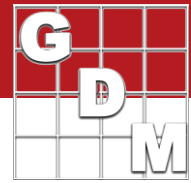
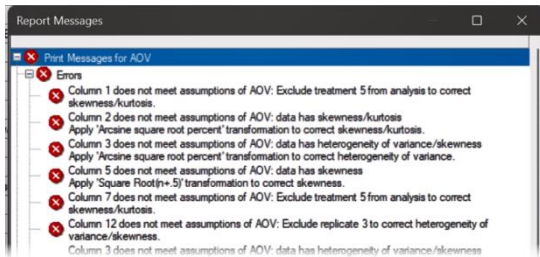


Common Questions: AOV Means Table



The AOV Means Table is the primary report for statistical analysis of a trial in ARM. In this video, we answer questions that are frequently asked about the AOV report from ARM.

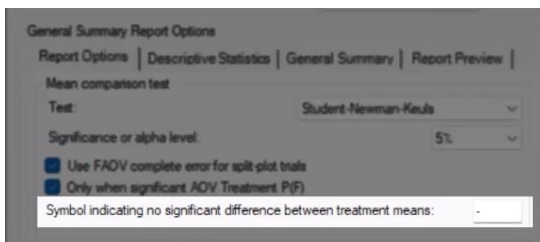


We begin in an example trial with a variety of assessments. Select File > Print Reports and then press Next to generate the report. A window first appears with some details about the analysis that was performed. In this case, the errors that appear are related to the assumptions of AOV. These are from an older tool for data review, where ARM scanned all columns and made recommendations on what actions to take. If you declined those actions, they became errors on this list. These should be just warnings, which we can ignore if we already reviewed the data with Column Diagnostics.

Treat	Treatment	Rate	Appl	1*	2*
No.	Name	Unit	Code		
1	Untreated Check	ABC		11.05	15.5 a
2	TUB	1 i/ha	ABC	11.60	1.7 b
3	TUB	1 i/ha	ABC	12.23	0.8 b
4	TILT 250	0.5 i/ha	ABC	12.13	2.3 b
5	MICO 60 FUNGOL	1.5 i/ha 1.25 i/ha	AB C	13.38	3.9 b
	LSD P= .05			1.343	3.15
	Standard Deviation			0.872	2.04

Now select Preview to view the report on-screen. Many of the questions that we receive follow a theme: "Where are my letters?". Significant differences between treatments is typically a desired outcome of a trial, so this does not come as a surprise. However, there are a few things to consider when the analysis does not show significance.

Our first question arises from column 1: Why do I not see any letters at all? Note that there are small dashes in the place where the significance letters typically display.



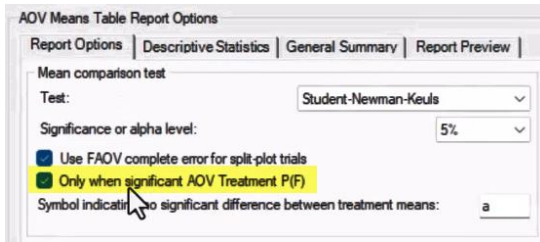
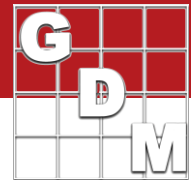
If we go back to the report options, the dashes come from the option "Symbol indicating no significant difference between treatment means". Up to 3 characters can be entered in this box to use in place of significance letters when no separation between treatments exists. Some common alternatives to the dash include: 'NS' for "no significance" or simply an 'A' so that all means have the same letter in common.

Use the Preview tab on this dialog to make it easier to toggle between the options and the report content.

Treat	Treatment	Rate	Appl	1*	2*
No.	Name	Unit	Code		
3	TUB	1 i/ha	ABC	12.23	a
4	TILT 250	0.5 i/ha	ABC	12.13	a
5	MICO 60 FUNGOL	1.5 i/ha 1.25 i/ha	AB C	13.38	a
	LSD P= .05			1.343	
	Standard Deviation			0.872	
	P(Kurtosis)			0.7385	
	Replicate F			1.807	
	Replicate Prob(F)			0.1995	
	Treatment F			2.698	
	Treatment Prob(F)			0.0818	

The next question is, why are there no significant differences being reported? After all, treatment 5 appears to have a larger response than the other treatments. To answer this, we need to review the results of the AOV analysis. The Treatment probability of F for this assessment is 0.08, which means we can only be 92% confident that there is at least 1 significant difference among these treatments. But our alpha significance level is set to 5%, establishing that we must be at least 95% confident in order to declare differences to be significant.

Common Questions: AOV Means Table



If AOV does not find "any" significance, then should we even bother running a mean comparison test? This is a known as a 'protected' mean comparison test, in an effort to avoid false positives. We can change this behavior by turning off the report option "only when significant AOV Treatment P(F)". Now ARM will perform the mean comparison test, regardless of the AOV results.

Trt No.	Treatment Name	Rate	Appl Unit	Code	Mean
1	Untreated Check		ABC		11.65 a
2	TUB	0.5 l/ha	ABC		11.60 a
3	TUB	1 l/ha	ABC		12.23 a
4	TILT 250	0.5 l/ha	ABC		12.13 a
5	MICO 60 FUNGOL	1.5 l/ha	AB	C	13.38 a
LSD P= 05					1.343
Standard Deviation					0.972
CV					7.15
Grand Mean					12.105

However, this data is set up for one more example, as we still do not see significance! Use the LSD value of 1.34 on the report to manually compare a pair of treatments. Treatment 2 is at 11.6, while treatment 5 is 13.4, with a difference of 1.8. Because this difference is larger than the LSD statistic, we would conclude that there is significance. So why does ARM disagree?

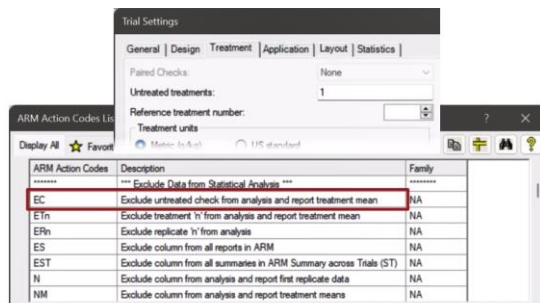
<https://gdmdata.com/Resources/Video-Tutorials/Statistics-and-ARM-Overview>

Means followed by same letter or symbol do not significantly differ (P= 05 Student-Newman-Keuls)
 Mean descriptions are reported in transformed data units, and are not transformed.
 Due to missing data, the effective replicates used for mean comparisons are: col 5=3.7
 * Adjusted means
 * Calculated from residual
 # Means are reported in de-transformed data units

We can find the answer in the footnotes at the bottom of the report. The first footnote lists the alpha level and mean comparison test that was performed, which is Student-Newman-Keuls in this case and not LSD. As discussed in the Statistics Overview video, this SNK test is more conservative than the LSD, reducing the rate of false positives (or Type I error).

AL	EC
4*	5*
dAL	
2.31 b	32.88
21.58 a	4.53 bc
28.96 a	3.93 c
27.82 a	8.59 a
11.46 a	5.13 b
5.705 - 18.976	0.830
0.2821	0.509
23.911	9.53
1.1811	5.347
0.792	8.893*

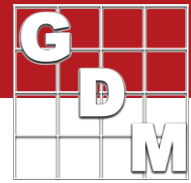
Let's move to column 5 for the next question. Here we are missing significance letters only for treatment 1, but the rest of the analysis is present. This is due to the "EC" entered in the ARM Action Codes field for the column, short for "Exclude Check".



Action Codes are commands given to ARM for the analysis of that specific assessment. In this case, the treatment defined in Settings as the Untreated Check is left out of the analysis entirely, and only the mean is reported for reference.

Also, the action code "ETn" excludes a specified treatment number, where n is replaced by the number. For example, ET3 would hide all of the data for treatment 3 from the analysis of that column. This is not commonly recommended, because it results in lower statistical power, but is used when something goes wrong with a treatment or the check should not be compared with the other products.

Common Questions: AOV Means Table



Days After First/Last Appl.	17, 17	78, 29	
Treatment Appl. Interval	-67 DA-C	29 DA-B	
Planting Interval	215 DP-1	276 DP-1	
Description			
ARM Action Codes			
Number of Decimals	2	1	
Trt Treatment No. Name	Rate Appl Rate Unit Code	1*	2*
1	Untreated Check ABC	11.65 a	15.5 a
2	TUB 0.5 l/ha ABC	11.60 a	1.7 b
3	TUB 1 l/ha ABC	12.23 a	0.8 b
4	TILT 250 0.5 l/ha ABC	12.13 a	2.3 b
5	MICO 60 FUNGOL 1.5 l/ha AB C	13.38 a	3.9 b
LSD P= .05	1.343	3.15	

The assessment header contains the answer to another common question: can I control how many digits are reported? The Number of Decimals field allows you to specify how many decimal places to report for the treatment means, on a per-column basis.

Report Options | Descriptive Statistics | General Summary | Report Preview

Missing data estimates: Yates

Assessment data header rows List:

De-Transform means for data correction transforms

Automatic transformations apply to 'Plot' experimental unit means if subsamples are present

Force number of decimals accuracy to:

For columns without a Number of Decimals value, ARM uses the report option "Force number of decimals accuracy" found on the General Summary section. If this option is left blank, then ARM reports one more decimal than was contained in the most accurate data point per column.

Name	Col	Plot	Trt	Mean	EC
	1	101	3	3.7	
	2	202	3	4.5	
	1	301	3	4.2	
	2	402	3	3.3	
	3	103	4	9.1	
	4	204	4	8.3	
	5	305	4		
	4	404	4	8.5	
	5	105	5	9.3	
	3	203	5	5.1	
	4	304	5	5.2	
	5	405	5	4.9	
				7.40	12.4

ARM Action Codes	EC
Trt Treatment No. Name	5*
1 Untreated Check	32.88
2 TUB	4.53 bc
3 TUB	3.93 c
4 TILT 250	8.59 a
5 MICO 60 FUNGOL	5.13 b

The last question is about the calculation of the means. There are a couple of situations where the mean on the report might not match the hand-calculated average of the assessment values.

The first example is for missing data, like plot 305 here in column 5. The average of the other three values for treatment 4 is 8.63, but ARM reports 8.59 instead.

Report Options | Descriptive Statistics | General Summary

Mean comparison test: Mean sorting: Mean

Symbol indicating no significant difference between treatment means: Adjusted treatment mean

Use adjusted mean as primary mean

Calculate adjusted mean only when justified by AOV

Mean descriptions: Primary mean

Arithmetic mean

Minimum and maximum

Standard deviation

Median

Adjusted mean (when available)

Calculated %s Reported decimals: 0 (95%)

1 (95.3%)

2 (95.37%)

Print untreated value from original (Abbott) values

Analysis method: Traditional AOV

Least square estimation

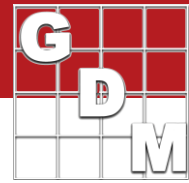
AOV Table

The reason for this difference is that the analysis uses an Adjusted Mean, as part of the Least Squares analysis. Only using 3 values for this treatment but not the others would result in unbalanced data, so we need to adjust the mean in order to fairly analyze this data.

	11 (Calculated)	12 (Calculated)	13 (Calculated)
Transformed values for Col 4		Avg of transformed values	Detransform Trt. Avg for Col 11
Log ₁₀ [(C ₄ + 1)		Trt. Avg (C ₁₁)	10 ^{Trt. Avg} [(C ₁₂) - 1]
T ₁₁ [4]		T ₃	T ₂
3		3	3
Trt	11 (Calculated)	12 (Calculated)	13 (Calculated)
1	0.602	0.520	2.310
1	0.477	0.520	2.310
1	0.639	0.520	2.310
1	0.301	0.520	2.310
2	1.362	1.354	21.581
2	1.230	1.354	21.581
2	1.279	1.354	21.581
2	1.544	1.354	21.581

The second situation occurs when there is an automatic data transformation applied, like the logarithm transformation in column 4. During the analysis, the plot values are transformed, and then the AOV is performed on the calculated values. But the "logarithm of percent" is not a simple unit to draw conclusions from! So ARM "de-transforms" the means using the inverse of the original formula.

Common Questions: AOV Means Table



Plot	Tit	4	276 DP-1	289 DP-1
102	7	3	TAB[2] 2	AL
205	7	2	3*	4* dAL
303	7	4	0.00 c	2.3 b
401	7	1	88.74 ab	21.6 a
104	2	22	95.62 a	29.0 a
201	2	16	85.11 ab	27.8 a
302	2	18	74.08 b	11.5 a
403	2	34	12.746	5.70 - 18.98
			0.872 7.15	2.04 42.0
			12.04	8.273 0.281 23.911

This creates a weighted mean, which can differ slightly from an average calculated from the raw values, like we see here.

AOV Means Table Report Options

Report Options | Descriptive Statistics | General Summary

Mean comparison test

T-test

Calculate adjusted mean only when justified by AOV

Mean descriptions

- Primary mean
- Arithmetic mean
- Minimum and maximum
- Standard deviation
- Median
- Adjusted mean (when available)

Arranged

- Beside mean
- Under mean

Although this is statistically accurate, if the audience for your report is not statistical in nature, you may also want to display the 'arithmetic' mean from the raw values. This can be added to the report with the Mean Description option, either 'beside' or 'under' the Primary mean.

	29 DA-B 276 DP-1	7 DA-C 289 DP-1
	TAB[2] 2	AL
	3*	4*
	A Mean	dAL A Mean
0.00 c	0.00	2.3 b 2.5
88.74 ab	88.74	21.6 a 22.5
95.62 a	95.62	29.0 a 33.0
85.11 ab	85.11	27.8 a 29.0
74.08 b	74.08	11.5 a 17.5
12.746		5.70 - 18.98
8.273		0.281
12.04		23.911
68.709		1.181
1.29		0.792

Note that when using 'beside', the statistical values are grouped on the left, while the raw means are displayed separately to the right.