# GxE Field Experiment 2020 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 Alejandro Castro Aviles, castroaviles@wisc.edu, is serving as the new G2F Coordinator. Any questions or concerns that you previously contacted Naser AlKhalifah about should now be directed to him.

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!**

# Document Contents

# GxE Field Experiment 2020 Checklist

**Preseason:**

**For new cooperators only:**

_____ Email Alejandro Castro at castroaviles@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 Alejandro Castro at castroaviles@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 Alejandro, 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 Alejandro Castro, 608-218-0903, castroaviles@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 2020 and 2021 seasons

a. Each trial is arranged in two replications (500 plots total). For the purposes of blocking in the field, the primary division is by replication (1 or 2) then by tester (PHP02, PHK76, PHZ51) if you have multiple testers. Most locations only included one tester.

b. Additional external blocks were created upon request for external Yellow Stripe replications to facilitate sampling or additional phenotyping. External experiments with 2 replications of 25 entries were also created upon request for Hybrid HIPS and Inbreed HIPS.

c. 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 multiple testers, an equal amount of the plots were assigned to each tester as separate experiments.

d. 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.

e. 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.

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

g. 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 4 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.

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

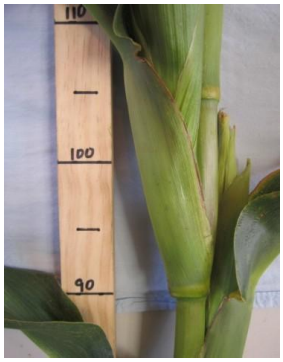
*Picture 2*

# 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

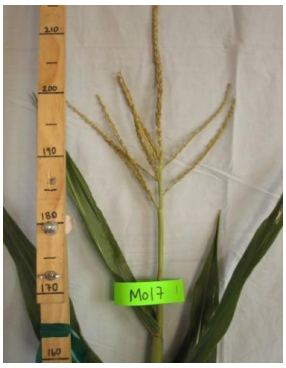
# Plant Height (PLTHT)

**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 2020

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, ON, NC, SC):** 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 330 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.

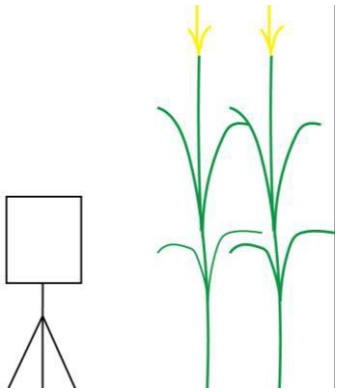
vi. Check for inhibitors or damage to the sensors:
   1. Waste in rain gauge
   2. Damaged sensor wires
   3. Damaged external parts
   4. Dirt on sensors

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**

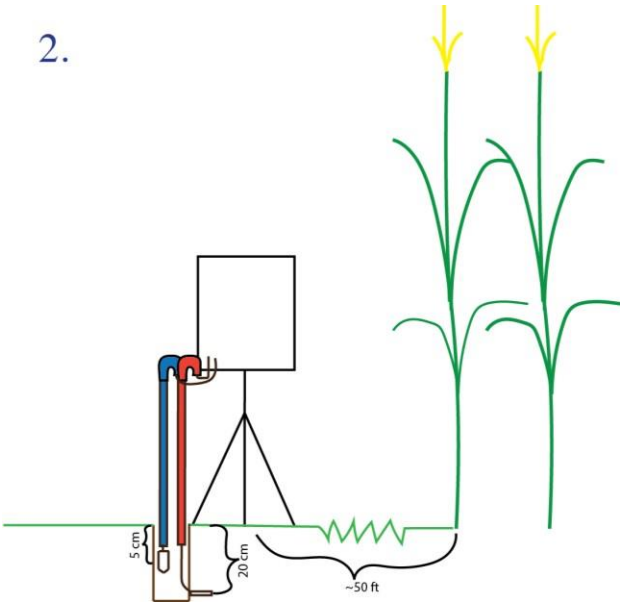


**Station Placement:**

_____ 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