GxE Field Experiment 2019 SOP v.3.1

Visit the GxE website for the latest SOP and information updates:
www.genomes2fields.org

About this document:

1. **Some changes to the weather station information have been made.**

Our goal is to collect the most "raw" and meaningful data possible, to be collated in a centralized database and shared with the public. Raw data will give us the most power to analyze and leverage insights from the data. It is a difficult and time-consuming task to assimilate all this information into one place in a consistent format. Therefore, we ask that you pay close attention to the form of data types collected in terms of units, formatting, etc.

Please note that Natalia de Leon, ndeleongatti@wisc.edu, is serving as the temporary contact until the new G2F Coordinator begins in November. Any questions or concerns that you previously contacted Naser AlKhalifah about should now be directed to her.

Lastly, we would like to thank you, our cooperators, for your monumental efforts and unprecedented collaborative spirit. Without you, the Genomes to Fields GxE Project would not be possible.

Thank you!

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GxE Field Experiment 2019 Checklist

Preseason:

For new cooperators only:

_____ Email Natalia de Leon at ndeleongatti@wisc.edu to get started

For all cooperators (including new):

_____ Order weather station components with assistance of Iowa Corn Promotion Board (David Ertl at dertl@iowacorn.org)
_____ Communicate seed packaging and shipping requirements with Natalia de Leon at ndeleongatti@wisc.edu
_____ Perform annual maintenance on weather station and clear existing data
_____ Begin work on Google Sheets location folder through your personalized link

At Planting:

_____ Install weather station in field (ideally one day before planting, if possible)
_____ Ensure external instruments are in correct port:
(soil moisture - port A, soil temperature - port B, solar radiation - port C)
_____ Collect and record the GPS coordinates of weather station
_____ Collect weather station serial number [m2700s0XXXX] on card inside weather station
_____ Perform weather station setup tasks and activate weather station recording
_____ Collect soil sample and send to Ward Laboratories in Kearney, NE (Appendix B)
_____ Record planting date in fieldbook provided through your personalized link
_____ Update Google Sheets metadata with:
_____ Weather station serial number and GPS coordinates
_____ Date weather station was placed in the field
_____ GPS coordinates of field corners, starting at corner of plot 1

In-Season:

_____ Create and upload field map to Google folder. Notify Natalia, of any field/planting issues or adjustments to original field map
_____ Perform weather station in-season checks at each field visit. Download data monthly, if possible
_____ Record the following phenotypic data in the fieldbook:
_____ Flowering dates
_____ Plant height
_____ Ear height
_____ If damaging winds occur, cooperators may choose to record green snap and date of event
_____ Stand count
_____ Record the following field information in the Google Sheets agronomic information:
_____ Pesticides and herbicides: type and amount applied
_____ Fertilizer: date, type, and amount applied
_____ Irrigation schedule: date and amount applied (if applicable)
_____ Fertigation schedule: date and amount applied (if applicable)
_____ Notes on field anomalies, phenotyping errors and any other issues

At Harvest:

_____ Record the following performance data in the fieldbook:
_____ Root lodging
_____ Stalk lodging
_____ Plot weight
_____ Plot moisture
_____ Test weight

Visit the www.genomes2fields.org for the latest SOP and information updates.
Contact Natalia de Leon, 608-770-5356, ndeleongatti@wisc.edu, with any questions.

Post-Season:

_____ Verify information in Google Sheets metadata
_____ Upload final field information, phenotype and performance data to Google Sheet
_____ Download weather station data and upload unedited SWD files to Google folder

I. Field Layout for 2018 and 2019 seasons

a. Each trial is arranged in two replications. For the purposes of blocking in the field, the primary division is by replication (1 or 2) then by tester (PHT69 or LH195) if you have both testers. Most locations only included one tester. Then the reps are divided by family group (PHW65_MoG, PHN11_PHW65 or Mo44_PHW65) within the replication-tester combination. If the field is large enough, the plot order will ensure this arrangement but if you must break the experiment across field or field blocks, try to separate between replications or family group within replication.

b. The objective of the experimental design was to balance the need for within-site replication against the overall goal of the GxE project to test as many different hybrids as possible at each trial site. If your location has hybrids with both testers, half of the plots were assigned to each tester as separate experiments.

c. Within an experiment there are two replications and each replication will have one plot of each of the core check hybrids (YS-Hybrids) based on seed availability. If there were enough plots to sample all hybrids, then all hybrids were assigned randomly to a replication, and if there were more plots available, a random sample of the hybrids was taken to fill up the remaining plots, with the second plot of a given hybrid being assigned to a different replication than the first plot. Within an experiment, the core check hybrids have two complete reps and at the larger locations, some of the DH hybrids also have two complete reps while most locations have an incomplete block design. It's important to note that within replication, hybrids are grouped by family but since we do not have the same number of DH lines for each family, the family groups are proportional to the family sizes. Order of family groups is randomized across replications and sites. This layout works to ensure balanced sampling of hybrids across all of the sites.

d. Most hybrid trials are arranged in two-row plots, 20' long with 30-72" alleys between plots. Filler should be used as needed to minimize edge effects.

e. The diagram on the following page represents the ideal setup with plot numbers. Departures from this specific layout are completely acceptable.

f. Each investigator is asked to choose one locally adapted hybrid to add as checks to each trial to increase connection among trials within a location. Ideally, this check will be replicated twice for 10 plots. Empty seed packets are provided for collaborators to fill. Investigators in similar areas are encouraged to choose one or more of the same common checks for connecting sets to provide additional connection among experiments and locations.

g. Planting density and plot dimensions are determined by individual collaborators and reported in the Metadata in the Google Sheet.

For suggested field layouts, see the following page (page 6).

24 Row Example

REP 2	FILLER				500	499	498	497	496	495	494	493	20'
	481	482	483	484	485	486	487	488	489	490	491	492	20'
	480	479	478	477	476	475	474	473	472	471	470	469	20'
	457	458	459	460	461	462	463	464	465	466	467	468	20'
	456	455	454	453	452	451	450	449	448	447	446	445	20'
	433	434	435	436	437	438	439	440	441	442	443	444	20'
	432	431	430	429	428	427	426	425	424	423	422	421	20'
	409	410	411	412	413	414	415	416	417	418	419	420	20'
	408	407	406	405	404	403	402	401	400	399	398	397	20'
	385	386	387	388	389	390	391	392	393	394	395	396	20'
	384	383	382	381	380	379	378	377	376	375	374	373	20'
	361	362	363	364	365	366	367	368	369	370	371	372	20'
	360	359	358	357	356	355	354	353	352	351	350	349	20'
	337	338	339	340	341	342	343	344	345	346	347	348	20'
	336	335	334	333	332	331	330	329	328	327	326	325	20'
	313	314	315	316	317	318	319	320	321	322	323	324	20'
	312	311	310	309	308	307	306	305	304	303	302	301	20'
	289	290	291	292	293	294	295	296	297	298	299	300	20'
	288	287	286	285	284	283	282	281	280	279	278	277	20'
	265	266	267	268	269	270	271	272	273	274	275	276	20'
	264	263	262	261	260	259	258	257	256	255	254	253	20'
REP 1	241	242	243	244	245	246	247	248	249	250	251	252	20'
	240	239	238	237	236	235	234	233	232	231	230	229	20'
	217	218	219	220	221	222	223	224	225	226	227	228	20'
	216	215	214	213	212	211	210	209	208	207	206	205	20'
	193	194	195	196	197	198	199	200	201	202	203	204	20'
	192	191	190	189	188	187	186	185	184	183	182	181	20'
	169	170	171	172	173	174	175	176	177	178	179	180	20'
	168	167	166	165	164	163	162	161	160	159	158	157	20'
	145	146	147	148	149	150	151	152	153	154	155	156	20'
	144	143	142	141	140	139	138	137	136	135	134	133	20'
	121	122	123	124	125	126	127	128	129	130	131	132	20'
	120	119	118	117	116	115	114	113	112	111	110	109	20'
	97	98	99	100	101	102	103	104	105	106	107	108	20'
	96	95	94	93	92	91	90	89	88	87	86	85	20'
	73	74	75	76	77	78	79	80	81	82	83	84	20'
	72	71	70	69	68	67	66	65	64	63	62	61	20'
	49	50	51	52	53	54	55	56	57	58	59	60	20'
	48	47	46	45	44	43	42	41	40	39	38	37	20'
	25	26	27	28	29	30	31	32	33	34	35	36	20'
	24	23	22	21	20	19	18	17	16	15	14	13	20'
	1	2	3	4	5	6	7	8	9	10	11	12	20'
Row#	1	3	5	7	9	11	13	15	17	19	21	23	

50 Row Example

Row#	REP 1																									REP 2													
1	1	50	51	100	101	150	151	200	201	250	251	300	301	350	351	400	401	450	451	500	20'
3	2	49	52	99	102	149	152	199	202	249	252	299	302	349	352	399	402	449	452	499	20'
5	3	48	53	98	103	148	153	198	203	248	253	298	303	348	353	398	403	448	453	498	20'
7	4	47	54	97	104	147	154	197	204	247	254	297	304	347	354	397	404	447	454	497	20'
9	5	46	55	96	105	146	155	196	205	246	255	296	305	346	355	396	405	446	455	496	20'
11	6	45	56	95	106	145	156	195	206	245	256	295	306	345	356	395	406	445	456	495	20'
13	7	44	57	94	107	144	157	194	207	244	257	294	307	344	357	394	407	444	457	494	20'
15	8	43	58	93	108	143	158	193	208	243	258	293	308	343	358	393	408	443	458	493	20'
17	9	42	59	92	109	142	159	192	209	242	259	292	309	342	359	392	409	442	459	492	20'
19	10	41	60	91	110	141	160	191	210	241	260	291	310	341	360	391	410	441	460	491	20'
21	11	40	61	90	111	140	161	190	211	240	261	290	311	340	361	390	411	440	461	490	20'
23	12	39	62	89	112	139	162	189	212	239	262	289	312	339	362	389	412	439	462	489	20'
25	13	38	63	88	113	138	163	188	213	238	263	288	313	338	363	388	413	438	463	488	20'
27	14	37	64	87	114	137	164	187	214	237	264	287	314	337	364	387	414	437	464	487	20'
29	15	36	65	86	115	136	165	186	215	236	265	286	315	336	365	386	415	436	465	486	20'
31	16	35	66	85	116	135	166	185	216	235	266	285	316	335	366	385	416	435	466	485	20'
33	17	34	67	84	117	134	167	184	217	234	267	284	317	334	367	384	417	434	467	484	20'
35	18	33	68	83	118	133	168	183	218	233	268	283	318	333	368	383	418	433	468	483	20'
37	19	32	69	82	119	132	169	182	219	232	269	282	319	332	369	382	419	432	469	482	20'
39	20	31	70	81	120	131	170	181	220	231	270	281	320	331	370	381	420	431	470	481	20'
41	21	30	71	80	121	130	171	180	221	230	271	280	321	330	371	380	421	430	471	480	20'
43	22	29	72	79	122	129	172	179	222	229	272	279	322	329	372	379	422	429	472	479	20'
45	23	28	73	78	123	128	173	178	223	228	273	278	323	328	373	378	423	428	473	478	20'
47	24	27	74	77	124	127	174	177	224	227	274	277	324	327	374	377	424	427	474	477	20'
49	25	26	75	76	125	126	175	176	225	226	275	276	325	326	375	376	425	426	475	476	20'

II. WatchDog 2700 Weather Station Configuration

a. For investigators with multiple GxE trial fields, weather stations should be located within ¼ mile of all trial fields. For trials > ¼ mile apart, or for trials with varying water treatments, request a second micro weather station to measure soil moisture differences.
b. In order to maintain consistency and adhere to meteorological measurement standards, the weather station should be placed at a height of 2 meters (~6 ft). Purchase a 1 ⅜" wide x 10' 6" long top rail fence post similar to one found here: https://goo.gl/40KoTW. This will replace the 3 ft. post that comes with the tripod. Cut the post at the non-tapered end so you're left with 7 ft.
c. Complete annual maintenance prior to the field season using checklist in Appendix C Part A
d. Complete weather station setup the day before planting, using checklist in Appendix C Part B
e. Throughout the field season, use Appendix C Part C to conduct weather station checks at each field visit. Record date and time of check in on location-specific Google Sheet
f. Record irrigation amounts and dates in on location-specific Google Sheet
g. Remove the station from the field after harvest using instructions in Appendix C Part D
h. Collect data and upload to Google Sheets using Appendix C Part E

III. Seed Information

a. Hybrid seed will be sent to most collaborators (excluding Southern locations) in early April. All seed has been chemically treated with Cruiser Extreme 250.

IV. Field Metadata Collection:

Collaborators will record the following metadata in the appropriate location on a location-specific Google Sheet through the link that was shared.

At Planting:

i. Planting dates [MM/DD/YY]
ii. Collect soil sample for basic analysis at Ward Laboratories. See Appendix B for detailed instructions.
iii. Weather station serial number [m2700s0XXXX]
iv. Latitude/longitude (GPS coordinates) of field location
v. Row spacing and plot dimensions
vi. Map of field layout with cardinal heading of first pass (i.e. the direction of pass 1 looking toward the end of the field). Need help figuring out cardinal direction? Visit http://acscdg.com/. Locate your field, draw a line from plot 1 parallel with rows and record Azimuth number.
vii. Local hybrid checks (5 total)
viii. Previous crop

ix. Tillage method
x. Weather station documents irrigation? (if applicable) [Y/N]
xi. Notes on planting errors, field anomalies, equipment, etc.

In-Season:

xii. Pesticides and herbicides: type and amount applied
xiii. Fertilizer: date, type, and amount applied
xiv. Irrigation schedule: date and amount applied (if applicable)
xv. Fertigation schedule: date and amount applied (if applicable)
xvi. Notes on field anomalies, phenotyping errors and issues

At Harvest:

xvii. Harvest dates [MM/DD/YY]
xviii. Notes on field anomalies, whole-field issues, equipment and technical issues, or harvesting issues

V. Phenotype and Performance Data Collection:

Evaluate hybrids for the following traits. See Appendix A for specific measurement instructions.

In-Season:

i. Stand Count – may be taken as juveniles and at harvest
ii. Anthesis [MM/DD/YY]
iii. Silking [MM/DD/YY]
iv. Plant Height (cm)
v. Ear Height (cm)
vi. If damaging winds occur, cooperators may choose to record green snap and date of event

At Harvest:

vii. Stalk Lodging – plant count (NOT percentage)
viii. Root Lodging – plant count (NOT percentage)
ix. Stand Count – plant count
x. Plot Weight (lbs)
xi. Grain Moisture (%)
xii. Test Weight (lbs/bu)

Appendix A: Phenotyping Handbook

Trait Summary					
Trait	**Abbreviation**	**Unit**	**Timing**	**Description/Procedure**	**Measurement Notes**
Pollen Date		date [MM/DD/YY]	at flowering	Date that 50% of plants in the plot began shedding pollen	
Silk Date		date [MM/DD/YY]	at flowering	Date that 50% of plants it the plot had visible silks	
Ear Height	EARHT	centimeter [cm]	plant maturity	Height to node of attachment of the ear.	One plant is considered sufficient since these are hybrids and are not segregating for traits
Plant Height	PLTHT	centimeter [cm]	plant maturity	Height to attachment of flag leaf.	One plant is considered sufficient since these are hybrids and are not segregating for traits
Root Lodging	RTLDG	count [number]	before harvest	Number of plants root lodged i.e. those stems that lean substantially to one side (□ 15% from vertical). Count includes goosenecked plant that have "straightened up" after becoming lodged earlier in the season	Emphasis is on the number of plants.
Stalk Lodging	SKLDG	count [number]	before harvest	Number of plants root lodged.	Emphasis is on the number of plants.
Stand Count	STAND	count [number]	before/at harvest	Number of plants in the plot.	Number of plants were in the plot at harvest time. Counting can occur earlier but if plot damage occurs before harvest the plot will need to be recounted.
Green Snap (optional)	GSP	count and date of causal event [MM/DD/YY]	before flowering	Number of plants broken between ground level and top ear node before flowering	Optional, cooperators may record this if an event causes substantial green snap
Plot Weight	WT	lbs [number.decimal]	at harvest	Weight of harvested grain	
Test Weight	TWT	lbs/bu [number.decimal]	at harvest	Grain density	
Grain Moisture	MOIST	percent [%]	at harvest	Percent moisture content of harvested grain.	

Pollen Date

Description/Procedure:

Taken as [MM/DD/YY] to 50 percent of a plot exhibiting anther exertion on greater than half of main tassel spike. Day of anthesis recording is shown in *Picture 1,* whereas the day after is shown *Picture 2*.

Timing: At Flowering
n = 1 date per plot
Unit: [MM/DD/YY]

Picture 1 *Picture 2*

Image Credit: 2004, 2006; Purdue University, RL Nielsen

Silk Date

Description/Procedure:
Taken as [MM/DD/YY] to 50 percent of plot exhibiting silk emergence (*Picture 1*). Following day is shown in *Picture 2*.

Timing: At Flowering
n = 1 date per plot
Unit:
[MM/DD/YY]

Picture 1

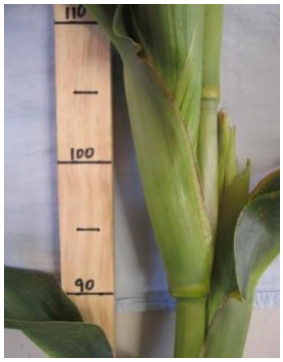
Picture 2

Ear Height (EARHT)

Description/Procedure:

Placing measuring stick on ground next to the root crown, "ear height" is measured at the primary ear bearing node.

See *Picture 1.*



Picture 1

Timing: At plant maturity
n = 1 representative plant per plot
Unit: centimeter [cm]

Notes: One plant is considered sufficient since these are inbreds and hybrids and are not

Plant Height (PLTHT)

Description/Procedure:

Placing measuring stick on ground next to the root crown, "plant height" is measured at the ligule of the flag leaf.

See *Picture 1.*

Timing: At plant maturity
n = 1 representative plant per plot
Unit: centimeter [cm]

Picture 1

Notes: One plant is considered sufficient since these inbreds and hybrids and are not segregating for traits. Please record date measured.

Root Lodging (RTLDG)

Description/Procedure:

Number of plants that show root lodging per plot, i.e., those stems that lean substantially to one side (≥ 15% from vertical) (*Picture 2*). Count includes "goosenecked" plants that have "straightened up" after becoming lodged earlier in the season (*Picture 1*).

Timing: Before Harvest
n = 1 count per plot
Unit: number of plants with RLD

Notes: Emphasis is on the number of plants, not the %. Accurate stand counts and lodging counts are essential and will be used to calculate a % lodging in later analyses.

Picture 1

Picture 2

Stalk Lodging (SKLDG)

Description/Procedure:

Number of plants broken between the ground level and the top ear node (*Picture 1)*.

Timing: Before Harvest
n = 1 count per plot
Unit: number of plants with SLD

Notes: Emphasis is on the number of plants, not the %, which does not tell us much. Accurate stand counts and lodging counts are essential and will be used to calculate a % lodging in later analyses.

Picture 1

Green Snap (GSP) (optional)

Description/Procedure:

Number of plants broken between the ground level and the top ear node **before flowering** (*Picture 2*).

Timing: Before flowering
n = 1 count per plot
Unit: number of plants with GSP and date of triggering event [MM/DD/YY]

Notes: Collaborators may choose to take counts of green snap following a weather event occurring before flowering that causes substantial numbers of stalks to snap. Please also record date of event.

Emphasis is on the number of plants, not the %, which does not tell us much. Accurate stand counts and lodging counts are essential and will be used to calculate a % lodging in later analyses.

Picture 2

Photo 1 credit: Gordon Johnson, UDel Extension
Photo 2 credit: UGA Cooperative Extension

Stand Count (STAND)

Description/Procedure:

Number of plants per plot at harvest.

Timing: At Harvest
n = 1 count per plot
Unit: count

Notes: Main consideration is how many plants were in the plot at harvest time. Accurate stand counts and lodging counts are essential and will be used to calculate a % lodging in later analyses. Counting can occur earlier but if a plot damage occurs before harvest they will need to be recounted.

Plot Weight (WT)

Plot Weight

Description/Procedure:

Shelled grain weight per plot

Timing: At Harvest
n = 1 weight per plot
Unit: lbs

Test Weight (TWT)

Test Weight

Description/Procedure:

Shelled grain weight per bushel

Timing: At Harvest
n = 1 weight per plot

Unit: lbs/bu

Grain Moisture (MOIST)

Description/Procedure: Water content in grain at harvest.

Timing: At Harvest
n = 1 measure per plot
Unit: percent [%]

Appendix B: Soil Sampling Handbook

a. Soil Sampling Instructions for GxE 2019

1. Each sample should be made up of a minimum of 10 cores to ensure accurate representation of the field, ideally 20 or more cores. Cores should be taken to a depth of 30cm.
2. For uniform fields: When gathering soil cores to make a composite sample, collect cores in a uniform pattern over the whole trial area.
3. For fields with known clines/variants: Sample in order to get an accurate representation of the majority of the field. If significant differences exist in areas of the field, sample areas separately and submit multiple, clearly labeled samples.
4. Thoroughly mix the cores before placing approximately 2 cups in the sample bag. This can be a sample bag, or a regular Ziploc bag.
5. Label the bag with PI name and experiment name.
6. Complete a sample submittal form.
7. Secure samples for shipping and send to:

   Ward Laboratories, Inc.
   4007 Cherry Ave, PO Box 788
   Kearney, Nebraska 68848-0788
   (308) 234-2418 Fax (308) 234-1940
   www.wardlab.com

   Use UW Madison Agronomy UPS Account: 55W1X6

8. **SOIL SAMPLES FROM REGULATED/FOREIGN AREAS (TX, GA, GE, NC, SC, ON):** All samples need to be shipped in sturdy, leak proof containers which preclude spillage or pest escape in transit and while awaiting processing. Sealed tubes, vials or cans placed in sealed coolers or sturdy boxes are acceptable shipping containers. All regulated or foreign soil must be shipped via Fedex, see account # above. All samples need to have a copy of the Soil Permit inside and affixed to the outside. For foreign soils, a copy of PPQ Form 550 goes on the outside of the box.

   This requirement applies to samples from **TX, GA, NC, SC, Ontario and Germany**.

Appendix C: Additional Weather Station Resources

For weather station issues, contact:

Hardware:
David Ertl
dertl@iowacorn.org

515-225-9242

Software/Technical Support:
Octavio Valle
ovalle@specmeters.com

815-436-4440 (mention Iowa Corn), or
800-248-8873 and ask for Terri or Tech Support

a. Annual Watchdog 2700 Pre-Season Tasks

i. Check that all sensors are reading correctly on LCD screen. See item (f) for specific instructions regarding the calibration/troubleshooting of individual instruments.

ii. Rearrange the external instruments to the following ports:
   1. Soil moisture - Port A
   2. Soil temperature - Port B
   3. Solar radiation - Port C
   4. PAR sensor - Port D

iii. Using the SpecWare software with the station connected, delete the data from the logger (Logger > WatchDog Manager > Advanced > Clear > OK)

iv. Using the SpecWare software with the station connected, turn off unused ports and verify instrument port location (Logger > WatchDog Manager > Properties > uncheck Enabled box for unused ports and correct Sensor/Units > OK)

v. Replace batteries - 4 AA.

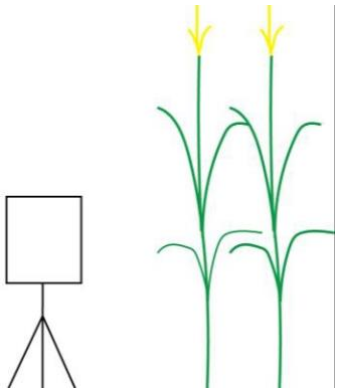
vi. Check for inhibitors or damage to the sensors:
   1. Waste in rain gauge
   2. Damaged sensor wires
   3. Damaged external parts
   4. Dirt on sensors

vii. Inspect fasteners and ensure all are tight.

viii. Check for moisture damage & corrosion. Inspect circuit board if there are signs of water damage or corrosion.

b. WatchDog 2700 Field Setup

Use the following checklist to complete setup of the weather station

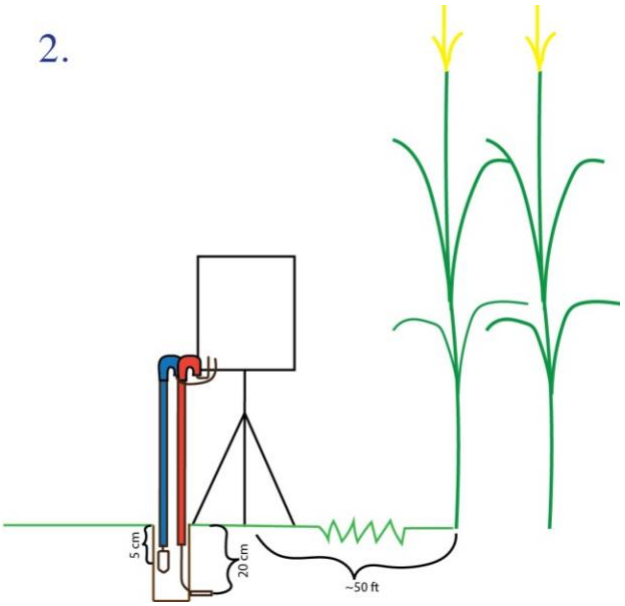


Station Placement:

_____ Place the weather station at the edge of GxE field trial on level ground so that there are no shadows from the corn or other obstructions hitting the station, approximately 6 to 10 feet away from the corn if possible.
_____ Drive the tapered end of the 7 ft post 1 ft into the ground
_____ Secure the tripod around the post
_____ Secure the feet of the tripod
_____ Secure the weather station on top of the tripod with the front facing south
_____ Point the wind vane and anemometer away from the rest of the station
_____ Use a compass to point the nose of the wind vane to North. Hit Display > Set > Set North > Set > Set to calibrate.
_____ Install rain bucket cover by bending legs of hardware cloth and inserting into bucket
_____ Check the date and time
_____ Set the logging interval to 30 minutes
_____ Clearly mark weather station location for passing farm equipment

Soil Temperature Sensor and Cable Protector:

2.



_____ Use a small shovel to dig a trench that is 20 cm (~8 in) deep and 15-18 cm (6-7 in) wide (see 2).
_____ Insert the soil temperature sensor horizontally into the wall at the bottom of the trench. If the soil is too dense make a small indentation (e.g. end of screwdriver) in the soil to get it started. Watch video for a demonstration. https://youtu.be/ZXpeI7ukEW8
_____ Lightly tamp the soil around the sensor to ensure complete contact
_____ Feed the sensor cable through the shaft and rain head of the red cable protector
_____ Place the shaft vertically in the soil
_____ Tamp the soil around the shaft to provide vertical support (The pipe [not the sensor] can be deeper than 20 cm (~8 in) in the soil)
_____ Use the cable tie to fasten the cable protector to the tripod leg, stick or rod with a cable tie
_____ Use a cable tie to secure extra cable off of the ground
_____ Plug the sensor lead into port "B" on the weather station
_____ Replace and *lightly compact* the soil until the trench is 5 cm (~2 in) deep

Soil Moisture Sensor and Cable Protector:

_____ Place the soil moisture sensor into the blue end of the shaft with the remaining cable pushed through the rain head. The shoulder of the sensor will rest on the cut face of the shaft. Make sure the sensor does not align with the slit in the end of the shaft (see 2)

_____ Loosen the soil using a soil probe to make a hole to insert the prove. Refill the hole with loose soil. Push the sensor gently into the soil so the top of the sensor is even with the soil in the trench. **DO NOT** push hard, the sensor is breakable!! Watch this video for a demonstration. https://youtu.be/ZXpeI7ukEW8

_____Tamp the remaining soil around the outside of the shaft to divert surface water and support the shaft.

_____ Use a cable tie to secure extra cable off the ground

_____ Plug the sensor into port "A" on the weather station

c. In-Field WatchDog 2700 Maintenance

Weather station checks should take place at each field visit. Note the date and time of station check in metadata sheet to allow proper data cleaning.

Anemometer:

_____ Clean dirt/debris from the wind cups

_____ Check display values to ensure the sensor is still working (Display > Current > Current > Up Arrow)

_____ Ensure the cups still spin freely

Wind vane:

_____ Clean dirt/debris from the wind vane

_____ Check display values to ensure the sensor is still working (Display > Current > Current > Up Arrow)

Rain bucket:

_____ Remove debris from the top of the bucket, both on and beneath hardware cloth cover

_____ Unscrew the top and lift lid

_____ Remove dirt/debris from inside the bucket

_____ Set the display to view rain values (Display > Current > Current > Up Arrow > Down Arrow) and tip the bucket to ensure the sensor is still working

_____ Replace the lid and cover for rain bucket

Solar radiation sensor:

_____ Remove dirt/debris from the solar radiation sensor

_____ Check display values to ensure the sensor is still working properly (Display > Current > Current > Up Arrow (x8 for Port C))

Soil temperature sensor:

_____ Check display values to ensure the sensor is still working properly (Display > Current > Current > Up Arrow (x7 for Port A))

Soil moisture sensor:

_____ Check display values to ensure the sensor is still working properly (Display > Current > Current > Up Arrow (x6 for

Port A))

All cables:

_____ Check all sensor cables for exposed wires/breakages

d. Post-Field Season WatchDog 2700 Removal

After the field is harvested, the weather station should be carefully removed to increase longevity.

_____ Unplug the soil temperature and soil moisture sensors from the weather station
_____ Remove the soil temperature and soil moisture sensors by carefully digging them out with a shovel
_____ Replace the soil for the trench
_____ Clean soil from the cable protectors and fold up sensor cables taking care to avoid sharp bends
_____ Take down the weather station
_____ Remove the 7 ft post from the soil and remove packed soil from the end

Transferring SWD files / data

To transfer files, i.e., to consolidate data from multiple locations and computers, you can download your WatchDog weather station data and upload it to CyVerse by doing the following:

i. Connect the weather station to the computer and open SpecWare to transfer data
ii. Select Logger > Get WatchDog 1000/2000 Data
iii. Navigate to your SpecWare folder on the C-drive
iv. Open the folder for the desired station
v. Select all .SWD files and upload to the Weather folder using the location-specific Google Sheet link that was shared

e. Additional Links to Resources:

1. Software Setup: SpecWare9 Quick Start Guide
2. Complete Watchdog Weather Station Manual
3. Additional Spectrum Technology manuals

f. WatchDog Troubleshooting and Calibration Methods

To test the weather station, press the "Display" button to turn on the display. Press the "Current/Archive" button until the display reads "Current Values". Then use the arrow keys to step through the various instrument readings and test the output. Please wait up to 30 seconds for the display to update the current conditions.

i. Anemometer:
   1. If wind speed constantly or intermittently reads zero
      a. Ensure the anemometer is fully plugged in
      b. Check for broken wires along the cable especially where the cable is secured
   2. If anemometer (wind cups) does not spin freely
      a. Use a 0.05" allen wrench (should have been included with station) to loosen screw and drop the cups slightly (approx. 1/16")
      b. Check wind speed output to determine if it is reasonable. If the speed seems too fast, tighten the screw. If the speed seems too slow, loosen the screw.

ii. Wind vane:
   1. If the wind direction does not update after the wind vane is moved
      a. Ensure the wind vane is fully plugged in
      b. Check for broken wires along the cable especially where the cable is secured
   2. If the wind direction on display does not match true direction
      a. Using a compass (or smart phone app) point the nose of the wind vane to the north
      b. Turn on the weather station display by pressing the "Display" button

c. Hit the "Set" button
d. Use the arrows until the display reads "Set North" then push "Set"
e. Point the nose of the wind vane to north and press "Set" again. The weather station will calibrate north and return to the "Current" display

iii. Rain bucket:

1. If the rain bucket is not collecting data when the bucket is tipped
    a. Loosen 4 screws at base of rain bucket twist the black bucket to the right about ½", and lift lid
    b. Remove dirt or debris that could be preventing the bucket from tipping
    c. Manually move the bucket back and forth several times. Each tip is one one-hundredth of an inch (or 0.254 millimeters).
    d. Check the display to determine if the proper amount of rain was recorded
2. If the LCD is not showing any or all of the manual tips of the spoon
    a. The magnetic sensor on the tipping spoon may be too far from the read switch or the sensor cable is bad. There are 2 cams on the base of the rain collector that can be rotated to move the tipping spoon closer to or further away from the read switch. Make this adjustment and check if the LCD shows that the logger can detect manual tips of the spoon. If so, proceed to step 3. If not, the sensor may need to be sent in for service.
3. If all the tips are being counted
    a. Replace the rain bucket and trickle a known amount of water into the bucket. CAUTION: The rain bucket is self-emptying so be sure there are no electronics/important papers near the station while completing this task. 84 ml of water should register 0.1 inches of water (2.5 mm). This is equivalent to 10 tips of the tipping spoon. The best results are attained when the water is added slowly. It is recommended that the water be put in a ziplock bag which is then punctured with a pin to allow the water to slowly enter the rain bucket. If the reading on the LCD is slightly high or slightly low, the sensor can be calibrated. When the spoon tips, it lands on screws on either side. If sensor is reading high, lower the screws. If it is reading low, raise the screws. It is recommended to adjust the screws a quarter turn and again run a known amount of water through the bucket to determine if additional adjustment is necessary.

iv. Thermometer/Relative Humidity:

1. If the temperature or humidity on the display seems unusually high/low
    a. Ensure the sensor is fully plugged in
    b. Check for broken or exposed wires along the cable

v. Soil thermometer:

1. If the soil thermometer display does not register or varies significantly from the air temperature
    a. Ensure the units on the display match the intended units. If the units do not match use the "Set" button to set the sensor type. Use the arrow keys to select to appropriate port and hit "Set". Use the arrow keys again to select the correct sensor and hit "Set" again.
    b. Ensure the cable is fully plugged in.
    c. Check for broken or exposed wires along the cable.

vi. Soil moisture sensor:

1. If the sensor display reads anything other than 0% VWC in air
    a. Ensure the sensor is fully plugged in
    b. Check for broken or exposed wires along the cable
2. If the sensor seems fine in air, but season data has issues
    a. Place the sensor in distilled water. If the sensor does not read ~55% VWC it may need to be calibrated/replaced.

vii. Solar radiation sensor:

1. If the solar radiation sensor display reads zero
    a. Ensure the sensor is fully plugged in
    b. Check for broken or exposed wires along the cable
    c. Ensure the units on the display match the intended units. If the units do not match use the "Set" button to set the sensor type. Use the arrow keys to select to appropriate port and hit "Set". Use the arrow keys again to select the correct sensor and hit "Set" again.
2. If the solar radiation display reads a very low number (<500 W/m2)
    a. Repeat steps a-c in item 1 above
    b. If it is sunny take the weather station outside to see if the numbers improve.

    The solar constant is 1400 W/m^2 so you shouldn't have any values greater than that.