Weight (lbs/bu)	Kernel Weight (mg)	Kernel Diameter (mm)	Large Kernels (%)	Small Kernels (%)	Hardness	Wheat Protein (%) <sup>1</sup>
Mountrail	60.5	38.0	2.7	45.0	14.0	79.9	13.9
Divide	61.4	39.8	2.8	68.0	7.0	78.3	15.4
Alkabo	62.2	39.3	2.8	60.0	10.0	79.4	13.3
Grenora	61.8	41.2	2.8	68.0	8.0	80.4	14.0
Tioga	62.1	39.0	2.8	67.0	8.0	80.1	14.9
Carpio	62.2	40.6	2.9	77.0	6.0	78.4	14.6
Joppa	62.1	40.3	2.8	68.0	6.0	81.1	13.7
Alzada	62.1	43.7	3.0	83.0	4.0	76.5	14.1
Dynamic	61.7	39.2	2.8	63.0	9.0	86.9	15.2
Fortitude	60.7	37.2	2.8	67.0	10.0	83.4	15.6
Precision	61.6	38.9	2.8	69.0	6.0	85.0	14.7
Vivid	62.4	39.9	2.8	72.0	7.0	82.2	14.9
MT112219	63.6	39.7	2.8	63.0	10.0	77.3	14.0
MTD16001	60.2	37.4	2.7	55.0	12.0	78.2	14.2
MTD16002	61.7	37.5	2.8	61.0	8.0	84.4	14.7
MTD16003	61.5	36.4	2.7	55.0	12.0	82.2	12.9
MTD16004	62.8	40.3	2.9	80.0	6.0	83.0	13.9
MTD16005	61.0	39.8	2.8	49.0	9.0	76.4	15.0
MTD16006	62.6	45.3	3.0	78.0	6.0	77.3	13.9
MTD16007	62.5	39.0	2.8	67.0	8.0	80.1	14.3
MTD16008	59.4	43.2	2.9	73.0	5.0	74.3	14.6
MTD16009	57.4	36.1	2.7	57.0	9.0	76.0	15.7
MTD16010	62.8	37.7	2.8	57.0	9.0	85.0	14.3
MTD16011	59.8	39.6	2.8	44.0	12.0	77.1	14.7

-one measurement of bulk sub-sample per line

<sup>1</sup>Reported on a 12% moisture basis

**Table 17. USDA-ARS semolina quality traits for 2017 irrigated location at Post Agronomy Farm in Bozeman, MT.**

<b>Line</b>	<b>Milling Yield (%)<sup>1</sup></b>	<b>L*</b>	<b>b*</b>	<b>Mixograph Pattern</b>	<b>Grain Ash (%)</b>	<b>Falling Number (sec)</b>	<b>Semolina Protein (%)<sup>2</sup></b>	<b>Semolina Ash (%)</b>
Mountrail	63.4	85.7	26.5	3.0	1.5	449.0	12.8	0.6
Divide	63.7	84.7	29.3	5.0	1.5	379.0	13.7	0.5
Alkabo	64.7	85.1	31.5	4.0	1.5	412.0	12.0	0.6
Grenora	63.6	85.1	30.1	4.0	1.6	428.0	12.6	0.6
Tioga	63.2	84.7	31.6	7.0	1.6	434.0	13.4	0.6
Carpio	64.4	84.7	31.8	7.0	1.4	424.0	12.7	0.6
Joppa	65.0	85.2	30.2	5.0	1.4	423.0	12.2	0.5
Alzada	64.4	84.4	30.7	7.0	1.6	450.0	13.0	0.6
Dynamic	64.3	84.5	33.3	5.0	1.5	415.0	13.2	0.6
Fortitude	62.3	84.5	32.7	7.0	1.6	412.0	13.8	0.7
Precision	62.4	84.4	33.0	7.0	1.6	450.0	13.4	0.6
Vivid	64.4	84.1	32.9	6.0	1.5	394.0	13.4	0.6
MT112219	64.6	83.9	28.7	6.0	1.6	450.0	12.6	0.6
MTD16001	63.9	84.7	29.9	6.0	1.5	421.0	13.0	0.6
MTD16002	63.9	84.3	29.1	3.0	1.4	450.0	13.9	0.5
MTD16003	65.1	85.2	28.5	3.0	1.4	416.0	11.7	0.6
MTD16004	64.3	84.4	26.2	3.0	1.4	439.0	12.9	0.5
MTD16005	63.7	84.5	30.0	3.0	1.5	437.0	13.7	0.5
MTD16006	63.9	84.8	26.7	3.0	1.5	411.0	13.1	0.6
MTD16007	64.7	85.0	22.9	4.0	1.5	404.0	13.0	0.5
MTD16008	62.5	83.8	28.2	4.0	1.6	450.0	13.5	0.6
MTD16009	60.0	84.6	26.4	4.0	1.5	390.0	14.9	0.6
MTD16010	64.8	85.0	28.4	4.0	1.5	450.0	13.3	0.6
MTD16011	62.9	84.5	30.9	5.0	1.5	439.0	13.7	0.6

-one measurement of bulk sub-sample per line

<sup>1</sup>Reported on a 14% moisture basis

<sup>2</sup>Reported on a 12% moisture basis

**Table 18. USDA-ARS seed quality traits for 2017 rainfed location at Post Agronomy Farm in Bozeman, MT.**

<b>Line</b>	<b>Test Weight (lbs/bu)</b>	<b>Kernel Weight (mg)</b>	<b>Kernel Diameter (mm)</b>	<b>Large Kernels (%)</b>	<b>Small Kernels (%)</b>	<b>Hardness</b>	<b>Wheat Protein (%)<sup>1</sup></b>
Mountrail	61.4	40.9	2.8	47.0	10.0	78.5	14.0
Divide	62.1	42.6	2.9	64.0	8.0	77.2	14.8
Alkabo	62.5	41.3	2.8	61.0	7.0	83.1	13.8
Grenora	62.0	42.3	2.8	63.0	7.0	83.4	14.0
Tioga	63.3	43.3	2.9	72.0	6.0	81.3	14.5
Carpio	60.9	40.7	2.8	69.0	7.0	78.8	14.2
Joppa	62.2	40.1	2.7	60.0	8.0	82.2	14.1
Alzada	61.0	40.7	2.9	68.0	7.0	80.2	15.1
Dynamic	61.1	38.5	2.7	45.0	12.0	84.0	16.3
Fortitude	61.0	37.2	2.8	62.0	8.0	85.6	15.5
Precision	62.4	37.7	2.7	55.0	9.0	89.2	15.1
Vivid	62.2	40.7	2.8	74.0	6.0	82.8	15.6
MT112219	62.6	36.1	2.7	47.0	14.0	82.1	14.3
MTD16001	60.6	39.2	2.7	54.0	10.0	81.8	14.4
MTD16002	61.2	38.1	2.7	55.0	8.0	89.4	15.0
MTD16003	62.0	39.2	2.8	60.0	9.0	84.3	13.0
MTD16004	62.8	40.5	2.9	73.0	5.0	83.7	14.0
MTD16005	61.3	42.6	2.8	61.0	6.0	79.5	14.9
MTD16006	61.8	45.7	2.9	79.0	4.0	80.0	14.7
MTD16007	62.6	39.5	2.8	63.0	6.0	81.1	14.6
MTD16008	61.3	45.4	2.9	78.0	4.0	80.9	14.5
MTD16009	59.2	39.5	2.8	60.0	6.0	81.2	15.3
MTD16010	62.6	37.6	2.8	60.0	8.0	85.6	14.5
MTD16011	61.3	41.7	2.8	53.0	8.0	77.3	14.7

-one measurement of bulk sub-sample per line

<sup>1</sup>Reported on a 12% moisture basis

**Table 19. USDA-ARS semolina quality traits for 2017 rainfed location at Post Agronomy Farm in Bozeman, MT.**

Line	Milling Yield (%) <sup>1</sup>	L*	b*	Mixograph Pattern	Grain Ash (%)	Falling Number (sec)	Semolina Protein (%) <sup>2</sup>	Semolina Ash (%)
Mountrail	64.5	85.1	26.7	3.0	1.2	394.0	13.0	0.5
Divide	64.0	85.0	28.7	4.0	1.2	377.0	13.4	0.5
Alkabo	62.8	85.2	31.1	4.0	1.2	392.0	12.3	0.5
Grenora	62.8	85.1	30.1	4.0	1.2	413.0	12.6	0.5
Tioga	64.7	85.3	30.7	6.0	1.2	365.0	13.0	0.4
Carpio	63.0	85.1	31.7	7.0	1.2	426.0	13.0	0.5
Joppa	64.2	85.0	30.5	6.0	1.2	412.0	12.6	0.5
Alzada	63.3	83.9	32.4	8.0	1.3	450.0	13.6	0.6
Dynamic	61.5	83.6	32.3	7.0	1.3	428.0	14.8	0.5
Fortitude	61.0	84.2	32.0	6.0	1.3	402.0	14.1	0.6
Precision	60.9	84.5	33.8	6.0	1.2	450.0	13.8	0.6
Vivid	62.0	84.5	33.3	6.0	1.3	407.0	13.7	0.6
MT112219	63.8	83.7	29.7	5.0	1.3	450.0	12.9	0.6
MTD16001	63.1	85.0	30.0	5.0	1.2	411.0	12.9	0.5
MTD16002	61.8	84.8	28.8	4.0	1.2	450.0	13.8	0.5
MTD16003	63.4	85.3	27.6	3.0	1.2	381.0	11.5	0.5
MTD16004	62.2	84.6	26.4	4.0	1.3	404.0	12.9	0.5
MTD16005	62.8	84.9	30.0	5.0	1.2	394.0	13.5	0.5
MTD16006	62.9	85.2	26.2	4.0	1.2	395.0	13.4	0.5
MTD16007	62.0	85.0	23.2	4.0	1.2	386.0	13.2	0.5
MTD16008	62.1	84.0	27.0	4.0	1.2	384.0	12.9	0.5
MTD16009	60.6	84.7	25.7	5.0	1.3	374.0	14.2	0.5
MTD16010	63.5	85.0	28.0	5.0	1.2	450.0	13.7	0.5
MTD16011	63.4	84.4	30.5	5.0	1.2	417.0	13.8	0.5

-one measurement of bulk sub-sample per line

<sup>1</sup>Reported on a 14% moisture basis

<sup>2</sup>Reported on a 12% moisture basis

**Table 20. USDA-ARS seed quality traits for 2017 rainfed location at Southern Agricultural Research Center Huntley, MT.**

Line	Test Weight (lbs/bu)	Kernel Weight (mg)	Kernel Diameter (mm)	Large Kernels (%)	Small Kernels (%)	Hardness	Wheat Protein (%) <sup>1</sup>
Mountrail	61.7	38.9	2.7	20.0	18.0	77.4	13.2
Divide	62.6	40.3	2.8	45.0	10.0	75.4	14.2
Alkabo	63.4	38.0	2.7	41.0	12.0	81.7	13.4
Grenora	61.8	38.9	2.7	42.0	12.0	80.9	13.7
Tioga	62.1	38.0	2.7	45.0	11.0	79.9	14.2
Carpio	60.6	37.2	2.7	44.0	11.0	79.9	14.1
Joppa	62.6	37.9	2.7	40.0	13.0	81.6	13.4
Alzada	61.6	42.5	3.0	45.0	6.0	75.5	14.0
Dynamic	60.7	34.6	2.6	17.0	20.0	86.1	15.4
Fortitude	61.6	36.0	2.7	48.0	11.0	84.5	14.6
Precision	61.6	35.2	2.6	43.0	12.0	85.5	15.0
Vivid	61.9	37.8	2.7	50.0	11.0	82.0	15.0
MT112219	63.8	37.1	2.7	44.0	14.0	80.8	12.9
MTD16001	61.0	38.7	2.7	34.0	15.0	80.0	13.6
MTD16002	61.3	36.8	2.7	25.0	15.0	82.6	13.9
MTD16003	62.2	36.9	2.7	42.0	13.0	79.3	12.7
MTD16004	63.4	39.8	2.8	67.0	6.0	79.3	13.2
MTD16005	61.2	38.4	2.7	27.0	14.0	78.9	14.2
MTD16006	62.4	44.2	2.9	75.0	4.0	74.0	13.6
MTD16007	62.6	36.4	2.7	30.0	14.0	81.2	14.0
MTD16008	61.0	39.6	2.8	57.0	9.0	76.5	13.3
MTD16009	57.6	35.3	2.7	24.0	16.0	79.8	14.8
MTD16010	62.4	36.7	2.7	34.0	13.0	83.6	14.3
MTD16011	61.9	39.3	2.7	33.0	13.0	77.5	13.9

-one measurement of bulk sub-sample per line

<sup>1</sup>Reported on a 12% moisture basis



**Table 21. USDA-ARS semolina quality traits for 2017 rainfed location at Southern Agricultural Research Center Huntley, MT.**

<b>Line</b>	<b>Milling Yield (%)<sup>1</sup></b>	<b>L*</b>	<b>b*</b>	<b>Mixograph Pattern</b>	<b>Grain Ash (%)</b>	<b>Falling Number (sec)</b>	<b>Semolina Protein (%)<sup>2</sup></b>	<b>Semolina Ash (%)</b>
Mountrail	62.9	84.7	26.6	3.0	1.3	450.0	12.5	0.5
Divide	63.9	84.6	29.5	4.0	1.3	444.0	12.8	0.6
Alkabo	62.0	84.4	31.6	4.0	1.4	450.0	12.3	0.6
Grenora	61.5	84.4	31.1	4.0	1.4	450.0	12.6	0.6
Tioga	64.1	84.1	32.1	7.0	1.5	450.0	13.3	0.6
Carpio	62.3	84.4	32.3	7.0	1.4	445.0	13.5	0.6
Joppa	63.1	84.6	31.9	5.0	1.3	447.0	12.4	0.5
Alzada	62.7	83.7	32.3	7.0	1.3	450.0	12.9	0.7
Dynamic	62.1	83.6	33.6	6.0	1.5	413.0	14.2	0.6
Fortitude	61.1	83.9	34.0	6.0	1.4	438.0	13.3	0.6
Precision	61.4	83.7	35.0	7.0	1.5	450.0	13.8	0.7
Vivid	62.7	83.9	33.8	6.0	1.4	446.0	13.9	0.6
MT112219	64.0	84.1	30.0	5.0	1.4	450.0	12.2	0.6
MTD16001	64.0	84.2	30.4	4.0	1.3	425.0	12.5	0.5
MTD16002	63.3	84.2	29.4	3.0	1.3	449.0	13.3	0.5
MTD16003	65.1	84.7	28.0	3.0	1.2	426.0	11.7	0.5
MTD16004	63.9	84.0	26.8	4.0	1.3	450.0	12.5	0.5
MTD16005	63.7	83.6	31.3	4.0	1.2	426.0	13.2	0.5
MTD16006	63.1	84.7	26.7	4.0	1.4	436.0	13.0	0.6
MTD16007	63.2	84.7	24.2	4.0	1.3	421.0	12.7	0.6
MTD16008	63.1	83.6	28.3	3.0	1.3	450.0	12.6	0.6
MTD16009	60.0	84.1	26.9	4.0	1.4	446.0	14.2	0.6
MTD16010	62.7	84.2	28.1	4.0	1.3	450.0	13.3	0.5
MTD16011	63.9	84.0	32.0	4.0	1.2	450.0	12.9	0.5

-one measurement of bulk sub-sample per line

<sup>1</sup>Reported on a 14% moisture basis

<sup>2</sup>Reported on a 12% moisture basis

**Table 22. USDA-ARS seed quality traits for 2017 irrigated location at Eastern Agricultural Research Center Sidney, MT.**

Line	Test Weight (lbs/bu)	Kernel Weight (mg)	Kernel Diameter (mm)	Large Kernels (%)	Small Kernels (%)	Hardness	Wheat Protein (%) <sup>1</sup>
Mountrail	61.3	41.1	2.9	72.0	7.0	70.7	11.4
Divide	60.4	41.4	2.9	76.0	6.0	65.1	11.8
Alkabo	60.9	42.8	2.9	79.0	6.0	64.2	12.1
Grenora	60.3	44.5	3.0	84.0	4.0	63.9	12.2
Tioga	60.2	45.7	3.1	85.0	4.0	54.0	11.1
Carpio	61.4	44.1	3.0	86.0	3.0	59.4	11.1
Joppa	61.0	44.6	3.0	81.0	4.0	61.8	10.6
Alzada	60.3	48.0	3.1	89.0	3.0	68.2	11.9
Dynamic	61.3	41.1	2.9	75.0	5.0	72.4	11.8
Fortitude	60.9	40.6	2.9	78.0	7.0	75.7	12.2
Precision	61.6	40.1	2.9	79.0	5.0	71.1	11.6
Vivid	61.3	42.6	2.9	81.0	5.0	71.5	12.2
MT112219	62.2	43.8	3.0	84.0	5.0	65.0	10.8
MTD16001	59.7	43.2	2.9	73.0	7.0	65.6	11.0
MTD16002	60.9	40.3	2.9	73.0	6.0	70.7	11.8
MTD16003	61.4	38.5	2.8	74.0	8.0	69.4	10.4
MTD16004	61.7	44.4	3.1	86.0	4.0	71.0	12.4
MTD16005	60.3	43.7	2.9	74.0	6.0	66.1	12.0
MTD16006	60.6	47.4	3.0	86.0	4.0	68.5	12.1
MTD16007	61.3	41.9	2.9	82.0	4.0	65.7	12.1
MTD16008	60.5	44.8	3.0	83.0	5.0	68.9	11.2
MTD16009	58.4	40.3	2.9	69.0	7.0	68.0	12.4
MTD16010	62.4	39.7	2.9	71.0	7.0	79.1	13.4
MTD16011	59.8	40.4	2.8	68.0	8.0	64.4	11.6

-one measurement of bulk sub-sample per line

<sup>1</sup>Reported on a 12% moisture basis

**Table 23. USDA-ARS semolina quality traits for 2017 irrigated location at Eastern Agricultural Research Center Sidney, MT.**

Line	Milling Yield (%) <sup>1</sup>	L*	b*	Mixograph Pattern	Grain Ash (%)	Falling Number (sec)	Semolina Protein (%) <sup>2</sup>	Semolina Ash (%)
Mountrail	64.5	85.8	22.8	3.0	1.6	450.0	10.4	0.6
Divide	64.0	85.9	23.8	6.0	1.4	450.0	10.1	0.6
Alkabo	64.5	85.9	25.8	5.0	1.4	450.0	10.5	0.5
Grenora	64.2	86.1	25.2	6.0	1.5	411.0	10.4	0.6
Tioga	65.9	86.1	24.7	6.0	1.6	445.0	9.7	0.6
Carpio	63.9	85.8	26.5	6.0	1.6	450.0	9.8	0.6
Joppa	64.5	86.3	24.5	6.0	1.5	450.0	9.7	0.6
Alzada	64.2	84.6	27.9	7.0	1.7	450.0	10.9	0.7
Dynamic	64.5	85.1	28.9	4.0	1.6	450.0	11.1	0.7
Fortitude	61.7	84.7	28.8	6.0	1.6	439.0	10.9	0.6
Precision	62.8	85.3	29.0	6.0	1.6	450.0	10.4	0.6
Vivid	63.4	84.7	28.7	6.0	1.5	450.0	11.1	0.6
MT112219	66.0	85.2	24.1	6.0	1.5	450.0	9.8	0.6
MTD16001	64.6	85.6	24.2	6.0	1.4	450.0	10.0	0.6
MTD16002	64.3	85.7	23.5	5.0	1.4	450.0	10.4	0.6
MTD16003	66.1	85.9	23.8	5.0	1.3	431.0	9.7	0.5
MTD16004	62.7	85.1	22.3	6.0	1.4	450.0	11.1	0.6
MTD16005	65.1	85.4	25.4	6.0	1.5	439.0	10.9	0.6
MTD16006	64.6	85.4	22.5	6.0	1.4	424.0	11.0	0.6
MTD16007	63.5	86.4	17.7	5.0	1.5	444.0	10.1	0.6
MTD16008	63.8	84.2	23.5	4.0	1.5	450.0	10.2	0.6
MTD16009	61.7	85.6	22.2	6.0	1.5	431.0	10.5	0.6
MTD16010	64.5	84.8	24.2	6.0	1.5	450.0	11.7	0.5
MTD16011	65.1	85.8	26.0	5.0	1.4	450.0	9.9	0.6

-one measurement of bulk sub-sample per line

<sup>1</sup>Reported on a 14% moisture basis

<sup>2</sup>Reported on a 12% moisture basis

**Table 24. USDA-ARS seed quality traits for 2017 rainfed location at Eastern Agricultural Research Center Sidney, MT.**

Line	Test Weight (lbs/bu)	Kernel Weight (mg)	Kernel Diameter (mm)	Large Kernels (%)	Small Kernels (%)	Hardness	Wheat Protein (%) <sup>1</sup>
Mountrail	59.3	36.5	2.7	26.0	16.0	76.7	13.9
Divide	59.1	37.4	2.6	42.0	14.0	73.0	13.4
Alkabo	60.3	37.6	2.6	40.0	11.0	77.3	13.3
Grenora	58.2	36.4	2.6	33.0	12.0	78.1	13.2
Tioga	59.2	35.1	2.6	45.0	11.0	76.6	13.9
Carpio	58.6	35.0	2.6	43.0	14.0	73.8	13.3
Joppa	59.0	36.6	2.6	39.0	13.0	76.3	13.8
Alzada	59.5	42.6	2.9	75.0	5.0	75.9	13.7
Dynamic	58.7	34.1	2.6	21.0	18.0	78.1	15.1
Fortitude	58.7	33.1	2.6	43.0	16.0	80.5	14.1
Precision	59.4	33.7	2.6	33.0	14.0	80.9	14.1
Vivid	59.5	34.2	2.6	40.0	15.0	80.4	14.7
MT112219	61.5	37.7	2.7	59.0	8.0	77.8	13.5
MTD16001	58.1	35.0	2.6	20.0	19.0	76.8	13.6
MTD16002	59.0	32.7	2.5	14.0	24.0	83.2	13.4
MTD16003	59.1	34.7	2.6	32.0	19.0	76.4	12.4
MTD16004	60.8	36.8	2.8	53.0	10.0	79.5	12.7
MTD16005	58.1	35.2	2.6	26.0	17.0	75.3	13.5
MTD16006	59.8	37.4	2.7	54.0	11.0	78.3	13.4
MTD16007	60.0	35.0	2.6	37.0	13.0	77.4	13.8
MTD16008	58.9	37.6	2.7	51.0	13.0	75.4	13.1
MTD16009	55.0	31.4	2.5	19.0	20.0	75.0	15.0
MTD16010	59.4	30.3	2.5	23.0	23.0	83.7	14.0
MTD16011	58.3	35.4	2.6	21.0	18.0	74.7	13.8

-one measurement of bulk sub-sample per line

<sup>1</sup>Reported on a 12% moisture basis

**Table 25. USDA-ARS semolina quality traits for 2017 rainfed location at Eastern Agricultural Research Center Sidney, MT.**

Line	Milling Yield (%) <sup>1</sup>	L*	b*	Mixograph Pattern	Grain Ash (%)	Falling Number (sec)	Semolina Protein (%) <sup>2</sup>	Semolina Ash (%)
Mountrail	63.2	84.7	25.5	3.0	1.2	450.0	12.6	0.6
Divide	61.7	84.8	25.8	6.0	1.2	423.0	12.4	0.6
Alkabo	61.3	84.9	29.0	6.0	1.2	450.0	11.9	0.5
Grenora	60.5	84.5	28.9	5.0	1.3	437.0	12.4	0.6
Tioga	62.0	84.5	28.5	7.0	1.3	450.0	12.9	0.6
Carpio	60.5	84.6	30.0	7.0	1.2	440.0	12.3	0.5
Joppa	61.0	84.7	28.1	7.0	1.4	450.0	12.9	0.5
Alzada	61.9	83.9	31.0	7.0	1.3	450.0	12.6	0.6
Dynamic	60.0	84.1	31.3	7.0	1.2	415.0	13.9	0.5
Fortitude	58.1	84.0	30.7	7.0	1.3	450.0	13.3	0.6
Precision	58.3	84.0	32.6	7.0	1.3	450.0	13.4	0.6
Vivid	59.5	83.8	31.5	7.0	1.2	450.0	13.6	0.6
MT112219	63.4	83.8	27.4	7.0	1.2	450.0	12.4	0.6
MTD16001	60.6	84.4	27.3	6.0	1.2	440.0	12.4	0.5
MTD16002	59.7	84.6	25.9	5.0	1.3	450.0	12.2	0.5
MTD16003	61.1	84.9	25.7	5.0	1.2	450.0	11.2	0.5
MTD16004	60.6	84.6	23.6	5.0	1.3	450.0	12.1	0.5
MTD16005	60.3	84.6	27.3	5.0	1.3	450.0	12.5	0.5
MTD16006	61.0	84.7	23.7	6.0	1.4	450.0	12.7	0.5
MTD16007	59.3	84.9	20.2	6.0	1.3	447.0	12.9	0.5
MTD16008	60.5	83.8	26.0	6.0	1.2	450.0	12.4	0.6
MTD16009	56.7	84.4	24.8	5.0	1.4	450.0	13.8	0.5
MTD16010	59.8	84.3	25.6	5.0	1.3	450.0	13.5	0.5
MTD16011	60.4	84.3	28.2	6.0	1.2	450.0	13.0	0.5

-one measurement of bulk sub-sample per line

<sup>1</sup>Reported on a 14% moisture basis

<sup>2</sup>Reported on a 12% moisture basis

**Table 26. USDA-ARS seed quality traits for 2017 rainfed location at Central Agricultural Research Center in Moccasin, MT.**

Line	Test Weight (lbs/bu)	Kernel Weight (mg)	Kernel Diameter (mm)	Large Kernels (%)	Small Kernels (%)	Hardness	Wheat Protein (%) <sup>1</sup>
Mountrail	55.5	31.0	2.4	1.0	60.0	69.3	19.1
Divide	58.1	31.2	2.4	2.0	48.0	76.3	18.0
Alkabo	57.8	31.4	2.4	2.0	40.0	75.8	18.2
Grenora	56.1	30.6	2.4	1.0	50.0	72.7	18.2
Tioga	55.5	29.2	2.3	1.0	51.0	72.5	20.9
Carpio	55.3	28.4	2.3	3.0	43.0	73.4	18.2
Joppa	56.6	31.5	2.4	2.0	54.0	70.8	19.0
Alzada	57.0	31.2	2.5	17.0	20.0	79.1	16.7
Dynamic	55.7	30.1	2.4	1.0	51.0	76.5	20.2
Fortitude	56.7	28.8	2.4	4.0	37.0	80.6	18.7
Precision	56.7	28.1	2.4	3.0	43.0	81.4	18.5
Vivid	56.7	29.5	2.3	4.0	37.0	79.6	19.2
MT112219	57.7	29.5	2.4	1.0	51.0	79.5	17.8
MTD16001	56.5	30.6	2.4	1.0	59.0	76.9	18.2
MTD16002	56.6	28.1	2.3	0.0	59.0	83.5	18.2
MTD16003	57.4	29.1	2.3	5.0	46.0	79.9	16.9
MTD16004	58.6	29.5	2.4	8.0	31.0	84.0	17.6
MTD16005	56.1	30.9	2.3	2.0	50.0	72.7	18.4
MTD16006	57.4	30.7	2.4	5.0	46.0	78.4	17.8
MTD16007	56.6	30.8	2.4	2.0	46.0	75.5	18.4
MTD16008	56.5	33.8	2.5	11.0	30.0	72.5	19.3
MTD16009	53.0	28.9	2.3	1.0	55.0	73.3	19.5
MTD16010	57.3	27.6	2.4	1.0	51.0	82.9	18.9
MTD16011	55.6	30.1	2.3	1.0	53.0	71.1	19.2

-one measurement of bulk sub-sample per line

<sup>1</sup>Reported on a 12% moisture basis

**Table 27. USDA-ARS semolina quality traits for 2017 rainfed location at Central Agricultural Research Center in Moccasin, MT.**

<b>Line</b>	<b>Milling Yield (%)<sup>1</sup></b>	<b>L*</b>	<b>b*</b>	<b>Mixograph Pattern</b>	<b>Grain Ash (%)</b>	<b>Falling Number (sec)</b>	<b>Semolina Protein (%)<sup>2</sup></b>	<b>Semolina Ash (%)</b>
Mountrail	58.9	83.3	26.2	3.0	1.5	450.0	17.8	0.7
Divide	58.9	83.9	25.1	6.0	1.4	450.0	16.6	0.7
Alkabo	58.4	83.7	29.6	5.0	1.6	450.0	17.2	0.7
Grenora	56.6	83.7	28.3	5.0	1.6	450.0	17.2	0.7
Tioga	56.9	83.8	29.6	6.0	1.7	450.0	19.6	0.7
Carpio	54.6	83.8	29.1	7.0	1.6	450.0	17.7	0.7
Joppa	57.5	83.5	29.6	7.0	1.5	450.0	17.8	0.7
Alzada	59.4	83.3	31.4	8.0	1.5	450.0	15.9	0.7
Dynamic	56.5	82.9	29.6	7.0	1.6	412.0	19.5	0.8
Fortitude	54.7	83.3	30.1	7.0	1.6	450.0	17.6	0.7
Precision	55.7	83.4	33.1	6.0	1.6	450.0	17.6	0.7
Vivid	56.8	82.9	30.6	6.0	1.6	404.0	18.3	0.7
MT112219	57.5	82.8	26.7	7.0	1.7	450.0	16.6	0.8
MTD16001	58.0	83.2	26.8	5.0	1.6	450.0	17.6	0.7
MTD16002	56.5	83.1	25.9	5.0	1.5	450.0	17.3	0.7
MTD16003	56.5	83.8	25.7	5.0	1.4	430.0	15.8	0.7
MTD16004	56.6	83.6	23.4	4.0	1.5	450.0	16.7	0.7
MTD16005	56.5	83.2	26.6	5.0	1.6	450.0	18.0	0.7
MTD16006	56.7	84.0	25.5	6.0	1.4	450.0	17.1	0.6
MTD16007	56.1	83.5	21.8	6.0	1.5	450.0	17.4	0.7
MTD16008	56.4	82.8	25.2	5.0	1.5	450.0	17.7	0.7
MTD16009	52.5	83.2	24.1	6.0	1.5	386.0	18.5	0.8
MTD16010	55.2	83.8	24.1	5.0	1.6	450.0	18.2	0.7
MTD16011	56.0	83.6	27.3	6.0	1.6	450.0	18.4	0.7

-one measurement of bulk sub-sample per line

<sup>1</sup>Reported on a 14% moisture basis

<sup>2</sup>Reported on a 12% moisture basis

**Table 28. USDA-ARS seed quality traits for 2017 rainfed location at Northern Agricultural Research Center in Havre, MT.**

Line	Test Weight (lbs/bu)	Kernel Weight (mg)	Kernel Diameter (mm)	Large Kernels (%)	Small Kernels (%)	Hardness	Wheat Protein (%) <sup>1</sup>
Mountrail	59.2	38.9	2.7	42.0	13.0	73.7	16.6
Divide	59.3	40.3	2.8	59.0	10.0	70.6	15.9
Alkabo	60.3	40.9	2.8	58.0	9.0	69.7	15.6
Grenora	59.0	41.8	2.8	56.0	8.0	71.9	15.7
Tioga	58.7	39.9	2.8	61.0	7.0	71.9	16.3
Carpio	56.6	35.9	2.6	51.0	13.0	69.5	15.8
Joppa	59.4	41.0	2.8	58.0	10.0	71.7	16.7
Alzada	59.5	47.0	3.1	90.0	3.0	67.5	16.4
Dynamic	58.4	36.0	2.7	40.0	12.0	75.4	17.5
Fortitude	59.0	36.4	2.7	61.0	10.0	78.1	16.8
Precision	59.6	37.0	2.7	51.0	8.0	79.1	16.9
Vivid	59.4	37.0	2.7	60.0	9.0	74.8	17.2
MT112219	61.0	41.4	2.9	73.0	4.0	71.7	15.5
MTD16001	57.6	38.4	2.7	39.0	5.0	73.5	15.4
MTD16002	58.3	35.1	2.6	37.0	15.0	77.8	16.1
MTD16003	59.8	36.7	2.7	49.0	13.0	72.8	14.3
MTD16004	60.5	37.0	2.7	65.0	8.0	77.7	15.3
MTD16005	58.4	39.8	2.7	46.0	12.0	70.5	17.0
MTD16006	59.0	42.4	2.9	70.0	6.0	70.8	16.3
MTD16007	59.4	38.4	2.8	57.0	7.0	76.2	16.2
MTD16008	58.6	42.8	2.9	69.0	6.0	68.4	16.3
MTD16009	55.7	35.2	2.6	37.0	14.0	69.1	17.0
MTD16010	58.9	34.5	2.7	38.0	16.0	80.0	16.2
MTD16011	58.6	39.6	2.7	40.0	10.0	73.1	16.7

-one measurement of bulk sub-sample per line

<sup>1</sup>Reported on a 12% moisture basis



**Table 29. USDA-ARS semolina quality traits for 2017 rainfed location at Northern Agricultural Research Center in Havre, MT.**

Line	Milling Yield (%) <sup>1</sup>	L*	b*	Mixograph Pattern	Grain Ash (%)	Falling Number (sec)	Semolina Protein (%) <sup>2</sup>	Semolina Ash (%)
Mountrail	61.3	84.6	26.6	3.0	1.4	450.0	15.7	0.6
Divide	61.4	84.6	26.8	4.0	1.4	450.0	15.2	0.6
Alkabo	60.8	84.2	29.8	4.0	1.4	450.0	14.9	0.6
Grenora	59.4	84.3	30.0	3.0	1.5	450.0	15.1	0.7
Tioga	62.2	84.4	29.4	7.0	1.1	450.0	15.6	0.6
Carpio	58.5	84.2	29.3	7.0	1.5	450.0	15.2	0.6
Joppa	61.2	84.1	30.2	7.0	1.5	450.0	15.5	0.6
Alzada	61.4	83.6	30.0	7.0	1.5	450.0	15.6	0.7
Dynamic	60.0	83.9	30.6	6.0	1.5	450.0	16.8	0.6
Fortitude	58.1	83.9	31.8	6.0	1.6	442.0	16.0	0.7
Precision	58.9	83.4	33.3	6.0	1.5	450.0	15.9	0.6
Vivid	61.3	83.0	31.4	6.0	1.5	450.0	16.1	0.7
MT112219	61.6	83.0	27.8	5.0	1.5	450.0	15.0	0.7
MTD16001	61.0	84.6	28.1	5.0	1.4	448.0	14.8	0.6
MTD16002	60.8	84.1	27.1	3.0	1.2	450.0	15.2	0.6
MTD16003	62.3	84.8	26.2	3.0	1.4	450.0	13.8	0.6
MTD16004	60.8	84.0	24.9	4.0	1.4	450.0	14.8	0.6
MTD16005	61.7	84.1	27.3	4.0	1.3	450.0	15.8	0.6
MTD16006	61.3	84.6	25.2	3.0	1.4	450.0	15.0	0.6
MTD16007	59.7	84.5	22.4	4.0	1.3	450.0	15.5	0.6
MTD16008	61.4	83.3	26.6	3.0	1.4	450.0	14.9	0.6
MTD16009	58.3	84.3	24.8	3.0	1.5	433.0	16.1	0.7
MTD16010	59.7	84.3	26.0	4.0	1.5	450.0	15.3	0.6
MTD16011	60.1	84.0	28.5	4.0	1.4	450.0	16.0	0.6

-one measurement of bulk sub-sample per line

<sup>1</sup>Reported on a 14% moisture basis

<sup>2</sup>Reported on a 12% moisture basis

**Table 30. USDA-ARS seed quality traits for 2017 rainfed location trial at Western Triangle Agricultural Research Center in Conrad, MT.**

Line	Test Weight (lbs/bu)	Kernel Weight (mg)	Kernel Diameter (mm)	Large Kernels (%)	Small Kernels (%)	Hardness	Wheat Protein (%) <sup>1</sup>
Mountrail	58.3	35.4	2.5	11.0	30.0	79.2	14.8
Divide	60.9	36.3	2.6	30.0	19.0	82.8	14.8
Alkabo	60.5	37.3	2.6	28.0	19.0	80.5	14.9
Grenora	60.2	35.5	2.6	29.0	18.0	83.1	15.1
Tioga	59.9	37.5	2.7	38.0	16.0	79.0	15.3
Carpio	59.9	35.3	2.6	37.0	15.0	79.3	14.1
Joppa	60.9	36.4	2.6	29.0	20.0	80.2	14.3
Alzada	60.7	41.5	2.9	68.0	7.0	77.8	14.9
Dynamic	60.0	35.5	2.6	26.0	19.0	84.3	14.6
Fortitude	59.4	32.3	2.6	27.0	20.0	86.8	16.4
Precision	60.2	35.1	2.6	29.0	17.0	84.1	15.6
Vivid	59.6	35.0	2.6	36.0	16.0	83.2	16.0
MT112219	61.7	36.5	2.7	44.0	13.0	82.7	14.2
MTD16001	58.2	34.7	2.5	12.0	29.0	77.9	15.2
MTD16002	58.7	31.6	2.5	4.0	31.0	85.1	15.4
MTD16003	59.8	33.5	2.5	22.0	24.0	82.6	14.2
MTD16004	61.5	35.5	2.6	40.0	16.0	81.0	13.6
MTD16005	59.7	35.6	2.5	23.0	21.0	76.8	15.1
MTD16006	59.7	36.0	2.6	30.0	14.0	78.5	14.8
MTD16007	61.0	35.8	2.6	27.0	18.0	81.6	15.0
MTD16008	59.0	36.9	2.6	41.0	17.0	77.3	14.9
MTD16009	56.6	32.3	2.5	14.0	24.0	76.9	15.9
MTD16010	61.4	34.2	2.6	34.0	17.0	86.6	15.2
MTD16011	58.8	34.6	2.5	13.0	22.0	77.9	15.6

-one measurement of bulk sub-sample per line

<sup>1</sup>Reported on a 12% moisture basis

**Table 31. USDA-ARS semolina quality traits for 2017 rainfed location trial at Western Triangle Agricultural Research Center in Conrad, MT.**

Line	Milling Yield (%) <sup>1</sup>	L*	b*	Mixograph Pattern	Grain Ash (%)	Falling Number (sec)	Semolina Protein (%) <sup>2</sup>	Semolina Ash (%)
Mountrail	59.5	85.3	26.6	3.0	1.4	450.0	14.4	0.6
Divide	61.0	84.6	28.5	4.0	1.3	442.0	13.4	0.5
Alkabo	60.4	84.7	30.6	4.0	1.3	450.0	13.2	0.5
Grenora	59.7	84.8	29.4	4.0	1.3	436.0	13.6	0.6
Tioga	61.9	84.6	29.1	6.0	1.3	450.0	13.9	0.6
Carpio	61.0	84.4	31.6	7.0	1.2	450.0	13.3	0.5
Joppa	61.9	84.6	30.4	6.0	1.2	437.0	13.1	0.5
Alzada	62.8	83.8	31.6	7.0	1.3	450.0	14.0	0.6
Dynamic	60.8	84.0	32.3	5.0	1.4	412.0	13.5	0.5
Fortitude	57.8	83.9	31.9	6.0	1.4	449.0	14.7	0.6
Precision	58.2	83.9	33.1	6.0	1.4	450.0	14.6	0.6
Vivid	59.3	83.5	33.1	7.0	1.3	435.0	14.4	0.6
MT112219	62.6	84.0	27.5	6.0	1.3	424.0	13.2	0.6
MTD16001	61.4	84.2	29.1	4.0	1.3	433.0	14.1	0.5
MTD16002	61.1	84.1	28.4	4.0	1.3	450.0	14.4	0.6
MTD16003	62.9	84.5	26.7	4.0	1.2	443.0	12.9	0.5
MTD16004	61.3	84.8	24.8	5.0	1.3	450.0	12.4	0.5
MTD16005	61.8	84.3	29.1	6.0	1.3	435.0	13.9	0.5
MTD16006	60.4	84.6	25.8	6.0	1.4	450.0	13.8	0.6
MTD16007	61.3	84.8	21.6	6.0	1.3	423.0	13.7	0.6
MTD16008	61.3	83.4	27.0	6.0	1.3	450.0	14.0	0.6
MTD16009	57.9	84.3	26.3	6.0	1.3	445.0	15.0	0.6
MTD16010	63.4	84.5	27.0	5.0	1.3	450.0	14.1	0.5
MTD16011	59.8	84.0	28.9	5.0	1.3	450.0	14.6	0.6

-one measurement of bulk sub-sample per line

<sup>1</sup>Reported on a 14% moisture basis

<sup>2</sup>Reported on a 12% moisture basis

**Table 32. USDA-ARS seed quality traits for 2017 rainfed location maintained by Northern Seeds, LLC., Conrad, MT.**

Line	Test Weight (lbs/bu)	Kernel Weight (mg)	Kernel Diameter (mm)	Large Kernels (%)	Small Kernels (%)	Hardness	Wheat Protein (%) <sup>1</sup>
Mountrail	56.2	32.7	2.4	3.0	44.0	70.7	16.9
Divide	57.9	31.6	2.4	11.0	34.0	77.5	16.1
Alkabo	57.8	32.1	2.4	15.0	30.0	78.1	15.8
Grenora	58.0	32.8	2.4	10.0	31.0	80.6	15.2
Tioga	56.5	31.2	2.4	13.0	33.0	77.2	17.6
Carpio	56.5	31.1	2.4	21.0	26.0	77.2	16.3
Joppa	58.2	32.8	2.5	13.0	29.0	79.9	15.8
Dynamic	58.0	33.5	2.5	14.0	24.0	80.1	17.2
Fortitude	57.7	29.8	2.4	14.0	30.0	83.7	17.3
Precision	58.7	30.6	2.4	16.0	27.0	86.0	16.8
Vivid	58.2	31.0	2.4	32.0	18.0	82.7	16.9
MT112219	61.0	33.9	2.6	32.0	16.0	87.0	14.3
MTD16001	55.9	29.6	2.3	5.0	46.0	77.5	16.4
MTD16002	56.1	28.6	2.3	5.0	45.0	81.9	16.2
MTD16003	58.1	29.8	2.4	16.0	26.0	83.7	14.7
MTD16004	58.6	30.0	2.4	16.0	33.0	82.4	16.0
MTD16005	55.8	32.5	2.4	9.0	34.0	75.1	16.4
MTD16006	57.4	31.1	2.4	14.0	29.0	74.8	15.9
MTD16007	56.6	30.1	2.4	10.0	35.0	76.6	17.1
MTD16008	54.8	31.6	2.4	21.0	27.0	69.4	17.5
MTD16009	54.6	31.1	2.4	11.0	31.0	74.9	17.2
MTD16010	58.0	29.2	2.4	11.0	34.0	85.0	16.6
MTD16011	56.5	30.5	2.3	7.0	36.0	74.4	16.6

-No Alzada planted in this trial

-one measurement of bulk sub-sample per line

<sup>1</sup>Reported on a 12% moisture basis

**Table 33. USDA-ARS semolina quality traits for 2017 rainfed location maintained by Northern Seeds, LLC., Conrad, MT.**

<b>Line</b>	<b>Milling Yield (%)<sup>1</sup></b>	<b>L*</b>	<b>b*</b>	<b>Mixograph Pattern</b>	<b>Grain Ash (%)</b>	<b>Falling Number (sec)</b>	<b>Semolina Protein (%)<sup>2</sup></b>	<b>Semolina Ash (%)</b>
Mountrail	56.0	83.7	26.9	3.0	1.5	450.0	15.7	0.8
Divide	56.2	83.7	27.0	7.0	1.4	411.0	15.2	0.6
Alkabo	56.4	83.9	29.8	6.0	1.4	450.0	14.8	0.7
Grenora	55.5	83.7	30.1	5.0	1.4	410.0	14.4	0.6
Tioga	55.5	83.3	30.7	7.0	1.6	450.0	16.7	0.6
Carpio	55.8	83.4	31.6	8.0	1.4	422.0	15.0	0.6
Joppa	57.2	83.7	30.7	7.0	1.3	431.0	14.7	0.6
Dynamic	56.9	83.4	31.9	6.0	1.5	425.0	15.6	0.6
Fortitude	54.1	83.4	32.5	7.0	1.5	450.0	16.1	0.6
Precision	55.4	83.1	33.9	7.0	1.5	450.0	16.0	0.6
Vivid	56.4	79.1	26.0	6.0	1.4	433.0	15.4	0.6
MT112219	59.7	83.4	28.4	5.0	1.4	450.0	13.2	0.6
MTD16001	55.2	83.5	28.5	5.0	1.5	399.0	15.4	0.7
MTD16002	54.0	83.2	27.3	4.0	1.4	450.0	15.5	0.6
MTD16003	56.7	84.1	25.9	4.0	1.3	424.0	13.7	0.6
MTD16004	55.1	83.3	25.3	6.0	1.4	450.0	15.2	0.6
MTD16005	54.9	83.1	28.5	6.0	1.4	411.0	15.5	0.6
MTD16006	56.6	83.7	25.9	5.0	1.4	441.0	15.3	0.7
MTD16007	55.3	83.4	25.7	6.0	1.5	384.0	15.9	0.7
MTD16008	54.3	82.5	26.3	5.0	1.6	450.0	16.1	0.7
MTD16009	53.4	83.5	26.2	5.0	1.3	404.0	15.8	0.6
MTD16010	56.7	83.5	26.8	4.0	1.4	450.0	15.7	0.6
MTD16011	55.2	83.0	29.7	5.0	1.3	427.0	15.2	0.6

-one measurement of bulk sub-sample per line

<sup>1</sup>Reported on a 14% moisture basis

<sup>2</sup>Reported on a 12% moisture basis

**2016 Supplemental Off-station Durum Variety Trials Conducted by  
Montana State University Agricultural Experiment Stations**

North-central Montana Off-Station Durum Variety Performance Evaluations <b>Research conducted by: Peggy F. Lamb and NARC staff</b>	Tables 34, 35
North-east Montana Off-Station Durum Variety Performance Evaluations <b>Research conducted by: Chengci Chen and EARC staff</b>	Tables 36, 37

**Table 34. Agronomic means from 2017 rainfed intrastate durum trial at Leon Cederberg Farm, Turner, MT. Maintained by Northern Agricultural Research Center in Havre, MT.**

Line	Stand (%)	Height (in.)	Yield (bu/ac) <sup>1</sup>	Test weight (lbs/bu)	Protein (%) <sup>2</sup>	Falling Number (sec)	Sawfly (%) <sup>3</sup>
Mountrail	98.7	17.3	15.5	59.7	16.2	308	0.3
Divide	97.3	17.6	15.3	60.6	16.4	314	<b>0.7</b>
Alkabo	<b>99.3</b>	17.4	15.9	60.8	15.9	314	0.0
Grenora	98.0	17.3	17.0	59.4	15.9	319	0.0
Tioga	98.0	19.2	17.7	<b>61.3</b>	15.9	291	0.7
Carpio	98.7	18.1	16.9	59.0	16.3	<u>284</u>	0.0
Joppa	99.7	18.3	19.2	60.0	16.2	311	0.3
Alzada	98.4	<u>16.9</u>	<u>13.7</u>	60.8	<u>16.1</u>	365	0.3
Dynamic	98.7	<b>20.3</b>	<b>20.0</b>	59.8	<b>17.6</b>	325	<u>0.0</u>
Fortitude	<u>95.0</u>	18.6	17.5	<u>59.3</u>	17.3	308	0.3
Precision	99.0	19.8	19.3	60.7	16.9	<b>330</b>	0.0
Vivid	97.4	20.1	16.6	60.5	16.9	302	0.7
Mean	98.2	18.4	17.0	60.2	16.5	314.2	0.3
CV (%)	2.0	7.3	7.3	0.6	1.3	3.5	158.7
LSD (0.05)	NS	2.3	2.1	0.6	0.4	18.6	NS
F>Prob	0.381	0.043	<0.0001	<0.0001	<0.0001	<0.0001	0.342

<sup>1</sup>Reported on a 13% moisture basis

<sup>2</sup>Reported on a 12% moisture basis

<sup>3</sup>Percent cut stems

NS = No significant difference based on ANOVA  $p < 0.05$

Underline/Bold = Highest values, underline = lowest

**Table 35. Agronomic means from 2017 rainfed intrastate durum trial at Kammerzell Farm, Chester, MT. Maintained by Northern Agricultural Research Center in Havre, MT.**

Line	Stand (%)	Height (in.)	Yield (bu/ac) <sup>1</sup>	Test weight (lbs/bu)	Protein (%) <sup>2</sup>	Falling Number (sec)	Sawfly (%) <sup>3</sup>
Mountrail	97.7	27.1	<b>33.9</b>	<u>56.6</u>	17.3	335	<u>0.0</u>
Divide	98.7	25.6	29.9	58.7	17.3	343	<u>0.0</u>
Alkabo	98.0	26.1	27.5	57.9	17.3	336	<b>1.0</b>
Grenora	99.0	27.0	33.1	57.0	17.1	341	0.7
Tioga	99.0	<b>28.5</b>	30.7	<b>59.5</b>	17.4	346	0.7
Carpio	99.0	24.9	26.6	56.9	17.6	343	0.3
Joppa	99.7	28.0	29.9	58.2	<u>16.8</u>	335	0.7
Alzada	99.7	<u>25.1</u>	31.9	57.7	17.5	<b>374</b>	0.3
Dynamic	<u>97.4</u>	25.6	28.1	57.1	<b>18.3</b>	<u>313</u>	<u>0.0</u>
Fortitude	<b>100.0</b>	26.0	31.3	57.1	17.9	338	0.3
Precision	99.0	26.0	29.0	<b>59.5</b>	18.0	352	0.3
Vivid	98.0	27.4	<u>26.1</u>	57.6	17.8	348	<u>0.0</u>
Mean	98.8	26.4	29.8	57.8	17.5	342.1	0.4
CV (%)	1.9	3.8	5.1	0.6	2.0	2.4	0.0
LSD (0.05)	NS	1.7	2.6	0.6	0.6	13.8	NS
F>Prob	0.833	0.004	<0.001	<0.001	<0.002	<0.0001	0.208

<sup>1</sup>Reported on a 13% moisture basis

<sup>2</sup>Reported on a 12% moisture basis

<sup>3</sup>Percent cut stems

NS = No significant difference based on ANOVA  $p < 0.05$

Underline/Bold = Highest values, underline = lowest



**Table 36. Agronomic means from 2017 rainfed durum trial in Wibaux County, MT. Maintained by Eastern Agricultural Research Center in Sidney, MT.**

Variety	Plant Height (in.)	Protein <sup>†</sup> (%)	Grain Yield <sup>†</sup> (bu/ac)
Alkabo	24.9	12.3	32.3
Alzada	22.0	13.1	34.9
Carpio	24.9	12.9	26.4
Divide	25.5	12.4	30.5
Grenora	24.5	13.1	31.7
Joppa	24.8	12.9	24.8
Mountrail	24.9	12.9	31.0
Tioga	25.3	12.3	26.1
Mean	24.6	12.7	29.7
CV (%)	9.3	4.2	14.7
LSD	10.1	0.9	7.6

<sup>†</sup>Adjusted to 12% moisture basis

**Table 37. Agronomic means from 2017 rainfed durum trial in Roosevelt County, MT. Maintained by Eastern Agricultural Research Center in Sidney, MT.**

Variety	Plant Height (in.)	Protein <sup>†</sup> (%)	Grain Yield <sup>†</sup> (bu/ac)
Alkabo	26.4	13.1	28.6
Alzada	24.3	13.3	26.5
Carpio	27.6	13.8	25.4
Dynamic	25.6	15.4	22.6
Fortitude	26.9	15.2	20.6
Precision	25.9	14.5	27.3
Vivid	26.8	15.4	25.6
Divide	26.6	14.3	22.9
Grenora	25.7	14.4	26.8
Joppa	28.1	14.4	23.3
Mountrail	26.1	13.9	29.7
Tioga	28.5	13.8	23.9
Mean	26.5	14.3	25.3
CV (%)	6.8	3.9	11.0
LSD	7.8	1.0	4.7

<sup>†</sup>Adjusted to 12% moisture basis