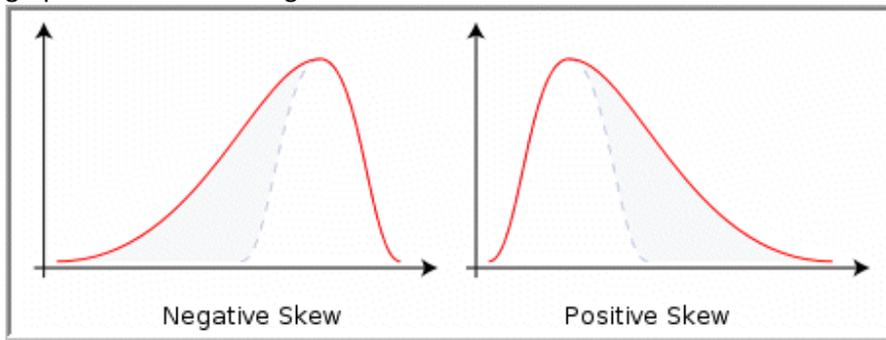


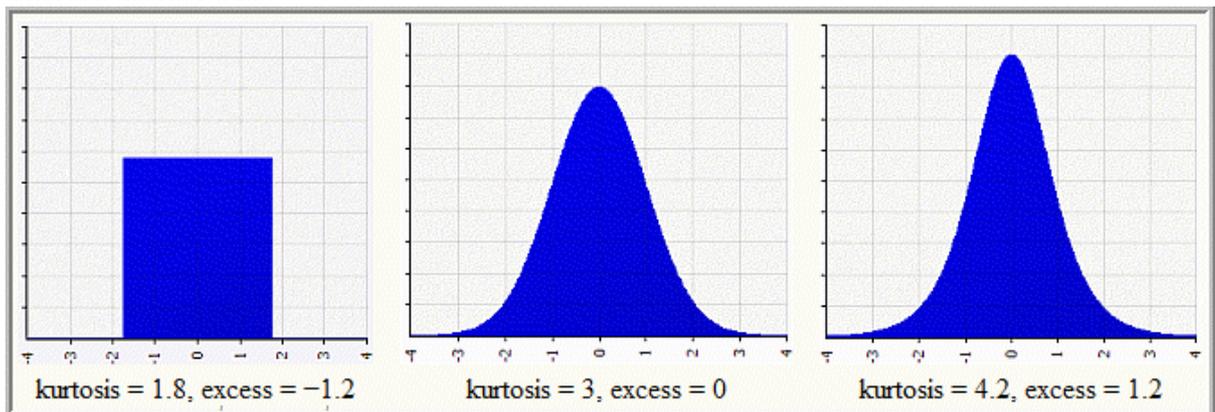
Treatment Homogeneity and Normality

- 1) Assumptions of AOV: data are random, independent, normally distributed, and have a common variance.
 - a) Normality - the distribution of observations from which samples were collected is a normal "bell" curve.
 - b) Homogeneity of variances - requires that different treatments do not change variability of observations. Why is this important? AOV is only valid when variances of different samples (treatments) are homogeneous. Heterogeneity reduces effectiveness of AOV, and can greatly reduce precision of distinguishing treatment differences using mean comparison tests.
 - c) Additivity - observations of different treatment effects are additive (linear) rather than multiplicative (proportional). Important because analysis of variance applies a linear model.
- 2) Detect violations of AOV assumptions in ARM using:
 - a) Skewness and Kurtosis tests of normality

- i) Skewness measures asymmetry of the data distribution, meaning that the peak on a data distribution graph is shifted either right or left:



- ii) Kurtosis measures "peakedness" of data distribution, meaning the peak is either flatter or sharper than a normal distribution:

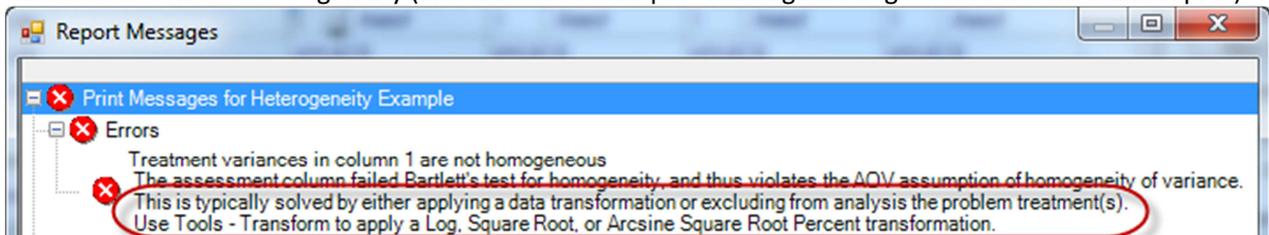


- b) Bartlett's test of homogeneity of variance

Assessment data columns with probability $\geq 95\%$ of treatment heterogeneity or non-normal data are indicated by * in descriptive statistics section at bottom of AOV Means Table report (Heterogeneity Example.dat8).

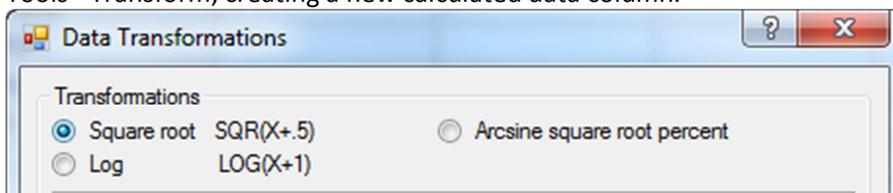
Trt No.	Treatment Name	Rate	Unit	1
1	Untreated Check			106.3 a (0.0%)
2	Sure Kill NIS	250 g ai/ha 0.5 % v/v		13.5 bc (87.3%)
3	Super Stomp NIS	250 g ai/ha 0.5 % v/v		17.0 bc (84.0%)
4	Sure Kill NIS	375 g ai/ha 0.5 % v/v		9.5 c (91.1%)
5	Super Stomp NIS	375 g ai/ha 0.5 % v/v		24.0 b (77.4%)
LSD (P=.05)				8.93
Standard Deviation				5.80
CV				17.03
Bartlett's X2				12.244
P(Bartlett's X2)				0.016*
Skewness				1.6078*
Kurtosis				1.0506

3) Methods to correct heterogeneity (also described in Report Messages dialog for AOV Means Table report)



a) Apply data correction transformation

- i) Tools - Transform, creating a new calculated data column.



- ii) ARM Action Code: AS, AL, AA perform data transformation during analysis (like APC) without creating a new data column.

ARM Action Codes	Description
*****	*** Following Identify Special AOV Means Calculations ***
APC	Automatic percent control (Control forced to 0% on AOV Means Table)
APOC	Automatic percent control (Control forced to 100% on AOV Means Table)
APOTM	Automatic percent of trial mean for summarized treatments (Trial Mean = 100%)
AS	Automatic square root transformation of X+0.5
AL	Automatic log transformation of X+1
AA	Automatic arcsine square root % transformation

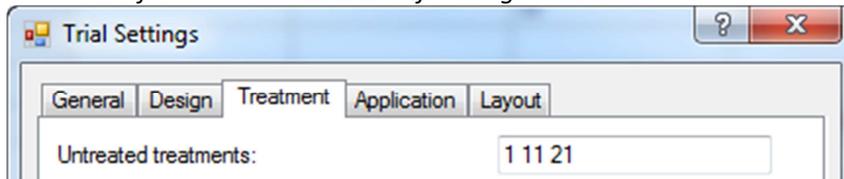
b) Exclude from analysis the treatment(s) with different heterogeneity

- i) Treatments option to “Print selected” in Global - General tab of Summary reports

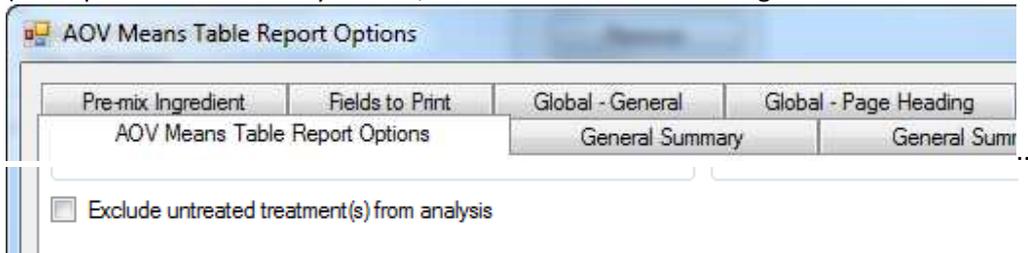


Note: The order treatments are selected defines the order treatments print on most reports.

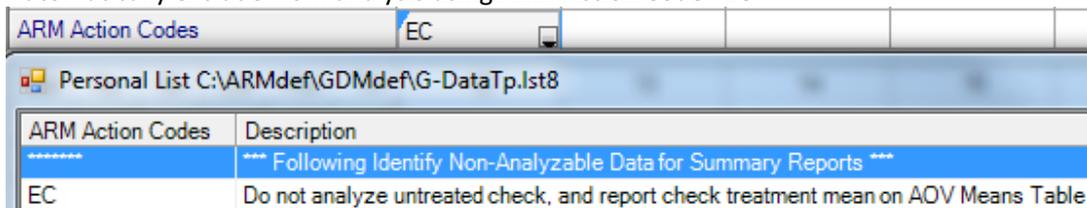
- ii) Special options to exclude untreated treatment(s). *All methods require untreated treatment number(s) to be identified in Treatments tab of Settings window:*



- (1) Automatically exclude from AOV Means Table: select the option below if by default ARM should never include untreated treatments when analyzing data columns for AOV Means Table report. (This option is turned off by default, so remember to turn if off again if it is ever turned on.)

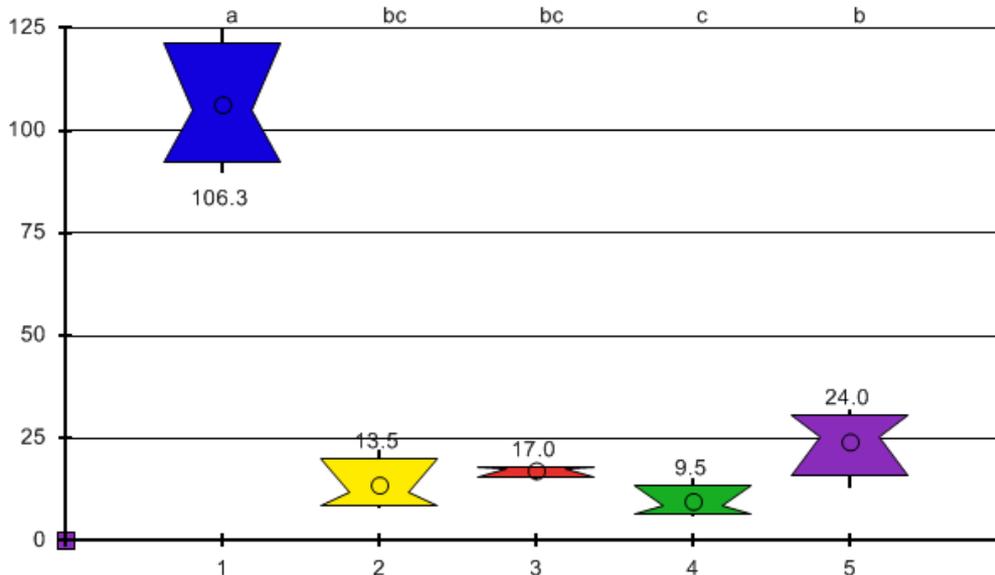


- (2) Automatically exclude from analysis using ARM Action Code “EC”



iii) Example trial showing different heterogeneity solutions (Heterogeneity Example.dat8)

Example: Data column 1 fails Bartlett's test. A box-whisker graph identifies treatment 1 (untreated check) as the treatment with different variance.



Data columns 2-4 illustrate different methods to correct the heterogeneity: Exclude untreated, Log, and Square Root transformation.

Rating Type ARM Action Codes		COUINS APC	COUINS EC APC	COUINS TL[1] APC	COUINS TS[1] APC
Trt Treatment No. Name	Rate Rate Unit	1	2	3	4
1 Untreated Check		106.3 a (0.0%)	106.3 (0.0%)	105.5 a (0.0%)	105.9 a (0.0%)
2 Sure Kill NIS	250 g ai/ha 0.5 % v/v	13.5 bc (87.3%)	13.5 b (87.3%)	12.6 cd (88.1%)	13.0 cd (87.7%)
3 Super Stomp NIS	250 g ai/ha 0.5 % v/v	17.0 bc (84.0%)	17.0 b (84.0%)	17.0 bc (83.9%)	17.0 c (84.0%)
4 Sure Kill NIS	375 g ai/ha 0.5 % v/v	9.5 c (91.1%)	9.5 b (91.1%)	9.0 d (91.4%)	9.2 d (91.3%)
5 Super Stomp NIS	375 g ai/ha 0.5 % v/v	24.0 b (77.4%)	24.0 a (77.4%)	22.8 b (78.3%)	23.4 b (77.9%)
LSD (P=.05)		8.93	6.15	0.14t	0.62t
Standard Deviation		5.80	3.84	0.09t	0.40t
CV		17.03	24.03	6.52	7.73
Bartlett's X2		12.244	6.488	7.706	5.596
P(Bartlett's X2)		0.016*	0.09	0.103	0.231
Skewness		1.6078*	0.677	0.8784	1.34*
Kurtosis		1.0506	-0.0687	-0.2758	0.399
Replicate F		6.201	5.120	6.867	9.986
Replicate Prob(F)		0.0087	0.0244	0.0060	0.0014
Treatment F		197.210	10.241	81.277	207.186
Treatment Prob(F)		0.0001	0.0029	0.0001	0.0001

t=transformed data

Means followed by same letter do not significantly differ (P=.05, Student-Newman-Keuls). t=Mean descriptions are reported in transformed data units, and are not de-transformed. Mean comparisons performed only when AOV Treatment P(F) is significant at mean comparison OSL.

Column 3: TL[1] = LOG([1] + 1)
Column 4: TS[1] = SQR([1] + .5)

Notice that method of correcting heterogeneity can influence statistical significance between treatments.

Column 2: Excluding the untreated solved heterogeneity and skewness. However because it reduced error degrees of freedom from 12 to 9, this solution is less precise than the log transformation.

Column 3: The log transformation solved heterogeneity and skewness, so is the recommended transformation for data column 1.

Column 4: The square root transformation solved heterogeneity but not skewness, so is less appropriate than the log transformation.