

In this video, we perform analysis of variance in ARM with the AOV Means Table report. Research trials always have variation that comes from a variety of sources. The Analysis of Variance (or AOV) helps us to understand this variation and draw conclusions from the data.

The analysis dissects the variability in the recorded observations. There is 'controlled' variability that comes from the treatment and blocking structures. (The researcher has a hand in determining this, as part of the trial design.) The 'uncontrolled' variability is everything that cannot be controlled, also called the experimental error. The goal is to evaluate whether the observed differences between treatments are due to random chance, or the treatments themselves.

We cover the details of the AOV calculations in part 2 of our statistics overview video. The end result is a p-value, the probability that no differences in treatments exist. We then perform a mean comparison test to understand which treatments differ from each other.

Analysis of Variance

- Break down observed variance into causes:
- Controlled (treatments, blocking)
- Uncontrolled (experimental error)
- Observed differences ~ random chance or treatments?
- p-value: probability/confidence that no differences exist

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		See	d Treatment with I	noculation demo
Protoco Project Study I Inve	al ID: AOV-Report of ID: G-All7 SDTR Inoc ID: G-All7 SDTR Inoc Director: Debra Dooley stigator: Rebecca Standis	Location: Anywhere, M Sponsor Contact: Sp	0, USA Trial Year onsor Name	2014
Rating	Date	22-Apr-24	29-Apr-24	27-May-24
Part Ra	ted	CANOPY, C	PLOT, C	CANOPY, C
Rating	Гуре	COUDIS	COUPLA	DILOGE
Rating	Unit	NUMBER	NUMBER	0.400
Rating	min/max/interval			0, 100,
Numbe	r of Subsamples	0.754140	0.75440	0.7541
CIOP I	/pe, Code	C, ZEAMD	C, ZEAMD	C, ZEAMI
Cmp Si	piontific Name	Zon mar indent>	Zoo mous indent?	Zoo maye indept
Crop N	amo	Dent com	Dent com	Dent cor
Pest Tu	ne	D Disease	Dent com	D Diseas
Pest Cr	de	PHYTHB		PHYTH
Pest Sc	cientific Name	Phytophthora hv>		Phytophthora hy
Pest Na	ame	Phytophthora hy>		Phytophthora hy
Pest St	age Scale	DESC	Philade Color	DES
Days A	fter First/Last Applic.	36, 36	43, 43	71.7
Trt-Eva	Interval	36 DA-A	43 DA-A	71 DA-
Plant-E	val Interval	21 DP-1	28 DP-1	56 DP-
ARM A	ction Codes	AS	IID	A
Trt	Treatment	1*	2*	3*

Let's see how this is all put together within ARM.

To perform this analysis on a trial in ARM, first select File, then Print Reports. Under Available Reports, go to the 'Summary" section to select the AOV Means Table. Press Add to place this report in the list of components to generate. Then press Next to run the analysis and generate a report.

Use Print Preview to view the report on the screen. Your company name will appear at the top, along with general header information from the trial.

Every rating from the trial is a column in the report table. First we have the header description of each assessment. The Part Rated, Rating Type, and Rating Unit define how the assessment was performed. Details about the crop and pest come next, followed by calculated timing intervals. Add a separate table to the report that describes the codes used in this header by using the "List validation comments" report option.

## The AOV Report



Plant-Ev ARM Ac	al Interval tion Codes	21 DP-1 AS	28 DP-1 IID	56 DP-1 AS
Trt No.	Treatment Name	1* AS	2*	3* AS
1	Untreated Check Seed Product 1	13.6 a	63.8 c	9.0 a
2	STD Seed Treatment Seed Product 1 Phytophthora infestans	8.3 b	71.0 ab	4.7 b
3	SDTR Chem 1 SDTR Chem 2 SDTR Chem 3 Seed Product 1 Phytophthora infestans	7.2 b	73.8 ab	4.2 c
4	SDTR Chem 1 SDTR Chem 2 SDTR Chem 3 Seed Product 1 Phytophthora infestans	7.5 b	70.0 b	4.5 bc
5	SDTR Chem 1 SDTR Chem 2 SDTR Chem 3 Seed Product 1 Phytophthora infestans	3.9 c	74.8 a	3.7 d
6	SDTR Chem 1 SDTR Chem 2 SDTR Chem 3 Seed Product 1 Phytophthora infestans	4.4 c	72.0 ab	3.8 d

Next in the report are the treatments. The key details from the Treatment editor are included here, with the treatment means for each assessment to the right. Next to the treatment means is the letter result from the means comparison test. Remember that means that do not share a letter in common are considered significantly different.

Next on the table are the descriptive statistics, summarizing the entire column. The LSD, Standard Deviation, and CV are commonly included, and we also have the tests for AOV assumptions here. The last section is a brief version of the AOV table that includes just the F statistic and p value for the replicate and treatment

sources.

Phytophithora intestans	I	
LSD P=.05	0.98	3.03
Standard Deviation	0.65	2.01
CV	8.7	2.84
Grand Mean	7.49	70.88
Levene's Prob(F)	0.432	0.746
P(Shapiro-Wilk) <sup>A</sup>	0.1285	0.4623
P(Skewness) <sup>A</sup>	0.1345	0.5652
P(Kurtosis) <sup>A</sup>	0.9397	0.3885
Derligets F	0.404	4.074
Replicate F	0.424	1.2/1
Replicate Prob(F)	0.7386	0.3199
Treatment F	112.986	15.021
Treatment Prob(F)	0.0001	0.0001

Means followed t	by same letter or symbol do not significantly differ (P=.05, Student-Newman-Keuls)
Mean compariso	ins performed only when AOV Treatment P(F) is significant at mean comparison O
*Adjusted means	s
*Calculated from	residual.

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footnotes at the bottom of the page. These provide
important documentation of the analysis options used in
the report. The first footnote details the alpha significance
level and mean comparison test that was performed. We
will use these footnotes to diagnose frequently asked
questions about the AOV report in the next video.
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The final component of the AOV report is the list of

_	Classification	Ciedi Jet		CORdiner	
	Internal V	·	Global Report Settings		
ier	neral Summary F	Report Options			
R	eport Options	Descriptive Statistics	General Summary   Report Previ	iew	
	Mean compariso	in test		M	
Test:			Student-Newman-Keuls	~ C	
Significance or alpha level: Use FAOV complete error for split-plot tria		alpha level: complete error for split-plot tr	None Grand Strength S		
	Only when s Symbol indicatin Adjusted treatm	ignificant AOV Treatment P g no significant difference t	Student-Newman-Keuls (f) Tukey's HSD ge Waller-Duncan k=100 Dunnett's vs. Control – Dunnett's vs. Reference – Scott-Knott	-Ci Fi	
	Use adjuste           Calculate ad	d mean as primary mean djusted mean only when jus	tified by AOV		

Now let's return to the Print Reports dialog for a look at the report options, which are in the middle of this dialog. Choose the Mean comparison test you wish to use. The top four are the most common and appear in order of most liberal to most conservative.

Report Options	Descriptive Statistics	General Summary   Report Previe	w	
Mean compariso	on test			Mean sorting
Test:		Student-Newman-Keuls ~		O None
Significance or	alpha level:	5%	~	Ascending     Descending
Ine FAOV	complete emorfor solt-olot	viale		
Minimum an Standard d Median	id maximum leviation		~	Analysis method Traditional AOV Least square estimation
Adjusted mean (when available)				AOV Table
Beside mean     Under mean				None     Brief

Choose the significance or alpha level here. Typically this is 5%, but you may need to adjust based on your penalty of failure. More details on these choices can be found in part 3 of our statistics overview video.

Another important choice is the analysis method. GDM recommends 'least square estimation', as it is more sophisticated compared to the Traditional AOV and handles missing data better. An adjusted mean is calculated using a linear regression model to minimize the sum of squared residuals, which is used on the report and in the mean comparisons.

## The AOV Report



Randomized Com	lete	Block (RCB) Lea	st square estim	nation AC	V For 22-Apr-
indentata Dent con	DDD	isease PHYTHB	Phytophthora	hybrids F	hytophthora h
Source Total	DF 23	Sum of Squares 247.095995 <sup>A</sup>	Mean Square	F	Prob(F)
Replicate Treatment Type III	35	0.540790 240.178033	0.180263 48.035607	0.424	0.7386 0.0001
Error(adj)	15		0.425145		
* Total Sum of Squ	ares	may not equal Si	um of Squares	reported	on this table b

Finally, select how to display the AOV results. We saw the Brief version earlier with just the F and p values. The "full" option prints on a separate page and includes a full AOV table for each assessment, listing the calculations for all sources of variation, including degrees of freedom, sum of squares, mean square, F statistic, and p-value.

Current printer Microsoft Print to PC	)F		Print
	ord Processor Sa Ado Quick(Merge	ibe PDF 📷 File d cells) 🗸 🗸	a starting page number.
Print each report se	t to new workbook:	Prompt ~	Print to
For Quick, force	Word Processor		
Print Trial Map a	s formatted cells		Adobe PDF
			File

A final tip: the Print dialog has options to save the report to a file instead of the printer. The PDF option always matches the preview, although offers fewer additional formatting options after-the-fact. The spreadsheet does not retain the spacing or formatting from the preview, but can be useful to perform additional calculations or graphs from the information in the report.