

Finding the needle in the haystack -Zegami – a new tool for visualizing phenotypic data sets

ICEC/AusPheno 2016 - Canberra

Bettina Berger, Trevor Garnett, George Sainsbury, Roger Noble, Samuel Conway









The Plant Accelerator – from standard greenhouse to automation





Phenotyping – past and present







- Manual measurements
- Direct contact with plants
- Relatively small data sets
- 'simple statistics' often sufficient

Phenotyping – past and present



- Automated measurements
- Limited visual assessment of plants
- Large image-based datasets
- Need for multidisciplinary team of experts for experimental design, setup, image and data analyses

A 'typical' high-throughput experiment

- Hundreds of genotypes
- Multiple treatments, uneven replication
- Over 1,000 plants, spread over two rooms
- 2 to 8 weeks of imaging
- 10,000s images
- Multiple traits per image
- Millions of cells in results file not uncommon

| 28 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | ſi | R | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
|------|------|------|-----|------|-----|------|-----|------|-----|------|-----|------|------|------|-----|------|-----|------|-----|------|-----|------|-----|------|------|
| Void | 280 | 280 | 243 | 243 | 200 | 200 | 190 | 190 | 203 | 203 | 178 | 178 | Void | 277 | 277 | 156 | 156 | Evap | 72 | 72 | 46 | 46 | 48 | 48 | Voic |
| √oid | Vaid | 183 | 183 | 2 | 2 | Evap | 187 | 187 | 241 | 241 | 59 | 59 | Void | 228 | 228 | 234 | 234 | 18 | 18 | 276 | 276 | 181 | 181 | 261 | 261 |
| Void | 26 | 26 | 104 | 104 | 177 | 177 | 120 | 120 | 68 | 68 | 271 | 271 | Void | 124 | 124 | 267 | 267 | 91 | 91 | 21 | 21 | 89 | 89 | Evap | Voic |
| Void | Vaid | 71 | 71 | 51 | 51 | 69 | 69 | 214 | 214 | Evap | 207 | 207 | Void | 49 | 49 | 236 | 236 | 208 | 208 | 66 | 66 | 246 | 246 | 144 | 144 |
| √oid | 232 | 232 | 222 | 222 | 163 | 163 | 134 | 134 | 284 | 284 | 170 | 170 | Void | 216 | 216 | Evap | 52 | 52 | 167 | 167 | 38 | 38 | 223 | 223 | Voic |
| √oid | Vaid | Evap | 146 | 146 | 3 | 3 | 102 | 102 | 58 | 58 | 182 | 182 | Void | 81 | 81 | 106 | 106 | 154 | 154 | 70 | 70 | 15 | 15 | 37 | 37 |
| √oid | 5 | 5 | 159 | 159 | 110 | 110 | 239 | 239 | 279 | 279 | 39 | 39 | Void | 257 | 257 | 94 | 94 | 275 | 275 | 235 | 235 | Evap | 136 | 136 | Voic |
| Void | Vaid | 79 | 79 | 148 | 148 | 97 | 97 | Evap | 105 | 105 | 218 | 218 | Void | 180 | 180 | 227 | 227 | 64 | 64 | 67 | 67 | 86 | 86 | 11 | 11 |
| /oid | 160 | 160 | 225 | 225 | 62 | 62 | 213 | 213 | 142 | 142 | 248 | 248 | Void | Evap | 40 | 40 | 152 | 152 | 198 | 198 | 250 | 250 | 1 | 1 | Voic |
| /oid | Void | 168 | 168 | Evap | 85 | 85 | 75 | 75 | 164 | 164 | 121 | 121 | Void | 176 | 176 | 195 | 195 | 260 | 260 | 268 | 268 | 264 | 264 | 139 | 139 |
| /oid | 25 | 25 | 286 | 286 | 22 | 22 | 23 | 23 | 145 | 145 | 31 | 31 | Void | 98 | 98 | 90 | 90 | 211 | 211 | Evap | 9 | 9 | 101 | 101 | Voic |
| /oid | Vaid | 273 | 273 | 300 | 300 | 230 | 230 | 42 | 42 | 53 | 53 | Evap | Void | 210 | 210 | 118 | 118 | 263 | 263 | 73 | 73 | 93 | 93 | 233 | 233 |
| /oid | 60 | 60 | 294 | 294 | 192 | 192 | 162 | 162 | 298 | 298 | 288 | 288 | Void | 132 | 132 | 265 | 265 | Evap | 237 | 237 | 224 | 224 | 245 | 245 | Voic |
| /oid | Void | 270 | 270 | 226 | 226 | Evap | 24 | 24 | 278 | 278 | 14 | 14 | Void | 30 | 30 | 95 | 95 | 113 | 113 | 185 | 185 | 127 | 127 | 135 | 135 |
| /oid | 171 | 171 | 47 | 47 | 229 | 229 | 27 | 27 | 63 | 63 | 61 | 61 | Void | 43 | 43 | 7 | 7 | 78 | 78 | 82 | 82 | 137 | 137 | Evap | Voic |
| /oid | Vaid | 117 | 117 | 221 | 221 | 175 | 175 | 17 | 17 | Evap | 74 | 74 | Void | 217 | 217 | 153 | 153 | 215 | 215 | 92 | 92 | 184 | 184 | 100 | 100 |
| /oid | 223 | 223 | 82 | 82 | 269 | 269 | 70 | 70 | 189 | 189 | 235 | 235 | Void | 200 | 200 | Evap | 155 | 155 | 217 | 217 | 195 | 195 | 207 | 207 | Voic |
| /oid | Vaid | Evap | 165 | 165 | 256 | 256 | 149 | 149 | 151 | 151 | 285 | 285 | Void | 108 | 108 | 126 | 126 | 79 | 79 | 205 | 205 | 47 | 47 | 23 | 23 |
| √oid | 208 | 208 | 12 | 12 | 140 | 140 | 18 | 18 | 291 | 291 | 78 | 78 | Void | 199 | 199 | 190 | 190 | 201 | 201 | 290 | 290 | Evap | 210 | 210 | Void |
| /oid | Void | 119 | 119 | 93 | 93 | 84 | 84 | Evap | 225 | 225 | 125 | 125 | Void | 64 | 64 | 299 | 299 | 63 | 63 | 174 | 174 | 283 | 283 | 116 | 116 |
| /oid | 54 | 54 | 143 | 143 | 7 | 7 | 33 | 33 | 160 | 160 | 46 | 46 | Void | Evap | 297 | 297 | 20 | 20 | 255 | 255 | 287 | 287 | 133 | 133 | Void |
| /oid | Void | 227 | 227 | Evap | 198 | 198 | 144 | 144 | 32 | 32 | 10 | 10 | Void | 260 | 260 | 60 | 60 | 123 | 123 | 145 | 145 | 178 | 178 | 159 | 159 |
| √oid | 261 | 261 | 45 | 45 | 141 | 141 | 34 | 34 | 128 | 128 | 192 | 192 | Void | 202 | 202 | 236 | 236 | 147 | 147 | Evap | 222 | 222 | 175 | 175 | Void |
| Void | Void | 153 | 153 | 36 | 36 | 197 | 197 | 259 | 259 | 99 | 99 | Evap | Void | 286 | 286 | 244 | 244 | 83 | 83 | 220 | 220 | 57 | 57 | 232 | 232 |

NW Smarthouse Position

Data analysis – the new phenotyping bottleneck

- ✤ A typical experiment takes ~ 4-12 weeks to run
- ✤ Basic image analysis with QC in parallel or ~ 1-2 weeks at completion
- Analysis of numeric data at the end can take months (or years)
 - Datasets are two large for basic stats approach
 - Time-course series
 - Plant scientists can feel overwhelmed with data sets
 - Exploration of data difficult with e.g. Excel, going through individual images impossible
 - QC required, outlier detection
 - Close collaboration between plant scientists and statisticians critical



Basic questions asked during or after experiment

- Did the treatment work? Was it the right level?
- Are there trends between rooms, across a room?
- Are there outliers? What type?
 - Technical (e.g. image analysis)
 - Biological (e.g. poor seedling development)

Apart from biomass over time, what other traits might be of interest?





Ways to answer questions and address data-analysis bottleneck

- Tools for visual quality control by expert user
- Tools for easy exploration of dataset by plant scientists to get a feel for the data

Meet Zegami: The visual search tool

| 2 Lagarri | | | | | | | | | | | | | - |
|----------------|----------|-----------------|--|--|-----------------|-----------|--|--------------|----------|---------------|----------------|----------------|-------|
| ← → C D demoze | gami.com | | | | UK Tein | 2014 | | | | | | | |
| 🔹 filters | ¥ | B.A | | | on trip | | 13 Note of 127 March | | <u> </u> | | sort by mage | ~ grant | y Now |
| · Nearty. | a | 63 | - | - | Do Ted | 1.00 | Carl and a | | 197 dia | - | - | In the second | The |
| · TACS | | antian PA | | and the state of t | State of the | | States . | Nor Long | la m | | Sec. | 1 | 8 |
| · MAGE | | | | | State of Column | 1000 | and a | | 1000 | and a | A States | | 100 |
| · UATE | | Income States | | 150 | | 1 | Minde | 8 | . All | - | and the second | 3TH | - |
| I WAESTER | | hand a section | | and the | anter- | - Charles | Statistical Statis | | all a | and the same | - SIGNAL CON | 10 | |
| · HEXANT | | | | | | | | State | | - | - | and the second | |
| · CANELLA | | ALL ALL | | toine a de | - | - | antidenters of | CHARTER . | | LINE | - | Sector Ba | 20 |
| · NCERL | | Prince Dian | | 1 | Sector Sector | | | 200 | 1212 | | _ | 24110 | |
| · F.STOR | | | | A REACHER | TAR | | | | | | Second | - | - |
| CATTUDE | | STREET, LANSING | BERNARD AND AND AND AND AND AND AND AND AND AN | 言题的机识 | | ALC: LOL | | ANTE | - And | CONTRACTOR OF | 1.200 | 2.5 | |
| I I LONGTUDE | | | and the second second | | | | 1000 | | - BARRAN | 14 Louis | | 1.12 | |

- Customized for plant phenotyping datasets
- Plotting tools
- Basic stats
- Login options



Message from eRSA: We will be performing an upgrade to our network infrastructure on Wednesday, 21 September 2016 between 9.30am and 1.30pm.

Zegami will be unavailable during this time.



0251 Nitrogen Use Efficiency and Water Use Efficiency in Wheat

Ten commercial wheat varieties were grown on the phenotyping platform of The Plant Accelerator from 22 to 74 days after the seedlings emerged and imaged every second day. The treatments consisted of three nitrogen levels (N1 (low), N2 (medium) and N3 (high) applied in the soil mix). For each of these nitrogen treatments there were four water availability treatments: D1, well watered; D2, restricted watering from day 22 but then well watered from day 48; D3, restricted water from day 22 onwards; and D4, well watered then restricted watering from day 48 onwards. There were 4 replicates per treatment with a total of 480 plants x 27 time points = 12960 image sets.

12960 items 🔹 🗸 completed 🛛 🛗 Processed: Tue Sep 22 2015 at 10:21am 🛛 🕑 Duration: 62h 41m 9s



0184 Salinity stress response of rice diversity panel - Walia Lab - Uni Nebraska - Part I

A rice diversity panel consisting of 373 accessions (Zhao et al 2011, http://dx.doi.org/10.1038/ncomms1467) was exposed to 90 mM NaCl during the early tillering stage (8 days after transplanting). The salt treatment was applied in two steps of 45 mM at 10 and 13 days after transplanting. To assess natural variation for salinity tolerance, morphological and physiological responses were monitored over a period of 14 d after 90 mM NaCl treatment. The experiment was replicated three times from August to October 2013. Campbell et al. (2015) http://dx.doi.org/10.1104/pp.15.00450

15552 items 🗸 completed 🛗 Processed: Mon Aug 29 2016 at 9:46am 🕐 Duration: 3h 9m 41s



0185 Salinity stress response of rice diversity panel – Walia Lab – Uni Nebraska – Part II

A rice diversity panel consisting of 373 accessions (Zhao et al 2011, http://dx.doi.org/10.1038/ncomms1467) was exposed to 90 mM NaCl during the early tillering stage (8 days after transplanting). The salt treatment was applied in two steps of 45 mM at 10 and 13 days after transplanting. To assess natural variation for salinity tolerance, morphological and physiological responses were monitored over a period of 14 d after 90 mM NaCl treatment. The experiment was replicated three times from August to October 2013. Campbell et al. (2015) http://dx.doi.org/10.1104/pp.15.00450

15552 items 🛛 🗹 completed 🛗 Processed: Mon Aug 29 2016 at 12:56pm 🕑 Duration: 8h 38m 49s



0186 Salinity stress response of rice diversity panel - Walia Lab - Uni Nebraska - Part III

A rice diversity panel consisting of 373 accessions (Zhao et al 2011, http://dx.doi.org/10.1038/ncomms1467) was exposed to 90 mM NaCl during the early tillering stage (8 days after transplanting). The salt treatment was applied in two steps of 45 mM at 10 and 13 days after transplanting. To assess natural variation for salinity tolerance, morphological and physiological responses were monitored over a period of 14 d after 90 mM NaCl treatment. The experiment was replicated three times from August to October 2013. Campbell et al. (2015) http://dx.doi.org/10.1104/pp.15.00450

15768 items 🗸 completed 🛗 Processed: Tue Aug 23 2016 at 12:41pm 🥝 Duration: 46h 26m 33s



0255 Rice response to salinity stress under waterlogged conditions - indica

Two rice diversity panels, indica and aus, containing a total of 553 genotypes, were phenotyped at The Plant Accelerator under waterlogged conditions. These panels were selected by breeders at the International Rice Research Institute (IRRI) and collaborating partners in the context of the Phenomics of Rice Adaptation and Yield Potential (PRAY) project, funded by the Global Rice Science Partnership (http://ricephenonetwork.irri.org/). Rice plants were exposed to salt stress (150 mM NaCl, applied to the flood water in which pots were immersed) when plants were 29 days old. Over a 13-day stress period, plant responses were monitored daily. The key traits analyzed were plant growth and transpiration, which allowed the calculation of transpiration use efficiency, a key index determined by the ratio of biomass produced per unit of water transpired.

Search...

TAGS

BARCODE

PLANT SPECIES

GENOTYPE ID

REPLICATE

LANE

POSITION

SMARTHOUSE

SALT TREATMENT

۲

0

0

0

0

🖨 🖓 A 📎 🛓 🖬

V

Q

200

group by: (None)

sort by: Barcode

V

14784 **111 111** 100% of 14784 items grid graph table

*

Two rice diversity panels, *indica* and *aus*, containing a total of 553 genotypes, were phenotyped at The Plant Accelerator under waterlogged conditions. These panels were selected by breeders at the International Rice Research Institute (IRRI) and collaborating partners in the context of the Phenomics of Rice Adaptation and Yield Potential (PRAY) project, funded by the Global Rice Science Partnership (<u>http://ricephenonetwork.irri.org/</u>).

Rice plants were exposed to salt stress (150 mM NaCl, applied to the flood water in which pots were immersed) when plants were 29 days old. Over a 13-day stress period, plant responses were monitored daily. The key traits analyzed were plant growth and transpiration, which allowed the calculation of transpiration use efficiency, a key index determined by the ratio of biomass produced per unit of water transpired.

TIME AFTER PLANTING [D]

SNAPSHOT TIME STAMP

WEIGHT BEFORE

WEIGHT AFTER

WATER AMOUNT

- PROJECTED SHOOT AREA [PIXELS]
- RGB_SV1 AREA

RGB_SV1 AREA DISTRIBUTION ABOVE POT ABSOLUTE Loading complete.

Close

| ∦ ∈Z(| egami | | 025 | Rice response to salinity stress | under waterlog | ged co | onditio | ons - a | lus | 200 |
|--------------|--|----------|--|--|-------------------------------------|--------|---------------|---------|------------------|----------------------|
| ۲ | filters | ~ | 🖂 🖸 A 📎 🚣 🖾 | | 14784 100% of 14784 items | grid | Lill graph | table | sort by: Barcode | ✓ group by: (None) ✓ |
| ۲ | Search | Q | | | | | | | | |
| ۲ | TAGS | = | | AND A REAL PROPERTY AND A REAL PROPERTY. | | | | | | |
| ۲ | BARCODE | | A REAL PROPERTY AND A REAL | | | | | | | |
| ۲ | PLANT SPECIES | | | | | | | | | |
| ۲ | GENOTYPE ID | | | | | | | | | |
| ۲ | SALT TREATMENT | | | | | | | | | |
| ۲ | REPLICATE | | | | | | | | | |
| ۲ | SMARTHOUSE | | | | | | | | | |
| ۲ | LANE | | | | | | | | | |
| ۲ | POSITION | | | | | | | | | |
| ۲ | SNAPSHOT TIME STAMP | | | | | | | | | |
| ۲ | TIME AFTER PLANTING [D] | | | | | | | | | |
| ۲ | WEIGHT BEFORE | | | | | | | | | |
| ۲ | WEIGHT AFTER | | | | | | | | | |
| ۲ | WATER AMOUNT | | | | | | | | | |
| ۲ | PROJECTED SHOOT AREA [PIXELS] | | | | | | | | | |
| ۲ | RGB_SV1 AREA | | TTAN STREET, STREET, STR | | | | | | | |
| ۲ | RGB_SV1 AREA DISTRIBUTION ABOVE POT ABSOLUTE | | | | | | | | | |

| % z | egami | | 0254 Rice response to sali | inity stress under waterlogg | ed conditions - au | IS | , , , , , , , , , , , , , , , , , , , | 200 |
|------------|------------------------------------|-------------|----------------------------|------------------------------|--------------------|----|---------------------------------------|-----------------------------|
| ٢ | filters 🗸 🗸 | 🗛 🖸 A 🏷 🕹 🖾 | | 14784 100% of 14784 items | grid graph table | | sort by: Salt Treatment | group by: (None) 🗸 🗸 |
| ۲ | Search Q | | | | | | 5696 | < 1 > × |
| ۲ | TAGS | F | | | | | Data | Notes |
| ۲ | BARCODE | | | | | | tags | + _ |
| ۲ | PLANT SPECIES | | | | | | Barcode | |
| ۲ | GENOTYPE ID | | | | | | 044752-C | |
| ۲ | SALT TREATMENT | | | | | | Plant Species Oryza sativa | |
| ۲ | REPLICATE | | | 1 1 1 | | | Genotype ID | |
| ۲ | SMARTHOUSE | | | | | | Salt Treatment | |
| ۲ | LANE | | | ANI | | | Control | |
| ۲ | POSITION | | E | | | | Replicate | |
| ۲ | SNAPSHOT TIME STAMP | | A | MAN | | | Smarthouse | |
| ۲ | TIME AFTER PLANTING [D] | | 1 | | | | lane | |
| ۲ | WEIGHT BEFORE | | X | | | | 18 | |
| ۲ | WEIGHT AFTER | | | | | | Position 16 | |
| ۲ | WATER AMOUNT | | | MAA | | | Snapshot Time St | amp |
| ۲ | PROJECTED SHOOT AREA [PIXELS] | | | - | | | Time after Plantin | ng [d] |
| ۲ | RGB_SV1 AREA | - | | | | | Weight Before | |
| ۲ | RGB_SV1 AREA | | | | | | 3601 | |
| | DISTRIBUTION ABOVE POT ABSOLUTE | | | | | | Weight After 4093 | |

| ₩ Z | egami | | | | | | | 0 |)254 | Rice | resp | onse | e to s | alin | ity s | stres | s un | der | wat | erlog | ged | l con | diti | ons - | aus | | | | | | | | | | | | | | 11 | 20 | 9 |
|------------|-------------------------|------|------------|-----------------------|------------|------------|------------|----------|------------|-----------|---------------|--------------------------|----------|------------|----------|-------------|---|---------------|----------|---------------|--------------|-------------|---|---------------|---------------|----------|--------------|------------|----------|--------|----------|----------|-----------------------|----------|--------------|----|--------|----------|------------|------------|----------|
| ۲ | filters | × 🗸 | ⊜ (| 3 | A | » 4 | 2 | 3 | | | | | | | | | | 7 % of | 14784 | 1056 items | g | rid g | .iii raph | table | D | _ | _ | _ | _ | s | ort t | oy: Si | a <mark>lt T</mark> r | eatme | ente | gr | oup t | oy: (N | lone) | X | ~ |
| ۲ | Search | Q 1 | | | | | | | | | | | | | | | | | | | | 1 | | | E. | | | | | | | | | | | | | | | | |
| ۲ | TAGS | E | ¥ | 4 | -1 | X | • • • | ·Z | ę | ¥ | ī. | e i | ý. | ÷ | 2 | <u>\$</u> * | * | Ŧ | y. | 2 | 9 <u>-</u> - | 2' | 1 | I | ł | 2 | | | ¥ | 2 | ż | | | 1 | 1 | ź | Ţ. | a. L | Ĩ | r | £ |
| ۲ | BARCODE | | <u>.</u> ¥ | ir v | * | 4 | <u>j</u> ; | 9 | Ý | * | 14 | 5 <u>3</u> | 2 | 2- | 3 | ×. | ¥: X | Ъ. | 4 | 2 | 1 | É | 2 | 1 | X | 2 | 1 | | Ž | 1 | 1 | 1 | 2 | Y | | 1 | 2 | 1 | <u>i</u> | 2 | Ž |
| ۲ | PLANT SPECIES | | 2 | 2 | 1 145 | 1 7 | 1 | 17 | r 7 | 1 | 2 2 | 4 | 17 | 1 | 1 | ż | T. | Ŷ | * | 2 4 | 2 | 4 | - | | 1 | | 2 3 | 4 | 1 1 | I. | 2 | | 1 | È | 2 3 | 1 | n L | 1 | - | 1 | r E |
| ۲ | GENOTYPE ID | | * | ¥ | r | έ <u>γ</u> | 1 | 2 | ě | * | 30 J | 2 | ₩2 | 1 | * | ž | 11 | <u>37</u> | 5 | 4 | ¥. | <u>\$</u> . | 1 | 2 | Ť | F | 1 | 4 | × | ŕ | 1 | <u>±</u> | - | 4 | 1 3 | | 5 | Ϋ́. | <u>ii</u> | 2 | <u>z</u> |
| ۲ | SALT TREATMENT | | I I | I j | | T T | 2 | Ϋ́, | 76 · * | ř | 1 1 1 1 | Σ Σ | Y Y | 1 | ž | ž | 4 | 2 | 1 2 | Tr Tr | 1 | * | r F | N. | T | 2 | 1 3 | | 1 | 2 | i | 1 2' | 1 | 1 | 2 4 2 4 | ľ | 2 | | 1 | : 1 | 2 |
| ۲ | REPLICATE | - 11 | * | * | 22 | 2 | 4 | <u>x</u> | <u>.</u> | ŕ | 1 | 2 | * | * | 2 | Ŧ | 4 | 9 <u>4</u> | 1 | 2 | ř | | 1 | <u>.</u> , | 1 | 4 | <u>*</u> - | ŝ | 44 > | 2 | <u>¢</u> | Ť | 1 | 1 | | 1 | ¥. | ž | <u>ē</u> | 1 | 2 |
| ۲ | SMARTHOUSE | | er F | I F | 1 1 | T. | 19 | Ŧ | Ť | 主 | 上口 | к у 1 | 2 | 1 | 1 | 2 | ě | 1 1 | | 1 1 | 2 | ž Ž | 1 2 | 1 | 1 Y | 1 | 1 i 1 i | 1 | 1 | 1 | r F | i | 1 | I ž | 2 3 | 2 | 1 | 2 | i i | 2 | 2. Z |
| ۲ | LANE | | | P | ** | 1 | ¥. | 2 | <u>•</u> y | * | 1 | 6 2 | | <u>.</u> | * | ×. | E | 14 | ¥ | ÿ. | ¥. | <u>¥</u> | 2 | <u>_t</u> | 1 <u>9</u> 2. | * | <u>r</u> 3 | | 1 | 1 | 2 | 1 | ż | <u>x</u> | 1 1 | 1 | 1 | <u>a</u> | 1 | 1 | <u>.</u> |
| ۲ | POSITION | | 1 | 2 | ar T | T. | 3 | Ť S | Ť | 1 | 1 | | 1 | 97. 94. | 2 | 1 | 1 2 | T' | 1 | ý Ý | £ | r r | 11 | N. | 1 | 15 14 | 1 1 | | | 4 4 | Ť | I Ş | I. je | 1 | 1 1 | 1 | 1 | 2 | 1 | 1 1 | 1 1 |
| ٢ | SNAPSHOT TIME STAMP | | ¥ | <u>18</u> 1, | <u>×</u> , | Ť | 3. | * | TP: | <u>it</u> | 2 | e ¥ | •g | 1 | <u>9</u> | 2 | 3 | <u>+</u> | Ť | ΈP | 2 | <u>.</u> | Ť | r | 1 | 2 | £ . | 2 | 2 | 1 | ż | 5 | 5 | Ĩ | 2 1 | 1 | - | * | 1 | <i>Y</i> : | 25 |
| ۲ | TIME AFTER PLANTING [D] | X | | N. N. | ¥. | 4 | F | 1 4 | 1 | 1 | | н <u>г</u> н <u>т</u> | 1 | 1 | 4 | N. | -12 -12 | 1 | 14 F | 2: 4 | 7 | Y I | 1et 1.5 | 1 | - | 14 14 | 12 U 11 U | | ž | i y | 2 | ei 17 | | - | 1 1 2 1 | 2 | 2 | 2 | í Í | 1 2 | 2 |
| | | | | Ŷ | * | 22 | 4 | 1 | 1 | F | Ŷ. | | <u>ý</u> | 2 | 4 | 2 | Ż | * | 412 2 | ŗ | £ | ġ. | <u>.</u> | 1 | 'Z' | 75 | i 1 | 2 | 2 | 4 | 3. | * | | £ | <u>y</u> y | 1 | 2 | * | i | 4 | : |
| | | | scatter | 1 1 1 1 1 | Ť | T. | Y. | 1 | 1. J. A. | 1 | <u>r</u> E | | 1 | 1 | 2 | | Ť Ý | ar X | 1. J. 1. | 7 2 | * | 1 | 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 | 12 - M | 1 | 14 Jac | ¥ 1 | | 7.1 | ż. | ž. | * | 1 | 4' | 11 -1 + 1 | | 21 11 | 10 | 4 | 21 A | I I |
| | | | expand | 32 | ¢ | * | ż | ¥. | 1 | ŕ | <u>y</u> | | Ť | 4 | 2 | <u>ŝ</u> * | Ě | 24 | 1 | 10 | ų, | 2 | 4 | £ | ž | Ŧ | -1 | <u>i</u> . | 2 | Ē | * | <u>_</u> | 1 | 3 | \$ J | Ŀ | × | Æ | 4 | r | 2 |
| | 42 to 42 | | Ŷ. | 1 | 1. 32 | ar. g | 14 13 | E. | | 1 | | E Z | 1 | 1 | 4 | 1966 L.U | 2 | <u>9</u> | | 1 | 2. | 1 | ÷ ÿ | | 2 | | 1 1 1 | | | 2 | z 1. | 1 | 1 1 | | 1 1 | 1 | e E | 2 | -10- -2 | ¥ | 2 4 |
| ٢ | WEIGHT BEFORE | | 29. | ¥ | ·¥ | \$ | Ĩ | £ | 3. | 5 | ż | Ť | ÷ | * | 3 | y | 79. | 22 | 1 | * | E' | <u>¥</u> . | r | 1 | 2 | x | r i | 7 | 2 | ň | 3 | 1 | 2 | ¥ | 1 1 | 1 | £ | 1 | 1 | 2 | ÷ |
| ٢ | WEIGHT AFTER | | Y 1 | 2 | A. | ¥ 4 | 3 | ¥1. | 3 3 | 1 | 1 | | 2 12 | 1 | 1 | iai I | 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1 | 1 | 1 | y Y | 9 9 | E. | 1 | 1 | ž. | 9 2 | 2 3 | | 19 12 | ¥. | 2 | | 2 | 12 12 | | | ž. | ř. | 1 7 | | 1 |
| ۲ | WATER AMOUNT | | 528 | (50%) | | | | | | | | | | | | | | | | | | | 528 | (50%) | | | | | | | | | | | | | | | | | |
| | | _ | | | | | | | | | | Cont | rol | | | | | | | | | | | | | | | | | | | Salt | | | | | | | | | |

| ₩Z(| egami | | | 0254 Rice response to sa | alinity | stress | unde | r wate | rlogge | d co | nditions | - aus | | | | | | | | | 206 | |
|-----|---------------------|-----|---|---|-------------------|---------------|-------------|--------------------------------|--|---------------|-------------------|----------|------------------------------|------------|------------|--------------|-------------------|-----------------------------|-----------------|---------------------------------|-------------------|--|
| ۲ | filters | × 🗸 | 🗛 🕑 A 🗞 🛓 🖬 | | | | 7 % | <mark>1(</mark> of 14784 it | 0 <mark>56</mark> tems | grid | graph tab | | | | | sort by: | Salt Treatm | ientr | group b | <mark>y: (None</mark>) |) 🗸 | |
| ۲ | Search | Q _ | 2 2 2 | | | | | | | | 1 1 | | | | | | | | | | | |
| ۲ | TAGS | в | * : 1 : 2 4 | <u>rrrir</u> | <u>†</u> 1 | Ŷ | T F | Y 3 | <u>9</u> - | 21 | ± 1 | Ē. | | 1 3 | X 3 | ż. | 11 | 1 3 | žž | <u>Ť</u> | <u>í</u> <u>r</u> | |
| ۲ | BARCODE | | <u>* * * ± ± ±</u> * | | 2 2 | ¥ V | * * | | | f . | 1 1 | 4 | * | 2 2 | 2 2 | 1 1 | 2 2 | <u>+</u> i > 1 | 1 2 | $\frac{1}{i}$ | 2 2 | |
| ۲ | PLANT SPECIES | | 2 - 2 2 2 3 | 1 2 2 2 4 4 7 | 2. 2. | ż | i ż | Ý 9 | (· | 4 | 1 | 2 | | | Î. | 2 | <u>s</u> i | 2 1 | 1: | 1 I | G G | |
| ۲ | GENOTYPE ID | | ***** | | <u>i</u> <u>r</u> | ž | 1 7 | <u> </u> | | * | 1.1 | Ť. | <u>r</u> | e ± | r r | i i | 2 4 | 1 1 | 1 1 | <u>4</u> <u>4</u> | 2 2 | |
| ۲ | SALT TREATMENT | | | | 1 2 | <u>r</u> ş | 2 Y 4 | 1 3 5 8 | 19 19 19 19 19 19 19 19 19 19 19 19 19 1 | 1 | <u>r</u> 1 , 2 | <u>r</u> | 2 <u>1</u> . | | * * | 2 1 | <u>1</u> 1 5 5 | $\frac{F}{7}$ $\frac{1}{4}$ | F 9 | <u>+</u> <u>+</u> + <u>+</u> | 1 2 | |
| | <u> </u> | | 15 # 2 2 1 3 | * * * * * * * | \$ 2 | Ŷ | 1 1 | 1 3 | ťľ | 4 | i i | | ÷. | r 😰 | 2 2 | ÷ ¥ | 1 1 | ż F | 1 2 | ŶŶ | 1 2 | |
| | | | sort I I F I I | | 1 1 | * | ¥ Ý 8 5 | 1 | | 1. E | * 1 | 1 | | : <u>i</u> | 1 1 | 1 2 | 11 | <u>3</u> <u>3</u> | 2 1 | T I | 2 2 | |
| | | | Projected Shoøt Ar | | 4 3 | r Ý | * * | 1 | | * | | 12 | e e | | ÷. | | 2 X | 2 1 | 1 1 | 2 2 | 1 1 | |
| | | | Snapshot Time Stamp Time after Planting [d |) [] | i | Í. | t ŕ | E E | t t | Y | 4 3 | £. | : i | <u>i</u> | <u>н</u> т | <u>\$</u> _1 | ı i | i 1 | 1 4 | żi | : Ì | |
| | à 8 | | Weight Before Weight After | | E 1 | 12 | 2 1 | 1 3 | E É. | r | 1 4 | 120 | E <u>1</u> | L Ł | 1 1 | E É | 2 2 | <u>F</u> 1 | 3 1 | <u>É</u> 1 | 1 1 | |
| ۲ | REPLICATE | - 1 | Water Amount Projected Shoot Area | [pixels] | .2. | 2 | e i | | | Ŷ | | | | | E S | 3 4 | | 1 I | 1 1 | 1 7 | | |
| ۲ | SMARTHOUSE | | RGB_SV1 Area RGB_SV1 Area Distrib | ution Above Absolut | ¥ | 4 | <u>v</u> 2 | 2 3 | | 1 | E P | Ξ. | c z | 2 2 | Y Y | 1 5 | 2 2 | ė f | 1 2 | ž ž | 1 2 | |
| ۲ | LANE | | RGB_SV1 Area Distrib RGB_SV1 Area Distrib | oution Above Relative oution Below Absolut | 1 | 2 | * * | 2 1 | | ý¢i. a | × 1 × < | 'Z : | s i | 2 2 | 2 4 | 1. 2 2 4 | 2 E | * * | 2 2 | <u>+ i</u> | * * | |
| ۲ | POSITION | | RGB_SV1 Area Distrib RGB_SV1 Boundary P | oution Below Relative oint Count | 3 | 9 9 | 4 X | 14 A | | , | 2 2 2 3 | 1 | | | ¥ ± | : 4 | s i | ž š | 1 2 | 1 2 | 1 3 | |
| 0 | SNAPSHOT TIME STAMP | | RGB_SV1 Boundary P RGB_SV1 Boundary P | oint Roundness oints To Area Ratio | 3 | <u>Š</u> * | <u>É</u> 24 | 4 | 2 | 2 | 1 1 | ž i | 1 - <u>1</u> | <u>.</u> | <u>\$</u> | 1 1 | 1 2 | <u>s</u> <u>i</u> | <u><u> </u></u> | <u>B</u> 4 | <u>r</u> | |
| 0 | | x | RGB_SV1 Caliper Leng RGB_SV1 Circumferer | gth nce | | 3 | 1 1 7 9 | | 1 E 1. 4 | 14 - 14 14 | 1 I ¥ 9 | | 1 <u>1</u> 1 1 | | * * | 2 2 | 4 2 | 1 1 | <u>1</u> 4 | 1 1 | * * | |
| • | 47 to 47 | | RGB_SV1 Center Of M RGB_SV1 Center Of M | 1ass X 1ass Y | 2 | y | ¥ 4 | 9.9 | E' | ¥. | r i | 2 | x y | i i | 2 2 | 1 1 | 3 2 | 1 1 | 3 1 | 1 1 | 2 8 | |
| 0 | WEIGHT BEFORE | | RGB_SV1 Compactnes RGB_SV1 Convex Hull | ss I Area | * 1 | -3- -3- | ž ž | 1 3 | | F | 1 1 | ŧ : | ± . | ŕx | 2 Z | 1 3 | 2 2 | T I | 22 | <u>E</u> <u>I</u> | | |
| 0 | WEIGHT AFTER | | 528 (50%) | | 2711.2 | ä | 2 2 | 12.11 | | 1.27 | 528 (50% | 5) | | 2 Z | 2002 | 34 1.2 | 2.1.2 | 1 1 | 1.1.1.1 | 7 7 | $\Sigma \to Z$ | |
| • | | | | Control | | | | | | | | | | | | Sal | t | | | | | |
| 0 | WATER AMOUNT | | | | | | | | | | | | | | | | | | | | | |





















| ₩ Z | zegami | | | 0254 Rice response to salinity stre | ess under waterlogged conc | litions - aus | | 200 |
|------------|--|-----|-------------|-------------------------------------|--|-------------------|-----------------------------------|---------------------|
| 0 | filters | x 🗸 | 🖴 🗗 A 🏷 📥 🖬 | | 20 411 20 | hi aph table | sort by: Time after Planting grou | ip by: (None) 🗸 🗸 🗸 |
| | AREA | * | | | | | | |
| ۲ | RGB_SV1 CONVEX HULL CIRCUMFERENCE | | | | | | | |
| ۲ | RGB_SV1 EXCENTRICITY | | | (FAC) | and late | (A IK | A VAN | |
| ۲ | RGB_SV1 OBJECT EXTENT X | | | | | | | |
| ۲ | RGB_SV1 OBJECT EXTENT Y | | | | | | | |
| ۲ | scatter area selected | × | | | 4 | | | |
| 0 | RGB_SV1 MEAN HUE | | (A) | AN AN | | Jacob Contraction | | |
| ۲ | RGB_SV1 MEAN HUE VARIANCE | | A | | H | · 24. // · | | |
| ۲ | RGB_SV1 MIN ENCLOSING CIRCLE DIAMETER | | | | | | | |
| ٢ | RGB_SV1 MIN AREA RECTANGLE AREA | | | a far | AMA | (MAS) | | |
| ۲ | RGB_SV1 ROUNDNESS | | | (M. A) | | (W) | NA MU. | |
| ٢ | RGB_SV1 HEALTHY AREA ABSOLUTE | | | | | | | |
| ٢ | RGB_SV1 HEALTHY AREA RELATIVE | | | | | | | |
| ۲ | RGB_SV1 SENESCENT AREA ABSOLUTE | | A C | FRAN | 1000 R | | | |
| ۲ | RGB_SV1 SENESCENT AREA RELATIVE | | A | - A | <u> </u> | A | <u> </u> | |
| | | | | | | | | |



| ₩ Z | egami | | | 0254 Rice response to salinity stress | under waterlogg | ed conditi | ons - aus | 2 9 |
|------------|--|-----|-------------|---------------------------------------|--|------------|-------------|--|
| ۲ | filters | × 🗸 | 🖴 🖸 A 🃎 🕹 🖬 | | 1 <mark>8</mark> <1% of 14784 items | grid graph | table | sort by: Time after Planting group by: (None) |
| | AREA | * | | | | | | |
| ۲ | RGB_SV1 CONVEX HULL CIRCUMFERENCE | | 4 | | | | 10 | |
| ۲ | RGB_SV1 EXCENTRICITY | | 1-March | and | ala | | ALA | We have a second |
| ۲ | RGB_SV1 OBJECT EXTENT X | | | | (And and a second secon | | TY N | <u> </u> |
| ۲ | RGB_SV1 OBJECT EXTENT Y | | | | | | | |
| ۲ | RGB_SV1 HEIGHT | x | 1 | | 1 | | | |
| | scatter area selected | H | · Ale | Wife | AND | | Aller | (A) (A) |
| ۲ | RGB_SV1 MEAN HUE | | 1 | | (AVA) | | MALA | |
| ۲ | RGB_SV1 MEAN HUE VARIANCE | | <u> </u> | <u> </u> | A | 4 | <u>'(Å)</u> | |
| ۲ | RGB_SV1 MIN ENCLOSING CIRCLE DIAMETER | | | Ű. | 1 | | | |
| ۲ | RGB_SV1 MIN AREA RECTANGLE AREA | | WA N | TANK . | Alles. | | - West | |
| ۲ | RGB_SV1 ROUNDNESS | | 1 | 1 C | | | T V | |
| ۲ | RGB_SV1 HEALTHY AREA ABSOLUTE | | | | | - | | |
| ۲ | RGB_SV1 HEALTHY AREA RELATIVE | | - Hon | (h) | | | | |
| ۲ | RGB_SV1 SENESCENT AREA ABSOLUTE | | (AAA | 1 ALAS | | | | |
| ۲ | RGB_SV1 SENESCENT AREA RELATIVE | | _ <u> </u> | - ñ | ñ | 4 | | |
| | | | | | | | | |

| ₩Z(| egami | | | | 02 | 254 Rice respon | se to salin | ity stre | ss under | waterlo | ggeo | l condi | tions | - aus | 200 |
|-----|--|-----|------------------|--|---|--|-------------|----------|----------|------------------------|------|----------|-------|-------|---|
| ۲ | filters | ~ | ₿ (| Z A 🃎 | * | | | | 100% of | 14784 f 14784 item: | g | rid grap | h tab | | sort by: Time after Planting group by: (None) V |
| ۲ | RGB_SV1 BOUNDARY POINTS TO AREA RATIO | * | | | | | | | | | | | | | |
| ٢ | RGB_SV1 CALIPER LENGTH | | | | | | | | | | | | | | |
| ۲ | RGB_SV1 CIRCUMFERENCE | | | | | | | | | | | | | | |
| ٢ | RGB_SV1 CENTER OF MASS X | | | | | | | | | | | | | | |
| ۲ | RGB_SV1 CENTER OF MASS Y | 111 | | | | | | | | | | | | | |
| F | RGB_SV1 COMPACTNESS rojected Shoot Area [pixels] RGB_SV1 Compactness | | range scatter | Projected S Snapshot T Time after I Weight Befo Weight Afte Water Amo Projected S RGB SV1 A | hoøt Ar ime Stamp Planting [d] ore er unt hoot Area [pix rea | els] | | | | | | | | | |
| ۲ | RGB_SV1 CONVEX HULL AREA | | | RGB_SV1 A RGB_SV1 A RGB_SV1 A | rea Distributio rea Distributio rea Distributio | n Above Absolut n Above Relative n Below Absolut | | | | | | | | | |
| ۲ | RGB_SV1 CONVEX HULL CIRCUMFERENCE | | | RGB_SV1 A RGB_SV1 B RGB_SV1 B | rea Distributio oundary Point oundary Point | n Below Relative Count Roundness | | | | | | | | | |
| ۲ | RGB_SV1 EXCENTRICITY | | | RGB_SV1 B RGB_SV1 C | oundary Points aliper Length | s To Area Ratio | | | | | | | | | |
| ۲ | RGB_SV1 OBJECT EXTENT X | | | RGB_SV1 C RGB_SV1 C RGB_SV1 C | enter Of Mass enter Of Mass | X Y | | | | | | | | | |
| ۲ | RGB_SV1 OBJECT EXTENT Y | | | RGB_SV1 C | onvex Hull Cire | cumference | - | | | | | | | | |
| ۲ | RGB_SV1 HEIGHT | - | | | | | | | | | | | | | |

| ₩ Z | egami | | 0254 Rice response | to salinity stress under waterlogged conditions - aus | 200 |
|------------|---|---|---|---|---|
| ۲ | filters | ~ | 🖴 🗗 🛦 🍉 📥 🖾 | 14784 100% of 14784 items grid graph table | sort by: Time after Planting group by: (None) V |
| ۲ | RGB_SV1 BOUNDARY POINTS TO AREA RATIO | * | | | |
| ٢ | RGB_SV1 CALIPER LENGTH | | | | |
| ٢ | RGB_SV1 CIRCUMFERENCE | | | | |
| ۲ | RGB_SV1 CENTER OF MASS X | | | | |
| ۲ | RGB_SV1 CENTER OF MASS Y | П | | | |
| (O) | RGB_SV1 COMPACTNESS Projected Shoot Area [pixels] RGB_SV1 Compactness | | Image Projected Shoøt Ar Scatter Projected Shoøt Ar Image Snapshot Time Stamp Time after Planting [d] Weight Before Weight After Water Amount Projected Shoot Area [pixels] | | |
| ۲ | RGB_SV1 CONVEX HULL AREA | | RGB_SV1 Area Distribution Above Absolut RGB_SV1 Area Distribution Above Relative RGB_SV1 Area Distribution Below Absolut | | |
| ۲ | RGB_SV1 CONVEX HULL CIRCUMFERENCE | | RGB_SV1 Area Distribution Below Relative RGB_SV1 Boundary Point Count RGB_SV1 Boundary Point Roundness RGB_SV1 Boundary Point Roundness | | |
| ۲ | RGB_SV1 EXCENTRICITY | | RGB_SV1 Boundary Points To Area Ratio RGB_SV1 Caliper Length | | |
| ۲ | RGB_SV1 OBJECT EXTENT X | | RGB_SV1 Circumference RGB_SV1 Center Of Mass X RGB_SV1 Center Of Mass Y RGB_SV1 Convex Hull Area | | |
| ۲ | RGB_SV1 OBJECT EXTENT Y | | RGB_SV1 Convex Hull Circumference | * | |
| ٢ | RGB_SV1 HEIGHT | - | | | |



| ₩ Z | egami | | 0254 Rice | response to salinity stress under | waterlogged conditions - aus | | 200 |
|------------|--|-----|-------------|-----------------------------------|------------------------------|---------------------|-------------------------------|
| ۲ | filters | × 🗸 | 🖴 🗗 A 📎 🕹 🖾 | <1% (| 15 and graph table | sort by: Time after | Plantin(group by: (None) V |
| ۲ | RGB_SV1 BOUNDARY POINTS TO AREA RATIO | * | | | | | |
| ۲ | RGB_SV1 CALIPER LENGTH | 0 | | í. | 5 7 | \sim | |
| ۲ | RGB_SV1 CIRCUMFERENCE | | CANAR. | | hik | - Alle | -ADA |
| ۲ | RGB_SV1 CENTER OF MASS X | | A . | (IN) | AN | A | AN |
| ۲ | RGB_SV1 CENTER OF MASS Y | H | | | | | |
| ۲ | RGB_SV1 COMPACTNESS | × | | 12 | X | χ. | N |
| | scatter area selected | | γ (| An | | // | \land |
| ۲ | RGB_SV1 CONVEX HULL AREA | | ALA | AA | 7042 | (PAG) | AR I |
| ۲ | RGB_SV1 CONVEX HULL CIRCUMFERENCE | | | | | "ANT | |
| ۲ | RGB_SV1 EXCENTRICITY | | | | | | |
| ۲ | RGB_SV1 OBJECT EXTENT | | | | | 1 | |
| ۲ | RGB_SV1 OBJECT EXTENT Y | | Child | 2016 | Ale | 260 | 79.62 |
| ۲ | RGB_SV1 HEIGHT | | | | MANA | (THER | (ALAN) |
| ۲ | RGB_SV1 MEAN HUE | | | | | | |
| ۲ | RGB_SV1 MEAN HUE VARIANCE | | | | | | |
| ۲ | RGB_SV1 MIN ENCLOSING CIRCLE DIAMETER | | | | | | |
| | | | | | | | |



| % z | egami | | | 0254 Rice response to salinit | y stress under waterlogg | ed con | ditions | - aus | | | 2 | 00 |
|------------|--|-----|-----------------------------|-------------------------------|--------------------------|--------|-------------|-------|---|-------------------------|------------------|----|
| ۲ | filters | x 🗸 | 🖴 🖸 A 🗞 🕹 🖬 | | 10 <1% of 14784 items | grid g | graph table | | _ | sort by: Salt Treatment | group by: (None) | ~ |
| ٢ | RGB_SV1 AREA DISTRIBUTION BELOW POT RELATIVE | * | | | | | | | | | | |
| ۲ | RGB_SV1 BOUNDARY POINT COUNT | | | | | | | | | | | |
| ۲ | RGB_SV1 BOUNDARY POINT ROUNDNESS | I | | | | | | | | | | |
| ۲ | RGB_SV1 BOUNDARY POINTS TO AREA RATIO | | (Asto) | (Planka) | | | | | | | | |
| ٢ | RGB_SV1 CALIPER LENGTH | | 14 M | 14 MA | | | | | | | | |
| ٢ | RGB_SV1 CIRCUMFERENCE | | | | | | | | | | | |
| ٢ | RGB_SV1 CENTER OF MASS X | | | | | | | | | | | |
| ۲ | RGB_SV1 CENTER OF MASS Y | | | Para | New | | | | | | | |
| ۲ | RGB_SV1 COMPACTNESS | X | | ATT FIT | 1987 | | | | | | | |
| | Projected Shoot Area [pixels] | | range Projected Shoot Ar | | A | | | | | | | |
| | RGB_SV1 Compactness | | | MA | A. | | | CAN | | CAMPA . | | |
| ٢ | RGB_SV1 CONVEX HULL AREA | | 8 (80%) | | н | | 2 (20%) | H | - | н | | |
| ٢ | RGB_SV1 CONVEX HULL CIRCUMFERENCE | | | Control | | | | | | Salt | | |

| ₩z | egami | | 0254 Rice response to salinity stress under waterlogged conditions - aus | | | | | | | <u> </u> | " 🖲 😧 |
|----|--|-----|--|----------|---------------|---------------------------------|-------------------------|------------------|-------------------------|------------------|----------|
| ٢ | filters | × 🗸 | 🗗 🖸 A 📎 🕹 | . 🔼 | | 10 <1% of 14784 items | grid graph table | | sort by: Salt Treatment | group by: (None) | ~ |
| | ADJULUTE | • | id | Barcode | Plant Species | Genotype ID | 崖 <u>Salt Treatment</u> | <u>Replicate</u> | <u>Smarthouse</u> | Lane | Position |
| ۲ | RGB_SV1 AREA DISTRIBUTION BELOW POT RELATIVE | | 223 | 044362-C | Oryza sativa | 8506 | Control | 1 | NE | 1 | 18 |
| | | | 224 | 044362-C | Oryza sativa | 8506 | Control | 1 | NE | 1 | 18 |
| ۲ | RGB_SV1 BOUNDARY POINT COUNT | | 3144 | 044570-C | Oryza sativa | 52441 | Control | 1 | NE | 10 | 18 |
| | | | 7350 | 044870-C | Oryza sativa | 47381 | Control | 1 | NE | 23 | 20 |
| ۲ | RGB_SV1 BOUNDARY POINT ROUNDNESS | | 11367 | 045157-C | Oryza sativa | 64775 | Control | 2 | NW | 12 | 6 |
| | | | 11366 | 045157-C | Oryza sativa | 64775 | Control | 2 | NW | 12 | 6 |
| • | RGB_SV1 BOUNDARY POINTS TO AREA RATIO | Ξ | 12597 | 045245-C | Oryza sativa | 73127 | Control | 2 | NW | 16 | 2 |
| ۲ | | | 15359 | 045442-C | Oryza sativa | 25925 | Control | 2 | NW | 24 | 16 |
| | | | 531 | 044384-S | Oryza sativa | 54072 | Salt | 1 | NE | 2 | 16 |
| ٢ | RGB_SV1 CALIPER LENGTH | | 532 | 044384-S | Oryza sativa | 54072 | Salt | 1 | NE | 2 | 16 |
| ۲ | RGB_SV1 CIRCUMFERENCE | | | | | | | | | | |
| ٢ | RGB_SV1 CENTER OF MASS X | | | | | | | | | | |
| ۲ | RGB_SV1 CENTER OF MASS Y | | | | | | | | | | |
| ٢ | RGB_SV1 COMPACTNESS | X | <u>101</u> | | | | | | | | |
| 1 | Projected Shoot Area [pixels] | | range Projected Show expand | t Aı | | | | | | | |
| ٢ | RGB_SV1 CONVEX HULL AREA | | | | | | | | | | |
| ٢ | RGB_SV1 CONVEX HULL CIRCUMFERENCE | | ✓ Ⅲ sum: 62693 | | | | | | | | 4 |







Summary

- * Zegami does not replace detailed statistical analysis by experts
- But it allows plant scientists to explore large image datasets
- Brings together images and numeric values
- Allows to generate complex graphs on the fly
- Helps with quality control and outlier detection
- Allows plant scientists to ask new questions and query data easily
- Adaptable to other datasets (e.g. microscopy, germplasm bank,....)

Acknowledgements

- Zegami Team (Roger Noble, Samuel Conway)
- Salt research lab at King Abdullah University of Science and Technology - KAUST (Nadia al-Tamimi, Sonia Negrao, Mark Tester)
- The Plant Accelerator Team in particular George Sainsbury
- http://www.plantphenomics.org.au/projects/zegami/
- https://zegami.plantphenomics.org.au/#/







