

Version 2 ▾

Sep 28, 2022

Data Processing of Technologica Chlorophyll Fluorescence Imager Data for Photoprotection and NPQ Relaxation V.2

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ABSTRACT

Data Processing of [Technologica Chlorophyll Fluorescence Imager Data](#) for Photoprotection and NPQ Relaxation using Matlab and Microsoft Excel to generate graphs of NPQ over time.

To use R studio to collate Discreta.csv and MedianNPQ.csv and additional Matlab scripts to calculate coefficients representing NPQ relaxation parameters by fitting a bi-exponential function please refer to [Gotarkar, D., Doran, L., Burns, M., Hinkle, A., Kromdijk, J., Burgess, S. J. High-throughput Analysis of Non-Photochemical Quenching in Crops using Pulse Amplitude Modulated Chlorophyll Fluorometry. J. Vis. Exp. \(185\), e63485, doi:10.3791/63485 \(2022\)](#).

PROTOCOL CITATION

Lynn Doran 2022. Data Processing of Technologica Chlorophyll Fluorescence Imager Data for Photoprotection and NPQ Relaxation. **protocols.io**
<https://protocols.io/view/data-processing-of-technologica-chlorophyll-fluorescence-imager-data-for-photoprotection-and-npq-relaxation-cg8ftztn>

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MANUSCRIPT CITATION please remember to cite the following publication along with this protocol

Gotarkar, D., Doran, L., Burns, M., Hinkle, A., Kromdijk, J., Burgess, S. J. High-throughput Analysis of Non-Photochemical Quenching in Crops using Pulse Amplitude Modulated Chlorophyll Fluorometry. *J. Vis. Exp.* (185), e63485, doi:10.3791/63485 (2022).

KEYWORDS

Chlorophyll Fluorescence, CF Imaging, Technologica CF Imaging, Photoprotection, NPQ Relaxation, Non-Photochemical Quenching, Data, Data processing

LICENSE

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IMAGE ATTRIBUTION

Lynn Doran

CREATED

Sep 28, 2022

LAST MODIFIED

Sep 28, 2022

PROTOCOL INTEGER ID

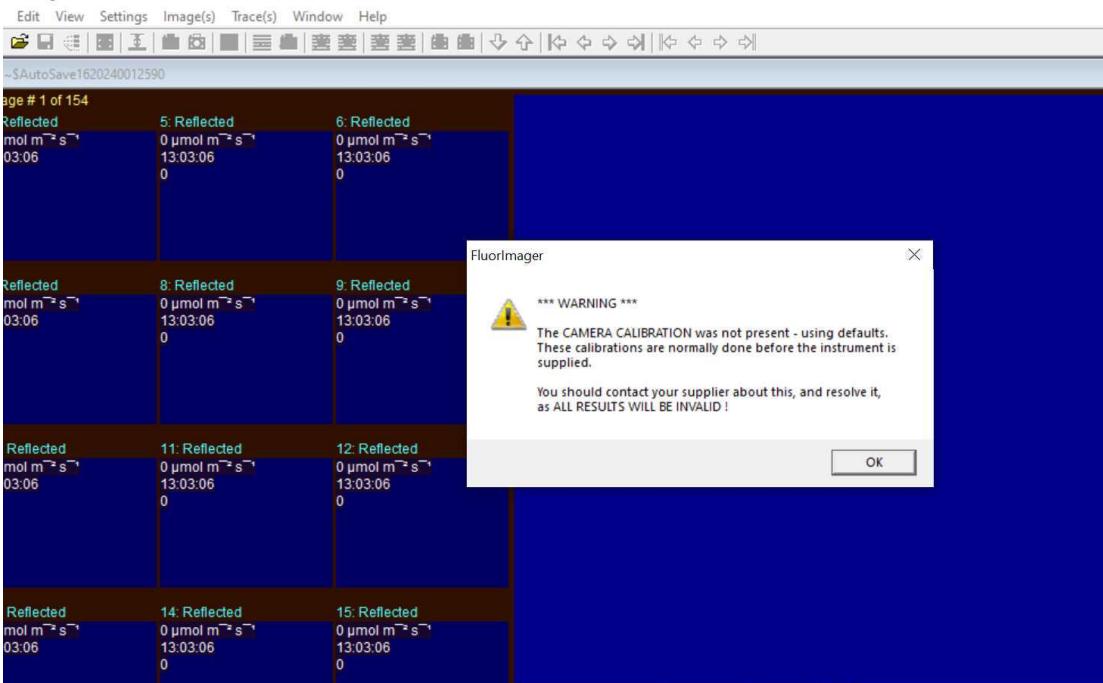
70631

BEFORE STARTING

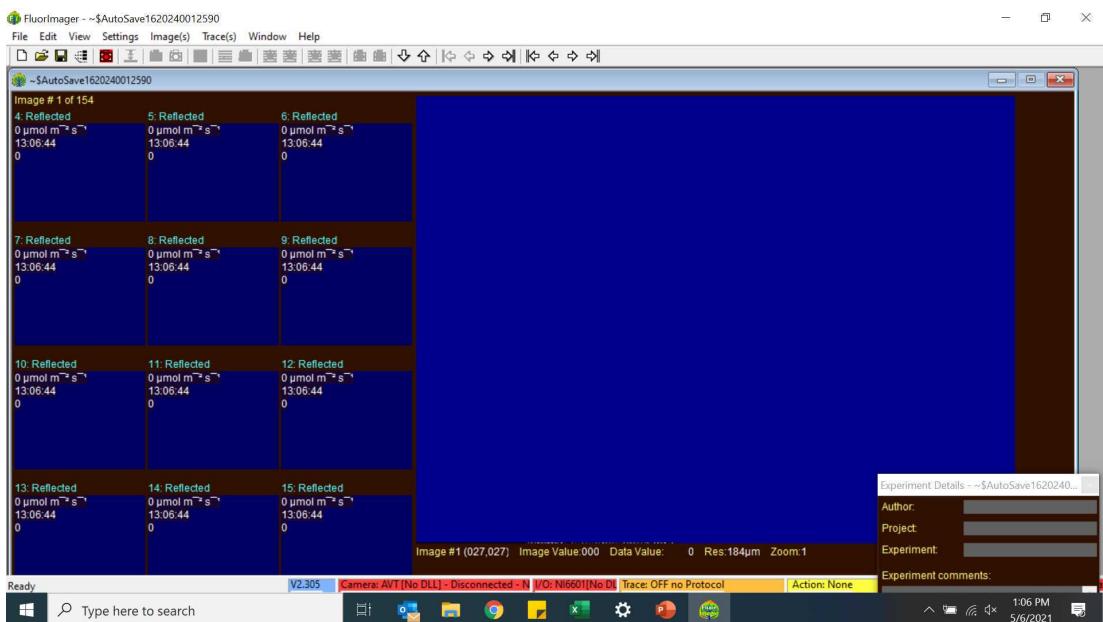
Download the following software:

- [Technologica FluorImager V2.305 Setup Lite](#)
- [!\[\]\(609f3372828e3526d7ce4ba9a1b5248e_img.jpg\) FluorImagerSetupLiteV2_305.exe](#)
- [MATLAB](#), if at UIUC download free from [UIUC Webstore](#).
- [Microsoft Excel](#), if at UIUC download free from [UIUC Webstore](#).

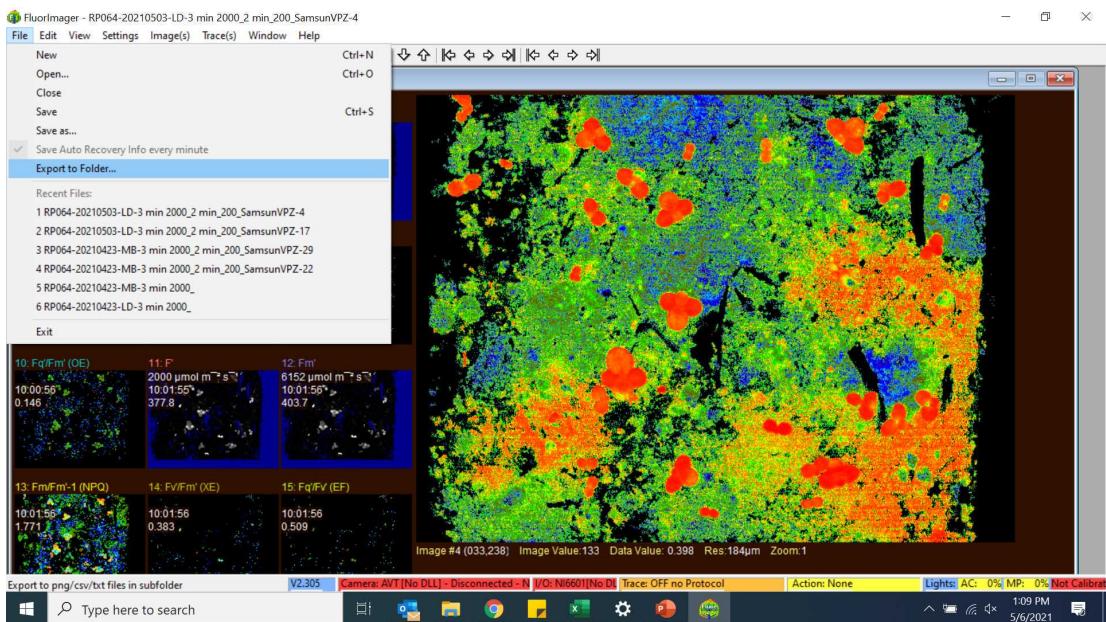
- 1 Open the .igr file generated from the CF Imager using the FluorImager software.
- 2 If you are using a computer removed from the instrumentation for data processing, click OK and ignore the warning about camera calibration. The camera is not necessary for data processing.



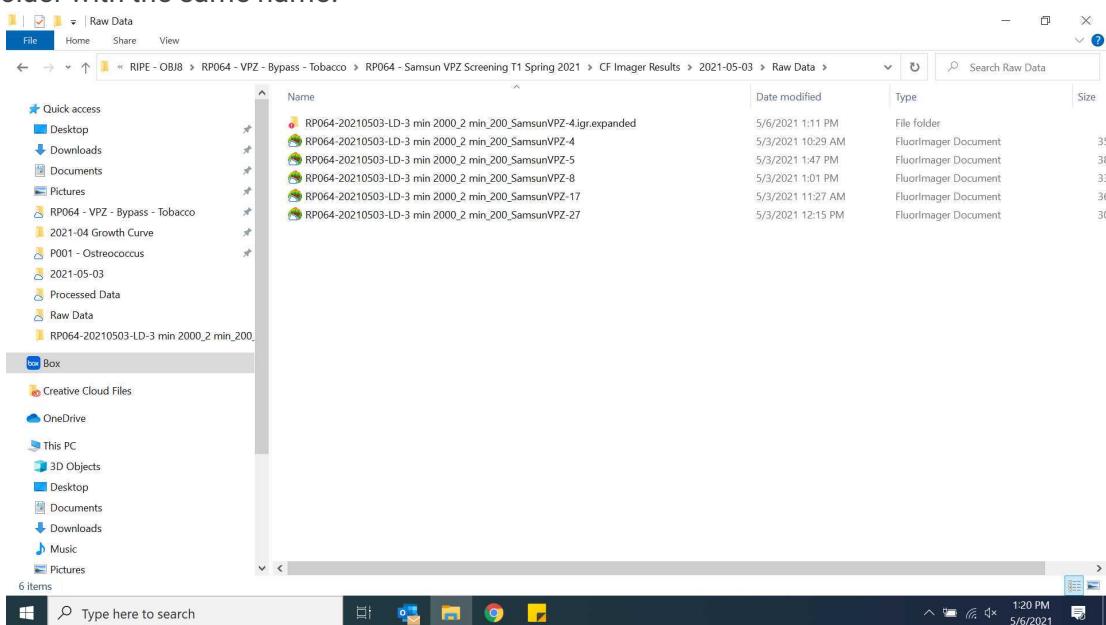
- 3 If initial screen that comes up, has "AutoSave" in the top name bar and all images are solid blue. Close this screen using the red X in the top right corner of the window.



- 4 The actual file should be open behind the AutoSave file. Export these files to a folder by clicking on "File" > "Export to Folder ...".



- 5 Return to the folder where the original .igr file was opened from. There should now be a new folder with the same name.



- 6 Copy the following three script files into the new folder.

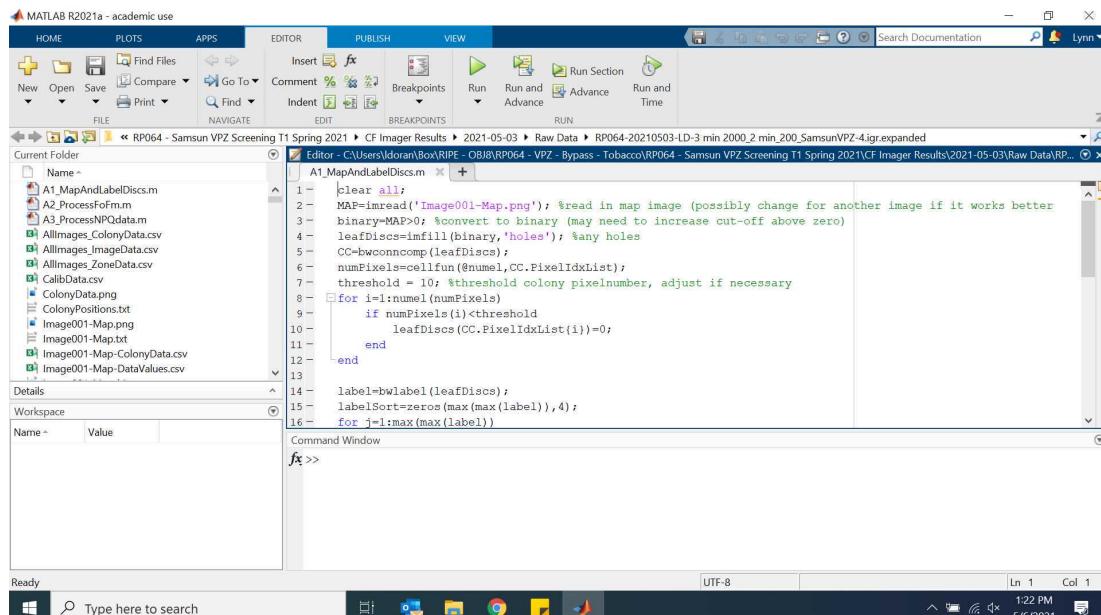
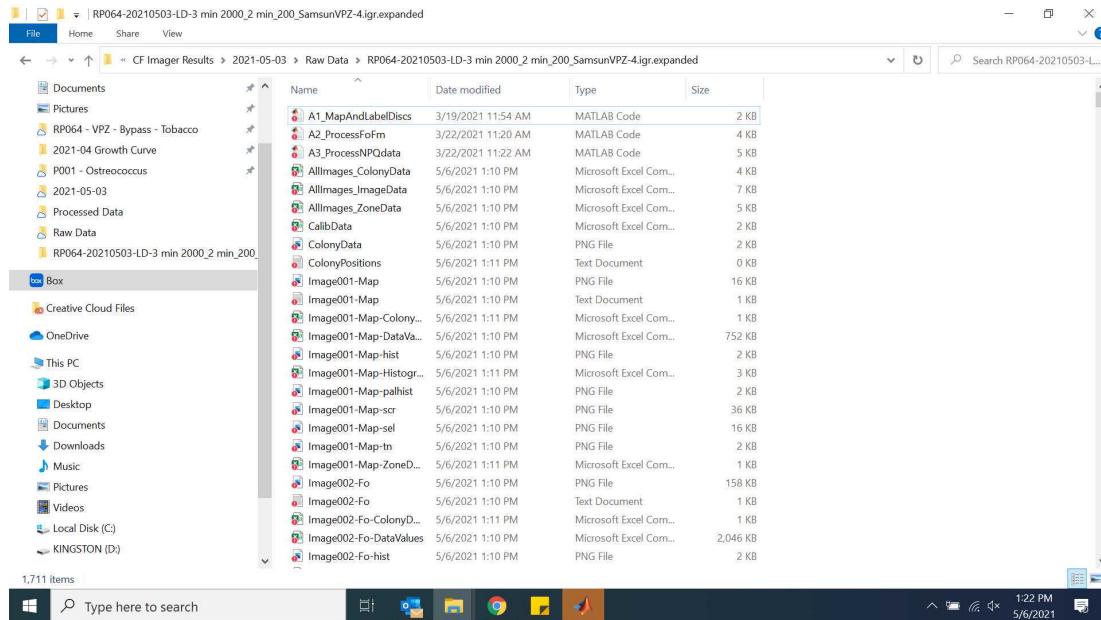
A1_MapAndLabelDiscs.m

A2_ProcessFoFm.m

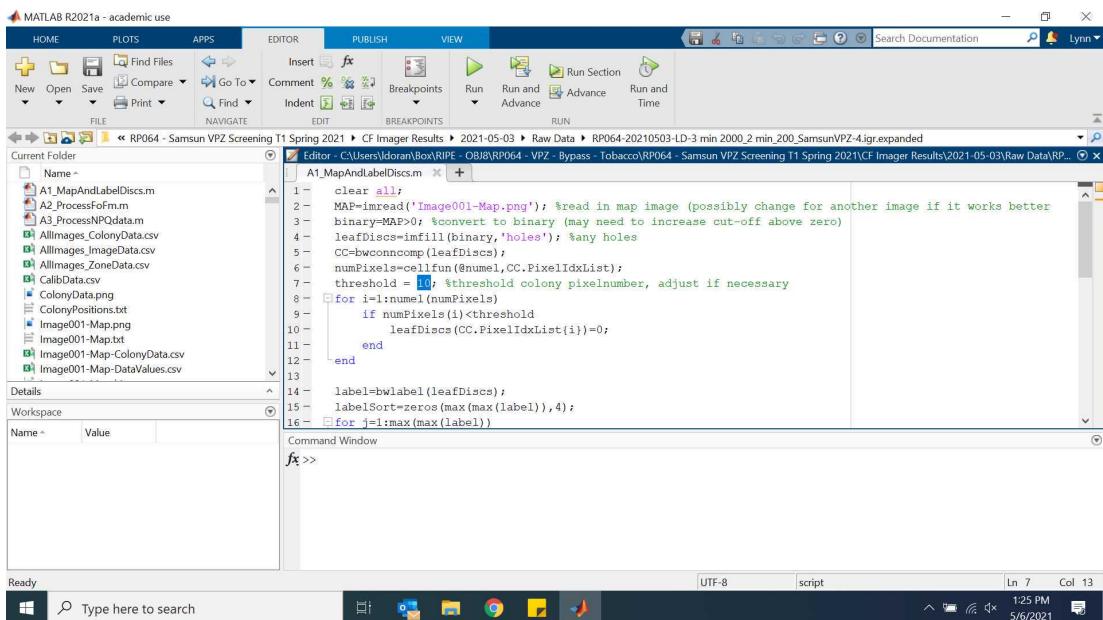
A3_ProcessNPQdata.m

*These files must be copied directly into each folder that you want to process.

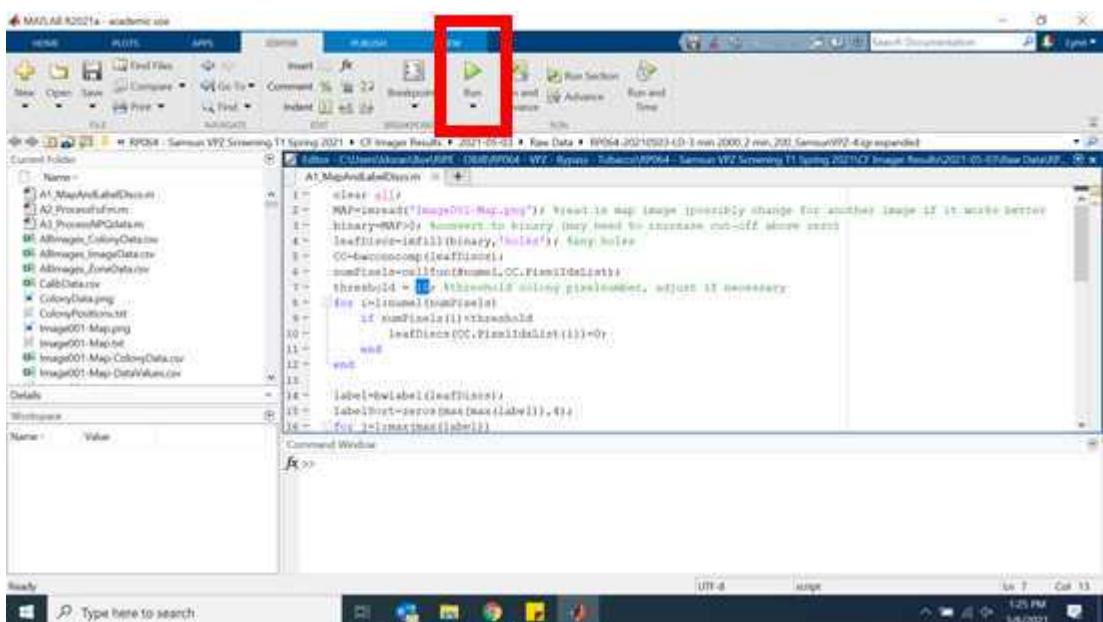
7 Open A1_MapAndLabelDiscs.m. This will open the first script in MATLAB.



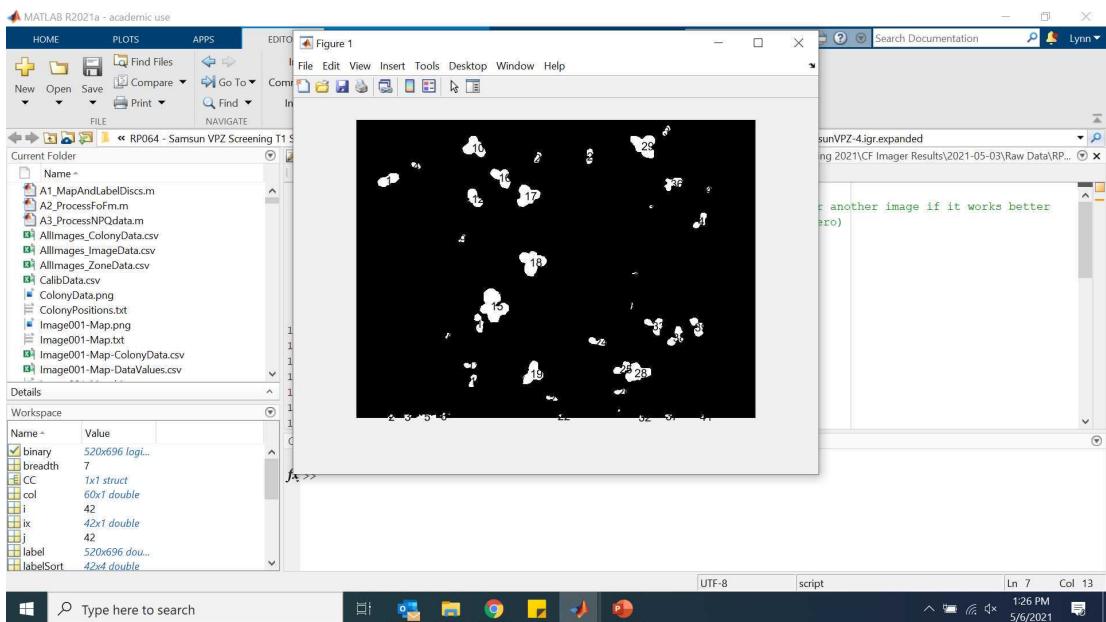
8 Adjust the threshold = #. The larger this number is made the more items from the original image that will be filtered out. The original value of 10 is sufficient if imagers were thoroughly isolated during CF Imaging. 100 is a good default number if some pixels remain outside the desired objects.



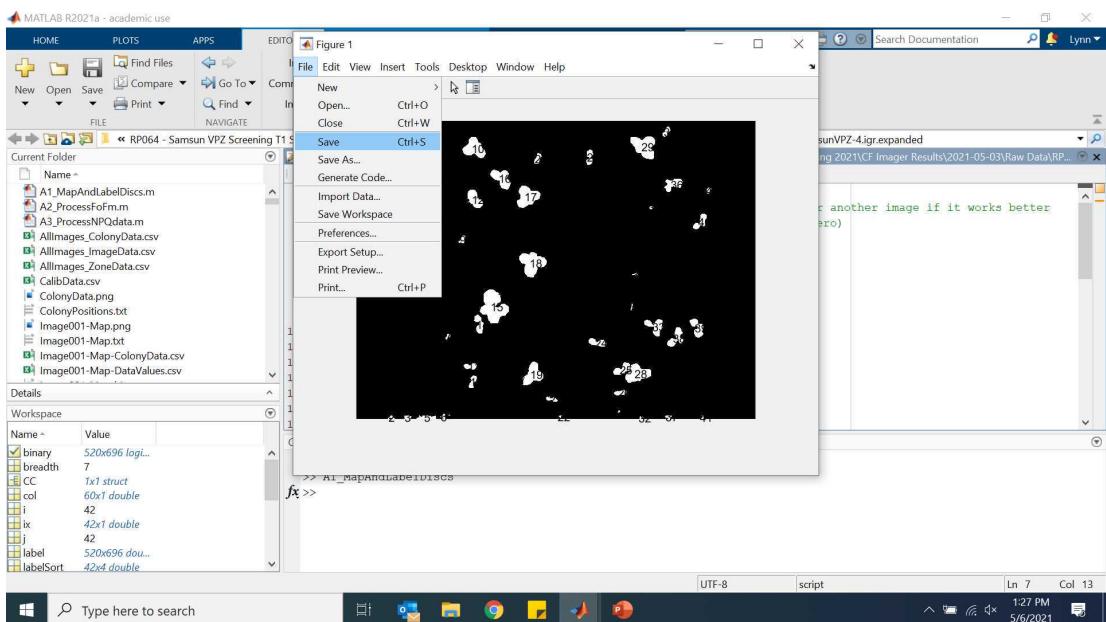
9 Press the green run arrow at the top.

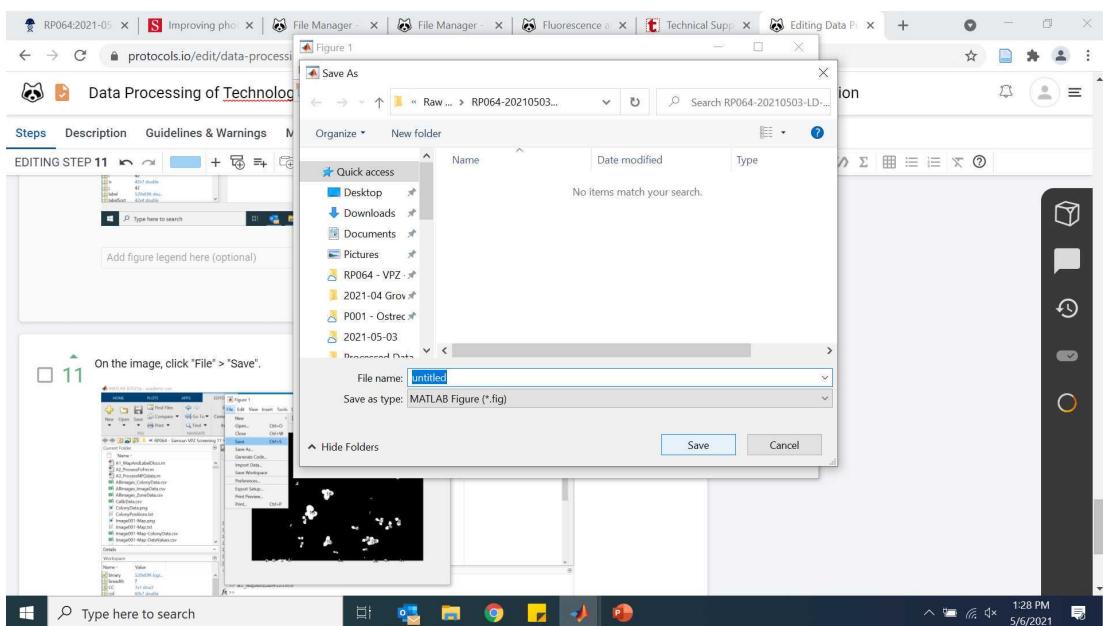


10 A black and white image will be generated that identifies and enumerates each object to be processed.

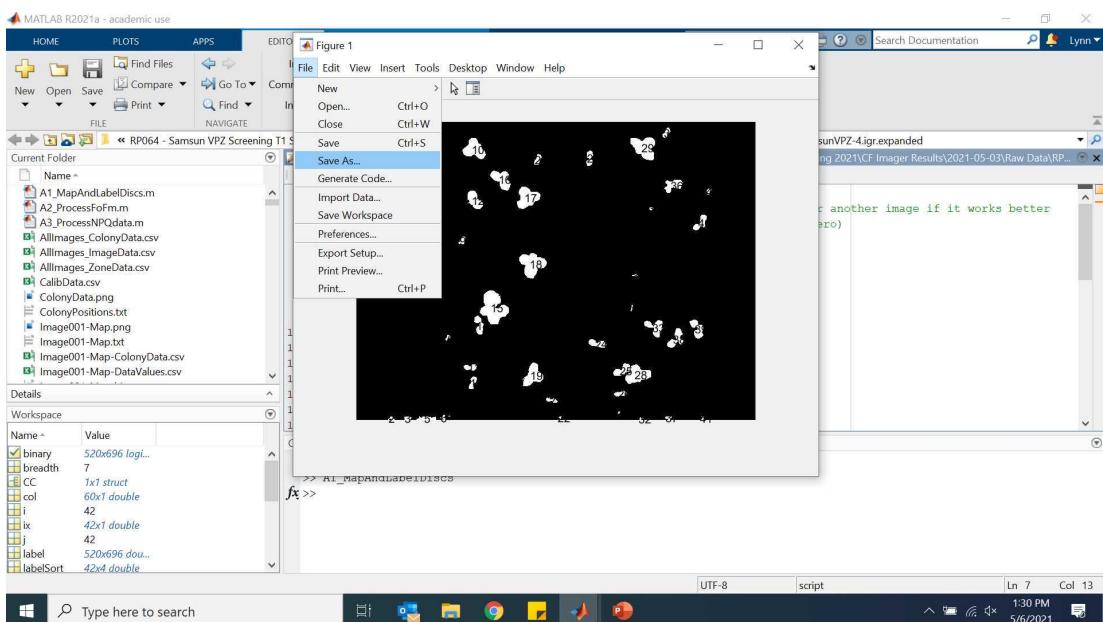


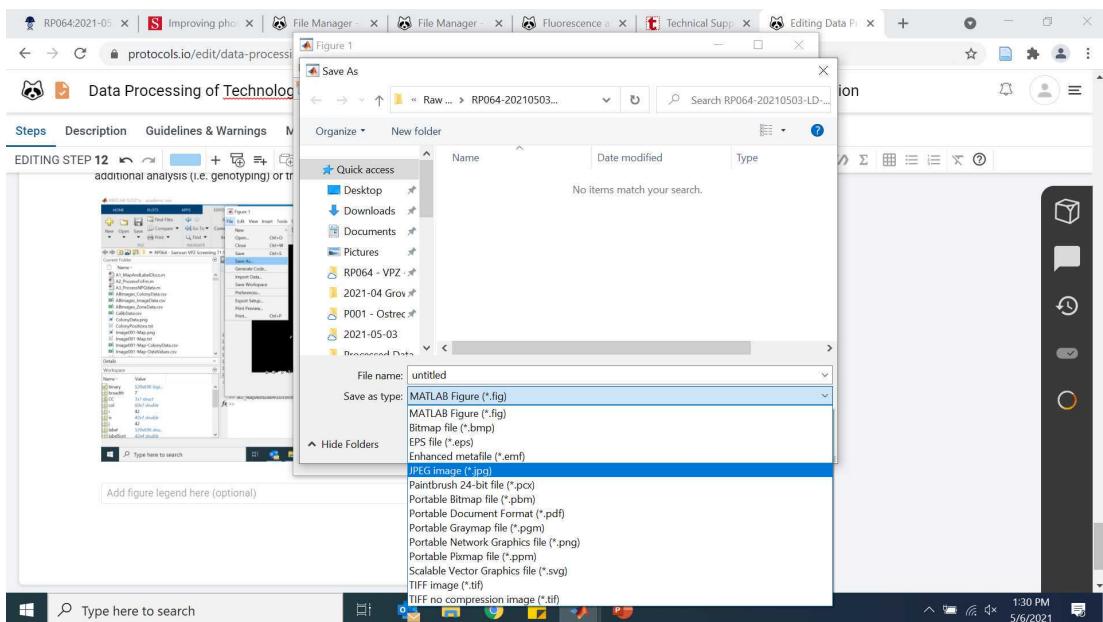
11 On the image, click "File" > "Save". Save the image as a .fig file in the current folder.



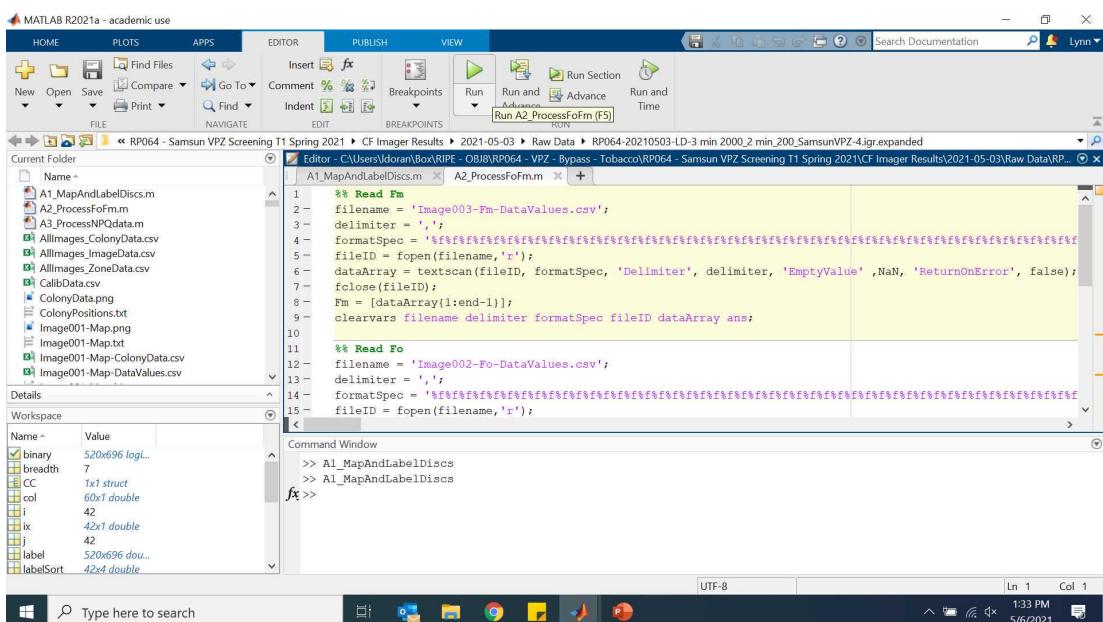


- 12 It is also advisable to "save as" a version of this image as a .jpeg. All processed data will be assigned to objects as identified. When screening seedlings, saving this image as a .jpeg allows you to select individual seedlings for additional analysis (i.e. genotyping) or transplanting.

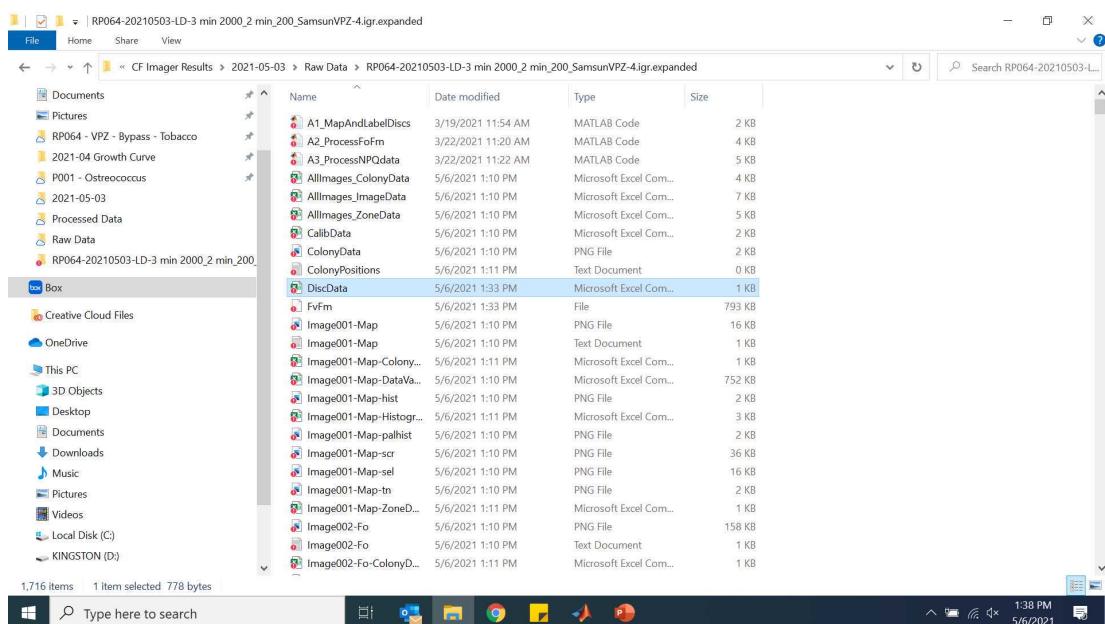
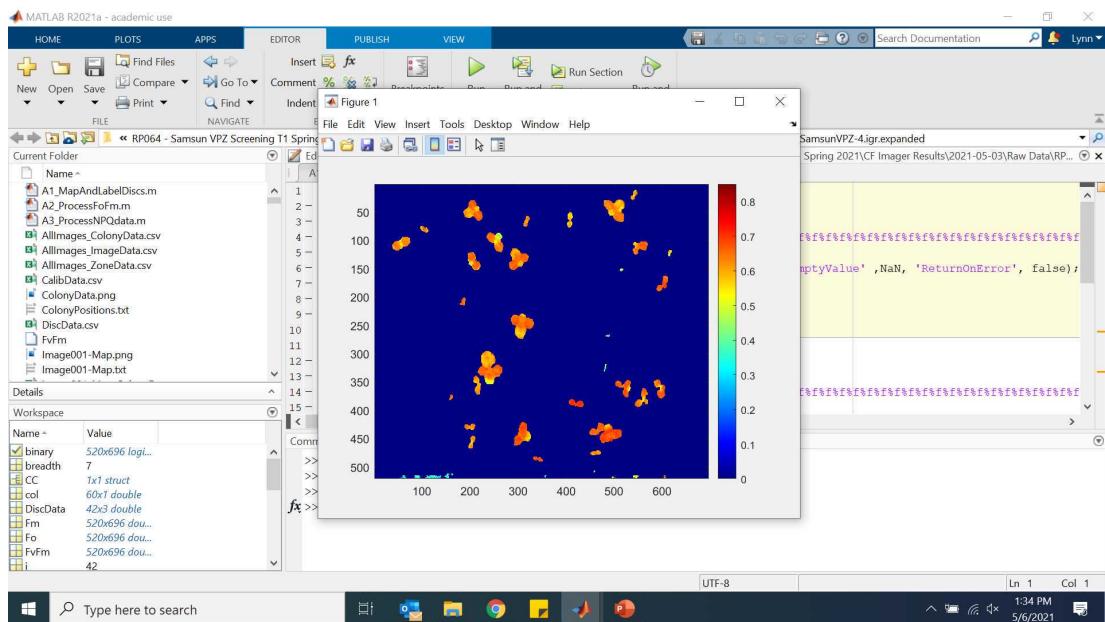




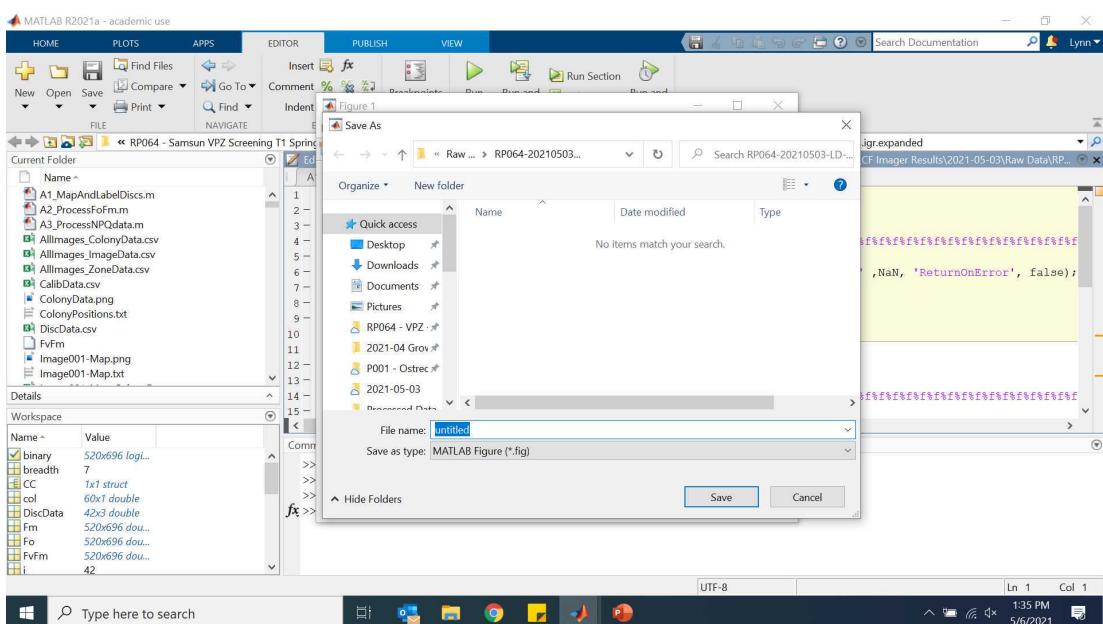
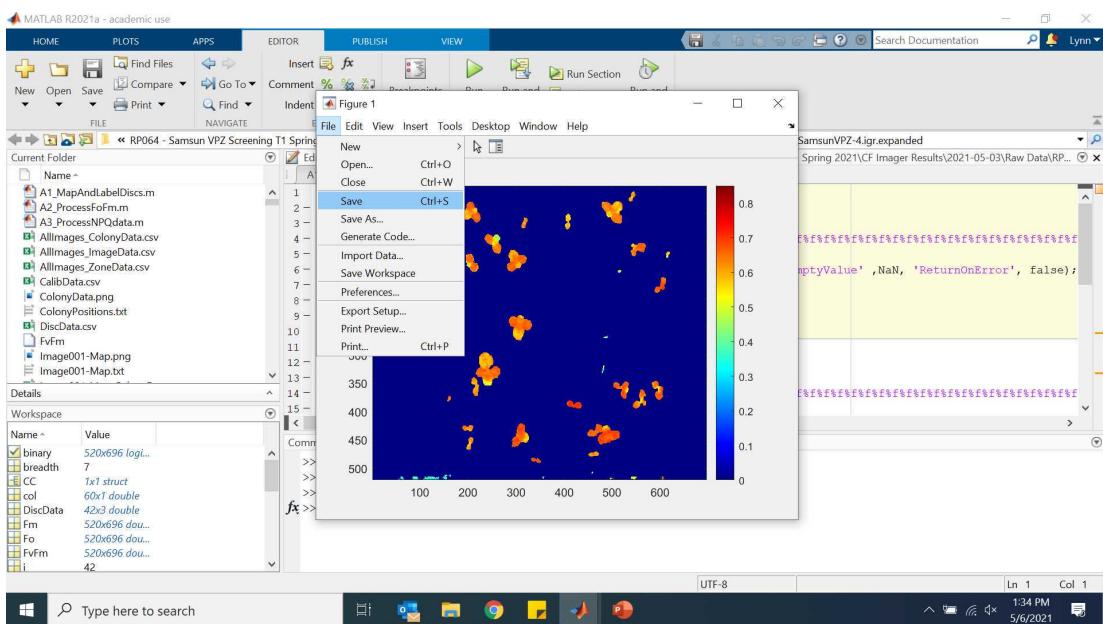
- 13 Return to the sample folder. Open A2_ProcessFoFm. This will open the second script in MATLAB. Click the green arrow at the top to run the A2_ProcessFoFm Script.



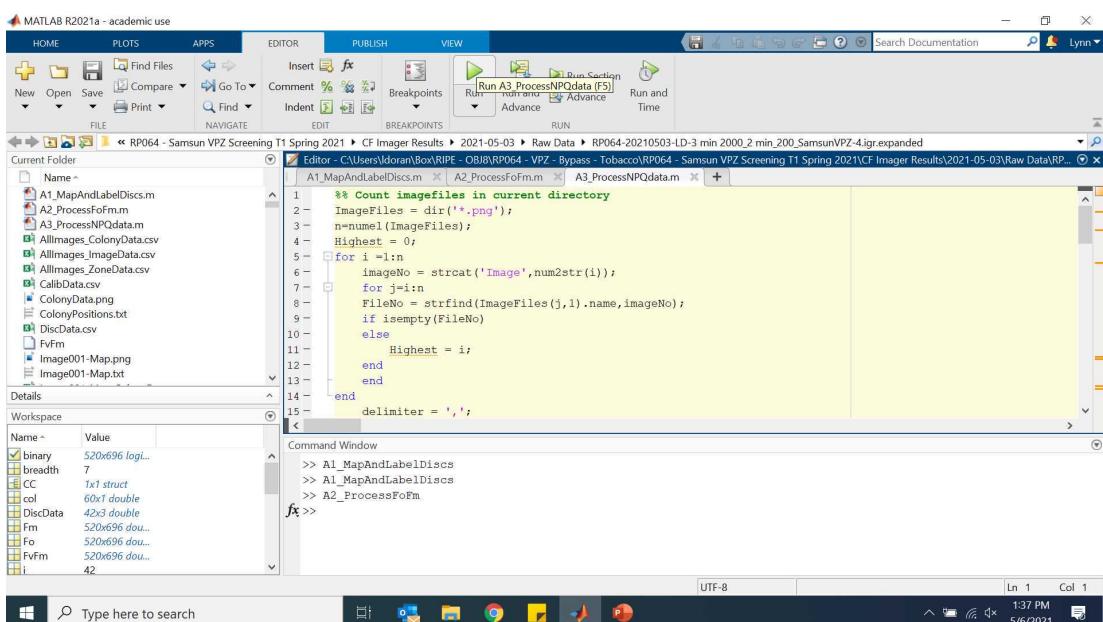
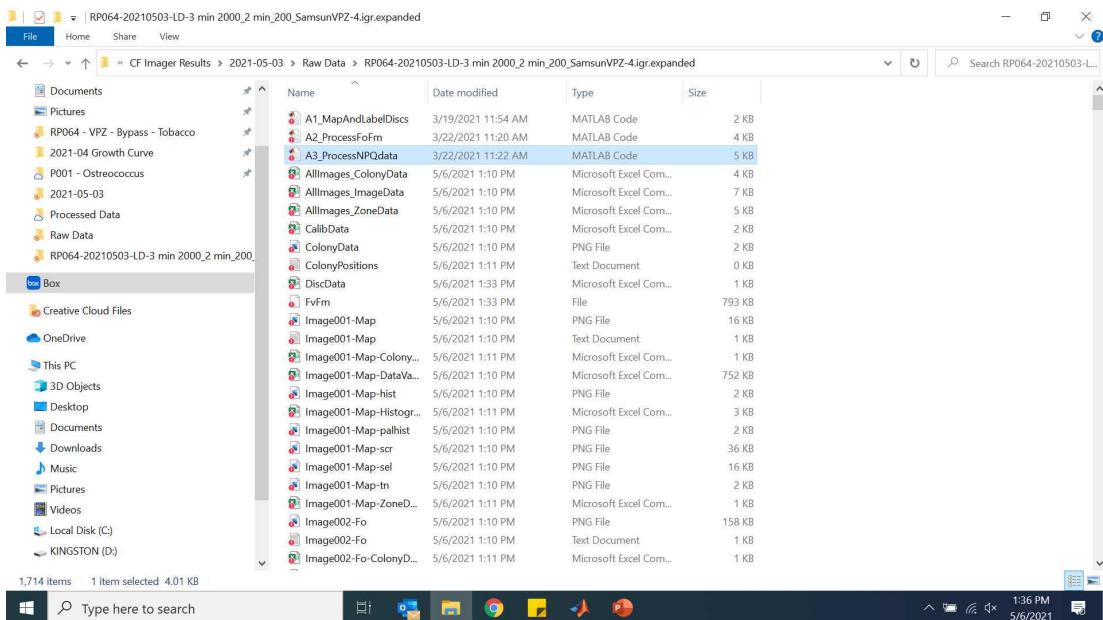
- 14 A heat map of your identified objects will be generated and Fv/Fm data will automatically be exported to an Excel sheet named "DiscData" in the sample folder.

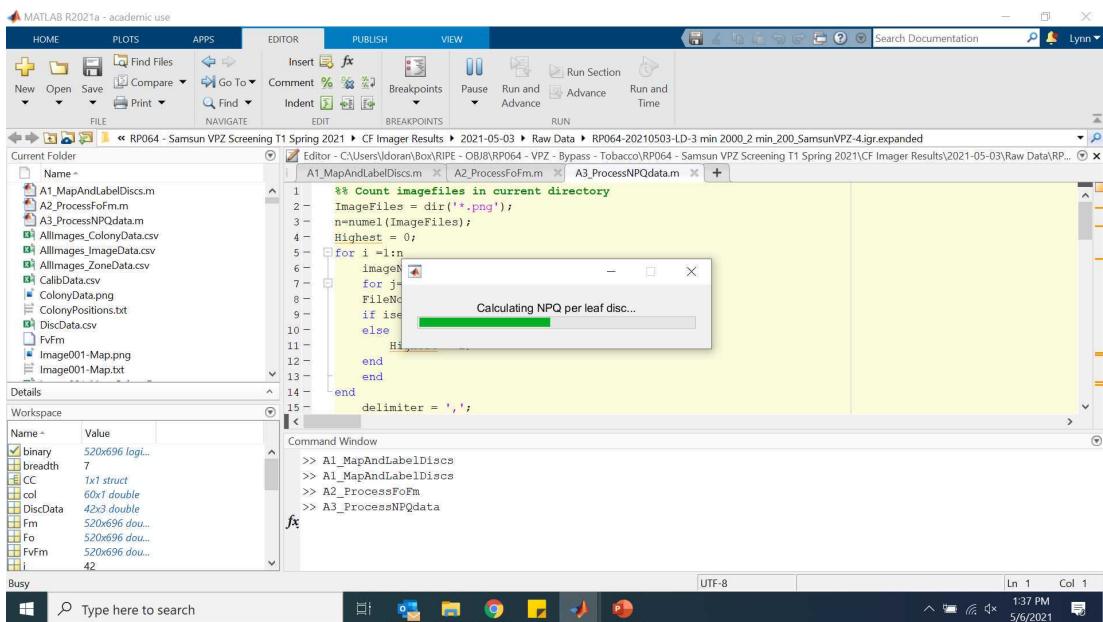


15 Click "File" > "Save". Save the image as a .fig file in the same folder.

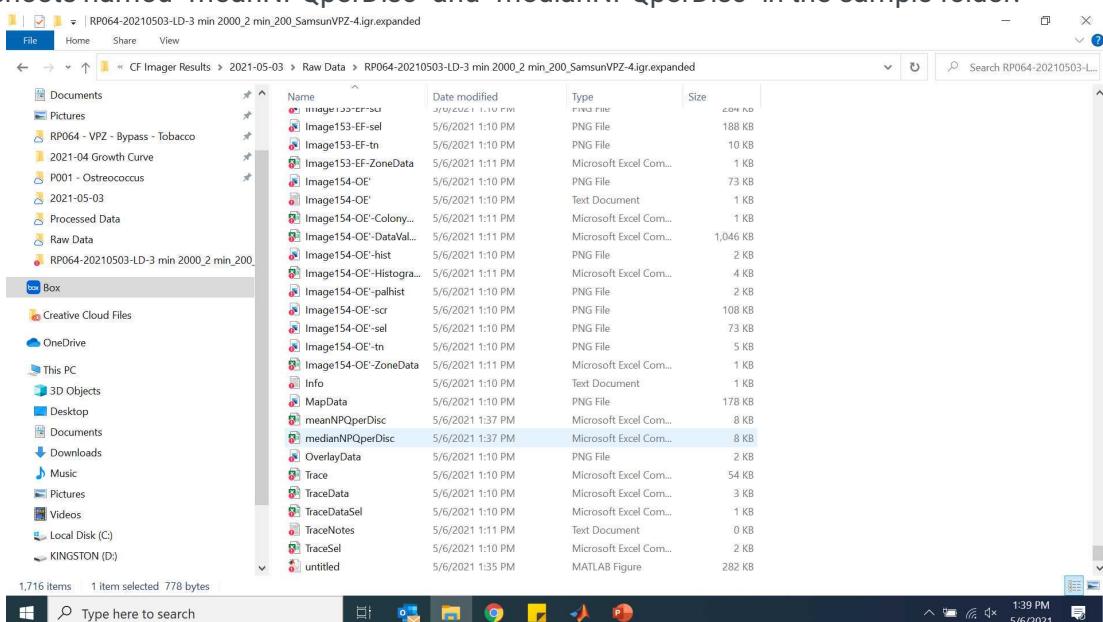


- 16 Return to the sample folder. Open A3_ProcessNPQdata. This will open the third script in MATLAB. Click the green arrow at the top to run the A3_ProcessNPQdata.





- 17 When the green status bar is complete, data will automatically be exported to two Excel sheets named "meanNPQperDisc" and "medianNPQperDisc" in the sample folder.



- 18 Open "DiscData" from step 14 in Excel. Insert a row above row 1. Add the header "Plant/Sample" to column A, "Mean Fv/Fm" to column B, and "Median Fv/Fm" to column C. Save the file.

Plant	Mean Fv/Fm	Median Fv/Fm
1	0.61539	0.6238
2	0.35766	0.36436
3	0.60873	0.61387
4	0.3474	0.35077
5	0.32142	0.30104
6	0.6485	0.65057
7	0.35169	0.36436
8	0.32473	0.30104
9	0.65195	0.65353
10	0.63185	0.63804
11	0.62515	0.6461
12	0.62383	0.62664
13	0.60778	0.61576
14	0.60978	0.60824
15	0.61968	0.62916
16	0.60227	0.6305
17	0.63616	0.64243
18	0.61647	0.61915
19	0.63246	0.64255
20	0.65165	0.6645
21	0.67089	0.67164

Plant	Mean Fv/Fm	Median Fv/Fm
1	0.61539	0.6238
2	0.35766	0.36436
3	0.60873	0.61387
4	0.3474	0.35077
5	0.32142	0.30104
6	0.6485	0.65057
7	0.35169	0.36436
8	0.32473	0.30104
9	0.65195	0.65353
10	0.63185	0.63804
11	0.62515	0.6461
12	0.62383	0.62664
13	0.60778	0.61576
14	0.60978	0.60824
15	0.61968	0.62916
16	0.60227	0.6305
17	0.63616	0.64243
18	0.61647	0.61915
19	0.63246	0.64255
20	0.65165	0.6645

- 19 Open either "meanNPQperDisc" and "medianNPQperDisc", whichever is the desired data set, from step 17 in Excel.

*We typically use the "medianNPQperDisc" file for AgSynBio Lab.

Insert a row above row 1. The header represents time points. Start A1 with 0 and continue sequentially across the row.

20 Return to the file "DiscData". Copy columns A through C.

Plant	Mean Fv/Fm	Median
1	0.61539	
2	0.35766	
3	0.60873	
4	0.3474	
5	0.32142	
6	0.6485	
7	0.35169	
8	0.32473	
9	0.65195	
10	0.63185	
11	0.62515	
12	0.62383	
13	0.60778	
14	0.60978	
15	0.61968	
16	0.60227	
17	0.63616	
18	0.61647	0.61915
19	0.63246	0.64255
20	0.65165	0.6645
21		

- 21 Return to file "medianNPQperDisc". Insert columns A-C copied from "DiscData" into "medianNPQperDisc" before column A.

Plant	Mean Fv/Fm	Median	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	
1	0.61539	0.61915	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18				
2	0.35766	0.6645	465	0.89536	0.66646	2.6664	2.8005	2.8328	0.73098	0.61616	2.9024	3.0009	3.0019	0.75017	0.643	3.0921						
3	0.60873		1666	0.5	0.33328	1.2498	1.4002	0.5	0.42761	1.2498	1.4002	0.60003	0.50003	1.4002	1.2498	1.4982	0					
4	0.3474		1912	0.44036	0.33634	1.1056	1.3011	1.364	0.43745	0.36837	1.3	1.4663	1.4743	0.44427	0.375	1.4002	1.5	1.5	0			
5	0.32142		1666	0.50006	0.44375	1.3665	1.4141	1.4982	0.50094	0.50006	1.5	1.4982	1.5989	0.66562	0.60038	1.5495	1.4991	1.5989	0			
6	0.6485		2	5.70791	0.24927	0.99887	0.99946	1.1656	0.24927	0.20075	0.99887	0.9977	1.1656	0.25	0.24927	1	1	1.1428	0			
7	0.35169		929	1.3609	1.435	2.5007	2.6664	2.7737	1.6109	1.618	2.9568	3.0832	3.1829	1.6779	1.7273	3.1829	3.2613	3.2857				
8	0.32473		749	0.33328	0.11042	0.66562	0.80011	0.99887	0.14276	0.1250	0.83281	0.83281	0.99887	0.22188	0.14276	0.99887	0.83281	0.99887	0			
9	0.65195		2	0.26746	0.055208	0.66562	0.66562	0.80011	0.1339	0.12504	0.80011	0.80011	0.19601	0.11339	0.80011	0.99887	0.99887	0				
10	0.63185		4004	0.83081	0.75007	1.9503	2.25	2.4418	0.93231	0.85714	2.471	2.6664	2.7588	0.98316	0.95097	2.8222	2.843	2.9164				
11	0.62515		558	1.5654	1.2883	3.25	3.3577	3.439	1.143	0.91372	3.4164	3.4662	3.471	0.94224	0.77218	3.5018	3.4662	3.4293	0			
12	0.62383		714	2.3624	1.9473	3.5891	3.6984	3.8142	1.5455	1.2275	3.7219	3.8142	3.8328	1.1538	0.91778	3.7186	3.7219	3.7219	0			
13	0.60778		893	2.3169	1.8078	3.5331	3.572	3.6176	1.286	1	3.3331	3.2867	3.2515	0.88888	0.71778	3.2361	3.0723	3.0006	0			
14	0.60978		1061	2.2502	1.7633	3.8924	4.0003	4.0596	1.133	0.91153	4.0552	4.1667	4.2521	1.0002	0.81999	4.1893	4.2361	4.2361	0			
15	0.61968		1662	3.3763	3.1109	4.144	4.2867	4.3583	2.7907	2.3333	4.3102	4.3583	4.3867	2.0436	1.6554	4.2	4.144	4.0794				
16	0.60227		501	3	2.8504	3.8662	4.144	4.2867	3.1771	2.8645	4.3102	4.4164	4.5	2.7004	2.2776	4.3328	4.3867	4.3867				
17	0.63616		422	1.0951	0.95129	2.9136	3.1003	3.2361	1.0813	1	3.3885	3.4443	3.5276	1.1003	1	3.5552	3.5805	3.6109				
18	0.61647		632	2.2914	2.0331	3.5805	3.7776	3.8485	1.5832	1.2331	3.7502	3.7776	3.7616	1.0625	0.86094	3.6667	3.6856	3.6377	0			
19	0.63246		24009	5.2139	5.3276	1.9354	1.5264	3.4748	3.6893	3.8495	1.2119	0.94313	3.824	3.939	3.9997	0.91409	0.73004	3.8831	3.9721	4.0006	0	
20	0.65165		2.2	3.0099	3.4225	2.5829	3.3268	3.6662	3.9207	4.0018	2.0872	1.6145	3.8333	3.8963	3.8963	1.3124	1.0245	3.7004	3.725	3.7143	0	
21	0.6645		0	2.213	3.0552	3.5018	2.3169	1.8406	3.572	3.6662	3.6437	1.2189	0.90258	3.5331	3.5331	3.4632	0.89204	0.72725	3.5018	3.4662	3.3763	0
			0	5.2201	5.3277	1.9354	1.5264	3.4748	3.6893	3.8495	1.2119	0.94313	3.824	3.939	3.9997	0.91409	0.73004	3.8831	3.9721	4.0006	0	
			0	5.2201	5.3277	1.9354	1.5264	3.4748	3.6893	3.8495	1.2119	0.94313	3.824	3.939	3.9997	0.91409	0.73004	3.8831	3.9721	4.0006	0	
			0	5.2201	5.3277	1.9354	1.5264	3.4748	3.6893	3.8495	1.2119	0.94313	3.824	3.939	3.9997	0.91409	0.73004	3.8831	3.9721	4.0006	0	
			0	5.2201	5.3277	1.9354	1.5264	3.4748	3.6893	3.8495	1.2119	0.94313	3.824	3.939	3.9997	0.91409	0.73004	3.8831	3.9721	4.0006	0	
			0	5.2201	5.3277	1.9354	1.5264	3.4748	3.6893	3.8495	1.2119	0.94313	3.824	3.939	3.9997	0.91409	0.73004	3.8831	3.9721	4.0006	0	
			0	5.2201	5.3277	1.9354	1.5264	3.4748	3.6893	3.8495	1.2119	0.94313	3.824	3.939	3.9997	0.91409	0.73004	3.8831	3.9721	4.0006	0	
			0	5.2201	5.3277	1.9354	1.5264	3.4748	3.6893	3.8495	1.2119	0.94313	3.824	3.939	3.9997	0.91409	0.73004	3.8831	3.9721	4.0006	0	
			0	5.2201	5.3277	1.9354	1.5264	3.4748	3.6893	3.8495	1.2119	0.94313	3.824	3.939	3.9997	0.91409	0.73004	3.8831	3.9721	4.0006	0	
			0	5.2201	5.3277	1.9354	1.5264	3.4748	3.6893	3.8495	1.2119	0.94313	3.824	3.939	3.9997	0.91409	0.73004	3.8831	3.9721	4.0006	0	
			0	5.2201	5.3277	1.9354	1.5264	3.4748	3.6893	3.8495	1.2119	0.94313	3.824	3.939	3.9997	0.91409	0.73004	3.8831	3.9721	4.0006	0	
			0	5.2201	5.3277	1.9354	1.5264	3.4748	3.6893	3.8495	1.2119	0.94313	3.824	3.939	3.9997	0.91409	0.73004	3.8831	3.9721	4.0006	0	
			0	5.2201	5.3277	1.9354	1.5264	3.4748	3.6893	3.8495	1.2119	0.94313	3.824	3.939	3.9997	0.91409	0.73004	3.8831	3.9721	4.0006	0	
			0	5.2201	5.3277	1.9354	1.5264	3.4748	3.6893	3.8495	1.2119	0.94313	3.824	3.939	3.9997	0.91409	0.73004	3.8831	3.9721	4.0006	0	
			0	5.2201	5.3277	1.9354	1.5264	3.4748	3.6893	3.8495	1.2119	0.94313	3.824	3.939	3.9997	0.91409	0.73004	3.8831	3.9721	4.0006	0	
			0	5.2201	5.3277	1.9354	1.5264	3.4748	3.6893	3.8495	1.2119	0.94313	3.824	3.939	3.9997	0.91409	0.73004	3.8831	3.9721	4.0006	0	
			0	5.2201	5.3277	1.9354	1.5264	3.4748	3.6893	3.8495	1.2119	0.94313	3.824	3.939	3.9997	0.91409	0.73004	3.8831	3.9721	4.0006	0	
			0	5.2201	5.3277	1.9354	1.5264	3.4748	3.6893	3.8495	1.2119	0.94313	3.824	3.939	3.9997	0.91409	0.73004	3.8831	3.9721	4.0006	0	
			0	5.2201	5.3277	1.9354	1.5264	3.4748	3.6893	3.8495	1.2119	0.94313	3.824	3.939	3.9997	0.91409	0.73004	3.8831	3.9721	4.0006	0	
			0	5.2201	5.3277	1.9354	1.5264	3.4748	3.6893	3.8495	1.2119	0.94313	3.824	3.939	3.9997	0.91409	0.73004	3.8831	3.9721	4.0006	0	
			0	5.2201	5.3277	1.9354	1.5264	3.4748	3.6893	3.8495	1.2119	0.94313	3.824	3.939	3.9997	0.91409	0.73004	3.8831	3.9721	4.0006	0	
			0	5.2201	5.3277	1.9354	1.5264	3.4748	3.6893	3.8495	1.2119	0.94313	3.824	3.939	3.9997	0.91409	0.73004	3.8831	3.9721	4.0006	0	
			0	5.2201	5.3277	1.9354	1.5264	3.4748	3.6893	3.8495	1.2119	0.94313	3.824	3.939	3.9997	0.91409	0.73004	3.8831	3.9721	4.0006	0	
			0	5.2201	5.3277	1.9354	1.5264	3.4748	3.6893	3.8495	1.2119	0.94313	3.824	3.939	3.9997	0.91409	0.73004	3.8831	3.9721	4.0006	0	
			0	5.2201	5.3277	1.9354	1.5264	3.4748	3.6893	3.8495	1.2119	0.94313	3.824	3.939	3.9997	0.91409	0.73004	3.8831	3.9721	4.0006	0	
			0	5.2201	5.3277	1.9																

- 23 Evaluate Median Fv/Fm values for plant stress. A properly adapted, healthy plant should give a Fv/Fm value of ~0.8. This has been shown to be highly stable between species. Significant deviation from this (e.g. <0.7) either suggests incomplete dark adaptation prior to imaging or stressed plant material.

Stressed plants with poor Median Fv/Fm

A1

		Fv/Fm	Plant	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16		
1	1	0.75624		0	1.1381	1.7395	2.1902	0.97214	0.82634	2.7066	2.765	2.7831	1	0.8888	2.8831	2.8645	2.8	0.94037	0.86094	2.8763	
2	2	0.74977		0	1.3246	2.2082	2.728	1.3636	1.1144	3.0506	3.1373	3.1667	1.1631	1.0682	3.2219	3.2504	3.2361	1	1.0752	1	3.2737
3	3	0.76177		0	1.109	1.6	1.9415	0.79141	0.63312	2.5397	2.4632	0.81458	0.69638	2.572	2.5003	2.4	0.75017	0.65226	2.5		
4	5	0.75845		0	1.1904	1.9415	2.4582	1.2063	1.0401	2.8807	2.9568	3.0006	1.1793	1.0638	3.1109	3.125	3.118	1.091	1.0228	3.2082	
5	6	0.76711		0	1	1.2505	1.4759	0.6831	0.61094	2.3763	2.4463	2.5397	1.1398	0.94899	2.75	2.7771	2.765	1.1851	1	2.8	
6	7	0.73038		0	1.1429	1.572	0.0004	0.78047	0.7	2.6503	2.8094	2.8959	1.0386	0.94856	3.0538	3.0663	3.0596	1.0808	1	3.1771	
7	8	0.75703		0	1.1788	1.9359	2.3935	1.1251	0.95679	2.8094	2.8763	2.9164	1.1204	1.022	3.0006	3	2.9582	1.0253	0.95679	3.0414	
8	9	0.74588		0	1.0444	1.6364	2.1111	0.95751	0.85733	2.6527	2.7616	2.841	1.0951	1.0195	2.9443	2.9564	2.9582	1.0407	0.97839	3.0389	
9	10	0.76038		0	1.0512	1.6331	2.154	1.0605	0.96262	2.7143	2.8003	2.8645	1.0909	1	2.9487	2.9503	2.9443	1.0254	0.95223	3	
10	11	0.75097		0	1.1109	1.6667	2.1331	0.97314	0.84104	2.6503	2.728	2.7737	1.0237	0.92682	2.8885	2.8504	0.97515	0.90014	2.9045		
11	12	0.75825		0	1.1514	1.7331	2.2177	1.0732	0.95542	2.8571	3	3.0552	2.2774	1.1024	3.1532	3.1771	3.2	1.1588	1.0772	3.2646	
12	13	0.74115		0	1.265	1.7827	2.2002	1.0627	0.85021	2.6006	2.6503	2.6503	0.97214	0.85722	2.7776	2.765	2.7219	0.91667	0.82941	2.8136	
13	14	0.75386		0	1.0327	1.4813	1.885	0.80494	0.973176	2.5714	2.7143	2.8094	1.0828	1	2.9503	3.0006	3.0006	1.0542	1	3.0552	
14	15	0.75033		0	0.93044	1.3238	1.8464	1.0003	0.94294	2.5714	2.7004	2.7907	1.1085	1.0314	2.8885	2.9045	2.9006	1.0833	1.0274	2.952	
15	16	0.76293		0	1.0552	1.5832	2.0005	0.73909	0.64727	2.6664	2.7331	2.7678	1	0.88588	2.9331	2.9331	2.8797	0.96656	0.88588	3	
16	17	0.76719		0	1.0772	1.4501	1.7219	0.70347	0.58076	2.4	2.4438	2.4994	1.0004	0.84638	2.6169	2.6437	2.6	1.0405	0.85733	2.6248	
17	18	0.75974		0	1.0327	1.5	1.9096	0.81594	0.72727	2.626	2.7219	2.7776	1.0003	0.89317	2.8885	2.925	2.8885	0.9582	0.87518	2.9331	
18	19	0.75417		0	1.1035	1.5388	1.9482	0.84209	0.70019	2.4759	2.5301	0.94294	0.84209	2.6006	2.5704	2.5301	0.90351	0.82856	2.5885		
19	20	0.75729		0	1.1433	1.731	2.1003	0.89513	0.78047	2.5885	2.6662	2.7066	1	0.90624	2.8478	2.824	2.8136	0.9716	0.89204	2.8885	
20	21	0.7626		0	1.0331	1.546	1.9482	0.90963	0.74229	2.6023	2.6662	2.7066	1	0.86656	2.8136	2.8136	2.8	0.929	0.82856	2.8478	

Healthy plants with good Median Fv/Fm

- 24 To graph, switch Fv/Fm to column A and Plant/Sample to column B. "Cut" column B, "insert cut cells" in front of column A. Highlight all cells with data, except for column A. Select "Insert", "Charts", "Scatter".

B1

		FvFr	Cut	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	1	0.		54	1.4663	1.5714	0.66656	0.56543	1.7863	1.9998	0.8	0.67756	2.25	2.364	2.4015	0.84998	0.7082	2.4284	
2	2	0.		182	1.6735	1.7908	0.75357	0.64186	1.8263	1.9594	2.0425	0.75012	0.70534	2.0005	2.1429	2.1903	0.78954	0.72626	2.1229
3	4	14.0		57	0.9824	1.1398	0.72584	0.68978	1.543	1.7807	2.0005	0.94843	0.85483	1.9682	2.118	2.2727	1.0189	0.91077	2.1771
5	6	0.		53	1.079	1.1624	0.74466	0.72985	1.6664	1.9132	2.1003	0.88588	0.83333	2.2945	2.4786	2.6006	0.9392	0.87812	2.6006
7	11	1.0		89	2.0573	2.3935	1.5122	1.2308	2.6899	2.9618	3.1373	1.2	1	3.0921	3.2857	3.3649	1.0888	0.93498	3.2663
8	10	0.		122	2.0987	2.4331	1.7895	1.5527	2.5519	2.8464	3.0400	1.5717	1.4148	3.1206	3.2914	3.429	1.4616	1.311	3.3333
9	7	0.		102	1.8391	2.1433	1.3599	1.2563	2.6666	3	3.2117	1.3659	1.2211	3.3081	3.4748	3.5639	1.3003	1.1526	3.5276
10	9	0.		101	2.046	2.345	1.5865	1.3429	2.5774	2.841	3.044	1.2222	1.0888	3.044	3.2379	3.3193	1.1708	1.0436	3.2117
11	3	0.		19	1.5593	1.7814	1	0.89368	2.1003	2.3481	2.5608	1.0933	0.95679	2.6407	2.8094	2.9136	1.091	0.95377	2.8885
12	5	0.		103	1.6187	1.8391	1.1164	1.0002	2.1433	2.4164	2.6091	1.0605	0.95679	2.6328	2.8193	2.9136	1.0002	0.89368	2.7776
13	8	0.		108	1.5714	1.8288	1.0416	0.97885	2.2694	2.5556	2.7777	1.1349	1.0225	2.8082	2.961	3.0936	1.1088	0.97898	3.0009
14	13	0.		167	1.8572	2.1942	1.3751	1.1666	2.4678	2.7508	2.9293	1.2128	1.0255	2.885	3.081	3.1745	1.0933	0.96066	3.0832
15	4	0.		97	2.22	2.5	1.6433	1.4332	2.6009	2.8371	3.0009	1.3013	1.1869	3.0009	3.1628	3.2776	1.2296	1.1151	3.1951
16	15	0.		44	1.3589	1.6208	1.0228	0.8957	2.2613	2.5714	2.8003	1.059	0.97214	2.9443	3.1429	3.2776	1.118	1.0228	3.2361

Screenshot of Microsoft Excel showing the 'Insert' tab selected. A context menu is open over cell A1, listing options like Cut, Copy, Paste Options, Paste Special, Insert Cut Cells, Delete, Clear Contents, Format Cells, Column Width..., Hide, and Unhide.

The main worksheet contains data from row 1 to 21. Row 1 has headers: Plant, 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16. Rows 2 through 21 contain numerical data corresponding to these columns.

Screenshot of Microsoft Excel showing the 'Home' tab selected. A context menu is open over cell AB16, listing options like General, Conditional Formatting, Format as Table, Sort & Filter, Select, Insert, Delete, Format Cells, and Cells.

The main worksheet contains data from row 1 to 21. Row 1 has headers: FvFn, Plant, 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16. Rows 2 through 21 contain numerical data corresponding to these columns.

AutoSave OFF

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AB16 : fx 1.0813

	A	B	C	D	E	F	G	H
1	VfFm	Plant	0	1	2	3	4	5
2	0.74034	1	0	1.1154	1.4663	1.5714	0.66656	0.56543
3	0.72262	2	0	1.2082	1.6735	1.7908	0.75357	0.64186
4	0.73872	14	0	0.7857	0.9824	1.1398	0.72584	0.68978
5	0.7183	6	0	0.94153	1.079	1.1624	0.74466	0.72985
6	0.74951	16	0	1.1111	1.4164	1.5714	0.82768	0.71992
7	0.73182	11	0	1.4189	2.0573	2.3935	1.5122	1.2308
8	0.73947	10	0	1.4422	2.0987	2.4331	1.7895	1.5527
9	0.72224	7	0	1.4002	1.8391	2.1433	1.3599	1.2563
10	0.72042	9	0	1.5001	2.046	2.345	1.5865	1.3429
11	0.72823	3	0	1.119	1.5593	1.7814	1	0.89368
12	0.73413	5	0	1.503	1.6187	1.8391	1.1164	1.0002
13	0.73576	8	0	1.1708	1.5714	1.8288	0.4016	0.97885
14	0.7421	13	0	1.2767	1.8572	2.1942	1.3751	1.1666
15	0.70192	4	0	1.6397	2.22	2.5	1.6433	1.4332
16	0.73252	15	0	1.1144	1.3589	1.6208	1.0228	0.8957
17								
18								
19								
20								
21								

Summary 20210423-VPZ-7 20210423-VPZ-9 20210423-VPZ-13 20210423-VPZ-15 2021C ... +

Average: 2.76059652 Count: 432 Sum: 1189.8171

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File Home Insert Page Layout Formulas Data Review View Help Acrobat Chart Design Format

Add Chart Quick Element Layout Change Colors Chart Styles

Chart Design

Chart 6

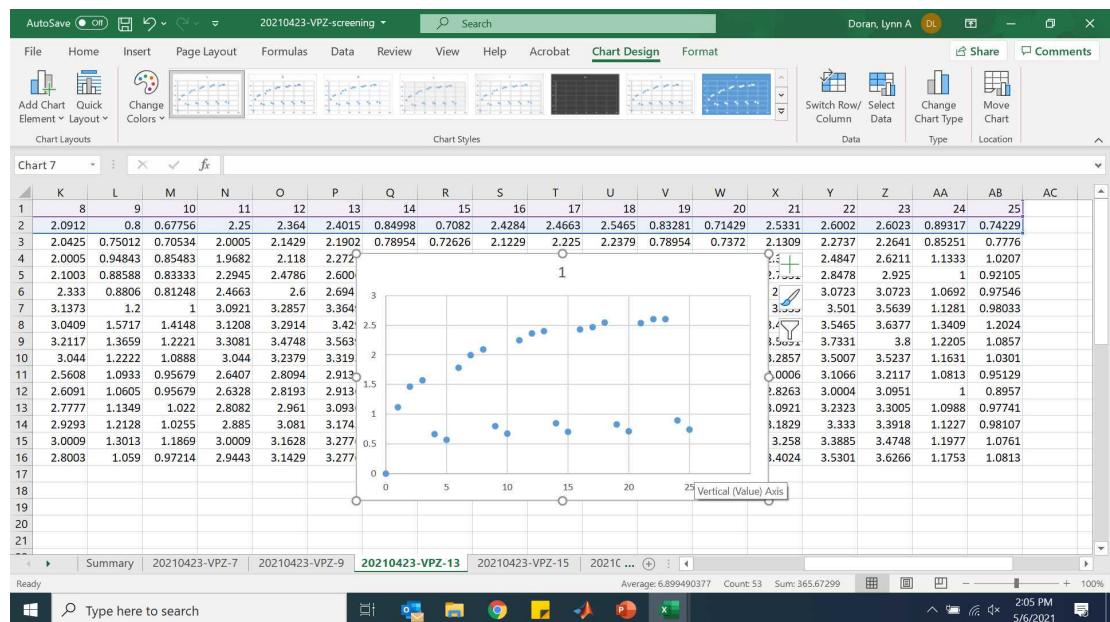
	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC
1	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	
2	2.0912	0.8	0.67756	2.25	2.364	2.4015	0.84998	0.7082	2.4284	2.4663	2.5465	0.82381	0.71429	2.5331	2.6002	2.6023	0.89317	0.74229	
3	2.0425	0.75012	0.70534	2.0005	2.1429	2.1902	0.78954	0.72626	2.1229	2.225	2.2379	0.78954	0.7372	2.1309	2.2737	2.2641	0.85251	0.7776	
4	2.0005	0.94843	0.85483	1.9682	2.118	2.272								3	2.4847	2.6211	1.1333	1.0207	
5	2.1003	0.88588	0.83333	2.2945	2.4786	2.600								7	2.8478	2.925	1	0.92105	
6	2.333	0.8806	0.81248	2.4663	2.6	2.694								2	3.0723	3.0723	1.0692	0.97546	
7	3.1373	1.2	1	3.0921	3.2857	3.364								3	3.5021	3.5639	1.1281	0.98033	
8	3.0409	1.5717	1.4148	3.1208	3.2914	3.42								4	3.5465	3.6377	1.3409	1.2024	
9	3.2117	1.3659	1.2221	3.3081	3.4748	3.563								5	3.7331	3.8	1.2205	1.0857	
10	3.044	1.2222	1.0888	3.044	3.2379	3.319								6	2.8507	3.5237	1.1631	1.0301	
11	2.5608	1.0933	0.95679	2.6407	2.8094	2.913								7	3.1063	3.2117	1.0813	0.95129	
12	2.6091	1.0605	0.95679	2.6328	2.8193	2.915								8	3.0008	3.0951	1	0.8957	
13	2.7777	1.1349	1.022	2.8082	2.961	3.093								9	3.2323	3.3005	1.0988	0.97741	
14	2.9293	1.2128	1.0255	2.885	3.081	3.174								10	3.1829	3.333	3.3918	1.1227	0.98107
15	3.0009	1.3013	1.1869	3.0009	3.1628	3.277								11	3.258	3.3885	3.4748	1.1977	1.0761
16	2.8003	1.059	0.97214	2.9443	3.1429	3.277								12	3.4024	3.5301	3.6266	1.1753	1.0813
17														13					
18														14					
19														15					
20														16					
21														17					

Summary 20210423-VPZ-7 20210423-VPZ-9 20210423-VPZ-13 20210423-VPZ-15 2021C ... +

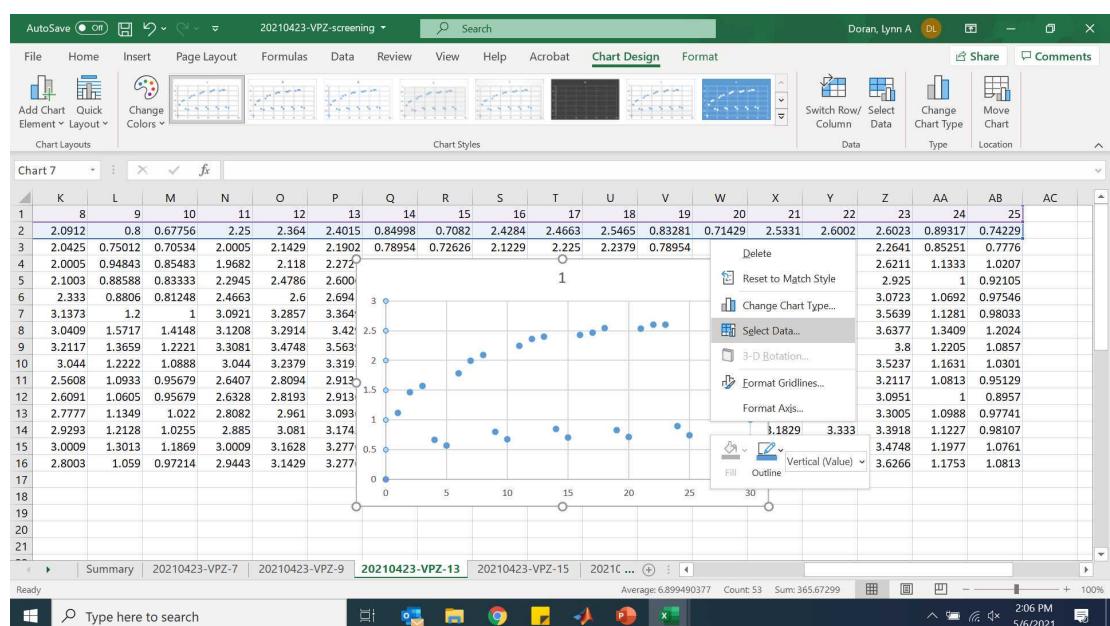
Average: 2.76059652 Count: 431 Sum: 1189.8171

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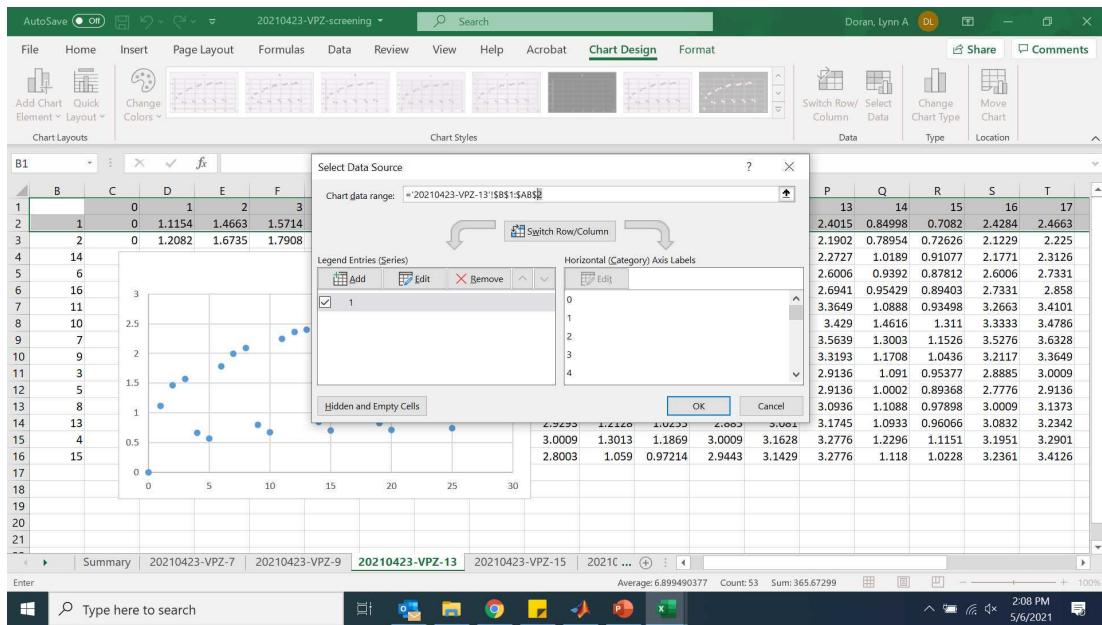
If you are having a difficult time getting Excel to plot the coordinates correctly, start by only highlighting row 1 and 2 and inserting a scatter plot.



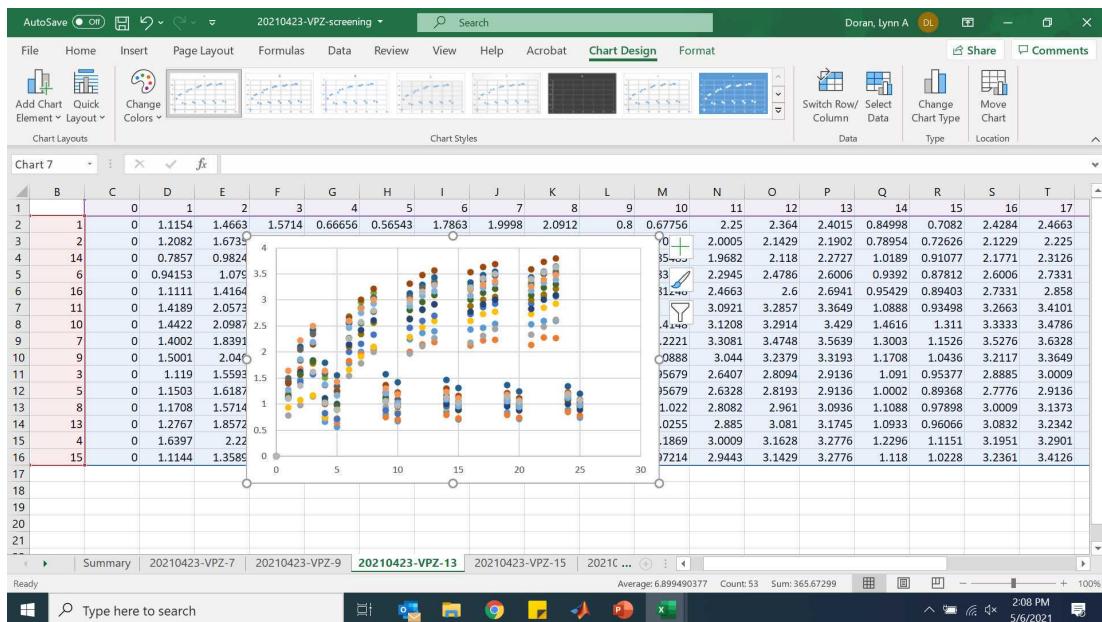
Once you've verified that it is plotting one data set correctly, you can expand the plotting range by right clicking on the graph and selecting "Select Data".



Change the last number in the "Chart data range:" to the last row of data. In this example the highlighted 2 below would be changed to 16.



The correct figure should now be available.



- 25 Add the desired chart elements (i.e. title, legend, horizontal and vertical axis labels). The data is ready for interpretation.

