

FIGURE 1 20WCFA22 ESTABLISHMENT AT L22 BERKS PHOTO COURTESY MIKE FIDANZA

2024



20WCFA Tall Fescue TWCA Qualification

PUBLIC QUALIFICATION REPORT

JACK KARLIN



https://teams.microsoft.com/l/meetup-join/19:meeting_Y2lwMmFIOGEtNzAzZi00ZDZiLTlhYjctYmU2ZDgxMWM2MjE5@thread.v2/0?context=%7B%22Tid%22:%222e1ff3ba-dfb2-4a29-a668-a3312aa080b6%22,%22Oid%22:%22953f1f08-eb47-4fbb-9626-6adf6bdd2428%22%7D

Contents

- Committee2
- Qualification3
 - Entries3
 - Standards3
 - Entries3
- 20WCFA Qualification5
 - Locations5
 - Reporting6
- Results6

Report compiled by Jack Karlin of Karlin Consulting llc on behalf of Turfgrass Water Conservation Alliance (TWCA.) contact jack karlin at jack.karlin@tgwca.org with questions or concerns.

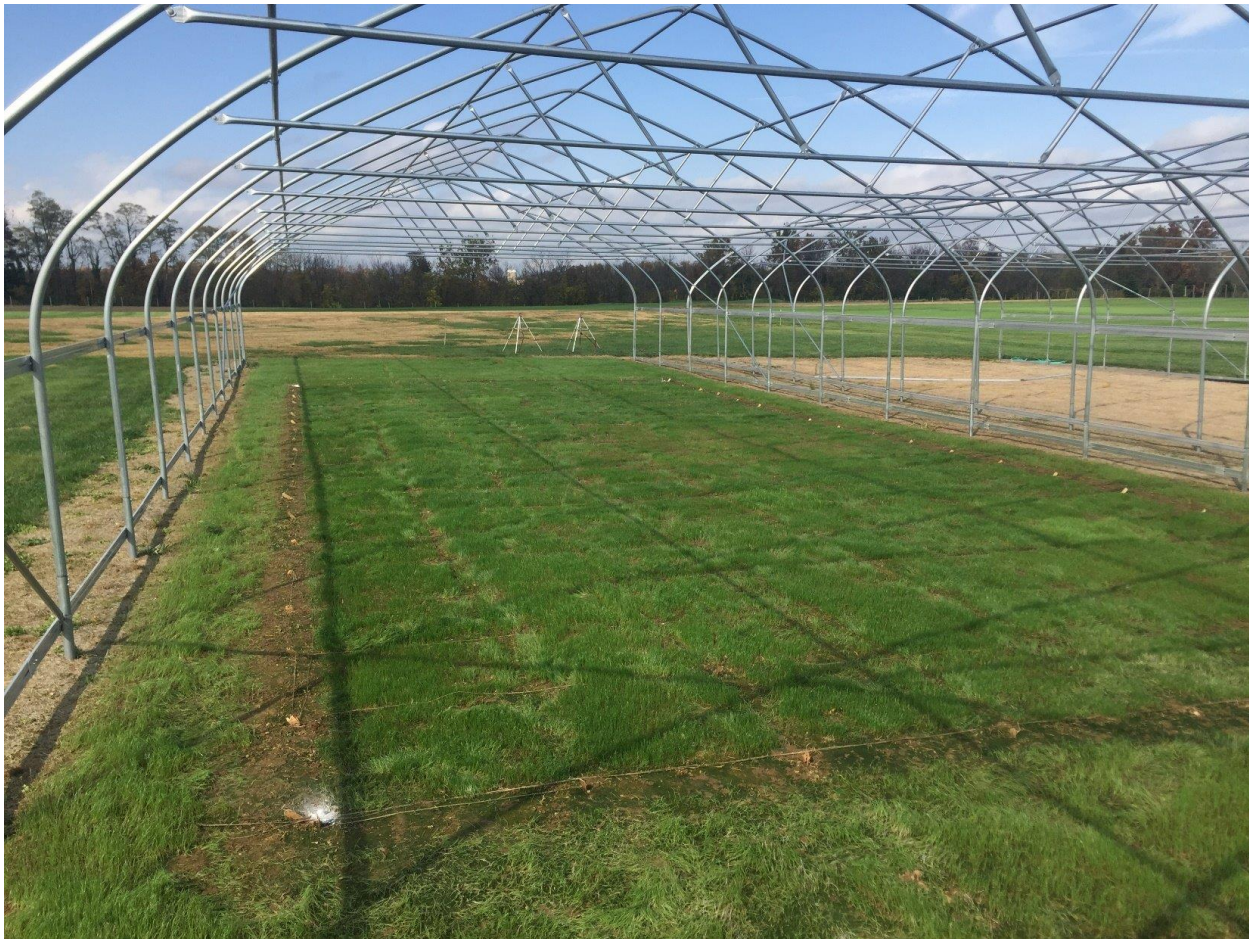
Committee

The research review committee consists of three voting members and two ex-officio members. Committee members are listed in Table 4.

TABLE 1: RRC COMMITTEE MEMBERS ATTESTATION OF REPORT

RRC Committee Member	Role
Cale Bigelow, PhD	Chair, reviewing member
John Stier, PhD	reviewing member
Matteo Serena, PhD	reviewing member
Tyler Carr, PhD	DESA, ex-officio
Jack Karlin	ED, ex-officio

FIGURE 1 20WCFA22 ESTABLISHMENT AT L22 BERKS PHOTO COURTESY MIKE FIDANZA





Qualification

Data collection costs for this trial were \$67500. This is thirty-six percent (36%) less than the initially budgeted \$105,000.

TWCA Qualification demonstrates consistent performance across location and through time. In most cases cultivars will perform within ten percent (10%) of the drought tolerant standards. In some instances, the thresholds have been adapted to accommodate real world conditions. In cases of adaptation or accommodation modifications are noted in the workbooks and report.

- Maintain an annual cultivar plant factor (CPF) equal or less than one point one zero (1.10) (unless otherwise noted in the workbook) across locations.
- Demonstrate persistence over time across a broad geographic range.

Entries

Standards

Trialing protocol requires six (6) standards in each trial, two drought-tolerant (noted *D-Tol*), two drought-susceptible (noted *D-Sus*) and two known standards (noted *Known*). The D-Tol standards selected for this trial the same standards used in 16WCFA. Standards are listed in Table 1. Research Review Committee (RRC) members remarked on the consistent performance of these D-Tol standards over time.

TABLE 2: 20WCFA STANDARDS

CHECK	EXPERIMENTAL	NAME	ENTRY
Known	PST-5SDT	RainDance	1
D-Tol	SBL	2nd Millenium	2
D-Sus	Firenza	Firenza	3
Known	K-31	K-31	4
D-Tol	ATF1426	Aquavita	5
D-Sus	SIXPOINT	SIXPOINT	6

Entries

20WCFAAnn included forty-six (46) non-standard entries raising the total number of entries to fifty (50). In cases of lapsed membership, the experimental and commercial names are replaced with the cultivar entry number. Genetics are sourced from six (6) separate breeding programs. Entry 2041 (Falcon H2O) was submitted with a heavily contaminated sample rendering it ineligible for evaluation. This is noted in the public cultivar tables. Partner tables include the values generated by the contaminated sample. The tall fescue sample was contaminated by annual ryegrass at the time of submission. Contamination was discovered at establishment and was remarked on by all cooperators.



TABLE 3 NON-STANDARD ENTRIES

CHECK	Published Entry	ENTRY#
	2007	7
	2008	8
	2009	9
	2010	10
	2011	11
	2012	12
	2013	13
	2014	14
	ATF1829	15
	ATF1992	16
	ATF1835	17
	PST-RSHD6	18
	PST-5E6	19
	PST-5FOE	20
	Thunderstruck*	21
	Thor	22
	Trinity	23
	Talladaga II	24
	Triad	25
	2026	26
	2027	27
	2028	28
	2029	29
	PST-5NOG-17	30
	PST-5MINI	31
	firenza II	32
	PST-5TRN	33
	PST-5HAF9	34
	PST5GQ	35
	2036	36
	2037	37
	2038	38
	2039	39
	RENEGADE DT	40
	FALCON H2O	41
	Zigzag	42
	Amity	43
	PST-5T24	44
	Saltillo	45
	PST-5GLBS	46
	PST-5LOD	47
	GLX ACED	48
	GLX Star	49
	PST-5DC24	50



20WCFA Qualification

Qualification requires performance within thresholds across locations and time. CPF thresholds are referenced at 1.10. This is interpreted as requiring up to one hundred ten percent of the drought tolerant standard water requirement. In some cases, the threshold is modified to reflect the physical conditions more accurately at trialing locations. CPF normalization of data creates a meaningful comparison between locations over time.

Locations

TABLE 4: 20WCFA COOPERATORS

TWCA CAMERA	Location (Noted as Ln)	Primary	Primary Last	Location	State	email
TWCAG1511	1	J	Derr	Virginia Beach	VA	jderr@vt.edu
	2	K	Hignight	Albany	OR	festuca@Nexgenturfresearch.net
TWCAG1509	3	C	Bigelow	West Lafayette	IN	cbigelow@purdue.edu
TWCAG1510	5	M	Richardson	Fayetteville	AR	mricha@comp.uark.edu
TWCAG1504	7	E	Lyons	Guelph	ON	elyons@uoguelph.ca
TWCAG1507	9	C	Fricker	Hubbard	OR	crystal@pureseedtesting.com
TWCAG1508	10	K	Kopp	Logan	UT	kelly.kopp@usu.edu
TWCAG1512	12	M	Fraser	Rolesville	NC	mfraser@pureseed.com
TWCAG1506	19	P	Raymer	Griffin	GA	praymer@gmail.com
TWCAG1505	24	M	Fidanza	Redding	PA	maf100@psu.edu

Ten locations were selected by the RRC for trialing drought tolerance. Site selection was performed by RRC in the fall of 2019. Locations were selected based on applicable market, climate appropriateness, and broad geographic range. Limiting elements include infrastructure, willingness to participate and funding. Three locations are operated by TWCA members as part of a private plant breeding operation. Seven locations are independent university-based research facilities. The objective third party analysis structure drastically reduces opportunity for data tampering.

Heavy rainfalls disturbed trialing efforts in locations across North America through 2023 causing a failure of analysis at L4 Fayetteville attributable to overland flow. Rainfall also caused infiltration into the shelter at L7 Guelph creating a loss of data for three (3) entries. These entries, eight (8), twenty-one (21) and forty-three (43), exclude this year of data from the analysis.

L10.23 data interactions are excluded from evaluation due to low confidence reflected in low R² values. The unfortunate failure of analysis for L3.21 deprives a deeper look at drought tolerance over time relative to extreme evapotranspiration events. However, the L3.22 data provides good insight into end goal performance. The RRC concluded this is a statistical outlier year in performance and excluded it from evaluative analysis.

In most cases of data reporting resulting in failure of analysis (FOA) the data did not result in a sigmoid curve and could not fit the model.



Reporting

TABLE 5: TRIAL LOCATION DATA REPORTING. * INDICATES A FAILURE OF ANALYSIS WHERE DATA DID NOT MEET THE REQUIRED THRESHOLDS FOR ANALYSIS. ** INDICATES DATA LOSS AFTER COLLECTION. *** INDICATES AN INCOMPATIBLE DATA SET IN UNANALYZABLE FORMAT.

Location (Noted as Ln)	Location	State	2020	2021	2022	2023
1	Virginia Beach	VA	EST	data reported	data reported	data reported
2	Albany	OR	EST	data reported	data reported***/trial lost	X
3	West Lafayette	IN	EST	data reported*	data reported/Trial lost	X
5	Fayetteville	AR	EST	X	data reported	data reported*
7	Guelph	ON		X	data reported	data reported
9	Hubbard	OR	EST	data reported**	data reported	data reported
10	Logan	UT	EST	X	data reported	data reported*
12	Rolesville	NC	EST	X	data reported*/trial lost	X
19	Griffin	GA	EST	X/Trial lost to Pythium	X	X
24	Redding	PA	EST	data reported*	X/Trial lost to labor dispute	X
Percent possible locations reporting			90.00%	50.00%	90.00%	100.00%

Ninety percent of locations established trials in 2020. L7 was established in spring of 2021. Fifty percent of total locations reported data in 2021 representing fifty five percent of potential sites reporting. Of reported 2021 data forty percent (twenty percent of the total locations) were lost to failure of analysis, and one was lost to data mishandling after collection. 2022 and 2023 had the highest data collection rate of the trial with one hundred percent of potential trials reporting (ninety and fifty percent of total locations respectively). In 2022 one location suffered failure of analysis (eleven percent of the trials reporting in 2022) while one data set was lost to incompatible reporting.

Encouraging greater adoption of Teams data submission is aimed at reducing points of contact in data submission. This will reduce the opportunity for data loss.

Overall reporting was sixty percent of data sets or eighty three percent (83% when adjusted for attrition. Twenty-six (26%) percent of the data reporting was unusably compromised with one instance of human error in data handling, one instance of accessibility and formatting and five instances of failure of analysis. Thirty percent of locations were unable to provide meaningful data for evaluation. Data collection costs for this trial were \$67500. This is thirty-six percent (36%) less than the initially budgeted \$105,000.

Results

Tables are presented in both public and partner-only format. Partners have full data access. Public tables have been edited to reflect the average performance of qualified cultivars. D-Tol standards lost an average of nine point five two (9.52) inches before achieving twenty-five percent (25%) green cover. This mean is bracketed by a low of five point five inches (5.5) and highs of eleven point nine five (11.95) inches. The mean qualifying CPF is one point zero five (1.05) which translates to an estimated water need of ten (10) inches. In the Annualized CPF tables (tables 6 and 14) all locations scores are summarized into a mean CPF across locations for a coarse view of overall



performance relative to other cultivars in the trial. Partners access unredacted data in table 6. Individual locations offer a more nuanced view of performance in specific geographies and over time.

The data shows a maximum water savings potential of forty-four percent (44%) and a minimum water savings of nearly nineteen percent (19%) and an average water savings across locations of thirty-four percent (34%).

RRC recommends thirty four of fifty (34/50) total entries for qualification based on trialing data generated by drought trial 20WCFA. This is a qualification rate of sixty eight percent (68%).

FIGURE 2 GREEN COVER CHECKS BEING RUN AT L7 GUELPH JUNE 2022 PHOTO COURTESY JOHN WATSON





TABLE 6 DIFFERENCE IN WATER USE BETWEEN HIGHEST AND LOWEST PERFORMING CULTIVARS MEASURED IN INCHES OF WATER LOST TO EVAPOTRANSPIRATION BEFORE REACHING 25% GREEN COVER

Location (Noted as Ln)	Location	State	min CPF25			max CPF25			difference		
			min	max	difference	min	max	difference	min	max	difference
1	Virginia Beach	VA	7.20	12.10	40.50%	6.30	10.40	39.42%	7.70	12.10	36.36%
2	Albany	OR	10.10	14.00	27.86%						
3	West Lafayette	IN				7.20	12.70	43.31%			
5	Fayetteville	AR				6.20	7.80	20.51%			
7	Guelfh	ON				4.70	5.80	18.97%	5.60	9.90	43.43%
9	Hubbard	OR				10.50	14.70	28.57%	6.80	12.20	44.26%
10	Logan	UT				8.70	13.00	33.08%			
12	Rolesville	NC									
19	Griffin	GA									
24	Redding	PA									



20WCFA Tall Fescue TWCA Qualification

Feb-24

TABLE 7: PUBLIC ANNUALIZED CPF

CHECK	NAME	ENTRY	PLOT #	Annualized CPF Score			Average CPF score	QUALIFIED	Comments	
				21	22	23	AVG			
Known	RainDance	1	111	0.96	1.07	1	1.05	2024	QUALIFIED	
D-Tol	2nd Millenium	2	150	0.96	1.07	1	1.05	2024	QUALIFIED	
D-Tol	Aquavita	5	148	0.96	1.07	1	1.05	2024	QUALIFIED	
	2007	7	108	0.96	1.07	1	1.05	2024	QUALIFIED	
	2008	8	145	0.96	1.07	1	1.05	2024	QUALIFIED	
	2009	9	135	0.96	1.07	1	1.05	2024	QUALIFIED	
	2011	11	127	0.96	1.07	1	1.05	2024	QUALIFIED	
	2012	12	146	0.96	1.07	1	1.05	2024	QUALIFIED	
	2013	13	140	0.96	1.07	1	1.05	2024	QUALIFIED	
	2014	14	119	0.96	1.07	1	1.05	2024	QUALIFIED	
	ATF1992	16	117	0.96	1.07	1	1.05	2024	QUALIFIED	
	ATF1835	17	126	0.96	1.07	1	1.05	2024	QUALIFIED	
	PST-RSHD6	18	136	0.96	1.07	1	1.05	2024	QUALIFIED	
	PST-5FOE	20	105	0.96	1.07	1	1.05	2024	QUALIFIED	
	2021	21	102	0.96	1.07	1	1.05	2024	QUALIFIED	
	2023	23	120	0.96	1.07	1	1.05	2024	QUALIFIED	
	2027	27	121	0.96	1.07	1	1.05	2024	QUALIFIED	
	2029	29	133	0.96	1.07	1	1.05	2024	QUALIFIED	
	PST-STRN	33	113	0.96	1.07	1	1.05	2024	QUALIFIED	
	PST-SHAF9	34	123	0.96	1.07	1	1.05	2024	QUALIFIED	
	PST5GQ	35	112	0.96	1.07	1	1.05	2024	QUALIFIED	
	2036	36	125	0.96	1.07	1	1.05	2024	QUALIFIED	
	2037	37	141	0.96	1.07	1	1.05	2024	QUALIFIED	
	2038	38	115	0.96	1.07	1	1.05	2024	QUALIFIED	
	2039	39	116	0.96	1.07	1	1.05	2024	QUALIFIED	
	RENEGADE DT	40	132	0.96	1.07	1	1.05	2024	QUALIFIED	
	Zigzag	42	143	0.96	1.07	1	1.05	2024	QUALIFIED	
	Amity	43	118	0.96	1.07	1	1.05	2024	QUALIFIED	
	PST-ST24	44	142	0.96	1.07	1	1.05	2024	QUALIFIED	
	Saltillo	45	137	0.96	1.07	1	1.05	2024	QUALIFIED	
	PST-5LOD	47	144	0.96	1.07	1	1.05	2024	QUALIFIED	
	GLX ACED	48	109	0.96	1.07	1	1.05	2024	QUALIFIED	
	GLX Star	49	130	0.96	1.07	1	1.05	2024	QUALIFIED	
	PST-5DC24	50	103	0.96	1.07	1	1.05	2024	QUALIFIED	
Known	K-31	4	129	1.05	1.01	0.94	1.02			
	FALCON H2O	41	124	CONTAMINATED SAMPLE SUBMISSION						DNQ Contaminated sample
	Talladaga II	24	114	0.94	1.16	1.06	1.05			
D-Sus	SIXPOINT	6	128	1.04	1.07	0.98	1.05		D-Sus	
	ATF1829	15	107	0.9	1.06	1.07	1.05			
	PST-5MINI	31	110	0.98	1.05	1.1	1.05			
	firenza II	32	134	0.99	1.06	1.02	1.06			
	BarNoble	28	139	0.99	1.11	1	1.07			
	ATF1617	10	147	1.11	1.06	0.96	1.07			
	PST-5GLBS	46	149	0.97	1.1	1.04	1.09			
	PST-5E6	19	106	0.94	1.1	1.12	1.09			
D-Sus	Firenza	3	122	0.93	1.16	1.02	1.09		D-Sus	
	PST-5NOG-17	30	104	0.98	1.13	1.07	1.09			
	Triad	25	131	0.98	1.15	1.09	1.12			
	Thor	22	101	1.11	1.19	1.04	1.14			
	PPG-TF 313	26	138	1	1.19	1.11	1.17			



TABLE 8 L1 VIRGINIA BEACH PUBLIC CPF

Drought stress type				ACUTE			
Location number/name				L1 Virginia Beach			
CHECK	NAME	ENTRY	PLOT #	21	22	23	AVG
Known	RainDance	1	111	0.93	1.02	0.99	0.98
D-Tol	2nd Miller	2	150	0.93	1.02	0.99	0.98
D-Tol	Aquavita	5	148	0.93	1.02	0.99	0.98
Qualified	2007	7	108	0.93	1.02	0.99	0.98
Qualified	2008	8	145	0.93	1.02	0.99	0.98
Qualified	2009	9	135	0.93	1.02	0.99	0.98
Qualified	2011	11	127	0.93	1.02	0.99	0.98
Qualified	2012	12	146	0.93	1.02	0.99	0.98
Qualified	2013	13	140	0.93	1.02	0.99	0.98
Qualified	2014	14	119	0.93	1.02	0.99	0.98
Qualified	ATF1992	16	117	0.93	1.02	0.99	0.98
Qualified	ATF1835	17	126	0.93	1.02	0.99	0.98
Qualified	PST-RSHD	18	136	0.93	1.02	0.99	0.98
Qualified	PST-5FOE	20	105	0.93	1.02	0.99	0.98
Qualified	2021	21	102	0.93	1.02	0.99	0.98
Qualified	2023	23	120	0.93	1.02	0.99	0.98
Qualified	2027	27	121	0.93	1.02	0.99	0.98
Qualified	2029	29	133	0.93	1.02	0.99	0.98
Qualified	PST-5TRN	33	113	0.93	1.02	0.99	0.98
Qualified	PST-5HAF	34	123	0.93	1.02	0.99	0.98
Qualified	PST5GQ	35	112	0.93	1.02	0.99	0.98
Qualified	2036	36	125	0.93	1.02	0.99	0.98
Qualified	2037	37	141	0.93	1.02	0.99	0.98
Qualified	2038	38	115	0.93	1.02	0.99	0.98
Qualified	2039	39	116	0.93	1.02	0.99	0.98
Qualified	RENEGAD	40	132	0.93	1.02	0.99	0.98
Qualified	Zigzag	42	143	0.93	1.02	0.99	0.98
Qualified	Amity	43	118	0.93	1.02	0.99	0.98
Qualified	PST-5T24	44	142	0.93	1.02	0.99	0.98
Qualified	Saltillo	45	137	0.93	1.02	0.99	0.98
Qualified	PST-5LOD	47	144	0.93	1.02	0.99	0.98
Qualified	GLX ACED	48	109	0.93	1.02	0.99	0.98
Qualified	GLX Star	49	130	0.93	1.02	0.99	0.98
Qualified	PST-5DC24	50	103	0.93	1.02	0.99	0.98
D-Sus	Firenza	3	122	0.92	1.14	0.94	1
Known	K-31	4	129	0.94	0.89	0.91	0.91
D-Sus	SIXPOINT	6	128	1.05	1.06	1.02	1.04
	ATF1617	10	147	1.24	1.18	1.06	1.16
	ATF1829	15	107	0.94	0.97	0.95	0.96
	PST-5E6	19	106	0.87	1.13	1.2	1.07
	Thor	22	101	1.19	1.33	1.04	1.19
	Talladaga	24	114	0.88	1.13	1.05	1.02
	Triad	25	131	0.94	1.11	1.07	1.04
	PPG-TF 31	26	138	0.93	1.25	1.04	1.07
	BarNoble	28	139	0.92	1.06	0.89	0.96
	PST-5NOG	30	104	1.01	1.19	1.15	1.12
	PST-5MIN	31	110	1.04	1.11	1.31	1.16
	firenza II	32	134	0.93	1.14	1.19	1.09
	FALCON H	41	124	CONTAMINATED			
	PST-5GLBS	46	149	0.9	1.19	1	1.03
				8.95	8.35	10.1	9.13



TABLE 9 L2 ALBANY PUBLIC CPF

Drought stress type				ACUTE			
Location number/name				L2 Albany			
CHECK	NAME	ENTRY	PLOT #	21	22	23	AVG
Known	RainDance	1	111	0.96	-	-	0.96
D-Tol	2nd Miller	2	150	0.96	-	-	0.96
D-Tol	Aquavita	5	148	0.96	-	-	0.96
Qualified	2007	7	108	0.96	-	-	0.96
Qualified	2008	8	145	0.96	-	-	0.96
Qualified	2009	9	135	0.96	-	-	0.96
Qualified	2011	11	127	0.96	-	-	0.96
Qualified	2012	12	146	0.96	-	-	0.96
Qualified	2013	13	140	0.96	-	-	0.96
Qualified	2014	14	119	0.96	-	-	0.96
Qualified	ATF1992	16	117	0.96	-	-	0.96
Qualified	ATF1835	17	126	0.96	-	-	0.96
Qualified	PST-RSHD	18	136	0.96	-	-	0.96
Qualified	PST-5FOE	20	105	0.96	-	-	0.96
Qualified	2021	21	102	0.96	-	-	0.96
Qualified	2023	23	120	0.96	-	-	0.96
Qualified	2027	27	121	0.96	-	-	0.96
Qualified	2029	29	133	0.96	-	-	0.96
Qualified	PST-5TRN	33	113	0.96	-	-	0.96
Qualified	PST-5HAF	34	123	0.96	-	-	0.96
Qualified	PST5GQ	35	112	0.96	-	-	0.96
Qualified	2036	36	125	0.96	-	-	0.96
Qualified	2037	37	141	0.96	-	-	0.96
Qualified	2038	38	115	0.96	-	-	0.96
Qualified	2039	39	116	0.96	-	-	0.96
Qualified	RENEGAD	40	132	0.96	-	-	0.96
Qualified	Zigzag	42	143	0.96	-	-	0.96
Qualified	Amity	43	118	0.96	-	-	0.96
Qualified	PST-5T24	44	142	0.96	-	-	0.96
Qualified	Saltillo	45	137	0.96	-	-	0.96
Qualified	PST-5LOD	47	144	0.96	-	-	0.96
Qualified	GLX ACED	48	109	0.96	-	-	0.96
Qualified	GLX Star	49	130	0.96	-	-	0.96
Qualified	PST-5DC24	50	103	0.96	-	-	0.96
D-Sus	Firenza	3	122	0.94	-	-	0.94
Known	K-31	4	129	1.15	-	-	1.15
D-Sus	SIXPOINT	6	128	1.03	-	-	1.03
	ATF1617	10	147	0.97	-	-	0.97
	ATF1829	15	107	0.87	-	-	0.87
	PST-5E6	19	106	1.02	-	-	1.02
	Thor	22	101	1.04	-	-	1.04
	Talladaga	24	114	1	-	-	1
	Triad	25	131	1.02	-	-	1.02
	PPG-TF 31	26	138	1.06	-	-	1.06
	BarNoble	28	139	1.05	-	-	1.05
	PST-5NOG	30	104	0.95	-	-	0.95
	PST-5MIN	31	110	0.92	-	-	0.92
	firenza II	32	134	1.05	-	-	1.05
	FALCON H	41	124	CONTAMINATED			
	PST-5GLBS	46	149	1.04	-	-	1.04
				11.6	0	-	11.6



TABLE 10: L3 WEST LAFAYETTE PUBLIC CPF

Drought stress type				ACUTE			
Location number/name				L3 West Lafayette			
CHECK	NAME	ENTRY	PLOT #	21	22	23	AVG
Known	RainDance	1	111	-	1.33	-	1.33
D-Tol	2nd Miller	2	150	-	1.33	-	1.33
D-Tol	Aquavita	5	148	-	1.33	-	1.33
Qualified	2007	7	108	-	1.33	-	1.33
Qualified	2008	8	145	-	1.33	-	1.33
Qualified	2009	9	135	-	1.33	-	1.33
Qualified	2011	11	127	-	1.33	-	1.33
Qualified	2012	12	146	-	1.33	-	1.33
Qualified	2013	13	140	-	1.33	-	1.33
Qualified	2014	14	119	-	1.33	-	1.33
Qualified	ATF1992	16	117	-	1.33	-	1.33
Qualified	ATF1835	17	126	-	1.33	-	1.33
Qualified	PST-RSHD	18	136	-	1.33	-	1.33
Qualified	PST-5FOE	20	105	-	1.33	-	1.33
Qualified	2021	21	102	-	1.33	-	1.33
Qualified	2023	23	120	-	1.33	-	1.33
Qualified	2027	27	121	-	1.33	-	1.33
Qualified	2029	29	133	-	1.33	-	1.33
Qualified	PST-5TRN	33	113	-	1.33	-	1.33
Qualified	PST-5HAF	34	123	-	1.33	-	1.33
Qualified	PST5GQ	35	112	-	1.33	-	1.33
Qualified	2036	36	125	-	1.33	-	1.33
Qualified	2037	37	141	-	1.33	-	1.33
Qualified	2038	38	115	-	1.33	-	1.33
Qualified	2039	39	116	-	1.33	-	1.33
Qualified	RENEGAD	40	132	-	1.33	-	1.33
Qualified	Zigzag	42	143	-	1.33	-	1.33
Qualified	Amity	43	118	-	1.33	-	1.33
Qualified	PST-5T24	44	142	-	1.33	-	1.33
Qualified	Saltillo	45	137	-	1.33	-	1.33
Qualified	PST-5LOD	47	144	-	1.33	-	1.33
Qualified	GLX ACED	48	109	-	1.33	-	1.33
Qualified	GLX Star	49	130	-	1.33	-	1.33
Qualified	PST-5DC24	50	103	-	1.33	-	1.33
D-Sus	Firenza	3	122	-	1.41	-	1.41
Known	K-31	4	129	-	1.06	-	1.06
D-Sus	SIXPOINT	6	128	-	1.28	-	1.28
	ATF1617	10	147	-	1.24	-	1.24
	ATF1829	15	107	-	1.27	-	1.27
	PST-5E6	19	106	-	1.23	-	1.23
	Thor	22	101	-	1.57	-	1.57
	Talladaga	24	114	-	1.48	-	1.48
	Triad	25	131	-	1.48	-	1.48
	PPG-TF 31	26	138	-	1.57	-	1.57
	BarNoble	28	139	-	1.33	-	1.33
	PST-5NOG	30	104	-	1.34	-	1.34
	PST-5MIN	31	110	-	1.15	-	1.15
	firenza II	32	134	-	1.24	-	1.24
	FALCON H	41	124	CONTAMINATED			
	PST-5GLBS	46	149	-	1.31	-	1.31
					11.95	0	11.95



TABLE 11 L5 FAYETTEVILLE PUBLIC CPF

Drought stress type		ACUTE			
Location number/name		L5 Fayetteville			
CHECK	NAME	21	22	23	AVG
Known	RainDance	-	1.06	-	1.06
D-Tol	2nd Millenium	-	1.06	-	1.06
D-Tol	Aquavita	-	1.06	-	1.06
Qualified	2007	-	1.06	-	1.06
Qualified	2008	-	1.06	-	1.06
Qualified	2009	-	1.06	-	1.06
Qualified	2011	-	1.06	-	1.06
Qualified	2012	-	1.06	-	1.06
Qualified	2013	-	1.06	-	1.06
Qualified	2014	-	1.06	-	1.06
Qualified	ATF1992	-	1.06	-	1.06
Qualified	ATF1835	-	1.06	-	1.06
Qualified	PST-RSHD6	-	1.06	-	1.06
Qualified	PST-5FOE	-	1.06	-	1.06
Qualified	2021	-	1.06	-	1.06
Qualified	2023	-	1.06	-	1.06
Qualified	2027	-	1.06	-	1.06
Qualified	2029	-	1.06	-	1.06
Qualified	PST-5TRN	-	1.06	-	1.06
Qualified	PST-5HAF9	-	1.06	-	1.06
Qualified	PST5GQ	-	1.06	-	1.06
Qualified	2036	-	1.06	-	1.06
Qualified	2037	-	1.06	-	1.06
Qualified	2038	-	1.06	-	1.06
Qualified	2039	-	1.06	-	1.06
Qualified	RENEGADE DT	-	1.06	-	1.06
Qualified	Zigzag	-	1.06	-	1.06
Qualified	Amity	-	1.06	-	1.06
Qualified	PST-5T24	-	1.06	-	1.06
Qualified	Saltillo	-	1.06	-	1.06
Qualified	PST-5LOD	-	1.06	-	1.06
Qualified	GLX ACED	-	1.06	-	1.06
Qualified	GLX Star	-	1.06	-	1.06
Qualified	PST-5DC24	-	1.06	-	1.06
D-Sus	Firenza	-	1.05	-	1.05
Known	K-31	-	1.01	-	1.01
D-Sus	SIXPOINT	-	0.99	-	0.99
	ATF1617	-	1.16	-	1.16
	ATF1829	-	1.06	-	1.06
	PST-5E6	-	1.13	-	1.13
	Thor	-	1.01	-	1.01
	Talladaga II	-	1.03	-	1.03
	Triad	-	1.05	-	1.05
	PPG-TF 313	-	1.11	-	1.11
	BarNoble	-	0.98	-	0.98
	PST-5NOG-17	-	1.05	-	1.05
	PST-5MINI	-	1.09	-	1.09
	firenza II	-	1.08	-	1.08
	FALCON H2O	CONTAMI	CONTAMI	CONTAMI	CONTAMI
	PST-5GLBS	-	1.05	-	1.05
		0	7.55	-	7.55



TABLE 12:L7 GUELPH PUBLIC CPF

Drought stress type				ACUTE			
Location number/name				L7 Guelph			
CHECK	NAME	ENTRY	PLOT #	21	22	23	AVG
Known	RainDance	1	111	-	1.01	0.94	0.98
D-Tol	2nd Miller	2	150	-	1.01	0.94	0.98
D-Tol	Aquavita	5	148	-	1.01	0.94	0.98
Qualified	2007	7	108	-	1.01	0.94	0.98
Qualified	2008	8	145	-	1.01	0.94	0.98
Qualified	2009	9	135	-	1.01	0.94	0.98
Qualified	2011	11	127	-	1.01	0.94	0.98
Qualified	2012	12	146	-	1.01	0.94	0.98
Qualified	2013	13	140	-	1.01	0.94	0.98
Qualified	2014	14	119	-	1.01	0.94	0.98
Qualified	ATF1992	16	117	-	1.01	0.94	0.98
Qualified	ATF1835	17	126	-	1.01	0.94	0.98
Qualified	PST-RSHD	18	136	-	1.01	0.94	0.98
Qualified	PST-5FOE	20	105	-	1.01	0.94	0.98
Qualified	2021	21	102	-	1.01	0.94	0.98
Qualified	2023	23	120	-	1.01	0.94	0.98
Qualified	2027	27	121	-	1.01	0.94	0.98
Qualified	2029	29	133	-	1.01	0.94	0.98
Qualified	PST-5TRN	33	113	-	1.01	0.94	0.98
Qualified	PST-5HAF	34	123	-	1.01	0.94	0.98
Qualified	PST5GQ	35	112	-	1.01	0.94	0.98
Qualified	2036	36	125	-	1.01	0.94	0.98
Qualified	2037	37	141	-	1.01	0.94	0.98
Qualified	2038	38	115	-	1.01	0.94	0.98
Qualified	2039	39	116	-	1.01	0.94	0.98
Qualified	RENEGAD	40	132	-	1.01	0.94	0.98
Qualified	Zigzag	42	143	-	1.01	0.94	0.98
Qualified	Amity	43	118	-	1.01	0.94	0.98
Qualified	PST-5T24	44	142	-	1.01	0.94	0.98
Qualified	Saltillo	45	137	-	1.01	0.94	0.98
Qualified	PST-5LOD	47	144	-	1.01	0.94	0.98
Qualified	GLX ACED	48	109	-	1.01	0.94	0.98
Qualified	GLX Star	49	130	-	1.01	0.94	0.98
Qualified	PST-5DC24	50	103	-	1.01	0.94	0.98
D-Sus	Firenza	3	122	-	1.18	1.06	1.12
Known	K-31	4	129	-	1.09	0.95	1.02
D-Sus	SIXPOINT	6	128	-	0.99	0.9	0.94
	ATF1617	10	147	-	0.99	0.8	0.89
	ATF1829	15	107	-	1.05	1.17	1.11
	PST-5E6	19	106	-	1.07	1.02	1.05
	Thor	22	101	-	1.05	0.99	1.02
	Talladaga	24	114	-	1.01	0.9	0.95
	Triad	25	131	-	0.99	1.04	1.02
	PPG-TF 31	26	138	-	1.09	1.06	1.07
	BarNoble	28	139	-	1.05	0.95	1
	PST-5NOG	30	104	-	1.05	0.98	1.01
	PST-5MIN	31	110	-	0.99	0.86	0.93
	firenza II	32	134	-	1.05	1.02	1.04
	FALCON H	41	124	CONTAMI	CONTAMI	CONTAMI	CONTAMI
	PST-5GLBS	46	149	-	0.97	0.96	0.97
					5.55	6.55	6.05



TABLE 13 L9 HUBBARD PUBLIC CPF

Drought stress type				ACUTE			
Location number/name				L9 Hubbard			
CHECK	NAME	ENTRY	PLOT #	21	22	23	AVG
Known	RainDance	1	111	-	0.93	0.94	0.94
D-Tol	2nd Miller	2	150	-	0.93	0.94	0.94
D-Tol	Aquavita	5	148	-	0.93	0.94	0.94
Qualified	2007	7	108	-	0.93	0.94	0.94
Qualified	2008	8	145	-	0.93	0.94	0.94
Qualified	2009	9	135	-	0.93	0.94	0.94
Qualified	2011	11	127	-	0.93	0.94	0.94
Qualified	2012	12	146	-	0.93	0.94	0.94
Qualified	2013	13	140	-	0.93	0.94	0.94
Qualified	2014	14	119	-	0.93	0.94	0.94
Qualified	ATF1992	16	117	-	0.93	0.94	0.94
Qualified	ATF1835	17	126	-	0.93	0.94	0.94
Qualified	PST-RSHD	18	136	-	0.93	0.94	0.94
Qualified	PST-5FOE	20	105	-	0.93	0.94	0.94
Qualified	2021	21	102	-	0.93	0.94	0.94
Qualified	2023	23	120	-	0.93	0.94	0.94
Qualified	2027	27	121	-	0.93	0.94	0.94
Qualified	2029	29	133	-	0.93	0.94	0.94
Qualified	PST-5TRN	33	113	-	0.93	0.94	0.94
Qualified	PST-5HAF	34	123	-	0.93	0.94	0.94
Qualified	PST5GQ	35	112	-	0.93	0.94	0.94
Qualified	2036	36	125	-	0.93	0.94	0.94
Qualified	2037	37	141	-	0.93	0.94	0.94
Qualified	2038	38	115	-	0.93	0.94	0.94
Qualified	2039	39	116	-	0.93	0.94	0.94
Qualified	RENEGAD	40	132	-	0.93	0.94	0.94
Qualified	Zigzag	42	143	-	0.93	0.94	0.94
Qualified	Amity	43	118	-	0.93	0.94	0.94
Qualified	PST-5T24	44	142	-	0.93	0.94	0.94
Qualified	Saltillo	45	137	-	0.93	0.94	0.94
Qualified	PST-5LOD	47	144	-	0.93	0.94	0.94
Qualified	GLX ACED	48	109	-	0.93	0.94	0.94
Qualified	GLX Star	49	130	-	0.93	0.94	0.94
Qualified	PST-5DC24	50	103	-	0.93	0.94	0.94
D-Sus	Firenza	3	122	-	1.04	1.06	1.05
Known	K-31	4	129	-	1.03	0.97	1
D-Sus	SIXPOINT	6	128	-	0.96	1.03	0.99
	ATF1617	10	147	-	0.98	1.02	1
	ATF1829	15	107	-	0.99	1.08	1.04
	PST-5E6	19	106	-	0.98	1.13	1.05
	Thor	22	101	-	1	1.1	1.05
	Talladaga	24	114	-	1.12	1.23	1.17
	Triad	25	131	-	1.14	1.16	1.15
	PPG-TF 31	26	138	-	1.01	1.23	1.12
	BarNoble	28	139	-	1.06	1.16	1.11
	PST-5NOG	30	104	-	1.04	1.08	1.06
	PST-5MIN	31	110	-	1.04	1.11	1.08
	firenza II	32	134	-	0.86	0.86	0.86
	FALCON H	41	124	CONTAMI	CONTAMI	CONTAMI	CONTAMI
	PST-5GLBS	46	149	-	1.1	1.14	1.12
					11.95	8.35	10.15



TABLE 14 L10 LOGAN PUBLIC CPF

Drought stress type				ACUTE			
Location number/name				L10 Logan			
CHECK	NAME	ENTRY	PLOT #	21	22	23	AVG
Known	RainDance	1	111	-	1.01	1.22	1.01
D-Tol	2nd Miller	2	150	-	1.01	0.85	1.01
D-Tol	Aquavita	5	148	-	1.01	0.85	1.01
Qualified	2007	7	108	-	1.01	1.24	1.01
Qualified	2008	8	145	-	1.01	0.57	1.01
Qualified	2009	9	135	-	1.01	1.21	1.01
Qualified	2011	11	127	-	1.01	1.34	1.01
Qualified	2012	12	146	-	1.01	1.16	1.01
Qualified	2013	13	140	-	1.01	1.34	1.01
Qualified	2014	14	119	-	1.01	1.04	1.01
Qualified	ATF1992	16	117	-	1.01	1.03	1.01
Qualified	ATF1835	17	126	-	1.01	1.22	1.01
Qualified	PST-RSHD	18	136	-	1.01	1.19	1.01
Qualified	PST-5FOE	20	105	-	1.01	1.39	1.01
Qualified	2021	21	102	-	1.01	0.75	1.01
Qualified	2023	23	120	-	1.01	1.03	1.01
Qualified	2027	27	121	-	1.01	1.28	1.01
Qualified	2029	29	133	-	1.01	0.93	1.01
Qualified	PST-5TRN	33	113	-	1.01	1.32	1.01
Qualified	PST-5HAF	34	123	-	1.01	1.48	1.01
Qualified	PST5GQ	35	112	-	1.01	1.39	1.01
Qualified	2036	36	125	-	1.01	0.99	1.01
Qualified	2037	37	141	-	1.01	0.79	1.01
Qualified	2038	38	115	-	1.01	1.03	1.01
Qualified	2039	39	116	-	1.01	0.59	1.01
Qualified	RENEGAD	40	132	-	1.01	0.95	1.01
Qualified	Zigzag	42	143	-	1.01	1.04	1.01
Qualified	Amity	43	118	-	1.01	0.97	1.01
Qualified	PST-5T24	44	142	-	1.01	1.48	1.01
Qualified	Saltillo	45	137	-	1.01	1.28	1.01
Qualified	PST-5LOD	47	144	-	1.01	0.85	1.01
Qualified	GLX ACED	48	109	-	1.01	0.76	1.01
Qualified	GLX Star	49	130	-	1.01	0.64	1.01
Qualified	PST-5DC24	50	103	-	1.01	1.39	1.01
D-Sus	Firenza	3	122	-	1.04	1.34	1.04
Known	K-31	4	129	-	1.01	0.95	1.01
D-Sus	SIXPOINT	6	128	-	1.06	1.24	1.06
	ATF1617	10	147	-	0.89	0.91	0.89
	ATF1829	15	107	-	1.04	1.14	1.04
	PST-5E6	19	106	-	1.07	0.13	1.07
	Thor	22	101	-	1	1.22	1
	Talladaga	24	114	-	1.05	1.08	1.05
	Triad	25	131	-	1.01	1.24	1.01
	PPG-TF 31	26	138	-	1.04	0.58	1.04
	BarNoble	28	139	-	1.04	1.24	1.04
	PST-5NOG	30	104	-	1.02	0.73	1.02
	PST-5MIN	31	110	-	0.96	1.16	0.96
	firenza II	32	134	-	0.99	0.9	0.99
	FALCON H	41	124	CONTAMI	CONTAMI	CONTAMI	CONTAMI
	PST-5GLBS	46	149	-	0.93	1.1	0.93
					10.2	8.45	10.2