Repeated Measures Analysis





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.

analysis report.

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

In this video, we demonstrate the Repeated Measures

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.

Report Options	- Treatment L	ST Comments	Treatment)		
Departed Max	General Summary	nepoil rieview	Solt Plat		
hepealeu Mea	sure.		SpiltFlot		
Mean compari	son test				
Test:		4	Tukey's HSD		1
Significance of	r alpha level:			5%	1
Only when	significant AOV trea	atment P(F)			_
Symbol indica	ting no significant di	ference between	treatment means:	-	_
					_
Adjusted treat	nent mean				
Use adjust	ed mean as primary	mean			
Descriptive sta	atistics		Martin Color Statements		
Adjust erro	r degrees of freedon	n:	Huynh-Feldt-Lecoutre a	: (H-F-L)	1
LSD (or H	SD if Tukey's)				
Standard [Deviation				
Coefficient	of Variation				
Include					
Correlation	s report				
Treatment	x time graph				
To Trank	ant Description table				

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.

Repeated Measures Analysis



Descriptive statistics	
Adjust error degrees of freedom: LSD (or HSD if Tukey's) Standard Deviation Coefficient of Variation	Huynh-Feldt-Lecoutre c (H-F-L) Huynh-Feldt-Lecoutre c (H-F-L) Greenhouse-Geisser c (G-G)

Column N	lumber											4			5			6 (Cal	ulated
Pest Type			D	Disea	ş	D	Disease	,	D	Disease		D	Disease		D	Disease	•	DY	Disea
Pest Code	e		ER	rSGT	4	ER	YSGT	Y	ERN	rSGT	~	ER	rSGT	Y	ER	rSGT	Y	ERYS	GT
Pest Nam	e		Pow	dery milder	1	Por	wdery mildev	Y	Pow	dery mildev	~	Pov	dery milder	Y	Por	dery milder	Y	Powd	ary mild
Crop Code	e		TR	ZAW	~	TR	ZAW	~	TR2	ZAW	~	TR	ZAW	~	TR	ZAW	2	TRZA	W
Crop Nam	ie .		Win	ter wheat	Y	We	ter wheat	Y	Win	ter wheat	~	Win	ter wheat	Y	Wir	ter wheat	Y	Winte	wheat
Rating Ty	Define Data Colum	n Matche	s for	Repeated	M	easu	ires Warnings												
Number o	Pest Code	ERYSOT	1		1	1	A Select	ed	asses	soments hav	ei	ncor	sistent inter	va	is of	14, 13, 14,	15	days.	
Tit-Eval Crop Code				Instructions															
ARM Act	Rating Date		5			Modify the matched columns by clicking a new column to match, selecting a newing a match or edition the 'Matched Fields'										a			
Number	Rating Type	COUDIS				 Olick 'View Selected' to view only the selected columns. 													
- 0.4	Rating Unit	PERCEN	Т				Click 7	les	t'to d	continue.									
+ 300	Trt-Eval Interval				ſ														
	ARM Action Codes																		
1	Number of Decimals																		
1		0	lear	3	1	Colu	mns matche	d:	1-5										
1	View Selected	Next	-	Can	cel		Graph	Op	tions.		н	elp							

4 mber	1			2			3			4			5		_	1	5 Calculated	1
e	1	Disease	8	D	Disease		DV	Disease	6	D	Disease	6	D	Diseas	æ		D V Disea	se
e	E	RYSGT	~	ER	SGT	2	ERYS	GT	~	ERYS	GT	~	ER	YSGT		~	STSGT	k
ne	F	owdery mildew	2	Pow	dery mildew	2	Powd	ery midev	Y	Powde	ery mildev	Y	Pow	vdery milde		~	Powdery mild	ev -
le	1	RZAW	Y	TR:	ZAW	2	TRZA	W	Y	TRZA	W	Y	TR	ZAW		~	TRZAW	-
ne	١	Vinter wheat	4	Win	ter wheat	2	Winte	r wheat	2	Winter	wheat	~	Win	ter wheat		~	Winter wheat	
D.C. D.L. C.L																		
Define Data Colu Heading Pest Code	Matches Matche ERYSGT	for Repeated	м	easu	res Errons Re S Ami	ni	lve erro	ans before 2 columns	co	ntinuing ust be r	a selected f	or	Repe	eated Mea	su	re		Pre
Define Data Colu Heading Pest Code Crop Code Rating Date Rating Type	mn Matches Matche ERYSGT	for Repeated	M		Errors Re A mil Instruction Modify previou	nia ns th	Ive end num of match o	ns before 2 columns ned colum or editing t	co m he	by click Match	selected f king a ner ed Fields	or I	Repe	eated Mea in to match	au	re	s. lecting a	Pre





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 Pest Scientific Name Pest Scientific Name Crop Code Crop Scientific Name Crop Name Parl Rated Rating Type Rating Unit Number of Subsamples		D - ERYSGT Blumeria gramins tritici Powdery mildew of wheat TRZAW Triticum aestivum (winter) Winter wheat PLANT P COUDIS PERCENT
Trt Treatment	Rate Appl	
TABLE OF Treatment ME	ANS	
1 Sure Kill	3 lb ai/a A	29.4 e
2 Sure Kill 2 Super Stomp	3 lb ai/a A 1.5 lb ai/a A	39.5 c
3 Sure Kill 3 930401	3 lb ai/a A 1 lb ai/a B	31.8 d
4 Sure Kill 4 930401	3.5 lb ai/a A 2.5 lb ai/a B	18.2 g
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 Standard Deviation CV	_)	1.70 2.05 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.







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 Data Column	Jun-8-2014 1	Jun-22-2014 2	Jul-5-2014 3	Jul-19-2014 4	Aug-3-2014 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	2		
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 wellcorrelated 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.