MONTANA STATE UNIVERSITY

MEMORANDUM

FROM: Michael J. Giroux and Andrew C. Hogg

DATE: 1/25/2023

RE: Motion for Release of MTD18148 spring durum wheat with supporting documentation.

RECOMMENDATION Public, protected **NAME** To be determined

CONTRIBUTORS

- Dr. Mike Giroux and Mr. Andy Hogg, MSU Bozeman, MT
- Dr. Pat Carr and Dr. Jed Eberly, MSU-CARC, Moccasin, MT
- Dr. Chengci Chen, Ms. Calla Kowatch-Carlson and Dr. Frankie Crutcher, MSU-EARC, Sidney, MT
- Ms. Peggy Lamb MSU-NARC, Havre,
- Dr. Ken Kephart and Ms. Valerie Smith, MSU-SARC, Huntley, MT
- Dr. Justin Vetch MSU-WTARC, Conrad, MT
- Mr. Doug Holen, MSU Foundation Seed, Bozeman, MT
- Mr. Craig Cook, 2nd Nature Research, LLC, Bozeman, MT
- Dr. Linda Dykes, USDA-ARS, Fargo, ND
- Dr. Xianming Chen USDA-ARS, Pullman, WA
- Dr. Li Huang, MSU, Bozeman, MT
- Dr. Zhaohui Liu, NDSU, Fargo, ND

SEED AVAILABILITY

Breeder's seed ($F_{5:10}$) was planted Fall 2022 in Yuma, AZ and will be rogued during the growing season for off-types. Seed harvested in Yuma will be replanted as Foundation seed in Bozeman Spring 2023, followed by registered seed in 2024 and certified seed in 2025. Expected availability to the public in 2026.

Crop Science

Entomology

Horticulture

Plant Biology

Plant Genetics

Plant Pathology

Dr. Michael Giroux
Professor and Head
Department of Plant Sciences and Plant Pathology
College of Agriculture
119 Plant BioScience Building
PO Box 173150
Montana State University
Bozeman, MT 59717-3150

Telephone: 406-994-7877
Fax: 406-994-7600
mgiroux@montana.edu

PEDIGREE

Joppa/Alzada

- **'Alzada'-Westbred, LLC, 2004**

'Alzada' was developed from the cross Mohawk/Kofa and was released by Westbred, LLC, Bozeman, MT. Alzada is a semi-dwarf, spring durum that is adapted to drier climates and has excellent quality traits (high yellowness, high gluten strength, and good color stability).

- **'Joppa'- North Dakota State University, 2013**

'Joppa' (Reg. No. CV-1115, PI 673106), spring durum wheat [*Triticum turgidum* L. subsp. *durum* (Desf.) Husn.] was developed by the North Dakota Agricultural Experiment Station in cooperation with USDA-ARS and released on 1 July 2013. The original cross 'Maier'/D97643 was made in fall 2000. Joppa was released on the basis of its high grain yield potential, disease resistance, and excellent end-use qualities. Joppa had higher yield than the predominant North Dakota cultivar Divide. Joppa has very strong dough mixing characteristics and a high gluten index.

Elias, Elias & Manthey, Frank. (2016). Registration of 'Joppa' Durum Wheat. Journal of Plant Registrations. 10. http://dx.doi.org/10.3198/jpr2015.11.0071crc

SELECTION HISTORY

MTD18148 is an offspring of a cross between the cultivars Joppa and Alzada. In 2015, Joppa was crossed to Alzada. The offspring from this cross was then advanced in the greenhouse and field by single seed descent to the F_5 generation at which point a whole head was harvested. In 2018, 177 Joppa/Alzada F_6 lines were planted in spaced head-rows (15 seeds/5 ft row) in Bozeman, MT at the Post Agronomy Farm and the best agronomic rows were visually selected and threshed using a Vogel thresher. Traits taken into consideration were tillering, straw strength, height, disease reactions, head size/shape, overall vigor, and maturity. Harvested grain was assessed for protein content and lines with protein below 13.5% were discarded.

In 2019, MTD18148 was included in the Bozeman Durum Preliminary Yield Trial which consisted of 550 $F_{6:7}$ entries which were grown as single 2-row plots (2 x 10 ft) using a randomized augmented design with Joppa and Alzada checks every 25 rows at the Post Agronomy Farm under dryland and irrigated conditions. Lines were evaluated for agronomic traits (height, heading date, maturity date, and grain yield) and quality traits (protein, seed size, and seed yellowness) and plots from the irrigated trial were harvested with a binder and Vogel thresher for seed stock. Relative to the semi-dwarf check, Alzada, MTD18148 had a 12% yield increase in the irrigated trial and a 23% increase in the dryland trial. Across

environments the protein content of MTD148 was 13.9% and Alzada was 14.2% and both were moderately susceptible to fungal leaf spot reaction. Under dryland conditions in Bozeman MTD18148 flowered one day later than Alzada and matured four days later. For these reasons, MTD18148 was advanced for statewide testing in 2020.

In 2020, MTD18148 ($F_{6:8}$) was grown at 7 MAES locations across the state and one off-station trial near Conrad, MT to evaluate agronomics and quality traits were assessed by the USDA quality lab in Fargo, ND. Locations tested were Bozeman Post Agronomy Farm (irrigated and dryland), SARC (dryland), EARC (irrigated, dryland and off-stations), CARC (dryland), and NARC (dryland and off-stations), and in Conrad, MT (2^{nd} Nature LLC.). In 2020 over all on-station dryland locations, MTD18148 (61.8 bu/ac) had a higher yield than Alzada (58.4 bu/ac), Joppa (60.8 bu/ac), and ND Riveland (61.2 bu/ac) but not significantly so. Averaged across the Conrad and Havre locations MTD18148 (53.5 bu/ac) had a statistically similar yield as Alzada (57.4 bu/ac) with both having an average protein of 15.2%. MTD18148 yielded higher than Alzada in both Bozeman trials, SARC, CARC, and both EARC trials.

Seed of MTD18148 ($F_{6:9}$) was tested again in the 2021 Montana State Durum Trials at the same locations as 2020 with the exception that WTARC replaced the private trial in Conrad. In 2021 across all dryland trials, MTD18148 (40.0 bu/ac, 15.8%) had a statistically similar yield and protein to Divide (40.7 bu/ac, 16.0%), Joppa (40.8 bu/ac, 15.7%) and ND Riveland (43.9 bu/ac, 15.7%). At WTARC MT18148 (54.1 bu/ac) was the second highest yielding line behind ND Riveland (57.0 bu/ac) and at the EARC dryland location MTD18148's yield (44.4 bu/ac) was statistically similar to the highest yielding line MT Blackbeard and higher than Joppa (38.2 bu/ac), Divide (39.2 bu/ac) and ND Riveland (42.4 bu/ac).

MTD18148 ($F_{6:10}$) was tested again in the 2022 Montana State Durum Trial at NARC, CARC, EARC, Bozeman, and a private trial in Conrad. MTD18148 was also tested in 2022 at six off-station locations. Across all dryland locations in 2022 MTD18148 and Alzada performed similarly in terms of yield, test weight, and protein (MTD18148= 40.8 bu/ac, 58.7 lb/bu, 15.3%; Alzada= 41.7 bu/ac, 58.2 lb/bu, 15.2%). Given MTD18148's performance in statewide trials it was selected for potential release.

PURIFICATION OF SEED STOCK

MTD18148 was developed using the single seed descent method F_1-F_4 from 2016-2018. A single F_5 head was harvested from the greenhouse and $F_{5:6}$ seed was planted in a head-row in spring 2018. In 2018, a $F_{5:6}$ head-row was selected and harvested by binder and threshed with a Vogel for seed stock. In 2019, a 2'x10' plot of $F_{5:7}$ was planted under irrigation and harvested by binder and threshed with a Vogel. In 2020, a 4 x 30 ft plot of $F_{5:8}$ was planted in Bozeman for seed increase. Any contaminants were removed prior to harvesting with a plot combine. In Spring 2021, 0.25 acres of $F_{5:9}$ breeders seed was planted in Bozeman, MT under irrigation. This $F_{5:9}$ plot was rogued throughout the growing season and seed from the breeder's increase plot was harvested with a clean combine by MSU foundation seed. Breeder's seed $F_{5:10}$ was planted Fall 2022 in Yuma, AZ and will be rogued during the growing season for off-types. Seed harvested in Yuma in Spring of 2023 will be replanted as Foundation seed in Bozeman, followed by registered seed in 2024 and certified seed in 2025. Expected availability to the public in 2026.

AGRONOMIC CHARACTERISTICS

MTD18148 is a semi-dwarf spring durum wheat (*Triticum turgidum* ssp. *durum*) developed at MSU that is approximately 24 inches tall, which is comparable to the top grown variety Alzada, but shorter than standard height varieties like Joppa and Divide (Table 2 and 3). MTD18148 has white glumes and awns and has a heading date of June 28th which is two days later than Alzada, one day earlier than Joppa and Divide, and two days earlier than ND Riveland (Table 3). Averaged over all locations and conditions (2020-22, 22 loc-year, no off-station) MTD18148 yielded significantly more than Alzada and equal to Joppa, and Divide (Table 2). Averaged over dryland locations (2020-22, 22 loc-year, no off-station) MTD18148 yielded equal-to or more than commonly grown cultivars Alzada, Joppa, and Divide (Table 3). In the North Central growing region where Alzada makes up 80% of the acreage, MTD18148 yielded equal to the top varieties Alzada, Divide, Joppa, and ND Riveland (Table 4). Sawfly cutting of MTD18148 over three years at NARC was significantly less than that seen for ND Riveland, ND Grano and Mountrail. MTD18148 had the third lowest cutting behind MT Raska and MT Blackbeard (Table 4). In the Northeast growing region over three years of irrigated and dryland trials at EARC MTD18148 significantly out yielded Alzada and was comparable to Divide and Joppa (Table 5).

QUALITY CHARACTERISTICS

Averaged over two years and all locations (16 loc-year), MTD18148 had a grain protein content (14.9%), that was significantly higher than Alzada, Divide, and Joppa and equal to ND Riveland and Carpio (Table 6). MTD18148 had grain ash (1.55%) and test weight (60.3 lb/bu) comparable to top grown cultivars (Table 6). Compared to Divide and Joppa, MTD18148 had a similar percent of large seeds (47.3%) and small seeds (14.3%) (Table 7). MTD18148 had a smaller individual seed weight (37.5 mg) compared to Alzada, Divide, Joppa, and ND Riveland (Table 7). After milling and sifting, MTD18148 had a semolina yield (59.7%) significantly higher than ND Riveland but less than Divide, Joppa and Alzada (Table 8). Like Alzada, MTD18148 had a high percent of shorts (13.7%) compared to other cultivars but it had a higher bran percent than Alzada (Table 8). Semolina from MTD18148 had significantly higher protein (13.7%) compared to Divide, Joppa, ND Riveland, and Alzada but a similar ash content (0.67%) (Table 8). MTD18148 had a similar gluten index (95) to Alzada and ND Riveland but significantly stronger than Joppa and Divide (Table 9). MTD18148 had a similar semolina color profile as Alzada that is yellower, less red and less bright than Divide, Joppa, and ND Riveland (Table 9). With high yellowness, high semolina protein, and high gluten index, MTD18148 is an excellent replacement for Alzada in terms of quality.

DISEASE EVALUATIONS

Fusarium head blight susceptibility was evaluated in 2021 at EARC and MTD18148 performed similarly as top grown cultivars in terms of severity, index, and fusarium damaged kernels with a susceptible reaction (Table 10). MTD18148 was found to be resistant to the most prevalent stem rust race in Montana TCMLK (Table 11). MTD18148 was evaluated for leaf spot caused by *Stagonospora nodorum* and *Pyrenophora tritici-repentis* (Ptr) and was found to be Ptr-ToxA sensitive and moderately susceptible to both races of Ptr and one isolate of *S. nodorum*, with similar ratings as Alzada (Table 12). MTD18148 was evaluated for resistance/susceptibility to stripe rust in 2022 at multiple locations in WA and displayed susceptibility at the seedling stage (8/9) like Alzada and ND Riveland and an intermediate susceptible reaction at the adult stage (5/9) at two heavily infested locations (Table 13).

STATISTICAL ANALYSIS

For yield data across years and locations, the entry mean from each location/year was considered a replicate and was analyzed as a RCBD using PROC GLIMMIX in SAS v9.4. For quality data, each location-year was considered as a replicate and analyzed as a RCBD using PROC GLIMMIX in SAS v9.4. A calculated LSD was used to determine significant differences between entries at the α=0.05 level. For the entry Alzada no data is available from 2021.

MTD18148 Traits of Interest

- Good yield potential
- Good test weight and protein
- Semi-dwarf plant height and early heading
- Excellent end-use qualities; high yellow semolina, high semolina protein and strong gluten.

Table 1. 2022 Montana Variety Share of Planted Acres by Region (2022 USDA, NASS-MWBC)

	North Central	Northeast	State
Variety	%	%	%
Alzada	80.9	1.6	20.4
ND Riveland	-	16.6	12.6
Divide	-	15.2	11.8
Transcend	-	13.2	10.4
Joppa	-	10.7	8.7
Mountrail	-	6.6	5.0
Carpio	-	3.5	3.0
Tioga	-	2.9	2.2
Other, unknown	19.1	29.7	25.9
Total	100	100	100

(-) No data, minor amount reported, or withheld to avoid disclosing data for individual operations.
1) Other, Unknown includes AC Avonlea, AC Strongfield, Alkabo, Ben, Kyle, Lebsock, Luster, VT Peach, Other and Unknown varieties.
-176 reporting parties, 790,000 acres planted 2022.

Figure 1. Traits of Interest to Montana Growers (2022 USDA, NASS-MWBC)

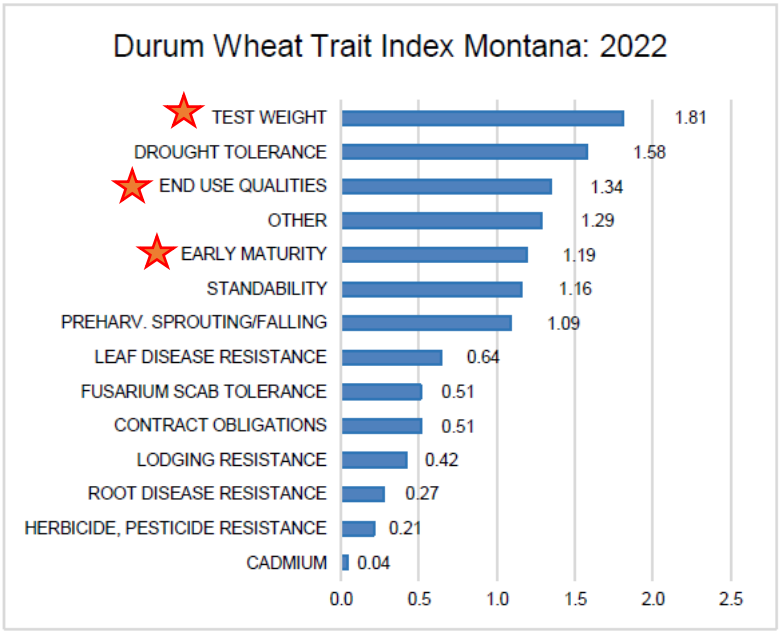

Table 2. Agronomic Evaluation of Irrigated and Dryland State Durum Trials (22 loc-year, 2020-22)

ID	Yield bu/ac[1]	Test weight lb/bu	Protein %[2]	Plant Height inch	Heading Julian
Alzada[3]	59.5	59.9	14.6	26.3	178
Carpio	64.5	59.9	14.9	32.4	183
Divide	63.0	60.4	14.9	32.8	181
Joppa	63.3	60.7	14.6	32.8	181
Lustre	64.4	59.3	15.2*	32.6	182
Mountrail	66.1	60.0	14.8	31.9	182
MT Blackbeard	66.4*	60.4	14.8	34.6*	183*
MTD18148	63.5	60.5	14.8	24.4	180
MT Raska	63.4	61.8*	14.9	25.4	178
ND Grano	65.8	60.9	14.9	32.1	182
ND Riveland	66.2	60.3	14.9	34.1	182
Mean	64.2	60.4	14.8	30.8	181
CV (%)	7.3	1.2	2.8	5.3	0.5
Prob > F	<0.001	<0.001	0.002	<0.001	<0.001
LSD	2.8	0.4	0.2	1.0	0.5

[1]Grain yield reported on a 13% moisture basis.
[2]Grain protein reported on a 12% moisture basis.
[3]No data for 2021, n=15.
*Indicates highest numerical value within a column.

Table 3. Agronomic Evaluation of Dryland State Durum Trials (16 loc-year, 2020-22)

ID	Yield bu/ac[1]	Test weight lb/bu	Protein %[2]	Plant Height inch	Heading Julian
Alzada[3]	48.9	59.4	14.9	25.6	177
Carpio	49.1	58.7	15.4	30.7	182*
Divide	48.8	59.6	15.3	31.5	180
Joppa	47.6	59.7	15.1	31.2	180
Lustre	49.9	58.4	15.6*	31.0	181
Mountrail	51.0	59.1	15.2	30.2	180
MT Blackbeard	52.4*	59.5	15.2	32.8*	182
MTD18148	50.6	59.8	15.1	23.5	179
MT Raska	50.9	61.3*	15.2	24.3	177
ND Grano	49.7	60.0	15.3	30.4	181
ND Riveland	50.8	59.3	15.4	32.3	181
Mean	50.0	59.5	15.2	29.4	180
CV (%)	7.8	1.1	2.6	5.4	0.5
Prob > F	0.059	<0.001	<0.001	<0.001	<0.001
LSD	2.8	0.4	0.3	1.1	0.7

[1]Grain yield reported on a 13% moisture basis.
[2]Grain protein reported on a 12% moisture basis.
[3]No data for 2021, n=11.
*Indicates highest numerical value within a column.

Table 4. North Central Agronomic Dryland Data from NARC, WTAC, and Conrad State Durum Trials (6 loc-years, 2020-22)

ID	Yield bu/ac[1]	Test weight lb/bu	Protein %[2]	Plant Height inch	Heading Julian	Sawfly[3] %	FN14[3] sec
Alzada[4]	43.6	58.6	15.3	26.3	175	10.3	519*
Carpio	38.8	57.0	16.0	29.4	180*	6.4	448
Divide	39.3	58.5	15.5	30.3	179	9.0	439
Joppa	36.6	58.4	15.6	30.0	178	12.8	436
Lustre	38.3	57.1	16.1*	29.7	179	8.2	451
Mountrail	40.7	58.0	15.9	28.9	179	14.7	453
MT Blackbeard	41.7	58.2	15.8	31.6*	180	4.4	515
MTD18148	41.7	58.8	15.6	23.3	177	6.5	514
MT Raska	43.6*	60.7*	15.5	24.3	176	1.2	449
ND Grano	37.8	58.7	15.9	28.8	180	15.9	432
ND Riveland	42.3	58.3	15.7	30.8	179	16.0*	466
Mean	40.4	58.4	15.7	28.5	178.4	9.6	465.6
CV (%)	9.3	1.1	2.7	5.4	0.6	59.1	3.8
Prob > F	0.031	<0.001	0.131	<0.001	<0.001	0.064	<0.001
LSD	4.4	0.8	0.5	1.8	1.5	9.9	31

[1]Yield reported on a 13% moisture basis.
[2]Protein reported on a 12% moisture basis.
[3]Sawfly cutting and Falling number (FN14) data are from NARC only, n=3.
[4]No data from 2021, n=4.

Table 5. Northeast Agronomic Data Irrigated and Dryland EARC State Durum Trials (6 loc-year, 2020-22).

ID	Yield[1] bu/ac	Test weight lb/bu	Protein[2] %	Plant Height inch	Heading Julian
Alzada[3]	51.0	61.2	14.4	26.0	175
Carpio	60.3	62.3	14.4	31.7	179
Divide	59.6	62.8	14.2	32.4	179
Joppa	60.8	63.1	14.0	32.6	178
Lustre	60.2	61.6	14.6	32.1	179
Mountrail	62.5	62.1	14.2	31.9	179
MT Blackbeard	63.1*	62.6	13.9	34.3	180
MTD18148	59.9	62.5	14.4	24.3	176
MT Raska	58.3	63.7*	14.5	25.3	175
ND Grano	62.4	63.2	14.3	31.6	179
ND Riveland	63.7	62.6	14.3	34.0	179
Mean	60.2	62.5	14.3	30.6	178
CV (%)	8.5	1.1	3.2	3.7	0.4
Prob > F	0.047	<0.001	0.222	<0.001	<0.001
LSD	6.0	0.8	0.5	1.3	1.0

[1]Yield reported on a 13% moisture basis.
[2]Protein reported on a 12% moisture basis.
[3]No data from 2021, n=4.

Table 6. Durum Seed Quality Evaluation I 15 location-years (2020-21)

ID	Test Weight	Grain Protein[1]	Grain Ash[2]	Falling Number
	lb/bu	%	%	seconds
Alzada[3]	60.1	14.3	1.56*	556*
Carpio	59.7	14.9	1.55	455
Divide	60.5	14.5	1.50	450
Joppa	60.8	14.3	1.52	434
Lustre	59.2	15.0	1.51	472
Mountrail	59.9	14.7	1.55	459
MT Blackbeard	60.5	14.8	1.56	482
MTD18148	60.3	14.9*	1.55	526
MT Raska	62.1*	14.8	1.53	450
ND Grano	60.9	14.7	1.54	444
ND Riveland	60.2	14.8	1.55	480
Mean	60.2	14.9	1.55	459
LSD (0.05)	0.5	0.4	0.04	21.7
Prob > F	<0.001	<0.001	<0.001	<0.001
CV (%)	1.2	3.7	3.2	6.5

[1]Grain protein reported on a 12% moisture basis.
[2]Grain ash reported on a 14% moisture basis.
[3]No data 2021, n=8.
*Indicates highest numerical value within a column. Not all lines used for analysis are included in table.

Table 7. Durum Seed Quality Evaluation II 15 location-years (2020-22)

ID	Large Seeds	Small Seeds	Hardness[1]	Individual Seed Weight[1]	Individual Seed Diameter[1]
	%	%		mg	mm
Alzada[2]	64.0	10.3	70.8	41.8*	2.96*
Carpio	50.9	14.3	73.3	37.9	2.76
Divide	51.1	13.8	73.7	39.0	2.79
Joppa	44.1	16.6	73.9	39.3	2.78
Lustre	37.7	17.6	74	37.7	2.74
Mountrail	39.4	18.7*	72.4	38.3	2.76
MT Blackbeard	65.3*	8.1	73.3	41.0	2.89
MTD18148	47.3	14.3	79.8	37.5	2.79
MT Raska	55.3	11.7	80.5*	37.1	2.83
ND Grano	44.0	17.5	74.4	37.8	2.76
ND Riveland	56.1	10.9	71.9	40.9	2.83
Average	51.4	13.6	75	38.7	2.8
LSD (0.05)	4.7	2.7	1.8	1.1	0.04
Prob > F	<0.001	<0.001	<0.001	<0.001	<0.001
CV (%)	12.7	27.6	3.3	4.1	2.2

[1]Measured by Single Kernel Characterization System.
[2] No data 2021, n=8.
*Indicates highest numerical value within a column. Not all lines used for analysis are included in table.

Table 8. Durum Semolina Quality Evaluation I 16 location-years (2020-21)

ID	Bran[1]	Shorts[1]	Semolina[1]	Semolina Protein[2]	Semolina Ash[2]
	%	%	%	%	%
Alzada[3]	25.0	14.1*	60.9	13.0	0.68*
Carpio	27.1	12.9	60.0	13.5	0.66
Divide	27.0	12.1	60.8	13.2	0.62
Joppa	26.6	12.2	61.2	13.0	0.63
Lustre	27.0	12.8	60.2	13.7	0.65
Mountrail	26.7	12.1	61.2	13.6	0.66
MT Blackbeard	26.6	12.5	60.9	13.1	0.66
MTD18148	26.6	13.7	59.7	13.7*	0.67
MT Raska	26.0	12.9	61.1	13.2	0.61
ND Grano	26.6	12.0	61.4*	13.3	0.63
ND Riveland	28.7*	13.4	57.9	13.2	0.64
Average	27.1	12.7	60.2	13.5	0.65
LSD (0.05)	0.5	0.3	0.7	0.4	0.07
Prob > F	<0.001	<0.001	<0.001	<0.001	<0.001
CV (%)	2.8	3.6	1.6	4.1	3.9

[1]Milling fractions from Brabender Quadramat Jr. milling and separated with a U.S. #35 sieve.
[2]Reported on a 14% moisture basis.
[3] No data 2021, n=8.
*Indicates highest numerical value within a column. Not all lines used for analysis are included in table.

Table 9. Durum Semolina Quality Evaluation II 16 location-years (2020-21)

ID	CIELAB Color Space[1]			Mix Time	Max Integral Peak[2]	Gluten Index[3]
	L*	b*	a*	Minutes	%TQ	
Alzada[4]	84.2	31.8	-2.84	4.0	206.6	97.9*
Carpio	84.7	31.7	-3.23	4.2	217.0	97.2
Divide	84.9	28.8	-2.82	3.3	154.6	78.5
Joppa	84.8	31.2	-3.02	3.9	177.3	88.7
Lustre	84.6	29.7	-2.70	3.2	150.7	64.2
Mountrail	85	26.9	-2.65*	2.2	102.5	34.2
MT Blackbeard	84.7	31.8	-3.16	4.6	228.8*	96.0
MTD18148	84.2	31.9	-2.86	4.3	204.0	95.0
MT Raska	84.6	29.4	-2.77	3.9	172.2	71.8
ND Grano	84.9	31.6	-3.25	3.3	159.0	82.7
ND Riveland	84.8	31.4	-3.16	4.0	201.7	92.5
Average	84.7	30.6	-2.99	3.7	178.3	80.1
LSD (0.05)	0.2	0.5	0.09	0.2	12.5	7.7
Prob > F	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
CV (%)	0.3	2.5	4.2	8.4	9.9	6.7

[1]CIELAB color space L*=whiteness, b*=yellowness, a* =redness.
[2]Mixograph Midline Analysis.
[3]Data from two environments only.
[4] No data 2021, n=8.
*Indicates highest numerical value within a column. Not all lines used for analysis are included in table.

Table 10. Durum Fusarium Head Blight Evaluation 2021 (Dr. Frankie Crutcher, EARC, Sidney, MT)

ID	Severity[1]	Incidence[2]	Index[3]	FDK[4]	Yield
	%	%		%	bu/ac
Carpio	26.7 AB	83.3	22.3 AB	25.0 AB	37.5 AB
Divide	28.4 AB	88.9	25.3 AB	21.7 AB	33.7 AB
Joppa	19.9 B	81.1	16.3 B	18.3 AB	43.0 AB
Lustre	27.4 AB	75.6	21.9 AB	16.7 AB	31.9 AB
Mountrail	34.8 AB	92.2	32.3 AB	16.7 AB	31.4 AB
MT Blackbeard	23.4 B	86.7	20.3 AB	26.7 AB	35.2 AB
MTD18148	27.8 AB	86.7	25.1 AB	28.3 AB	21.5 B
MT Raska	27.2 AB	90	24.8 AB	43.3 A	32.4 AB
ND Grano	18.9 B	82.2	16.2 B	13.3 AB	36.1 AB
ND Riveland	15.1 B	83.3	12.6 B	16.7 AB	46.0 A
Mean	25.2	83.5	21.6	22.5	33.5
p-value	<0.001	0.160	0.001	0.030	0.040
CV (%)	37.0	12.0	44.1	50.9	25.2
HSD (5%)[5]	23.5	N/A	25.1	32.7	24.4

[1]Pest Severity: Average percent area of head covered by disease. Thirty heads were evaluated for each plot
[2]Pest Incidence: Percent of thirty plants per plot that had visible FHB symptoms
[3]Index: Severity X Incidence / 100
[4]Percent of Fusarium diseased kernels
[5]Letters in common did not differ significantly according to a Tukey's HSD test at a significance level of 5%. Not all lines used for analysis are included in table.

Table 11. Durum Stem Rust Evaluation 2021 (Dr. Li Huang, MSU, Bozeman, MT)

ID	Infection Type[1]	Level of Reaction
Mountrail	;	R
Divide	1=1C	R
Carpio	;	R
Joppa	1=~2C	R~MR
ND Riveland	1=	R
Lustre	1=1+C	R
MT Blackbeard	1-	R
MTD18148	1-C	R
MT Raska	1-C	R

[1]Inoculated with *Puccinia graminis* isolate TPMKC on 4/19/2021 scored 5/3/2021. 0 = immune (R), ";" = Very Resistant (VR), 1=Resistant (R), 2 = Moderately resistant (MR), 3 = Moderately susceptible (MS), 4 = Susceptible (S), Chlorosis (C). Variations are given by + and = to indicate more or less than usual

Table 12. Durum Fungal Leaf Spot Evaluation 2022 (Dr. Zhaohui Liu, NDSU, Fargo, ND)

ID	ToxA[1]	Ptr-ND[1]	DW5[1]	SN4[1]
Alzada	0	3.3	3.7	3.2
Carpio	1	2.7	2.5	2.8
Divide	1	3.2	2.3	2.8
Joppa	1	2.8	2.5	3.5
Lustre	1	2.7	1.3	3.0
Mountrail	0	4.0	2.8	3.2
MT Blackbeard	1	2.5	3.5	2.8
MTD18148	1	2.8	3.7	3.0
MT Raska	1	2.8	1.3	2.2
ND Grano	1	3.0	3.3	3.0
ND Riveland	0	3.8	2.5	2.8
Salamouni (check)	0	1.3	1.0	2.7
Glealea (check)	1	4.0	2.5	4.5
6B662 (check)	0	2.3	3.7	3.8
6B365 (check)	0	4.2	2.2	3.0
BR34 (check)	0	-	-	1.2

[1]*P. tritici-repentis* (Ptr) ToxA: 0=insensitive; 1=sensitive. ToxA sensitivity is conferred by wheat *Tsn1* gene.
[2]Evaluation with Ptr races ND (predominant in North Dakota) and DW5 using a 0-5 scale, 1,2=resistant, 3=moderately susceptible, 4, 5=highly susceptible, averaged over three plants.
[3]Evaluation with *Septoria nodorum* isolate Sn4 (predominant in North Dakota) using 0-5 scale, 0-2=resistant, 3=moderately susceptible, 4,5=highly susceptible, averaged over three plants.

Table 13. Durum Stripe Rust Evaluation 2022 (Dr. Xianming Chen, USDA-ARS, Pullman, WA)

Location (WA)	Pullman		MT. Vernon[2]		MT. Vernon[2]		Central Ferry	
Date	7/5/2022		5/19/2022		6/27/2022		6/23/2022	
Feekes[3]	10.54		2		10.54		10.5	
ID	**IT[1]**	**%**	**IT[1]**	**%**	**IT[1]**	**%**	**IT[1]**	**%**
Alzada	2	5	8	20	2	20	2	15
Divide	2	5	5	20	2	10	2	10
Carpio	2	10	8	10	2	15	2	2
Joppa	3	20	5	30	3	20	5	40
Lustre	2	5	3	30	2	15	2	10
Mountrail	2	15	8	10	3	20	5	40
ND Riveland	3	20	8	20	3	20	2	10
ND Grano	2	5	5	20	2	5	2	10
MT Raska	7	70	8	20	7	90	5	60
MTD18148	2	15	8	20	5	50	5	40
MT Blackbeard	5	50	8	20	5	50	5	40
AvS (Sus check)	9	100	8	20	9	100	9	100
MOREX barley	5	20	0	0	8	30	8	50

[1]Infected with naturally occurring *Puccinia striiformis*. Infection Type (IT) was recorded based on the 0-9 scale with ITs 8 and 9 combined as 8 (the most susceptible reaction) in field data. Generally, 0-3 are considered resistant, 4-6 intermediate, and 7-9 susceptible. Heterogenous reactions of an entry were indicated by two or more ITs separated by "," for most plants with the first IT and few plants with the second IT or connected with "-" for entries containing plants with continuous ITs

[2]Entries with a high IT in the first note, but a low IT in the second note at Mt. Vernon may indicate that they have high-temperature, adult-plant (HTAP) resistance

[3]Feekes (Fks) scale for wheat growth stages. 2= early tillering, 10.53= late flowering