PROJECT TITLE:

2018 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 2018, twelve experimental durum lines and twelve elite durum varieties were tested at six Montana Agricultural Experiment Stations (Table 1). This year's trial included 11 experimental lines (MTD16001-MTD16011) developed at Montana State University-Bozeman that carry genetic markers associated with reduced cadmium accumulation and/or a licensed gene that increases pasta firmness and one experimental line (MT112219) developed by Dr. Joyce Eckhoff (MSU-EARC) with reduced cadmium accumulation. Elite durum lines tested include releases from North Dakota State University, the Canadian Crop Development Center-University of Saskatchewan, and Westbred. Rainfed experiments were grown in Bozeman, MT (MSU-Post Agronomy Farm), Havre, MT (MSU-NARC), Sidney, MT (MSU-EARC), Conrad, MT (MSU-WTARC), Huntley, MT (MSU-SARC), 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 in a randomized complete block design except for at SARC where plots were planted and analyzed using an alpha-lattice 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 5-12 with overall quality data summarized in Tables 13 and 14. Individual location quality data can be found in Tables 15-32. Agronomic data for off-station variety trails grown in the north central and north-eastern part of Montana can be found at the end of this report (Tables 33-38). 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 by Dr. Chengci Chen (MSU-EARC).

AGRONOMIC RESULTS SUMMARY:

Across eight locations in 2018, MTD16001 (84.6 bu/ac) was highest yielding followed by MTD16004 (81.0 bu/ac). MTD16001 yielded significantly more than the check Mountrail (78.5 bu/ac) (Table 2). MT112219 had the largest test weight (62.9 bu/ac) overall but had the second lowest protein content (13.7%) after MTD16003 (13.6%), which were both significantly lower than Mountrail (Table 2). Dynamic (15.6%), MTD16009 (15.6%) and Vivid (15.5%) had the highest protein content which was significantly higher than Mountrail (Table 2). MTD16009 had the highest protein content of the experimental lines (15.6%) but also had the second lowest yield (74.1 bu/ac) and lowest test weight (58.6 lbs/bu) in the trial (Table 2). MTD16008 (15.3%) also had significantly higher protein than the check Mountrail (14.7%) (Table 2). MT112219 (28.7 in.) was the shortest entry followed by Alzada (29.6 in.), and both are semi-dwarfs, while the tallest lines were MTD16002 (41.1 in.) and MTD16006 (40.2 in.) (Table 2). Alzada and MT112219 also had a significantly earlier heading date (-4 days) compared to Mountrail (Table 2).

Under irrigated conditions, MTD16001 had the highest yield (120.6 bu/ac), which was significantly higher than Mountrail, and Alzada had the lowest yield (90.1 bu/ac) (Table 3). MTD16010 had the highest test weight (64.0 lb/bu) which was significantly higher than Mountrail (Table 3). MTD16009 had the lowest test weight (61.1 lb/ac) and the highest protein content (15.5%). MTD16003 had the lowest protein content (12.9%) followed by MT112219 (13.7%), both were significantly lower than Mountrail (14.8%) (Table 3).

In rainfed trials, MTD16001 (73.2 bu/ac) was highest yielding, significantly higher than Mountrail (67.7 bu/ac) (Table 4). MT112219 had the highest test weight (62.9 lb/bu), was the shortest (28.8 in.) and had the lowest protein content (13.9%) (Table 4). CDC-Dynamic (16.1%) and MTD16009 (16.0%) had the highest protein of the lines.

QUALITY RESULTS SUMMARY:

Grain quality results from USDA-ARS showed significant differences for all traits measured (Tables 13, 14). MT112219 had the highest test weight (62.7 bu/ac), whereas Alzada had the largest individual seed weight (45.0 mg), individual kernel diameter (3.0 mm), and percent large kernels (81.5 %). MTD16009 had the lowest test weight (57.9 bu/ac), lowest number of large kernels (49.1%), and the highest grain protein (15.7%). MT112219 and MTD16003 had the lowest grain protein (13.7%).

MTD16003 had the highest milling yield (63.3%) followed by MT112219 (63.2%) while MTD16009 had the lowest milling yield (59.1%). Semolina protein results reflected the grain protein results with MTD16009 having the highest protein content (14.5%) followed by Dynamic (14.1%) while

MTD16003 (12.2%) and MT112219 (12.5%) had the lowest protein content. Dynamic and Precision had the highest grain ash content (1.59%) while Alzada, MT112219, and MTD16009 had the highest semolina ash content (0.69%). MTD16001 had the lowest grain ash content (1.43%) and lowest semolina ash content (0.59%). Alzada had the highest falling number (439.8 s), while Vivid had the lowest falling number (391.4 s).

Though significant differences existed for semolina whiteness (L*) the range was very small (1.5 units), with the whitest line being Mountrail (85.4) and the least white lines being MTD16008 (83.8) and MT112219 (84.4). Semolina yellowness had a larger range (6.5 units) with the highest yellow values coming from Precision (31.8), Dynamic (31.7), Vivid (31.6,) and Fortitude (31.1). MTD16007 (21.8) had the least yellow semolina which was significantly lower than Mountrail (25.3). The range for yellowness in the MSU experimental lines ranged from 25.5 to 28.8. As measured by mixograph, Alzada had the strongest gluten strength with a mixograph pattern of 6.6 while Mountrail had the weakest gluten with a mixograph pattern of 3.0. The MSU experimental lines had mixograph patterns that ranged from 3.8 to 5.3.

Table 1. 2018 test site information across Montana.

Description	Bozeman	Bozeman (I)	SARC	CARC
Latitude	45° 41'	45° 41'	45° 35'	47° 03'
Longitude	111° 00'	111° 00'	108° 13'	109° 57'
Planting Date	5/5/2018	5/3/2018	4/21/2018	4/26/2018
Harvest Date	9/6/2018	9/10/2018	8/14/2018	8/31/2018
Crop Year Precipitation	20.09"	20.09"	21.70"	21.71"
Growing Season Precipitation	6.45"	6.45"	10.45"	10.15"
Irrigation	-	2"	-	-
Herbicide	Huskey -15 oz/ac	Huskey (15 oz/ac)	Bromac (16 oz/ac); Advanced Affinity (0.5 oz/ac); 1 lbs AMS.	Curtail M 28oz/ac
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	N(0-24")6.5 ppm, P-8 ppm,
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	50 lbs/ac NPKS 20-30-20-10 at planting plus 80 lbs/ac 46-0-0 on 5/30/18
Previous Crop	Fallow	Fallow	Fallow	Fallow
Description	NARC	EARC	EARC (I)	WTARC
Latitude	48° 29'	47° 46'	47° 46'	48° 18'
Longitude	109° 48'	104° 14'	104° 14'	111° 55'
Planting Date	5/1/2018	4/27/2018	5/4/2018	5/4/2018
Harvest Date	8/9/2018	8/22/2018	8/24/2018	8/23/2018
Crop Year Precipitation[1]	13.15"	14.34"	14.19"	11.79"
Growing season Precipitation[1]	4.28"	8.48"	8.94"	5.19"
Irrigation	-	-	2.68"	-
Herbicide	Bromac -16 oz/ac, Affinity 0.6 oz/ac	NA	NA	RT3-40 oz/ac
Soil Fertility	N(0-48")-112.0 lbs/ac PKS-27-345-9 ppm	N-44.5 lbs/ac P_2O_5 30 lbs/ac	N-38.6 lbs/ac P_2O_5 15 lbs/ac	N(0-48")-15.9 lb/ac PK-30-528 ppm
Fertilizer applied	NPKS 100-20-10-10 lb/ac	73.4 lbs/ac N 46-0-0 + 20.8 P_2O_5 lbs/ac	104.2 lbs/ac N 46-0-0 + 29.5 lbs/ac P_2O_5	NPK 11-22-0 lb/ac plus 230-0-20 banded at planting
Previous Crop	Fallow	Fallow	Fallow	Fallow

[1]Crop year precipitation=Sept 2017 - Aug 2018, growing year precipitation=May 2018 -Aug 2018
EARC Crop Year precipitation is Oct 2017 – Sept 2018.

Table 2. Agronomic means from 2018 intrastate durum trials all locations (n=8) and conditions.

Line	Source[1]	Release year	Heading (Julian)	Plant height (in)	Yield (bu/ac)[2]	Test weight (lb/bu)	Protein (%)[3]
Mountrail	NDSU	1998	179.7	37.2	78.5	61.7	14.7
Divide	NDSU	2005	180.9	39.8	75.7	62.1	14.9
Alkabo	NDSU	2005	178.6	37.3	77.0	62.4	14.4
Grenora	NDSU	2005	178.1	36.4	78.5	61.3	14.6
Tioga	NDSU	2010	179.7	39.9	75.2	61.7	15.3
Carpio	NDSU	2012	180.5	37.4	77.8	61.6	14.6
Joppa	NDSU	2013	178.8	38.7	74.4	62.1	14.5
Alzada	WestBred	2004	176.0	29.6	<u>69.1</u>	61.4	14.6
Dynamic[+]	CDC	2016	181.0	38.5	79.2	61.6	<u>**15.6**</u>
Fortitude[+]	CDC	2015	179.5	35.8	79.3	61.7	15.2
Precision[+]	CDC	2016	179.5	38.4	78.0	61.9	15.5
Vivid[+]	CDC	2013	179.5	38.0	77.3	62.0	15.6
MT112219[+]	MSU	-	<u>175.9</u>	<u>28.7</u>	75.0	<u>**62.9**</u>	13.7
MTD16001*	MSU	-	181.2	38.2	<u>**84.6**</u>	61.5	14.0
MTD16002[+*]	MSU	-	<u>**182.2**</u>	<u>**41.1**</u>	77.2	61.6	14.7
MTD16003	MSU	-	179.3	37.8	76.7	62.2	<u>13.6</u>
MTD16004*	MSU	-	179.2	37.2	81.0	62.7	14.5
MTD16005[+*]	MSU	-	181.4	38.8	77.7	61.3	14.7
MTD16006[+]	MSU	-	180.3	40.2	79.0	61.8	14.6
MTD16007[+]	MSU	-	180.0	37.5	78.2	62.4	14.8
MTD16008[+*]	MSU	-	179.1	38.9	74.3	60.3	15.3
MTD16009	MSU	-	181.7	39.6	<u>74.1</u>	<u>58.6</u>	15.6
MTD16010*	MSU	-	180.8	39.6	76.2	62.4	15.1
MTD16011[+*]	MSU	-	181.4	38.6	74.5	61.4	14.9
Mean	-	-	179.8	37.6	77.0	61.7	14.8
CV (%)	-	-	0.4	3.6	9.0	1.0	4.0
LSD (0.05)	-	-	0.4	0.8	3.9	0.3	0.3
F < Prob	-	-	<0.001	<0.001	<0.001	<0.001	<0.001

[+]Low cadmium accumulation gene is present

*Contain a licensed pasta firmness gene

[1]NDSU-North Dakota State University, CDC-University of Saskatchewan Crop Development Center, MSU-Montana State University

[2]Reported on a 13% moisture basis

[3]Reported on a 12% moisture basis

Underline/Bold = Highest values, underline = lowest

Table 3. Agronomic means from 2018 irrigated intrastate durum trials (n=2).

Line	Heading (Julian)	Plant height (in)	Yield (bu/ac)[1]	Test weight (lb/bu)	Protein (%)[2]
Mountrail	183.5	39.9	110.5	62.9	14.8
Divide	185.0	42.5	113.0	63.6	14.7
Alkabo	182.0	38.3	109.1	63.3	14.3
Grenora	181.7	38.3	117.3	62.6	14.4
Tioga	183.2	42.0	112.1	63.4	14.9
Carpio	184.0	39.2	113.7	63.8	14.3
Joppa	182.3	41.3	106.2	63.4	14.5
Alzada	180.0	28.9	90.1	61.7	14.9
Dynamic	**185.7**	40.3	118.8	63.7	15.3
Fortitude	183.3	36.9	114.1	62.6	15.3
Precision	183.3	40.1	114.7	63.6	15.3
Vivid	183.2	39.6	112.4	63.5	15.5
MT112219	180.2	28.9	100.4	62.5	13.7
MTD16001	185.3	40.0	**120.6**	63.4	14.0
MTD16002	185.5	**45.1**	109.9	62.9	15.1
MTD16003	182.8	39.7	114.9	63.5	12.9
MTD16004	183.0	39.2	110.0	63.6	14.8
MTD16005	185.7	40.4	111.1	63.1	14.6
MTD16006	184.8	41.5	108.7	63.1	14.9
MTD16007	183.5	38.6	111.9	64.0	14.9
MTD16008	182.7	40.8	113.6	62.1	15.1
MTD16009	185.3	41.8	116.4	61.1	**15.5**
MTD16010	185.2	40.6	112.4	**64.0**	15.0
MTD16011	185.5	40.5	104.7	63.3	14.8
Mean	183.6	39.3	111.1	63.1	14.7
CV%	0.4	3.3	6.8	0.6	2.3
LSD (P=0.05)	0.8	1.5	9.7	0.5	0.4
Prob > F	<0.001	<0.001	<0.001	<0.001	<0.001

[1]Reported on a 13% moisture basis
[2]Reported on a 12% moisture basis
Underline/Bold = Highest values, underline = lowest

Table 4. Agronomic means from 2018 rainfed intrastate durum trials (n=6).

Line	Heading (Julian)	Plant height (in)	Yield (bu/ac)[1]	Test weight (lb/bu)	Protein (%)[2]
Mountrail	177.9	36.8	67.7	61.2	14.9
Divide	179.2	39.3	62.1	61.4	15.3
Alkabo	176.8	37.2	66.0	62.1	14.7
Grenora	176.1	36.1	64.1	60.7	15.0
Tioga	178.2	39.4	61.7	61.0	15.8
Carpio	179.1	37.4	66.0	60.9	14.9
Joppa	176.9	38.3	63.6	61.6	14.8
Alzada	174.0	30.1	62.6	61.1	14.7
Dynamic	179.2	38.3	65.2	60.9	**16.1**
Fortitude	177.6	35.9	67.9	61.4	15.4
Precision	177.6	38.2	64.7	61.4	15.9
Vivid	177.6	37.7	64.8	61.4	15.9
MT112219	<u>173.7</u>	<u>28.8</u>	66.7	**62.9**	<u>13.9</u>
MTD16001	179.4	37.9	**73.2**	61.0	14.2
MTD16002	**180.8**	40.0	65.1	61.1	14.8
MTD16003	177.5	37.6	64.4	61.7	14.0
MTD16004	177.3	36.8	71.1	62.4	14.6
MTD16005	179.8	38.9	66.3	60.7	15.1
MTD16006	178.3	**40.4**	70.3	61.4	14.6
MTD16007	178.5	37.5	67.6	61.9	15.0
MTD16008	177.5	38.7	60.1	59.5	15.7
MTD16009	180.2	38.9	<u>58.9</u>	<u>57.5</u>	16.0
MTD16010	179.0	39.8	65.2	62.1	15.2
MTD16011	179.6	38.4	63.7	60.6	15.3
Mean	178.0	37.4	65.4	61.2	15.1
CV%	0.50	3.6	10.4	1.5	4.1
LSD (P=0.05)	0.50	0.8	3.9	0.5	0.4
Prob > F	<0.001	<0.001	<0.001	<0.001	<0.001

[1]Reported on a 13% moisture basis
[2]Reported on a 12% moisture basis
Underline/Bold = Highest values, underline = lowest

Table 5. Agronomic means from 2018 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)[1]	Protein (%)[2]	Hardness[3]	Kernel diameter (mm)[3]	Kernel weight (mg)[3]
Mountrail	187.7	44.0	121.1	14.2	77.0	<u>3.0</u>	40.7
Divide	187.7	46.3	121.0	14.8	74.6	3.1	42.9
Alkabo	186.0	42.0	125.0	13.8	74.4	3.1	42.2
Grenora	185.3	42.1	126.6	14.3	74.6	3.1	44.9
Tioga	187.3	46.2	117.6	14.5	71.5	3.2	**<u>47.1</u>**
Carpio	188.0	42.7	124.6	13.8	73.5	3.2	43.9
Joppa	186.3	44.8	116.6	14.0	77.4	3.0	42.3
Alzada	<u>184.0</u>	31.9	<u>102.6</u>	14.4	74.8	**<u>3.3</u>**	46.8
Dynamic	**<u>188.3</u>**	43.3	124.0	15.2	80.5	3.1	41.2
Fortitude	187.7	42.8	126.0	15.0	**<u>82.5</u>**	3.0	<u>39.1</u>
Precision	187.7	43.6	124.8	15.1	79.4	3.1	42.1
Vivid	187.3	44.5	131.2	15.2	77.1	3.1	45.3
MT112219	184.0	<u>31.4</u>	116.9	13.3	78.5	3.0	41.1
MTD16001	188.0	43.7	**<u>129.5</u>**	13.6	75.4	3.1	43.9
MTD16002	188.0	**<u>46.6</u>**	119.8	14.9	78.0	3.0	40.1
MTD16003	186.7	44.1	124.7	<u>12.4</u>	77.1	3.0	41.1
MTD16004	187.7	43.7	122.7	14.3	79.4	3.1	41.5
MTD16005	188.3	44.2	119.7	14.6	72.6	3.1	43.2
MTD16006	187.7	45.8	117.5	14.5	<u>69.4</u>	3.1	46.4
MTD16007	188.3	42.5	117.4	14.5	76.9	3.1	41.9
MTD16008	186.7	45.4	122.2	14.9	71.8	3.1	45.5
MTD16009	188.0	45.7	127.1	**<u>15.7</u>**	76.0	3.0	40.7
MTD16010	188.0	44.1	123.0	14.6	81.1	3.1	41.1
MTD16011	188.3	43.8	119.6	14.9	74.9	3.0	42.4
Mean	187.2	43.1	121.7	14.4	76.2	3.1	42.8
CV (%)	0.2	3.0	3.9	1.5	3.3	2.2	4.9
LSD (P=0.05)	0.7	2.1	7.9	0.4	4.2	0.1	3.4
Prob > F	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

[1]Reported on a 13% moisture basis
[2]Reported on a 12% moisture basis
[3]Determined using Single Kernel Characterization System
Underline/Bold = Highest values, underline = lowest

Table 6. Agronomic means from 2018 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)[1]	Protein (%)[2]	Hardness[3]	Kernel diameter (mm)[3]	Kernel weight (mg)[3]
Mountrail	187.3	41.5	119.1	13.9	79.7	2.9	38.5
Divide	188.0	43.0	113.0	14.2	76.8	3.0	38.8
Alkabo	186.3	42.4	114.3	13.3	74.6	3.0	41.9
Grenora	186.3	40.7	113.8	13.8	78.5	3.0	41.5
Tioga	187.7	**44.4**	109.2	14.0	76.5	3.1	42.0
Carpio	188.0	40.6	112.0	13.4	71.6	**3.2**	**44.0**
Joppa	187.0	41.6	106.5	13.5	79.0	3.0	39.3
Alzada	184.0	29.8	97.1	14.4	78.4	3.1	41.5
Dynamic	188.3	41.6	113.8	**15.3**	80.2	3.0	39.5
Fortitude	188.0	38.8	112.5	14.6	78.7	3.0	38.9
Precision	187.7	42.5	116.7	14.5	79.4	3.0	40.5
Vivid	188.0	44.0	111.6	15.1	78.9	3.0	40.6
MT112219	184.0	30.1	99.6	13.5	79.1	2.9	39.5
MTD16001	188.0	40.7	119.6	13.5	76.6	3.0	40.5
MTD16002	188.7	44.1	112.1	14.0	79.1	2.9	38.2
MTD16003	187.7	40.2	103.3	12.4	80.5	2.9	36.1
MTD16004	187.3	41.9	**127.2**	13.6	80.5	3.0	38.2
MTD16005	188.3	41.5	112.0	14.2	74.4	3.0	41.3
MTD16006	188.0	43.8	109.7	14.0	73.2	3.0	43.4
MTD16007	188.0	40.8	109.1	14.1	76.6	3.1	39.9
MTD16008	188.0	44.0	110.6	14.3	73.3	3.1	42.4
MTD16009	188.3	43.4	101.5	15.0	79.0	2.9	37.5
MTD16010	188.3	43.3	106.8	14.3	**81.2**	3.0	39.2
MTD16011	**189.0**	42.0	111.3	14.3	78.2	2.9	39.1
Mean	187.5	41.2	110.9	14.1	77.7	3.0	40.1
CV (%)	0.2	2.2	8.0	1.5	3.0	1.9	4.1
LSD (P=0.05)	0.6	1.5	NS	0.3	3.8	0.1	2.7
Prob > F	<0.001	<0.001	0.080	<0.001	<0.001	<0.001	<0.001

[1]Reported on a 13% moisture basis
[2]Reported on a 12% moisture basis
[3]Determined using Single Kernel Characterization System
NS = No significant difference based on ANOVA $p<0.05$
Underline/Bold = Highest values, underline = lowest

Table 7. Agronomic means from 2018 rainfed intrastate durum trial conducted at Southern Agricultural Research Center Huntley, MT.

Line	Heading (Julian)	Plant height (in)	Yield (bu/ac)[1]	Test weight (lb/bu)	Protein (%)[2]
Mountrail	174.7	45.2	65.4	59.7	15.9
Divide	177.1	47.8	66.2	60.6	16.1
Alkabo	173.0	44.3	65.8	**61.6**	15.5
Grenora	173.0	43.7	58.0	58.6	16.2
Tioga	176.4	46.2	57.1	59.5	16.6
Carpio	177.9	45.0	64.5	59.5	15.5
Joppa	173.3	47.1	65.1	60.1	15.7
Alzada	169.3	33.8	56.2	58.0	16.2
CDC Dynamic	177.6	45.2	56.4	59.6	**17.5**
CDC Fortitude	174.4	42.8	65.5	60.5	16.6
CDC Precision	174.6	45.1	64.0	60.2	17.0
CDC Vivid	173.0	44.2	61.3	60.4	17.2
MT112219	168.6	33.2	59.3	60.3	15.1
MTD16001	176.5	43.5	**74.7**	60.4	14.7
MTD16002	178.2	45.8	62.2	59.8	15.8
MTD16003	173.6	45.8	70.8	61.1	14.1
MTD16004	173.6	43.3	70.1	61.5	15.9
MTD16005	**178.7**	46.5	57.4	58.1	16.8
MTD16006	176.3	**48.2**	67.9	59.5	15.7
MTD16007	177.5	43.7	65.8	60.4	16.2
MTD16008	174.8	47.1	60.7	57.4	16.6
MTD16009	178.6	45.6	56.4	55.0	16.8
MTD16010	176.3	**48.2**	62.6	61.4	15.6
MTD16011	178.3	44.9	58.6	59.3	16.7
Mean	175.2	44.4	63.0	59.7	16.1
CV%	0.5	3.5	9.4	1.7	2.8
LSD (P=0.05)	1.6	2.6	10.9	1.8	0.8
Prob > F	<0.001	<0.001	0.034	<0.001	<0.001

[1]Reported on a 13% moisture basis
[2]Reported on a 12% moisture basis
Underline/Bold = Highest values, underline = lowest

Table 8. Agronomic means from 2018 irrigated intrastate durum trial conducted at Eastern Agricultural Research Center Sidney, MT.

Line	Heading (Julian)	Plant height (in)	Yield (bu/ac)[1]	Test weight (lb/bu)	Protein (%)[2]
Mountrail	179.3	35.8	100.0	63.3	15.4
Divide	182.3	38.7	105.0	64.3	14.6
Alkabo	178.0	34.6	93.2	63.3	14.7
Grenora	178.0	34.4	107.9	62.8	14.6
Tioga	179.0	37.8	106.6	63.3	15.4
Carpio	180.0	35.8	102.8	64.1	14.8
Joppa	178.3	37.9	95.7	63.5	15.0
Alzada	176.0	25.9	77.6	60.0	15.3
Dynamic	183.0	37.3	**113.7**	**64.8**	15.4
Fortitude	179.0	31.0	102.2	62.4	15.6
Precision	179.0	36.6	104.6	63.9	15.5
Vivid	179.0	34.6	93.6	63.6	**15.9**
MT112219	176.3	26.4	84.0	61.9	14.2
MTD16001	182.7	36.2	111.7	63.5	14.4
MTD16002	183.0	**43.7**	99.9	63.2	15.3
MTD16003	179.0	35.3	105.2	64.6	13.4
MTD16004	178.3	34.6	97.4	63.8	15.3
MTD16005	**183.0**	36.6	102.5	63.7	14.6
MTD16006	182.0	37.1	99.8	63.3	15.2
MTD16007	178.7	34.6	106.3	64.4	15.3
MTD16008	178.7	36.2	105.1	62.5	15.3
MTD16009	182.7	37.9	105.6	61.6	15.4
MTD16010	182.3	37.1	101.7	64.5	15.3
MTD16011	182.7	37.1	89.8	63.5	14.7
Mean	180.0	35.6	100.5	63.3	15.0
CV (%)	0.4	3.5	9.5	0.5	2.8
LSD (P=0.05)	1.3	2.1	15.8	0.5	0.7
Prob > F	<0.001	<0.001	0.009	<0.001	<0.001

[1]Reported on a 13% moisture basis
[2]Reported on a 12% moisture basis
Underline/Bold = Highest values, underline = lowest

Table 9. Agronomic means from 2018 rainfed intrastate durum trial conducted at Eastern Agricultural Research Center Sidney, MT.

Line	Heading (Julian)	Plant height (in)	Yield (bu/ac)[1]	Test weight (lb/bu)	Protein (%)[2]
Mountrail	177.0	36.4	64.2	64.4	14.3
Divide	177.7	39.8	62.7	64.0	14.3
Alkabo	176.7	37.1	60.4	64.5	14.6
Grenora	176.0	35.3	65.9	63.7	14.8
Tioga	176.3	38.3	65.7	64.5	14.1
Carpio	177.3	35.8	65.2	64.7	14.4
Joppa	176.7	37.9	61.0	64.6	14.2
Alzada	<u>172.0</u>	29.8	58.1	64.1	13.8
Dynamic	178.0	38.3	66.5	64.7	13.9
Fortitude	176.3	34.1	62.6	63.9	14.3
Precision	177.3	37.9	62.4	64.5	14.4
Vivid	177.0	35.6	65.1	64.1	15.3
MT112219	172.3	<u>26.6</u>	61.6	65.7	13.3
MTD16001	177.7	37.4	**<u>67.9</u>**	64.1	12.9
MTD16002	**<u>179.3</u>**	**<u>39.1</u>**	66.5	64.1	14.1
MTD16003	176.3	36.0	60.4	64.5	13.1
MTD16004	176.7	36.1	62.6	65.3	13.1
MTD16005	178.0	37.0	60.0	63.4	13.7
MTD16006	177.7	36.9	58.8	63.8	13.9
MTD16007	177.0	35.6	<u>57.3</u>	64.5	14.1
MTD16008	176.3	36.1	62.5	62.8	14.1
MTD16009	178.0	38.8	59.9	60.7	15.1
MTD16010	178.0	37.7	57.5	64.2	15.2
MTD16011	178.0	36.5	58.1	63.7	13.5
Mean	176.8	36.3	62.2	64.1	14.1
CV (%)	0.4	3.7	6.4	6.3	0.5
LSD (P=0.05)	1.1	2.2	6.5	0.5	NS
Prob > F	<0.001	<0.001	0.036	<0.001	0.096

[1]Reported on a 13% moisture basis
[2]Reported on a 12% moisture basis
NS = No significant difference based on ANOVA $p<0.05$
Underline/Bold = Highest values, underline = lowest

Table 10. Agronomic means from 2018 rainfed intrastate durum trial at Central Agricultural Research Center in Moccasin, MT

Line	Heading (Julian)	Plant height (in)	Yield (bu/ac)[1]	Test weight (lb/bu)	Protein (%)[2]
Mountrail	178.0	37.0	50.9	62.0	10.3
Divide	178.0	37.7	46.8	62.1	10.7
Alkabo	177.3	35.3	51.7	61.8	10.8
Grenora	177.3	34.0	53.9	61.7	<u>9.8</u>
Tioga	177.3	39.7	46.0	61.6	11.8
Carpio	178.3	37.3	49.1	60.6	11.2
Joppa	<u>177.0</u>	38.3	47.5	62.0	10.9
Alzada	177.0	32.3	51.3	62.4	10.6
Dynamic	178.7	37.0	49.2	61.5	11.8
Fortitude	177.3	35.7	56.2	62.2	10.7
Precision	177.0	36.7	52.1	62.3	11.3
Vivid	177.3	36.0	51.7	62.0	10.9
MT112219	177.0	<u>30.3</u>	54.8	**63.4**	10.3
MTD16001	178.7	38.0	53.8	60.8	10.5
MTD16002	**180.0**	38.7	50.8	61.8	10.1
MTD16003	178.0	38.0	47.6	61.8	11.7
MTD16004	177.3	36.7	53.8	63.2	10.9
MTD16005	178.3	38.3	54.9	61.6	<u>9.8</u>
MTD16006	177.3	**39.7**	**56.6**	61.9	11.1
MTD16007	178.0	37.7	52.2	62.5	10.8
MTD16008	177.7	37.0	<u>40.6</u>	60.9	**12.6**
MTD16009	178.7	38.7	48.4	<u>58.8</u>	11.2
MTD16010	178.3	38.0	44.6	61.9	12.0
MTD16011	178.0	38.3	49.9	61.3	10.3
Mean	177.8	37.0	50.5	61.7	10.9
CV (%)	0.4	2.5	8.4	0.8	6.9
LSD (P=0.05)	1.2	1.5	7.0	0.8	1.2
Prob > F	<0.001	<0.001	0.005	<0.001	0.003

[1]Reported on a 13% moisture basis
[2]Reported on a 12% moisture basis
Underline/Bold = Highest values, underline = lowest

Table 11. Agronomic means from 2018 rainfed intrastate durum trial at Northern Agricultural Research Center in Havre, MT.

Line	Heading (Julian)	Plant height (in)	Yield (bu/ac)[1]	Test weight (lb/bu)	Protein (%)[2]	Falling number (s)[3]
Mountrail	176.0	26.3	38.2	58.8	18.4	365.0
Divide	176.7	32.3	41.1	59.7	17.8	361.0
Alkabo	175.3	29.9	41.3	59.6	17.2	365.1
Grenora	175.0	30.4	40.2	58.2	17.7	377.0
Tioga	175.3	33.1	40.3	58.3	18.7	374.5
Carpio	176.0	29.4	_35.8_	57.4	18.6	364.9
Joppa	174.7	29.7	41.1	59.7	17.5	358.9
Alzada	172.0	_25.6_	37.9	59.3	17.3	**_398.0_**
Dynamic	175.7	31.4	41.2	57.5	**_19.3_**	_328.2_
Fortitude	176.0	29.4	37.9	58.3	18.6	347.7
Precision	175.3	31.3	39.5	57.9	18.7	371.0
Vivid	175.7	32.4	40.5	58.1	18.8	363.1
MT112219	_171.3_	25.8	**_48.4_**	**_61.1_**	_16.3_	371.0
MTD16001	178.0	32.3	44.6	57.9	17.7	352.8
MTD16002	**_179.0_**	**_35.2_**	45.8	58.6	17.5	368.8
MTD16003	175.0	31.5	41.2	59.1	17.0	362.3
MTD16004	174.7	29.5	43.8	59.8	17.6	335.7
MTD16005	177.0	31.9	41.1	58.0	18.8	354.1
MTD16006	175.7	34.4	42.2	59.0	17.7	353.2
MTD16007	175.0	32.1	44.2	58.3	18.1	362.9
MTD16008	173.7	32.8	40.0	57.9	17.8	350.4
MTD16009	178.7	33.8	39.7	_54.8_	18.8	354.4
MTD16010	176.0	32.8	39.4	58.5	18.1	360.0
MTD16011	178.0	32.2	45.1	58.7	18.0	368.2
Mean	175.7	31.1	41.3	58.5	18.0	361.2
CV (%)	0.5	5.7	6.7	0.7	1.7	2.7
LSD (P=0.05)	1.4	2.9	4.5	0.7	0.5	16.3
Prob > F	<0.001	<0.001	0.003	<0.001	<0.001	<0.001

[1]Reported on a 13% moisture basis
[2]Reported on a 12% moisture basis
[3]Reported on a 14% moisture basis
Underline/Bold = Highest values, underline = lowest

Table 12. Agronomic means from 2018 rainfed intrastate durum trial at Western Triangle Agricultural Research Center in Conrad, MT.

Line	Heading (Julian)	Plant height (in)	Yield (bu/ac)[1]	Test weight (lb/bu)	Protein (%)[2]	Lodging (%)
Mountrail	177.7	31.3	69.0	59.8	15.3	2.7
Divide	179.3	33.0	<u>53.6</u>	60.2	16.4	1.7
Alkabo	176.3	32.3	64.2	60.8	15.3	8.0
Grenora	174.0	30.7	62.3	60.1	15.6	5.7
Tioga	178.0	33.7	58.4	59.3	17.1	4.0
Carpio	178.7	33.0	70.2	60.0	15.0	4.7
Joppa	176.7	32.3	63.9	60.7	15.2	8.0
Alzada	174.3	28.0	70.8	61.1	14.7	5.7
Dynamic	178.3	34.0	69.0	59.2	16.6	8.7
Fortitude	177.3	31.7	72.4	60.8	15.9	2.0
Precision	177.3	33.3	59.9	60.4	**<u>17.1</u>**	3.7
Vivid	178.3	32.7	62.5	60.7	16.5	2.3
MT112219	<u>174.0</u>	<u>25.7</u>	73.0	**<u>63.0</u>**	<u>13.9</u>	<u>1.3</u>
MTD16001	180.0	34.0	72.0	59.7	15.1	1.7
MTD16002	**<u>181.3</u>**	35.7	59.3	60.0	15.8	2.0
MTD16003	177.7	32.0	62.2	60.8	14.6	4.0
MTD16004	177.7	32.0	72.9	61.7	14.9	**<u>15.0</u>**
MTD16005	179.7	34.7	70.3	60.8	15.4	4.7
MTD16006	177.7	**<u>36.0</u>**	**<u>79.4</u>**	61.5	14.6	10.0
MTD16007	177.3	33.0	73.8	61.9	15.4	6.7
MTD16008	177.3	32.7	53.9	58.4	16.6	5.7
MTD16009	180.3	32.7	55.2	<u>56.5</u>	16.9	4.3
MTD16010	179.3	35.3	72.8	61.7	15.6	5.7
MTD16011	178.7	34.3	63.1	59.3	16.5	5.0
Mean	177.8	32.7	66.0	60.4	15.7	5.1
CV (%)	0.6	4.7	15.0	1.5	5.2	79.3
LSD (P=0.05)	1.9	2.5	NS	1.6	1.3	7.1
Prob > F	<0.001	<0.001	0.109	<0.001	<0.001	0.043

[1]Reported on a 13% moisture basis
[2]Reported on a 12% moisture basis
NS = No significant difference based on ANOVA $p<0.05$
Underline/Bold = Highest values, underline = lowest

Table 13. USDA-ARS seed quality means from all locations (n=8) for 2018 intrastate durum trial.

Line	Test weight (lb/bu)	Kernel weight (mg)	Kernel diameter (mm)	Large kernels (%)	Small kernels (%)	Hardness	Wheat protein (%)[1]
Mountrail	61.3	40.9	2.8	54.5	10.9	74.8	14.4
Divide	61.8	42.2	2.8	63.9	9.0	73.1	14.9
Alkabo	62.1	43.1	2.8	64.4	8.3	73.2	14.5
Grenora	60.9	42.5	2.8	63.3	8.4	75.5	14.6
Tioga	61.6	43.9	2.9	68.3	7.0	<u>72.3</u>	15.2
Carpio	61.4	42.4	2.9	67.9	8.4	72.8	14.3
Joppa	61.8	41.9	2.8	62.8	8.3	76.4	14.5
Alzada	60.9	**<u>45.0</u>**	**<u>3.0</u>**	**<u>81.5</u>**	<u>3.5</u>	73.5	14.6
Dynamic	61.4	39.5	2.8	56.3	10.0	78.9	15.6
Fortitude	61.4	38.2	2.8	63.1	9.4	81.4	15.1
Precision	62.0	40.2	2.8	66.5	7.3	82.1	14.9
Vivid	61.7	40.8	2.8	68.5	7.6	77.8	15.6
MT112219	**<u>62.7</u>**	40.7	2.8	68.6	8.4	77.1	13.7
MTD16001	61.1	41.6	2.8	58.4	9.8	77.6	13.9
MTD16002	61.4	38.8	2.8	53.4	10.6	82.1	14.6
MTD16003	61.9	38.9	2.8	57.9	11.1	77.2	<u>13.7</u>
MTD16004	62.4	40.3	2.9	70.3	7.0	79.2	14.4
MTD16005	61.0	41.7	2.8	58.0	9.4	74.4	14.7
MTD16006	61.5	44.3	2.9	70.5	6.3	74.8	14.4
MTD16007	61.9	38.9	2.8	58.8	8.8	78.0	14.9
MTD16008	59.9	42.9	2.8	70.9	6.8	72.6	14.9
MTD16009	<u>57.9</u>	38.3	<u>2.7</u>	<u>49.1</u>	11.6	73.8	**<u>15.7</u>**
MTD16010	62.1	<u>37.7</u>	2.7	54.9	10.9	**<u>83.2</u>**	15.1
MTD16011	60.9	40.6	2.7	49.9	**<u>12.6</u>**	74.5	14.8
Mean	61.4	41.1	2.8	62.6	8.8	76.5	14.7
CV (%)	1.3	4.3	2.4	13.0	33.2	2.9	3.7
LSD (0.05)	0.8	1.7	0.1	8.0	2.9	2.2	0.5
F > Prob	>0.001	>0.001	>0.001	>0.001	>0.001	>0.001	>0.001

[1]Reported on a 12% moisture basis

Underline/Bold = Highest values, underline = lowest

Table 14. USDA-ARS semolina quality means from all locations (n=8) for 2018 intrastate durum trial.

Line	Milling yield (%)	Semolina L*	Semolina b*	Mixograph pattern	Grain ash (%)[1]	Falling number (s)	Semolina protein (%)[1]	Semolina ash (%)[1]
Mountrail	62.9	**85.4**	25.3	3.0	1.5	421.1	13.5	0.7
Divide	62.5	85.2	27.1	5.0	1.4	419.5	13.3	0.6
Alkabo	62.1	85.1	29.2	4.3	1.5	402.1	13.0	0.6
Grenora	61.2	85.2	28.5	4.4	1.5	417.3	13.2	0.7
Tioga	62.7	85.1	28.8	5.5	1.6	400.1	13.9	0.6
Carpio	62.3	85.0	30.5	6.5	1.5	424.4	13.2	0.6
Joppa	62.0	85.0	29.0	5.6	1.5	411.6	13.2	0.6
Alzada	62.7	84.4	30.7	**6.6**	1.6	**439.8**	13.2	**0.7**
Dynamic	61.7	84.5	31.7	5.5	**1.6**	400.0	14.1	0.7
Fortitude	60.3	84.9	31.1	5.9	1.6	409.8	13.6	0.7
Precision	60.3	84.9	**31.8**	5.5	1.6	429.6	13.7	0.7
Vivid	61.9	84.6	31.6	5.6	1.5	391.4	13.9	0.7
MT112219	63.2	84.4	27.5	5.3	1.5	404.5	12.5	0.7
MTD16001	62.7	85.3	27.7	4.4	1.4	395.0	12.7	0.6
MTD16002	60.7	85.1	27.5	3.9	1.4	421.5	13.3	0.6
MTD16003	**63.3**	85.2	26.5	3.8	1.4	418.4	12.2	0.6
MTD16004	61.0	85.0	24.6	4.0	1.5	414.8	13.0	0.6
MTD16005	61.8	85.0	28.4	4.9	1.4	415.3	13.4	0.6
MTD16006	61.7	85.1	24.9	4.8	1.5	407.9	13.2	0.6
MTD16007	61.1	85.3	21.8	4.9	1.5	410.5	13.5	0.6
MTD16008	61.3	83.8	26.5	4.4	1.5	421.3	13.7	0.7
MTD16009	59.1	84.6	25.5	5.1	1.6	398.5	**14.5**	0.7
MTD16010	61.5	85.0	26.3	4.9	1.5	434.0	13.8	0.6
MTD16011	61.9	84.8	28.8	4.6	1.5	428.8	13.5	0.6
Mean	61.8	84.9	28.0	4.9	1.5	413.8	13.3	0.6
CV (%)	1.5	0.3	2.2	13.7	3.5	5.1	3.8	4.9
LSD (0.05)	0.9	0.3	0.6	0.7	0.1	21.0	0.5	0.03
F > Prob	>0.001	>0.001	>0.001	>0.001	>0.001	>0.001	>0.001	>0.001

[1]Reported on a 14% moisture basis

Underline/Bold = Highest values, underline = lowest

Table 15. USDA-ARS seed quality means for Bozeman rainfed for 2018 intrastate durum trial.

Line	Test weight (lb/bu)	Kernel weight (mg)	Kernel diameter (mm)	Large kernels (%)	Small kernels (%)	Hardness	Wheat protein (%)[1]
Mountrail	63.0	41.5	2.84	73	5	76.0	13.7
Divide	62.9	43.4	2.94	81	4	74.0	14.1
Alkabo	64.1	45.9	2.96	85	3	72.0	13.6
Grenora	63.0	45.2	3.01	82	3	76.7	13.9
Tioga	63.8	47.0	3.06	88	2	73.5	14.1
Carpio	63.4	46.4	3.03	89	2	71.6	13.5
Joppa	63.2	44.8	2.92	81	3	74.8	13.6
Alzada	62.6	48.2	3.16	92	2	73.9	14.2
Dynamic	63.0	42.5	2.91	80	4	76.6	15.5
Fortitude	62.7	43.7	2.99	82	4	75.2	14.9
Precision	62.8	43.0	2.92	82	2	80.7	14.3
Vivid	63.4	43.0	2.92	85	2	77.7	15.5
MT112219	64.2	43.4	2.95	83	4	77.6	13.6
MTD16001	62.0	43.9	2.93	78	4	76.0	13.3
MTD16002	62.3	41.2	2.87	72	4	77.8	14.0
MTD16003	63.8	41.8	2.93	76	5	76.2	12.8
MTD16004	63.5	43.4	3.01	86	2	77.5	13.9
MTD16005	62.0	44.7	2.94	78	3	72.5	14.2
MTD16006	62.8	48.0	3.03	86	2	71.5	13.7
MTD16007	63.8	42.4	2.92	80	3	76.3	13.9
MTD16008	61.3	45.6	2.97	86	2	71.6	14.0
MTD16009	60.6	43.5	2.94	79	4	74.5	14.7
MTD16010	63.5	41.2	2.90	77	4	81.9	14.4
MTD16011	62.4	43.5	2.88	70	5	75.0	14.5

[1]Reported on a 12% moisture basis

Table 16. USDA-ARS semolina quality means from Bozeman rainfed for 2018 intrastate durum trial.

Line	Milling yield (%)	Semolina L*	Semolina b*	Mixograph pattern	Grain ash (%)[1]	Falling number (s)	Semolina protein (%)[1]	Semolina ash (%)[1]
Mountrail	65.2	85.2	24.7	3	1.27	393	12.6	0.58
Divide	64.6	85.0	27.9	4	1.20	387	12.8	0.57
Alkabo	63.6	85.1	29.1	3	1.25	351	12.2	0.52
Grenora	63.2	84.9	28.5	4	1.31	370	12.4	0.54
Tioga	64.5	85.1	29.5	5	1.30	354	12.7	0.54
Carpio	65.1	85.3	31.8	5	1.20	377	12.2	0.55
Joppa	63.5	85.0	29.4	4	1.28	383	12.3	0.56
Alzada	63.6	84.4	30.3	6	1.35	426	13.1	0.65
Dynamic	64.0	84.5	32.5	4	1.37	382	13.8	0.57
Fortitude	61.7	85.2	30.8	4	1.29	357	13.2	0.57
Precision	60.9	85.0	31.4	4	1.37	389	13.0	0.62
Vivid	62.9	84.9	31.7	4	1.31	359	13.7	0.61
MT112219	63.5	84.1	27.2	5	1.35	365	12.3	0.65
MTD16001	63.9	84.9	28.2	4	1.21	345	12.2	0.54
MTD16002	61.9	84.4	27.8	4	1.26	341	12.8	0.56
MTD16003	64.9	85.1	27.6	3	1.17	389	11.2	0.50
MTD16004	62.5	84.7	24.7	3	1.28	346	12.4	0.52
MTD16005	62.1	84.8	29.7	4	1.29	364	12.8	0.54
MTD16006	62.9	85.1	25.3	4	1.26	376	12.7	0.51
MTD16007	62.8	85.4	22.1	3	1.27	381	12.6	0.54
MTD16008	61.8	84.2	27.3	3	1.26	376	12.8	0.55
MTD16009	60.7	84.8	25.6	4	1.34	356	13.6	0.59
MTD16010	62.4	85.1	26.7	4	1.33	398	13.0	0.53
MTD16011	62.3	84.8	30.2	4	1.21	389	13.0	0.56

[1]Reported on a 14% moisture basis

Table 17. USDA-ARS seed quality means for Bozeman irrigated for 2018 intrastate durum trial.

Line	Test weight (lb/bu)	Kernel weight (mg)	Kernel diameter (mm)	Large kernels (%)	Small kernels (%)	Hardness	Wheat protein (%)[1]
Mountrail	62.6	43.9	2.95	77	5	75.0	14.0
Divide	63.0	47.6	3.05	89	3	71.9	14.8
Alkabo	63.4	47.9	3.03	88	3	69.2	13.9
Grenora	62.4	49.9	3.12	91	2	73.4	14.2
Tioga	63.5	52.8	3.23	92	1	68.8	14.6
Carpio	63.4	49.5	3.13	93	2	71.7	14.2
Joppa	63.3	47.5	3.05	85	3	72.7	14.1
Alzada	63.4	52.0	3.26	94	1	70.5	14.8
Dynamic	62.6	45.7	3.02	85	3	74.9	15.0
Fortitude	62.7	43.0	3.04	88	4	78.1	14.8
Precision	63.4	45.9	3.05	91	2	79.1	14.8
Vivid	63.4	48.0	3.11	93	2	76.2	15.6
MT112219	64.4	44.0	2.98	86	4	76.6	13.4
MTD16001	62.6	49.0	3.06	88	3	73.3	13.6
MTD16002	62.2	43.7	2.96	85	3	77.9	14.7
MTD16003	64.1	45.7	3.05	87	3	76.1	12.6
MTD16004	63.5	44.6	3.06	91	2	76.3	14.0
MTD16005	62.4	46.7	2.99	84	4	72.0	14.7
MTD16006	62.8	52.2	3.13	93	1	70.1	14.7
MTD16007	63.5	45.0	3.02	86	2	74.5	14.4
MTD16008	61.6	49.6	3.09	91	2	70.4	14.5
MTD16009	60.6	44.1	2.98	86	3	73.5	16.2
MTD16010	63.5	43.8	2.99	83	3	81.6	14.7
MTD16011	63.0	47.8	3.01	87	2	72.4	14.9

[1]Reported on a 12% moisture basis

Table 18. USDA-ARS semolina quality means from Bozeman irrigated for 2018 intrastate durum trial.

Line	Milling yield (%)	Semolina L*	Semolina b*	Mixograph pattern	Grain ash (%)[1]	Falling number (s)	Semolina protein (%)[1]	Semolina ash (%)[1]
Mountrail	63.4	85.7	24.5	3	1.37	402	13.0	0.63
Divide	62.8	85.2	27.3	4	1.33	387	13.4	0.58
Alkabo	62.0	85.6	28.7	3	1.34	369	12.6	0.55
Grenora	62.2	85.5	27.9	4	1.42	398	13.1	0.61
Tioga	64.5	85.5	28.4	4	1.42	357	13.4	0.57
Carpio	64.5	85.3	30.9	6	1.29	401	12.8	0.58
Joppa	63.3	85.0	28.8	4	1.37	407	12.6	0.57
Alzada	63.4	84.9	29.6	6	1.51	431	13.2	0.68
Dynamic	63.9	84.8	32.3	5	1.43	353	13.8	0.60
Fortitude	62.7	85.5	31.1	6	1.41	381	13.6	0.59
Precision	61.2	85.2	30.9	6	1.51	398	13.5	0.61
Vivid	64.0	84.8	31.3	5	1.43	339	13.8	0.61
MT112219	64.0	84.8	26.6	4	1.41	419	12.3	0.65
MTD16001	64.8	85.6	27.1	4	1.32	375	12.4	0.52
MTD16002	62.0	85.1	26.8	3	1.36	374	13.7	0.55
MTD16003	66.1	85.6	26.7	3	1.28	388	11.2	0.55
MTD16004	62.9	85.2	24.0	3	1.39	372	12.8	0.60
MTD16005	63.8	85.4	28.6	4	1.27	399	13.4	0.57
MTD16006	62.8	85.5	24.0	3	1.38	372	13.2	0.57
MTD16007	62.9	85.8	21.3	3	1.30	393	13.2	0.56
MTD16008	61.8	84.3	26.5	3	1.45	344	13.5	0.59
MTD16009	61.0	85.1	25.1	4	1.44	328	14.8	0.62
MTD16010	64.4	85.2	25.4	4	1.39	379	13.6	0.56
MTD16011	65.5	85.2	28.7	4	1.29	386	13.7	0.60

[1]Reported on a 14% moisture basis

Table 19. USDA-ARS seed quality means from WTARC for 2018 intrastate durum trial.

Line	Test weight (lb/bu)	Kernel weight (mg)	Kernel diameter (mm)	Large kernels (%)	Small kernels (%)	Hardness	Wheat protein (%)[1]
Mountrail	59.7	39.0	2.68	26	17	75.9	15.2
Divide	60.0	39.4	2.64	38	15	76.5	15.9
Alkabo	60.6	38.6	2.63	38	14	77.6	15.3
Grenora	60.2	39.2	2.67	43	12	82.4	15.0
Tioga	59.8	40.2	2.71	46	12	74.5	16.4
Carpio	60.2	40.7	2.73	53	12	77.0	14.1
Joppa	61.2	38.7	2.65	41	14	79.2	14.7
Alzada	61.1	44.7	2.95	75	5	78.7	14.6
Dynamic	59.7	37.2	2.64	38	13	81.4	16.0
Fortitude	60.9	38.2	2.73	54	10	84.5	15.0
Precision	60.5	36.0	2.62	36	13	84.5	16.3
Vivid	60.7	37.5	2.63	53	11	80.9	16.2
MT112219	63.0	39.0	2.74	53	13	84.4	14.0
MTD16001	59.5	37.5	2.61	29	17	81.5	14.9
MTD16002	60.3	35.0	2.56	22	19	84.6	15.6
MTD16003	60.7	35.8	2.59	37	15	82.3	14.1
MTD16004	61.9	37.8	2.73	57	9	81.7	14.9
MTD16005	60.9	43.2	2.78	49	9	76.1	14.7
MTD16006	61.8	42.9	2.82	65	6	81.4	14.5
MTD16007	62.2	38.3	2.72	53	9	81.1	15.1
MTD16008	58.4	40.4	2.69	60	10	72.5	15.9
MTD16009	56.6	35.7	2.58	26	18	76.1	16.9
MTD16010	61.9	36.9	2.68	43	13	86.0	15.1
MTD16011	59.6	37.2	2.55	24	18	75.0	16.0

[1]Reported on a 12% moisture basis

Table 20. USDA-ARS semolina quality means from WTARC for 2018 intrastate durum trial.

Line	Milling yield (%)	Semolina L*	Semolina b*	Mixograph pattern	Grain ash (%)[1]	Falling number (s)	Semolina protein (%)[1]	Semolina ash (%)[1]
Mountrail	63.3	85.5	27.4	3	1.24	450	14.2	0.57
Divide	61.8	84.7	29.1	7	1.25	450	14.4	0.58
Alkabo	61.6	85.1	31.3	6	1.33	435	13.6	0.57
Grenora	61.1	85.5	30.5	5	1.33	426	13.7	0.58
Tioga	61.4	84.9	30.4	7	1.41	450	15.3	0.68
Carpio	62.4	84.6	32.7	7	1.31	450	13.3	0.58
Joppa	62.2	85.1	30.7	7	1.29	391	13.8	0.56
Alzada	63.2	84.8	32.7	7	1.27	450	12.9	0.58
Dynamic	60.8	84.5	32.7	6	1.42	386	14.4	0.60
Fortitude	59.8	84.7	32.9	6	1.35	411	13.8	0.63
Precision	59.4	84.5	33.9	6	1.42	450	15.1	0.64
Vivid	NA	NA	NA	NA	1.29	438	NA	NA
MT112219	63.2	84.4	29.7	5	1.25	365	12.1	0.63
MTD16001	62.3	85.0	30.4	5	1.25	358	13.6	0.55
MTD16002	61.0	85.0	29.3	4	1.25	450	14.2	0.60
MTD16003	62.0	85.0	28.2	5	1.27	433	12.8	0.56
MTD16004	61.9	85.1	26.4	5	1.28	450	13.3	0.57
MTD16005	63.0	84.7	30.1	5	1.22	439	13.5	0.57
MTD16006	62.8	85.3	26.8	5	1.32	420	12.9	0.57
MTD16007	61.8	85.2	23.4	6	1.32	399	13.7	0.59
MTD16008	60.4	83.4	27.5	5	1.35	450	14.5	0.65
MTD16009	58.1	84.2	27.0	5	1.40	401	15.8	0.64
MTD16010	62.3	85.0	28.6	5	1.39	450	14.0	0.61
MTD16011	60.7	84.5	30.4	5	1.27	436	14.6	0.64

[1]Reported on a 14% moisture basis

Table 21. USDA-ARS seed quality means from NARC for 2018 intrastate durum trial.

Line	Test weight (lb/bu)	Kernel weight (mg)	Kernel diameter (mm)	Large kernels (%)	Small kernels (%)	Hardness	Wheat protein (%)[1]
Mountrail	59.3	38.0	2.66	38	12	78.4	18.0
Divide	60.5	36.4	2.58	33	15	78.9	17.8
Alkabo	60.5	36.1	2.61	38	14	75.9	17.5
Grenora	58.7	33.0	2.51	26	20	78.2	17.7
Tioga	59.0	35.5	2.58	37	13	81.7	18.8
Carpio	57.8	40.9	2.88	76	3	76.2	18.4
Joppa	59.8	33.7	2.54	20	18	80.0	17.4
Alzada	59.7	31.3	2.50	32	17	85.9	17.8
Dynamic	57.8	32.7	2.47	24	20	80.8	19.5
Fortitude	59.1	33.8	2.49	33	17	80.2	18.8
Precision	58.5	38.5	2.77	56	8	80.0	18.5
Vivid	58.7	33.7	2.50	15	21	81.1	19.2
MT112219	61.6	33.6	2.54	15	20	85.6	16.3
MTD16001	58.2	32.8	2.49	29	21	79.6	17.8
MTD16002	59.1	35.6	2.68	48	10	83.5	17.5
MTD16003	59.1	35.7	2.54	24	15	76.6	17.1
MTD16004	60.2	37.2	2.61	36	14	78.8	17.8
MTD16005	58.1	33.5	2.56	22	15	80.5	18.8
MTD16006	59.5	40.5	2.74	62	8	74.8	17.4
MTD16007	58.7	34.4	2.57	12	19	74.6	18.1
MTD16008	58.5	32.1	2.52	16	22	85.6	17.5
MTD16009	55.0	37.3	2.62	22	16	77.4	19.6
MTD16010	59.4	38.0	2.66	38	12	78.4	18.3
MTD16011	59.0	36.4	2.58	33	15	78.9	18.0

[1]Reported on a 12% moisture basis

Table 22. USDA-ARS semolina quality means from NARC for 2018 intrastate durum trial.

Line	Milling yield (%)	Semolina L*	Semolina b*	Mixograph pattern	Grain ash (%)[1]	Falling number (s)	Semolina protein (%)[1]	Semolina ash (%)[1]
Mountrail	59.0	85.0	26.0	3	1.93	450	16.2	0.82
Divide	60.4	84.9	25.8	5	1.99	450	17.5	0.81
Alkabo	60.8	84.4	29.6	5	1.89	450	17.3	0.84
Grenora	57.6	84.6	29.8	4	1.80	450	16.3	0.76
Tioga	59.7	84.7	29.5	7	1.74	450	16.1	0.78
Carpio	57.0	84.4	29.4	8	1.97	426	18.0	0.85
Joppa	59.8	84.8	29.6	7	1.90	450	17.2	0.80
Alzada	61.1	84.1	30.6	8	1.97	450	17.4	0.86
Dynamic	58.7	84.3	30.9	7	1.86	450	17.3	0.83
Fortitude	56.3	84.1	31.2	7	1.78	450	15.1	0.79
Precision	57.9	84.3	33.3	6	1.89	442	16.4	0.78
Vivid	58.2	83.9	32.2	6	1.79	450	16.3	0.76
MT112219	62.2	84.0	27.6	6	1.83	450	15.4	0.80
MTD16001	59.8	84.8	28.0	4	1.84	446	16.1	0.81
MTD16002	58.6	84.7	27.1	4	1.89	450	17.5	0.81
MTD16003	59.2	84.9	25.5	4	1.95	450	16.1	0.81
MTD16004	58.4	84.5	24.7	4	1.90	448	16.5	0.80
MTD16005	60.1	84.6	26.9	6	1.82	450	16.7	0.82
MTD16006	59.5	85.0	25.0	6	1.95	450	18.3	0.88
MTD16007	58.3	85.0	22.6	6	1.94	450	17.0	0.81
MTD16008	60.1	83.9	25.7	4	1.72	450	17.0	0.79
MTD16009	55.8	84.4	25.0	6	1.93	450	16.2	0.82
MTD16010	58.4	84.6	25.6	5	1.99	450	17.5	0.81
MTD16011	60.2	84.9	27.2	5	1.89	450	17.3	0.84

[1]Reported on a 14% moisture basis

Table 23. USDA-ARS seed quality means from SARC for 2018 intrastate durum trial.

Line	Test weight (lb/bu)	Kernel weight (mg)	Kernel diameter (mm)	Large kernels (%)	Small kernels (%)	Hardness	Wheat protein (%)[1]
Mountrail	58.8	34.0	2.56	20	23	74.5	15.8
Divide	59.0	34.8	2.55	36	20	73.4	16.6
Alkabo	60.9	37.8	2.68	39	16	80.2	16.1
Grenora	56.7	32.1	2.45	27	21	75.7	17.3
Tioga	59.0	34.3	2.59	48	13	78.2	17.1
Carpio	59.7	37.6	2.72	63	12	71.8	15.0
Joppa	58.5	35.1	2.57	35	15	80.1	16.0
Alzada	57.3	37.1	2.74	59	7	74.9	15.7
Dynamic	59.3	31.1	2.53	20	22	83.8	18.1
Fortitude	59.9	31.7	2.58	34	18	87.5	16.6
Precision	62.6	39.0	2.82	75	5	89.9	15.4
Vivid	61.4	36.2	2.64	55	12	82.9	16.8
MT112219	59.5	31.4	2.49	33	22	80.4	14.7
MTD16001	61.1	39.3	2.74	61	9	86.0	14.4
MTD16002	60.8	35.3	2.63	43	14	88.6	15.2
MTD16003	59.5	32.7	2.54	34	21	79.4	14.4
MTD16004	61.0	33.3	2.60	45	16	81.6	15.7
MTD16005	58.0	33.0	2.52	30	23	76.8	17.0
MTD16006	58.7	36.8	2.64	51	13	75.1	16.0
MTD16007	58.6	30.5	2.46	23	24	79.8	18.0
MTD16008	56.9	33.7	2.54	43	15	73.9	16.5
MTD16009	53.4	30.3	2.42	22	23	69.0	17.3
MTD16010	60.0	31.0	2.47	27	23	85.0	16.1
MTD16011	57.6	31.3	2.37	14	34	73.7	16.4

[1]Reported on a 12% moisture basis

Table 24. USDA-ARS semolina quality means from SARC for 2018 intrastate durum trial.

Line	Milling yield (%)	Semolina L*	Semolina b*	Mixograph pattern	Grain ash (%)[1]	Falling number (s)	Semolina protein (%)[1]	Semolina ash (%)[1]
Mountrail	62.2	84.3	26.5	3	1.59	450	14.7	0.75
Divide	61.5	84.3	27.6	5	1.61	450	14.4	0.75
Alkabo	60.9	84.6	30.7	4	1.64	397	14.2	0.70
Grenora	58.2	84.0	29.9	5	1.76	450	15.2	0.81
Tioga	59.8	84.1	29.7	6	1.74	450	15.2	0.72
Carpio	62.5	84.6	30.1	7	1.58	450	14.0	0.69
Joppa	58.0	85.0	30.4	6	1.66	446	14.5	0.68
Alzada	60.1	84.3	32.0	7	1.77	450	14.6	0.73
Dynamic	58.9	83.5	31.7	6	1.86	401	16.3	0.80
Fortitude	57.8	84.2	32.4	7	1.71	450	14.9	0.74
Precision	58.8	84.5	32.6	6	1.69	414	14.3	0.69
Vivid	60.4	84.1	32.5	6	1.55	382	14.7	0.68
MT112219	60.7	84.1	29.3	6	1.71	450	13.6	0.73
MTD16001	60.1	85.0	28.2	3	1.51	399	12.6	0.60
MTD16002	57.0	84.9	28.3	3	1.58	412	13.5	0.63
MTD16003	63.1	84.6	26.7	3	1.55	422	13.1	0.70
MTD16004	58.1	84.2	25.5	3	1.71	439	14.3	0.73
MTD16005	57.7	84.3	29.3	5	1.55	420	15.3	0.67
MTD16006	57.5	84.6	26.0	5	1.75	411	14.4	0.67
MTD16007	57.2	84.5	22.4	5	1.68	412	16.0	0.75
MTD16008	59.3	82.7	27.2	5	1.76	450	15.1	0.78
MTD16009	55.7	83.5	26.3	6	1.80	426	15.8	0.82
MTD16010	58.4	84.6	27.6	5	1.54	445	14.4	0.68
MTD16011	57.5	84.0	29.9	5	1.70	422	15.0	0.74

[1]Reported on a 14% moisture basis

Table 25. USDA-ARS seed quality means from CARC for 2018 intrastate durum trial.

Line	Test weight (lb/bu)	Kernel weight (mg)	Kernel diameter (mm)	Large kernels (%)	Small kernels (%)	Hardness	Wheat protein (%)[1]
Mountrail	62.5	39.8	2.75	49	13	77.8	10.2
Divide	63.0	42.6	2.86	71	7	69.8	10.8
Alkabo	62.2	41.0	2.77	62	9	74.5	10.8
Grenora	62.4	40.9	2.78	61	8	74.6	9.8
Tioga	62.3	43.8	2.89	66	7	72.4	11.9
Carpio	61.0	39.2	2.69	54	12	74.4	11.0
Joppa	62.9	40.1	2.76	59	10	78.6	10.8
Alzada	62.9	45.1	2.97	81	4	78.3	10.8
Dynamic	62.1	38.0	2.68	50	11	85.0	11.9
Fortitude	62.8	36.5	2.73	64	9	87.4	10.7
Precision	62.8	38.9	2.76	67	7	84.9	10.9
Vivid	62.5	39.9	2.74	69	7	78.3	11.1
MT112219	64.2	42.5	2.88	75	7	76.9	10.6
MTD16001	61.3	38.8	2.70	48	13	78.8	10.5
MTD16002	62.5	39.2	2.73	47	13	83.0	9.9
MTD16003	62.6	39.1	2.73	62	9	75.8	11.7
MTD16004	63.8	39.4	2.76	67	8	83.5	11.0
MTD16005	62.2	40.5	2.75	59	9	77.4	10.0
MTD16006	62.7	44.6	2.89	68	8	80.3	11.3
MTD16007	63.0	37.9	2.72	60	7	81.4	10.6
MTD16008	61.3	43.3	2.82	67	7	76.6	12.0
MTD16009	59.0	37.0	2.65	46	12	74.3	11.3
MTD16010	62.9	36.4	2.67	50	11	85.9	12.0
MTD16011	62.2	40.2	2.74	49	11	78.0	10.3

[1]Reported on a 12% moisture basis

Table 26. USDA-ARS semolina quality means from CARC for 2018 intrastate durum trial.

Line	Milling yield (%)	Semolina L*	Semolina b*	Mixograph pattern	Grain ash (%)[1]	Falling number (s)	Semolina protein (%)[1]	Semolina ash (%)[1]
Mountrail	63.3	86.4	25.0	3	1.41	414	9.3	0.66
Divide	62.3	86.4	26.9	4	1.43	398	9.5	0.61
Alkabo	61.3	86.1	28.8	4	1.46	414	9.5	0.66
Grenora	62.4	86.7	27.1	4	1.48	424	8.7	0.65
Tioga	63.1	86.1	29.1	6	1.55	430	10.9	0.64
Carpio	61.7	85.7	30.7	6	1.46	448	10.0	0.69
Joppa	63.7	85.7	28.0	6	1.57	402	9.8	0.67
Alzada	63.9	85.4	30.9	6	1.50	450	9.7	0.68
Dynamic	61.1	85.0	32.1	5	1.52	405	10.6	0.70
Fortitude	60.6	85.9	31.0	5	1.50	415	9.6	0.66
Precision	61.1	85.9	31.2	5	1.47	450	9.9	0.66
Vivid	61.7	85.8	31.4	6	1.52	386	9.8	0.67
MT112219	63.8	85.6	27.5	6	1.48	431	9.6	0.68
MTD16001	62.9	86.0	27.2	6	1.42	407	9.4	0.61
MTD16002	61.9	86.3	27.5	4	1.33	445	9.1	0.60
MTD16003	62.7	85.8	26.0	5	1.38	425	10.3	0.64
MTD16004	61.5	85.8	25.0	5	1.39	450	9.7	0.61
MTD16005	61.9	86.2	27.9	4	1.34	403	9.0	0.60
MTD16006	63.4	85.9	25.1	6	1.50	425	10.0	0.63
MTD16007	62.6	86.3	21.4	6	1.45	406	9.6	0.65
MTD16008	61.9	85.0	26.4	6	1.59	447	11.1	0.72
MTD16009	60.2	85.7	25.3	5	1.51	392	10.3	0.65
MTD16010	61.7	85.7	26.3	6	1.57	450	10.8	0.67
MTD16011	62.1	85.9	28.2	4	1.43	450	9.3	0.62

[1]Reported on a 14% moisture basis

Table 27. USDA-ARS seed quality means from EARC rainfed for 2018 intrastate durum trial.

Line	Test weight (lb/bu)	Kernel weight (mg)	Kernel diameter (mm)	Large kernels (%)	Small kernels (%)	Hardness	Wheat protein (%)[1]
Mountrail	63.0	42.6	2.88	70	6	72.8	13.7
Divide	62.7	44.7	2.93	72	6	70.3	14.1
Alkabo	63.0	46.0	2.99	80	5	68.3	14.6
Grenora	62.6	46.3	3.01	81	3	72.2	14.4
Tioga	63.3	46.3	3.00	80	5	69.4	13.4
Carpio	62.8	43.9	2.94	78	4	70.9	14.1
Joppa	63.3	45.4	2.98	79	4	73.1	14.2
Alzada	62.2	48.6	3.18	92	2	68.2	14.0
Dynamic	63.3	40.9	2.89	72	6	77.4	13.8
Fortitude	62.6	39.5	2.86	68	8	78.8	14.3
Precision	63.1	40.4	2.82	72	6	79.0	14.1
Vivid	62.0	41.1	2.82	77	5	75.2	14.9
MT112219	63.9	44.7	3.03	83	4	71.2	12.9
MTD16001	62.3	43.9	2.95	69	6	72.8	12.7
MTD16002	62.7	39.9	2.81	66	7	80.4	13.9
MTD16003	62.8	39.6	2.79	62	8	75.3	13.3
MTD16004	63.8	43.1	3.00	82	4	76.4	12.6
MTD16005	61.8	41.9	2.81	59	8	73.2	13.3
MTD16006	62.2	42.8	2.89	77	4	74.6	13.8
MTD16007	63.1	39.5	2.81	62	7	78.1	14.4
MTD16008	60.7	42.2	2.84	74	6	72.1	13.8
MTD16009	58.7	37.3	2.71	44	10	76.1	14.6
MTD16010	62.7	38.8	2.81	64	6	80.0	14.8
MTD16011	61.5	41.0	2.78	55	10	74.3	13.3

[1]Reported on a 12% moisture basis

Table 28. USDA-ARS semolina quality means from EARC rainfed for 2018 intrastate durum trial.

Line	Milling yield (%)	Semolina L*	Semolina b*	Mixograph pattern	Grain ash (%)[1]	Falling number (s)	Semolina protein (%)[1]	Semolina ash (%)[1]
Mountrail	63.1	86.0	25.3	3	1.48	431	12.7	0.67
Divide	62.6	85.5	26.3	6	1.44	418	13.0	0.59
Alkabo	62.5	85.4	28.7	5	1.42	429	13.1	0.57
Grenora	61.6	85.5	28.3	5	1.50	450	13.4	0.59
Tioga	63.8	85.6	28.1	5	1.46	355	12.6	0.56
Carpio	61.8	85.2	29.6	7	1.48	415	13.2	0.59
Joppa	62.5	85.3	28.4	6	1.49	448	13.0	0.61
Alzada	63.2	84.3	31.1	7	1.56	450	12.4	0.67
Dynamic	61.6	85.0	31.3	6	1.56	431	12.1	0.60
Fortitude	59.5	85.2	31.1	6	1.55	450	12.7	0.64
Precision	60.7	85.4	31.7	6	1.61	450	12.6	0.65
Vivid	61.7	84.6	32.2	6	1.54	389	13.9	0.65
MT112219	63.9	84.4	27.4	6	1.59	444	12.0	0.65
MTD16001	62.7	85.7	26.6	4	1.40	450	11.8	0.52
MTD16002	60.2	85.3	26.6	5	1.49	450	12.8	0.56
MTD16003	62.3	85.5	26.5	4	1.44	441	11.6	0.58
MTD16004	60.2	85.7	23.9	4	1.46	450	11.6	0.56
MTD16005	62.0	85.2	27.9	6	1.46	450	12.4	0.61
MTD16006	61.3	85.4	24.2	5	1.54	432	12.5	0.60
MTD16007	60.1	85.7	20.8	6	1.48	450	13.0	0.62
MTD16008	61.4	84.1	26.8	6	1.47	446	12.7	0.61
MTD16009	58.5	85.0	25.2	6	1.55	450	13.8	0.65
MTD16010	60.7	85.2	25.7	5	1.50	450	13.9	0.61
MTD16011	62.2	85.0	28.7	5	1.50	447	12.2	0.59

[1]Reported on a 14% moisture basis

Table 29. USDA-ARS seed quality means from EARC rainfed for 2018 intrastate durum trial.

Line	Test weight (lb/bu)	Kernel weight (mg)	Kernel diameter (mm)	Large kernels (%)	Small kernels (%)	Hardness	Wheat protein (%)[1]
Mountrail	61.8	48.4	3.03	82	5	68.5	14.9
Divide	63.0	47.8	3.05	85	4	69.6	14.8
Alkabo	62.2	49.6	3.09	85	4	65.5	14.3
Grenora	61.2	49.7	3.13	88	3	70.0	14.4
Tioga	62.0	50.7	3.16	88	2	65.5	14.9
Carpio	62.6	49.0	3.15	87	3	67.0	14.1
Joppa	62.4	48.0	3.05	85	4	70.7	15.0
Alzada	58.0	43.1	2.99	83	4	67.4	15.0
Dynamic	63.1	46.7	3.06	85	3	72.1	14.9
Fortitude	60.8	41.7	3.00	83	5	74.0	15.3
Precision	62.0	45.5	3.02	85	3	77.5	14.9
Vivid	61.8	47.0	3.03	83	5	71.2	15.9
MT112219	60.8	42.2	2.96	80	5	69.4	14.1
MTD16001	61.7	47.1	3.03	79	5	70.9	14.1
MTD16002	61.0	42.6	2.93	77	5	78.6	15.7
MTD16003	62.8	43.5	2.96	76	7	72.7	13.5
MTD16004	61.8	45.6	3.10	86	5	72.8	15.2
MTD16005	62.2	48.1	3.02	81	4	70.4	14.9
MTD16006	61.2	50.1	3.11	88	2	66.5	14.2
MTD16007	62.6	44.5	3.01	84	3	72.7	14.5
MTD16008	60.6	48.1	3.08	84	4	68.8	15.0
MTD16009	59.2	44.1	2.98	78	4	72.0	15.0
MTD16010	62.6	41.4	2.92	79	5	79.5	15.0
MTD16011	61.6	46.5	2.96	78	5	69.9	15.4

[1]Reported on a 12% moisture basis

Table 30. USDA-ARS semolina quality means from EARC irrigated for 2018 intrastate durum trial.

Line	Milling yield (%)	Semolina L*	Semolina b*	Mixograph pattern	Grain ash (%)[1]	Falling number (s)	Semolina protein (%)[1]	Semolina ash (%)[1]
Mountrail	63.6	85.1	22.7	3	1.63	379	14.0	0.65
Divide	64.3	85.4	25.7	5	1.51	416	13.0	0.63
Alkabo	63.6	84.9	26.6	4	1.64	372	13.1	0.62
Grenora	63.6	84.9	25.8	4	1.67	370	12.8	0.63
Tioga	64.7	84.6	25.8	4	1.63	355	13.7	0.63
Carpio	63.5	84.6	28.7	6	1.54	404	13.0	0.63
Joppa	62.9	84.4	26.6	5	1.61	366	13.5	0.63
Alzada	63.3	83.3	28.2	6	1.76	411	13.7	0.77
Dynamic	64.6	84.9	30.4	5	1.56	416	13.7	0.60
Fortitude	64.0	84.7	28.6	6	1.71	364	13.7	0.64
Precision	62.4	84.6	29.1	5	1.69	436	13.6	0.71
Vivid	64.3	84.3	29.8	6	1.68	388	14.1	0.69
MT112219	64.4	83.6	24.3	4	1.70	312	12.6	0.74
MTD16001	65.5	85.2	25.9	5	1.50	384	12.8	0.57
MTD16002	63.1	85.0	26.4	4	1.51	450	14.0	0.59
MTD16003	66.1	85.2	25.1	3	1.54	399	12.0	0.58
MTD16004	62.5	84.6	22.2	5	1.66	365	13.5	0.69
MTD16005	63.9	84.9	26.7	5	1.52	397	13.3	0.64
MTD16006	63.4	84.2	22.8	4	1.61	377	13.4	0.66
MTD16007	62.6	85.0	20.3	4	1.52	395	13.3	0.66
MTD16008	63.8	83.3	24.7	3	1.63	407	13.5	0.68
MTD16009	62.5	84.5	24.5	5	1.62	385	13.8	0.66
MTD16010	63.4	84.6	25.0	5	1.62	450	13.8	0.68
MTD16011	64.6	84.5	27.2	5	1.55	450	13.6	0.66

[1]Reported on a 14% moisture basis

Table 31. Agronomic means from 2018 rainfed off-station durum trial Roosevelt Co., MT.

Line	Plant height (in)	Yield (bu/ac)[1]	Test weight (lb/bu)	Protein (%)[2]
Mountrail	22.4	19.3	61.0	17.9
Divide	21.7	15.4	61.6	17.2
Alkabo	20.2	16.6	**62.6**	16.8
Grenora	19.6	17.6	61.3	16.8
Tioga	22.8	15.3	62.1	17.4
Carpio	20.1	15.4	61.6	17.5
Joppa	22.4	19.1	62.6	17.2
Alzada	21.4	**22.4**	60.6	16.3
Dynamic	20.1	15.7	61.6	**19.5**
Fortitude	23.0	20.8	61.6	18.5
Precision	22.3	17.5	62.3	18.6
Vivid	23.2	17.2	61.0	18.4
MT112219	19.8	20.3	62.3	16.0
MTD16001	22.2	17.0	61.5	16.7
MTD16002	**25.2**	12.4	60.8	19.0
MTD16003	22.7	17.8	61.3	16.1
MTD16004	24.4	17.1	61.2	17.3
MTD16005	22.6	19.0	60.8	18.2
MTD16006	24.3	17.6	61.5	17.2
MTD16007	23.4	20.2	61.8	18.0
MTD16008	23.6	14.0	60.6	18.2
MTD16009	21.3	14.4	58.8	19.0
MTD16010	21.7	14.7	61.6	17.9
MTD16011	22.6	15.1	60.2	18.0
Mean	22.2	17.2	61.3	17.6
CV (%)	8.4	15.6	0.7	1.8
LSD (P=0.05)	3.0	4.4	0.7	0.5
Prob > F	0.025	0.005	<0.001	<0.001

[1]Reported on a 13% moisture basis
[2]Reported on a 12% moisture basis
NS = No significant difference based on ANOVA $p<0.05$
Underline/Bold = Highest values, underline = lowest

Table 32. Agronomic means from 2018 rainfed off-station durum trial Wibaux Co., MT.

Line	Plant height (in)	Yield (bu/ac)[1]	Test weight (lb/bu)	Protein (%)[2]
Mountrail	34.6	39.2	60.4	15.5
Divide	37.3	42.0	60.2	16.1
Alkabo	34.4	40.1	60.0	15.0
Grenora	34.0	44.3	58.6	15.6
Tioga	38.5	**44.7**	59.6	16.1
Carpio	33.6	36.4	59.3	15.3
Joppa	36.4	41.8	60.1	15.5
Alzada	27.4	37.5	59.6	15.6
Dynamic	37.9	44.0	60.1	**17.1**
Fortitude	32.0	37.6	59.8	17.0
Precision	34.9	34.4	59.8	16.9
Vivid	33.9	<u>26.3</u>	60.5	16.6
MT112219	<u>25.1</u>	39.3	**60.8**	14.5
MTD16001	38.2	38.5	59.3	16.3
MTD16002	**39.8**	39.3	60.2	15.5
MTD16003	35.7	37.5	60.4	14.6
MTD16004	36.1	35.6	60.3	16.8
MTD16005	37.3	37.6	58.8	15.9
MTD16006	37.0	39.2	60.2	<u>14.2</u>
MTD16007	34.3	42.1	60.5	16.1
MTD16008	35.2	40.2	59.6	16.1
MTD16009	38.5	37.2	<u>56.8</u>	15.7
MTD16010	35.7	30.3	60.7	15.8
MTD16011	37.1	42.0	59.1	16.1
Mean	35.2	38.6	59.8	15.8
CV (%)	5.1	17.9	0.8	6.7
LSD (P=0.05)	2.9	NS	0.8	NS
Prob > F	<0.001	0.365	<0.001	0.097

[1]Reported on a 13% moisture basis
[2]Reported on a 12% moisture basis
NS = No significant difference based on ANOVA $p<0.05$
Underline/Bold = Highest values, underline = lowest

Table 33. Agronomic means from 2018 rainfed off-station durum trial Valley Co., MT.

Line	Plant height (in)	Yield (bu/ac)[1]	Test weight (lb/bu)	Protein (%)[2]	Weed damage (%)
Mountrail	32.5	34.0	64.7	10.1	6.7
Divide	34.9	30.6	64.4	9.0	3.3
Alkabo	34.0	42.3	64.9	11.4	3.3
Grenora	33.5	44.0	65.5	10.7	0.0
Tioga	38.2	45.1	65.0	10.8	0.0
Carpio	34.3	44.1	63.9	11.9	0.0
Joppa	34.6	38.1	64.7	12.2	0.0
Alzada	29.1	<u>29.7</u>	64.8	10.2	13.3
Dynamic	33.7	40.5	65.4	10.3	0.0
Fortitude	33.6	43.2	65.2	10.5	0.0
Precision	33.9	34.0	**66.1**	10.4	0.0
Vivid	35.8	40.8	65.2	10.7	6.7
MT112219	<u>26.2</u>	44.8	66.0	10.6	0.0
MTD16001	35.0	30.4	63.7	10.4	3.3
MTD16002	**38.2**	40.1	64.4	11.2	10.0
MTD16003	36.2	41.6	65.0	9.5	0.0
MTD16004	34.1	40.0	65.3	11.0	6.7
MTD16005	36.5	40.2	64.3	10.7	0.0
MTD16006	34.4	33.3	64.3	10.6	0.0
MTD16007	34.8	37.4	65.1	11.3	13.3
MTD16008	35.2	40.9	64.1	10.4	16.7
MTD16009	36.5	39.6	<u>62.3</u>	10.7	0.0
MTD16010	35.2	36.8	65.0	11.0	0.0
MTD16011	34.3	**45.4**	64.6	10.8	0.0
Mean	34.4	39.0	64.6	10.7	3.5
CV (%)	5.2	21.2	2.1	9.7	240.1
LSD (P=0.05)	2.9	NS	NS	NS	NS
Prob > F	<0.001	0.467	0.111	0.251	0.338

[1]Reported on a 13% moisture basis
[2]Reported on a 12% moisture basis
NS = No significant difference based on ANOVA $p<0.05$
Underline/Bold = Highest values, underline = lowest

Table 34. Agronomic means from 2018 rainfed off-station durum trial Turner, MT.

Line	Stand (%)	Plant height (in)	Yield (bu/ac)	Adj. yield (bu/ac)	Test weight (lb/bu)	Protein (%)	Cutting (%)	Falling number (sec)
Mountrail	92.3	25.5	32.4	35.2	60.6	16.0	0.7	345.2
Divide	93.4	28.3	32.1	34.4	61.4	16.4	0.7	334.8
Alkabo	88.8	25.7	31.0	35.1	61.5	15.9	1.0	335.2
Grenora	92.7	26.2	36.3	39.2	61.1	16.0	0.0	368.4
Tioga	86.4	28.5	35.3	40.8	62.0	16.0	0.7	345.3
Carpio	92.8	24.8	35.7	38.6	60.8	15.6	0.7	357.0
Joppa	<u>80.1</u>	27.3	31.4	39.3	61.8	16.2	0.7	336.8
Alzada	**<u>96.1</u>**	23.7	31.7	<u>33.0</u>	61.1	16.1	0.3	**<u>371.8</u>**
Dynamic	94.4	26.1	35.9	38.1	60.0	**<u>17.6</u>**	0.3	341.7
Fortitude	83.8	26.6	32.5	39.0	61.1	16.9	0.7	355.4
Precision	77.1	27.3	33.3	**<u>43.3</u>**	61.9	17.0	0.3	366.5
Vivid	95.3	27.8	**<u>36.4</u>**	38.2	60.7	16.6	1.0	349.1
MT112219	98.0	<u>22.1</u>	34.4	35.1	**<u>62.2</u>**	15.4	0.3	349.7
MTD16001	87.8	26.2	35.3	40.5	60.9	<u>15.2</u>	0.0	342.2
MTD16002	88.7	28.8	35.9	40.4	61.2	15.9	1.0	347.2
MTD16003	95.7	25.9	32.0	33.5	61.6	14.6	0.0	348.4
MTD16004	95.3	25.7	34.2	35.7	61.5	16.2	0.3	328.8
MTD16005	91.4	28.8	34.3	37.6	60.3	16.6	0.3	351.7
MTD16006	80.4	**<u>29.2</u>**	31.5	39.1	61.2	15.9	0.3	<u>328.3</u>
MTD16007	85.7	26.7	34.7	40.7	61.3	16.3	0.7	350.0
MTD16008	92.0	28.3	35.3	38.5	60.5	16.8	0.7	342.6
MTD16009	84.4	25.4	<u>30.9</u>	36.8	<u>58.6</u>	16.9	0.0	332.2
MTD16010	92.0	28.5	35.4	38.6	61.1	16.2	0.0	357.3
MTD16011	83.7	26.7	33.0	39.5	60.6	16.4	0.7	350.5
Mean	89.5	26.7	33.8	37.9	61.0	16.2	0.5	347.3
CV (%)	11.6	5.5	10.1	5.8	0.5	1.1	-	1.3
LSD (0.05)	NS	2.4	NS	3.6	0.5	0.3	-	7.7
Prob > F	0.594	<0.001	0.628	<0.001	<0.001	<0.001	-	<0.001

[1]Reported on a 13% moisture basis
[2]Reported on a 12% moisture basis
[3]Percent cutting by sawfly
NS = No significant difference based on ANOVA $p<0.05$
Underline/Bold = Highest values, underline = lowest

Table 35. Agronomic means from 2018 rainfed off-station durum trial Chester, MT.

Line	Stand (%)	Plant height (in)	Yield (bu/ac)	Test weight (lb/bu)	Protein (%)	Cutting (%)[3]	Falling number (sec)
Mountrail	99.7	31.3	30.0	55.0	17.7	0.5	334.2
Divide	99.3	33.1	28.4	57.8	16.6	0.5	347.8
Alkabo	99.0	32.6	30.1	57.1	17.1	0.5	336.4
Grenora	98.4	32.3	29.6	56.0	17.5	0.3	342.7
Tioga	99.7	35.1	30.9	57.2	18.2	0.2	358.2
Carpio	98.4	31.5	27.0	55.3	17.4	0.3	336.8
Joppa	98.0	35.0	24.7	56.4	17.1	0.7	317.5
Alzada	99.7	28.0	33.9	54.4	16.8	1.8	**367.1**
Dynamic	100.0	31.8	27.3	55.9	**18.6**	0.0	304.5
Fortitude	99.3	32.0	29.6	55.8	18.0	0.2	353.3
Precision	99.3	33.3	**34.8**	58.0	18.0	0.2	360.9
Vivid	98.7	34.1	31.0	56.8	18.1	0.3	337.5
MT112219	99.0	28.0	31.4	55.9	16.1	0.3	342.9
MTD16001	99.0	33.0	28.6	56.9	17.1	0.5	347.8
MTD16002	99.3	31.5	25.7	57.0	17.0	0.0	331.2
MTD16003	98.7	31.7	29.9	56.2	17.4	0.7	345.0
MTD16004	98.7	32.9	33.7	**58.1**	17.5	0.3	340.6
MTD16005	99.0	34.3	25.2	55.5	18.0	0.2	348.7
MTD16006	99.3	**36.2**	28.0	57.7	17.4	0.3	335.4
MTD16007	99.0	33.0	27.8	56.4	18.0	0.3	337.3
MTD16008	99.7	34.1	22.4	55.9	17.1	1.7	353.4
MTD16009	98.4	32.1	24.0	53.2	17.7	0.3	332.8
MTD16010	98.4	33.1	26.0	56.8	17.0	0.0	346.7
MTD16011	98.4	33.6	27.0	55.6	17.4	0.5	343.9
Mean	99.0	32.7	28.6	56.3	17.4	0.4	341.8
CV (%)	1.3	4.2	7.5	0.7	2.5	-	1.9
LSD (0.05)	NS	2.2	3.5	0.6	0.7	-	10.7
Prob > F	0.935	<0.001	<0.001	<0.001	<0.001	-	<0.001

[1]Reported on a 13% moisture basis
[2]Reported on a 12% moisture basis
[3]Percent cutting by sawfly
NS = No significant difference based on ANOVA $p<0.05$
Underline/Bold = Highest values, underline = lowest

Table 36. Agronomic means from 2018 rainfed off-station durum trial Loring, MT.

Line	Stand (%)	Plant height (in)	Yield (bu/ac)	Test weight (lb/bu)	Protein (%)	Cutting (%)	Falling number (sec)
Mountrail	95.1	**28.4**	**35.6**	60.6	15.6	0.3	336.1
Divide	96.1	28.1	32.7	61.1	15.7	0.0	322.5
Alkabo	92.1	24.5	29.1	**61.9**	15.2	0.0	320.1
Grenora	90.1	27.1	29.9	61.2	15.9	0.7	340.5
Tioga	94.1	27.7	32.4	61.7	16.2	2.0	306.6
Carpio	91.5	25.7	31.7	61.2	15.0	0.3	343.0
Joppa	<u>85.2</u>	26.2	27.1	61.9	16.3	0.3	326.4
Alzada	94.1	<u>21.0</u>	31.3	61.3	15.6	0.3	**379.6**
Dynamic	97.0	25.7	<u>23.3</u>	60.4	**17.5**	0.7	335.8
Fortitude	97.0	24.8	35.2	60.8	16.7	0.3	344.7
Precision	90.7	25.0	30.4	61.9	16.6	0.0	345.5
Vivid	93.1	25.9	32.8	61.5	15.9	0.7	325.7
MT112219	96.0	21.4	26.9	61.7	16.2	0.0	315.3
MTD16001	90.5	27.4	33.0	60.8	15.2	0.0	328.0
MTD16002	93.4	24.3	34.4	61.2	15.4	0.0	331.2
MTD16003	94.4	23.3	28.7	61.4	<u>14.8</u>	0.3	333.0
MTD16004	96.7	27.1	28.3	61.7	15.7	0.7	310.1
MTD16005	96.7	26.7	32.0	60.4	16.3	0.3	324.0
MTD16006	92.4	24.1	31.9	61.2	16.0	0.0	316.5
MTD16007	90.4	24.9	31.2	61.3	16.3	0.0	338.9
MTD16008	93.4	20.9	26.2	59.3	17.6	0.0	<u>293.2</u>
MTD16009	94.1	23.2	30.7	<u>58.9</u>	16.2	0.0	309.4
MTD16010	89.4	26.0	29.4	60.7	16.2	0.7	334.1
MTD16011	<u>**97.1**</u>	25.6	34.0	60.1	15.8	0.0	327.6
Mean	93.4	25.2	30.8	61.0	16.0	0.3	328.7
CV (%)	5.7	3.9	6.0	0.6	2.4	-	3.9
LSD (0.05)	NS	1.6	3.0	0.6	0.6	-	21.3
Prob > F	0.534	<0.001	<0.001	<0.001	<0.001	-	<0.001

[1]Reported on a 13% moisture basis
[2]Reported on a 12% moisture basis
[3]Percent cutting by sawfly
NS = No significant difference based on ANOVA $p<0.05$
Underline/Bold = Highest values, underline = lowest