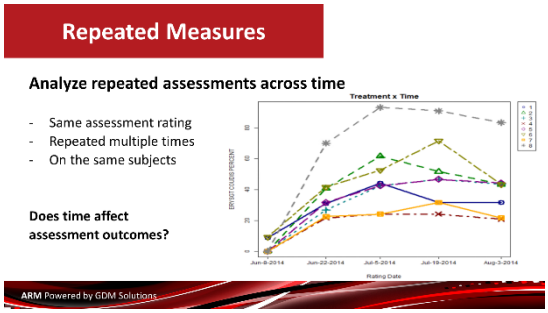
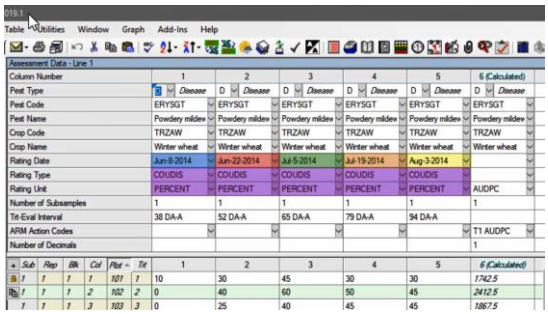
Repeated Measures Analysis



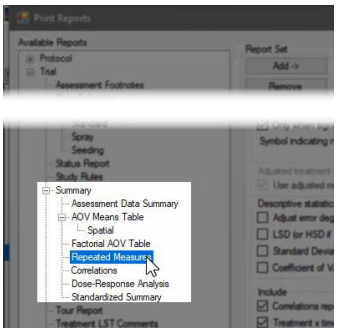
In this video, we demonstrate the Repeated Measures analysis report.

The Repeated Measures analysis is designed for any assessment that has been repeated at regular time intervals during the season. We then try to determine whether time had an effect on the assessment outcomes.

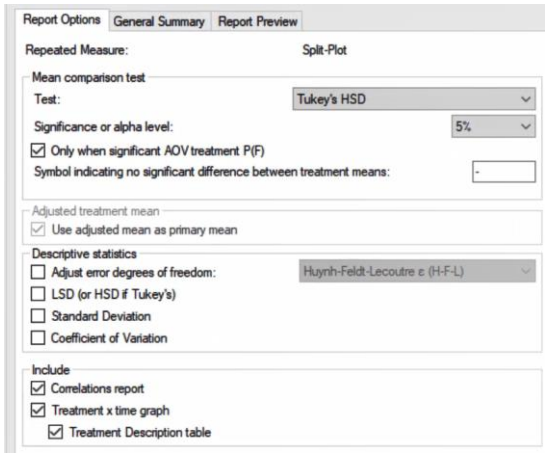


We begin by opening a tutorial file – the AUDPC1 trial is a good example to use.

Let's first look at the data in this trial. We have disease counts repeated through June, July, and August. And the last column is an AUDPC transformation, calculating the 'Area Under Disease' Progress Curve calculation on the other columns.



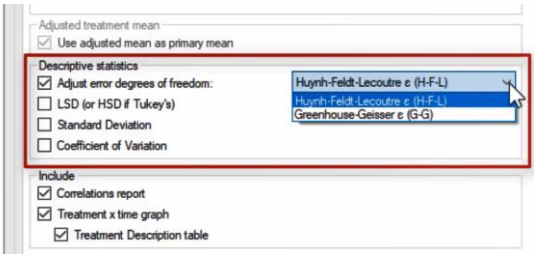
Repeated measures is performed as a report in ARM. So select File > Print Reports to begin. In the Available Reports list, double-click on the Repeated Measures report within the Summary section to add it to our report list.



There are a few options to customize the analysis and output. The first option sets the model used in calculations. Currently, ARM supports the Split-Plot model, wherein the treatments are factor A and the assessment dates are factor B.

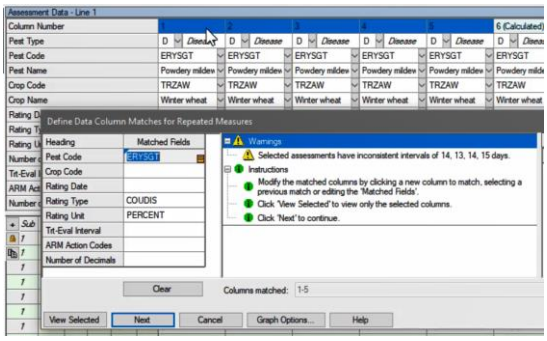
Next, set the mean comparison test and significance level to be used in the analysis, just like an AOV Means Table report. The Adjusted mean is always used as part of the Repeated Measures analysis.

The next section adds descriptive statistics to each means section on the report.



The first option adjusts the error degrees of freedom in the analysis, applying a correction to adjust for the correlation in repeated measurements. We lose degrees of freedom in a repeated measures situation because time is not independent, unlike in a true split-plot where subplots can be independently randomized.

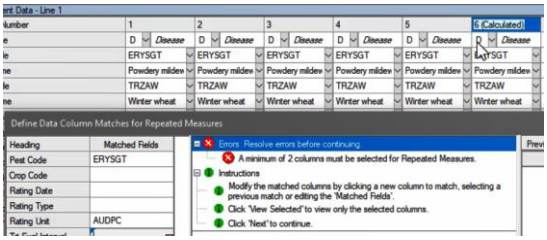
This report can also include a correlations report, and a treatment x time graph. We will discuss both of these when we look at the output. Now press the Next button to proceed to the next step.



Here we define what assessment columns are the repeated measurements.

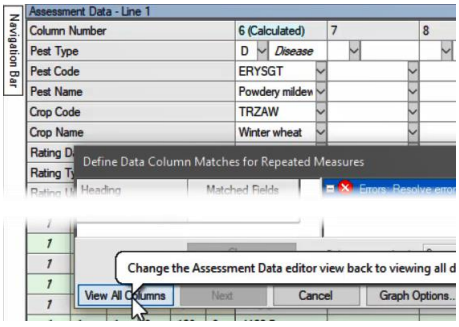
First, click on a column, and ARM finds similar columns, based on certain matched fields. In this case, columns 1 through 5 all matched, as expected.

We could also manually adjust how columns are matched, to widen or narrow the selection.



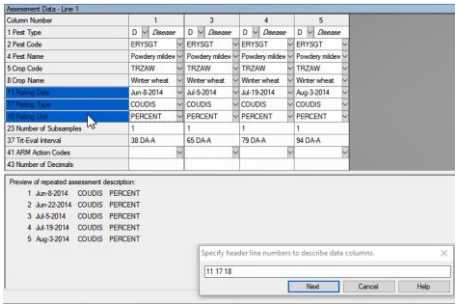
The status and the instructions for matching are in the middle of this dialog. If we chose a column that has no matches, then there is an error stating that more than 1 column must be included for the analysis.

A history of your previous column matches will display on the right once you run repeated measures on different data sets.



The View Selected button changes the ARM view to show only columns that are currently matched. Select this button again to go back to all columns visible.

You can also set the graph options for the Treatment x Time graph that can be included on the report. Let's switch back to match our repeat assessments, and then press next.



Now we define how to describe the data column assessments on the report. Typically the distinguishing field would be the Rating Date, but others can be included as well by clicking on the prompt.

When we press Next, now the report is generated. Let's preview it on-screen.

Repeated Measures Analysis

Pest Type		D
Pest Code		ERYSGT
Pest Scientific Name		Blumeria graminis tritici
Pest Name		Powdery mildew of wheat
Crop Code		TRZAW
Crop Scientific Name		Triticum aestivum (winter)
Crop Name		Winter wheat
Part Rated		PLANT P
Rating Type		COUDIS
Rating Unit		PERCENT
Number of Subsamples		1

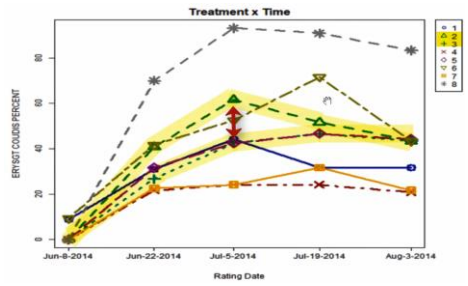
Trt	Treatment	Rate	Rate Unit	Appl Code	
TABLE OF Treatment MEANS					
1	Sure Kill	3	lb ai/a	A	29.4 e
2	Sure Kill	3	lb ai/a	A	39.5 c
	Super Stomp	1.5	lb ai/a	A	
3	Sure Kill	3	lb ai/a	A	31.8 d
	930401	1	lb ai/a	B	
4	Sure Kill	3.5	lb ai/a	A	18.2 g
	930401	2.5	lb ai/a	B	
5	Sure Kill	3	lb ai/a	A	33.0 d
6	Sure Kill	4	lb ai/a	A	43.7 b
7	Super Stomp	2.5	lb ai/a	A	20.0 f
8	Untreated				67.5 a
Error DF Correction (H-F-L)					
Tukey's HSD P=.05					1.70
Standard Deviation					2.05
CV					5.79

This report is similar to the Factorial AOV report, but where the treatments are factor A and the assessment dates are factor B. So a table of treatment means are created across all rating dates, followed by a table of rating date means across all treatments. (Mean comparisons and descriptive statistics are also included.) Then a third table with treatment x time means that extends a few pages.

REPEATED MEASURES AOV For D ERYSGT Blumeria graminis tritici Powdery mildew of wheat TRZAW Tri
PLANT P COUDIS PERCENT 1

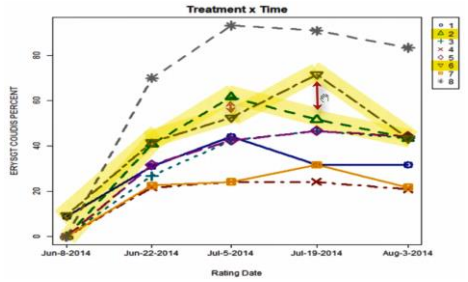
Source	DF	Sum of Squares	Mean Square	F	Prob(F)	HSD (.05)	Variance
Total	220.0	141626.962500					
Replicate	5.0	65.637500	13.127500	3.127	0.0195		0.223238
Treatment	7.0	51065.995833	7295.142262	1737.776	0.0001	1.70	
Treatment Error	35.0	146.929167	4.197976				-0.246155
Rating Date	3.6	71570.358333	17892.589583	3295.895	0.0001	1.31	
Treatment x Rating Date	25.1	17909.441667	639.622917	117.821	0.0001	5.35	
Error/Residual	143.6	868.600000	5.428750				5.428751

Next is the Repeated Measures AOV table. This gives insight into the Treatment effect, Rating Date effect, and the interaction between the two.



Next is the Treatment x Time line graph, plotting treatment means over time. Use this to visually identify treatment interaction across assessments.

For example, treatments 2 and 3 performed similarly in the first and last assessments, but treatment 2 was less effective during the middle weeks of the season.



Or we can compare treatments 2 and 6. These two went back and forth on which was more effective through the season, while settling to the same spot in the end.

Rating Date	Jun-8-2014	Jun-22-2014	Jul-5-2014	Jul-19-2014	Aug-3-2014
Data Column	1	2	3	4	5
Residual Covariance 5	-0.4583	0.1786	-1.4226	-0.9821	6.6071
Estimated Covariance	-0.2462	-0.2462	-0.2462	-0.2462	5.1826
Residual Correlation	-0.3172	0.0272	-0.2088	-0.1859	1.0000
Estimated Correlation	-0.0475	-0.0475	-0.0475	-0.0475	1.0000
Residual Covariance 4	0.0774	0.5655	1.1429	4.2262	
Estimated Covariance	-0.2462	-0.2462	-0.2462	5.1826	
Residual Correlation	0.0670	0.1076	0.2098	1.0000	
Estimated Correlation	-0.0475	-0.0475	-0.0475	1.0000	
Residual Covariance 3	0.4220	-1.2411	7.0232		
Estimated Covariance	-0.2462	-0.2462	5.1826		
Residual Correlation	0.2833	-0.1832	1.0000		
Estimated Correlation	-0.0475	-0.0475	1.0000		
Residual Covariance 2	-0.1399	6.5327			
Estimated Covariance	-0.2462	5.1826			
Residual Correlation	-0.0973	1.0000			
Estimated Correlation	-0.0475	1.0000			
Residual Covariance 1	0.3161				
Estimated Covariance	5.1826				
Residual Correlation	1.0000				
Estimated Correlation	1.0000				

The last section of the report is the Correlations table, displaying all possible correlations between data column assessments.

Review the Residual Correlation values in the table (ignoring the main diagonal). If these values are close to 1 or -1, then a correction should be applied to adjust the error degrees of freedom in the analysis. If the data is well-correlated with time, then future assessments are affected by previous values and so we must adjust the analysis accordingly.

In this example, there is no evidence of a strong correlation, and so no adjustment is necessary.