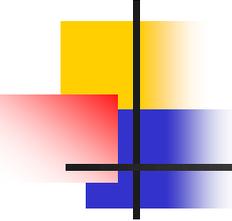


Important Statistic Tools in ARM



Steven R. Gylling, Ph.D.
Gylling Data Management, Inc.



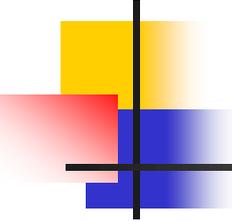


Overview: Research Questions

When we pose a research question, we want to know whether the outcome is from:

- the treatments (independent variables), or
- chance (meaning tested treatments are probably not effective)

based on experiment samples we collect.



Statistics

- Inferential statistics are used to make generalizations from a sample to a population
- The reason for calculating an inferential statistic is to get a p value (p = probability)
- For crop research, Analysis of Variance is commonly used for initial statistical analysis to obtain a p value

AOV Table for RCB Design

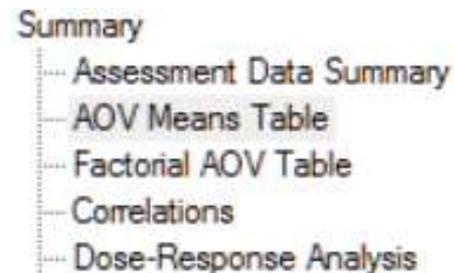
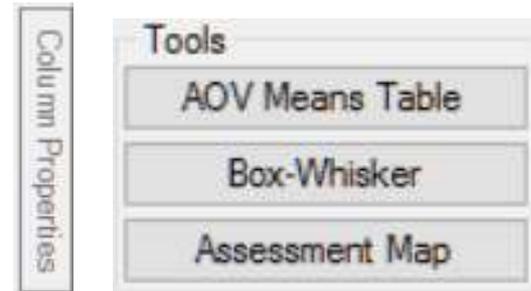
- Randomized Complete Block is a common design
- Consider key components of AOV table when planning and conducting trials:

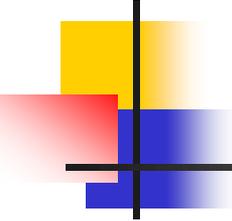
Randomized Complete Block (RCB) AOV

Source	DF	Sum of Squares	Mean Square	F	Prob(F)
Total	19	4519.800000			
→ Replicate	3	305.800000	101.9333333	0.626	0.6121
→ Treatment	4	2258.800000	564.7000000	3.466	0.0421
→ Error	12	1955.200000	162.9333333		

ARM Tools Can Assist With Important Trial Activities

- **Planning**
- Trial Layout
- Data Review
- Statistical Analysis





Planning - Key Considerations

- At least **12 error DF** (degrees of freedom) for RCB: $\text{Error DF} = (\text{Trts} - 1) \times (\text{Reps} - 1)$
 - 2 T x 13 R
 - 3 T x 7 R
 - 4 T x 5 R
 - 5 T x 4 R
 - 7 T x 3 R
 - 13 T x 2 R
- Include **enough** replicates to statistically distinguish expected treatment differences
- Minimum **alpha** for statistical significance?

Power and Efficiency Planner

Define in ARM Protocol and Trial Settings

Protocol Settings

General Design Treatment Application Layout

Randomized Complete Block (RCB)

Factors: 1

Treatments

A: [] 5 [] Do not merge []

B: [] [] Do not merge []

C: [] [] Do not merge []

The Treatment editor Type column (field) uses the factor description entered above as the default entry.

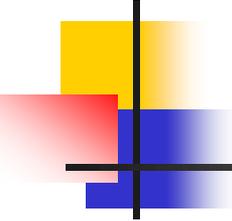
Clear

Power and Efficiency

CV 10.0 [] Reps 4 [] Power 80 [] α SL 5% [] % Mean Diff 10.0 []

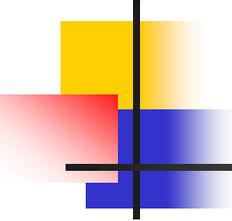
Lock at [] [] [] [] [] []

CV	Reps	Power	α SL	% Mean Diff	Error DF	'Plot' EUs
3.83	3	80	5%	10	8	15
4.63	4				12	20
5.3	5				16	25
5.9	6				20	30
6	7				24	35
6.9	8				28	40
8	11				40	55
10	17				64	85
12	24				92	120
14	32				124	160



Power and Efficiency Planner

- Help plan experiments that successfully detect expected treatment differences
- Available in both protocols and trials so:
 - Protocol writers can more effectively plan experiments
 - Trialists can verify whether CV expectations are realistic based on local experience for specified crop(s)



Power and Efficiency Planner

Calculates "power" based on:

- Estimated CV of key assessment (e.g. yield)
- Number of replicates
- Power = Level of certainty to detect "real" treatment effects (80% or 90%)
- Alpha Significance Level (e.g. 5%, 10%)
- % Mean Diff = estimated treatment effect, expressed as percentage of overall (grand) mean across treatments of key assessment

Power and Efficiency Planner



Power and Efficiency

CV 10.0 Reps 4 Power 80 α SL 5% % Mean Diff 10.0

Lock at

- "Lock at" to keep 3 columns constant
- Calculates table of possible values for "unlocked" columns (e.g. Rep or CV)
- Values entered by protocol writer are carried into trials created from protocol, conveying protocol expectations

Power and Efficiency Planner

Compare effect of significance level on minimum replicates for CV=6% vs. 10%

Power and Efficiency

CV 10.0 Reps 4 Power 80 **alpha SL 5%** % Mean Diff 10.0

Lock at

CV	Reps
4.37	3
5.05	4
5.64	5
6.2	6
7.14	8
6	6
8	11
10	16
12	23
14	31

Power and Efficiency

CV 10.0 Reps 4 Power 80 **alpha SL 10%** % Mean Diff 10.0

Lock at

CV	Reps	Power	alpha SL	% Mean Diff
4.93	3	80	10%	10
5.7	4			
6.36	5			
7	6			
8.04	8			
6	5			
8	8			
10	13			
12	18			
14	25			

Power and Efficiency Planner

Consider impact of Replicates on precision to detect treatment differences

Power and Efficiency

CV 5.0 Reps 4 Power 80 α SL 5% % Mean Diff 5.0

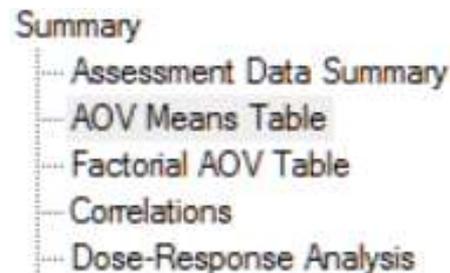
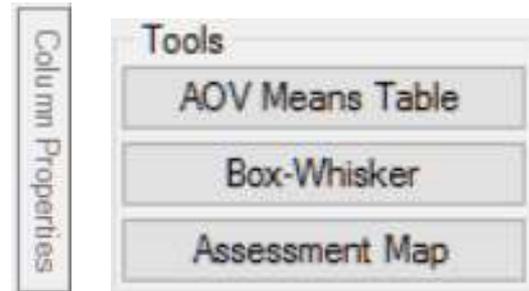
Lock at

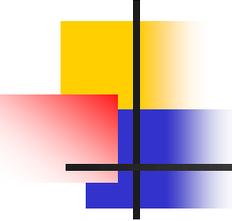
CV	Reps	Power	α SL	% Mean Diff	Error DF	'Plot' EUs
5	3	80	5%	13	8	15
	4			10.8	12	20
	5			9.4	16	25
	6			8.5	20	30
	8			7.26	28	40
	9			7	32	45
	12			6	44	60
	17			5	64	85
	26			4	100	130
	45			3	176	225

Click on column heading to sort

ARM Tools Can Assist With Important Trial Activities

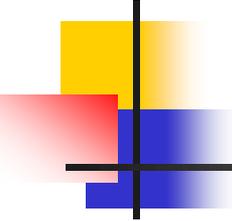
- Planning
- **Trial Layout**
- Data Review
- Statistical Analysis





Trial Layout

- Experimental site
 - Is it uniform?
 - Is there a known gradient?
- Use an effective Block (replicate)
 1. Placement: within rep more uniform than trial
 2. Shape: reduce distance between plots
- Want to decrease Error Sum of Squares by increasing Replicate Sum of Squares



Trial Layout Should Include Randomization Quality Review

Goal is to improve experiment precision:

1. Arrange replicates as squares, not strips
2. Equalize treatment distribution
 - a. Balance average distance from all other treatments
 - b. Balance "Edge effect" across treatments
3. Randomize all replicates

Trial Map

75%

Properties

- Color by
 - Replicate
 - Treatment
 - Current Treatment
- Auto-select for move
 - Treatment
 - 'Plot' Experimental Unit
 - Replicate

Treatment

Trt	Code	At Edge	Ave Dist.	StDev	Min	Max
1	CHK	3	79	18.6	40.4	121
2		3	96	26.2	40.4	128
3		2	76.5	26.6	19.1	128
4		3	86	24.6	46.8	138
5		2	82	20.0	46.8	117
6		2	69	21.0	38.3	106
7		2	67	13.9	49	102
8		2	68	18.2	27.6	102
9		2	66	25.6	19.1	117
10		2	64.7	23.2	25.5	117
11		2	69	19.2	27.6	104
12		2	66	21.8	25.5	106
13		?	61	22.3	25.5	125
14		a	56	17.6	21.3	89
15			67	22.8	32	125
16		2	64.7	22.3	27.6	123
17		2	71.5	24.0	27.6	113
18		2	67	25.0	27.6	110
19		2	60.6	19.2	21.3	102
20		2	63	24.2	27.6	125
21		2	79	27.4	25.5	128
22		2	69	27.0	14.9	121
23		2	70	26.0	14.9	110
24	REF	3	b	27.7	38.3	138

Options | Movement Arrows | Treatment Description | Comment | **Quality**

Suggested block size (*optimum):

Block Size	6	8*	12	24
Rep Width	50.5	67.5	101.5	203.5
Rep Length	103	77	51	25
Surface/Area	0.059	0.056*	0.059	0.090
Trial Width	50.5	67.5	101.5	203.5
Trial Length	415	311	207	103
Unused 'Plot'	0	0	0	0

Replicate shape

Replicate 1 is defined as non-randomized. It is best statistical practice to randomize all replicates.

1

2

3

a

b

Settings...
Re-Randomize
Re-Number 'Plots'
Accept Current
Cancel
Help

Arrange Replicates as Squares not Strips

"Optimum" is smallest surface-to-area ratio

Options	Movement Arrows	Treatment Description	Comment	Quality
Suggested block size (*=optimum):		<input type="button" value="Apply"/>		
Block Size	6	8*	12	24
Rep Width	50.5	67.5	101.5	203.5
Rep Length	103	77	51	25
Surface/Area	0.059	0.056*	0.059	0.090
Trial Width	50.5	67.5	101.5	203.5
Trial Length	415	311	207	103

Options	Movement Arrows	Treatment Description	Comment	Quality
Suggested block size (*=optimum):		<input type="button" value="Apply"/>		
Block Size	6	8*	12	24
Rep Width	50.5	67.5	101.5	203.5
Rep Length	103	77	51	25
Surface/Area	0.059	0.056*	0.059	0.090
Trial Width	50.5	67.5	101.5	203.5
Trial Length	415	311	207	103

Options	Movement Arrows	Treatment Description	Comment	Quality
Suggested block size (*=optimum):		<input type="button" value="Apply"/>		
Block Size	6	8*	12	24
Rep Width	50.5	67.5	101.5	203.5
Rep Length	103	77	51	25
Surface/Area	0.059	0.056*	0.059	0.090
Trial Width	50.5	67.5	101.5	203.5
Trial Length	415	311	207	103

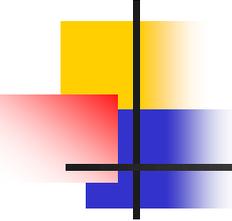
Options	Movement Arrows	Treatment Description	Comment	Quality
Suggested block size (*=optimum):		<input type="button" value="Apply"/>		
Block Size	6	8*	12	24
Rep Width	50.5	67.5	101.5	203.5
Rep Length	103	77	51	25
Surface/Area	0.059	0.056*	0.059	0.090
Trial Width	50.5	67.5	101.5	203.5
Trial Length	415	311	207	103

Equalize Treatment Distribution

"Undesirable" layout of 7 treatments and 5 replicates in Randomized Complete Block:

- Trt. 6 in middle 3 columns of all reps
- Trt. 5 in right 2 cols for all but one plot

2e	4e	7e	1e	6e	3e	5e
1d	7d	3d	4d	6d	2d	5d
7c	5c	4c	6c	2c	3c	1c
2b	1b	3b	6b	7b	5b	4b
7a	2a	6a	3a	4a	1a	5a

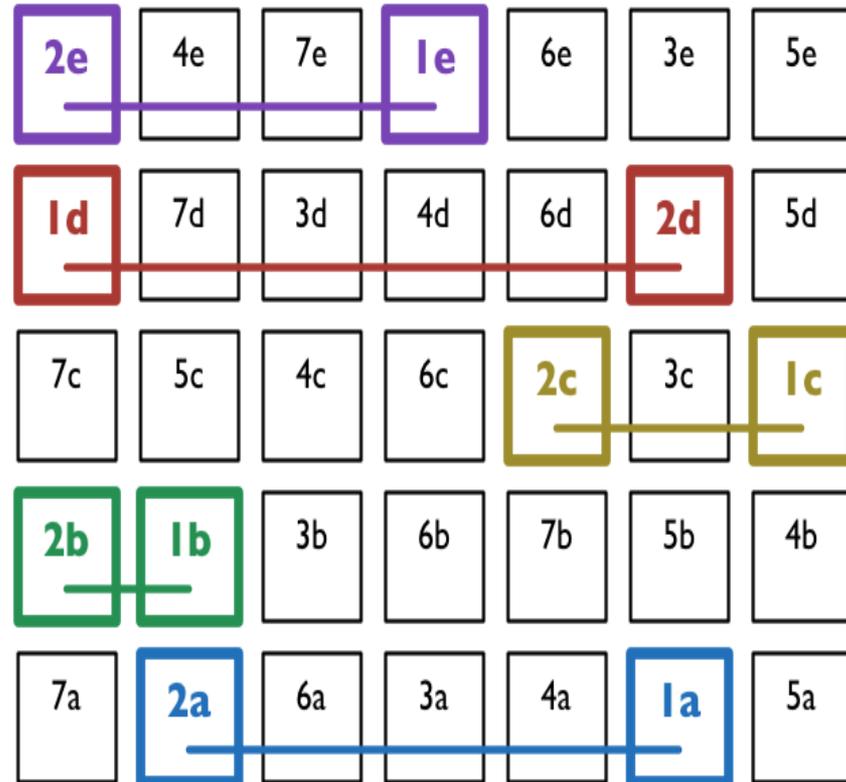


Uses "Average Distance of Treatment" Comparison (ADTC)

- van Es and van Es, "Spatial Nature of Randomization and Its Effect on the Outcome of Field Experiments", *Agronomy Journal*, 85:420-428 (1993).
- Comparison between treatments 1 and 2 is taken from 5 plots for each treatment.
- Measure the plot-to-plot distance for each plot containing treatment 1 to the paired plot within replicate containing treatment 2, for a total of 5 distances.
- ADTC for the treatment pair 1-2 is the average of the 5 distances.

Distances, Treatments 1-2

Average distance = 3 plots = 24 feet
for 8 foot
wide plots



Unequal Treatment Distribution

- Average distance from 17.9 to 24.6
- Ranges from 11.9(T3,T6) to 34(T2,T5)
- Error variances for treatments may not be homogeneous



Trt	At Edge	Ave Dist.	StDev	Min	Max
1	4	24.4	6.24	13.6	32.3
2	3	24.6	5.56	17	34
3	2	19.8	5.66	11.9	25.5
4	3	21.3	3.18	17	25.5
5	3	27	5.83	20.4	34
6	2	17.9	3.53	11.9	22
7	3	23.8	4.3	18.7	29

Unbalanced "Edge effect"

Treatment 1 occurs at edge 4 times,
T2 and T3 at edge only 2 times

501 7	502 2	503 6	504 3	505 4	506 1	507 5
401 2	402 1	403 3	404 6	405 7	406 5	407 4
301 7	302 5	303 4	304 6	305 2	306 3	307 1
201 1	202 7	203 3	204 4	205 6	206 2	207 5
101 2	102 4	103 7	104 1	105 6	106 3	107 5

Trt	At Edge	Ave Dist.	StDev	Min	Max
1	4	24.4	6.24	13.6	32.3
2	3	24.6	5.56	17	34
3	2	19.8	5.66	11.9	25.5
4	3	21.3	3.18	17	25.5
5	3	27	5.83	20.4	34
6	2	17.9	3.53	11.9	22
7	3	23.8	4.3	18.7	29

Properties

Color by

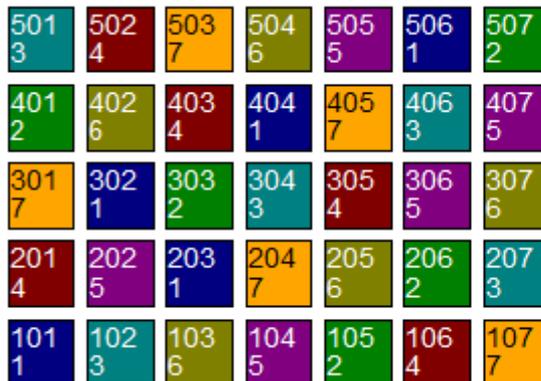
- Replicate
- Treatment
- Current Treatment

Auto-select for move

- Treatment
- 'Plot' Experimental Unit
- Replicate

Balanced Treatment Distribution and Edge Effect

- Average distance from 21.3 to 24.4
- Distances range from 18.7 to 27.2
- "Edge effect" is balanced



501 3	502 4	503 7	504 6	505 5	506 1	507 2
401 2	402 6	403 4	404 1	405 7	406 3	407 5
301 7	302 1	303 2	304 3	305 4	306 5	307 6
201 4	202 5	203 1	204 7	205 6	206 2	207 3
101 1	102 3	103 6	104 5	105 2	106 4	107 7

Trt	At Edge	Ave Dist.	StDev	Min	Max
1	2	22	2.15	20.4	25.5
2	3	23.8	3.57	18.7	27.2
3	3	24.4	1.76	22	27.2
4	3	22.4	3.47	18.7	25.5
5	3	22	3.4	18.7	27.2
6	3	21.3	2.58	18.7	25.5
7	3	22.7	2.56	18.7	25.5

Randomize All Replicates

- This frame displays when a non-randomized replicate is defined in Settings
- Select "Randomize All Replicates" to follow recommended statistical practice

Suggested block size (*=optimum):

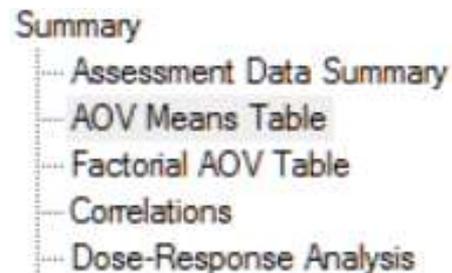
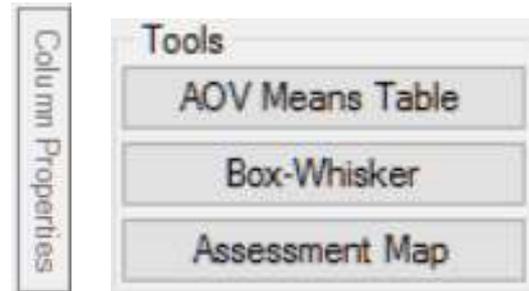
Block Size	6	8*	12	24
Rep Width	50.5	67.5	101.5	203.5
Rep Length	103	77	51	25
Surface/Area	0.059	0.056*	0.059	0.090

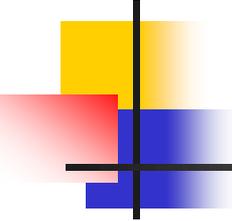
Replicate shape

Replicate 1 is defined as non-randomized. It is best statistical practice to randomize all replicates.

ARM Tools Can Assist With Important Trial Activities

- Planning
- Trial Layout
- **Data Review**
- Statistical Analysis





Assessment Data Review

- Check for measurement or entry mistakes
 - If possible, perform immediately after making the assessment, while it is still feasible to verify and correct any mistake
 - If do check "later", only option may be to mark any questionable measurement as missing data, losing 1 error DF for each missing data point
- Goal: preserve error DF for better precision

Assessment Data Review Tools

- **Column Properties panel**

- **Tools button group**

The screenshot displays the 'Assessment Data - Line 1' window. The 'Column 9 Properties' panel is highlighted with a red box and contains the following information:

Column 9 Properties	
Column Flags:	Original
Min/Max entry:	0 100
Low/High value:	0.00 90.00
Descriptive Statistics Refresh	
LSD P=.05:	19.666
Standard Deviation:	12.765
CV:	61.074
Grand Mean:	20.9
P(Bartlett's X2):	0.016
P(Friedman's X2):	0.072
Skewness:	0.3594
Kurtosis:	-1.0412
Replicate Prob(F):	0.6121
Treatment Prob(F):	0.0421

Below the statistics, a warning message is displayed: 'Does not meet assumptions of AOV: data has heterogeneity of variance' with a 'Fix' button.

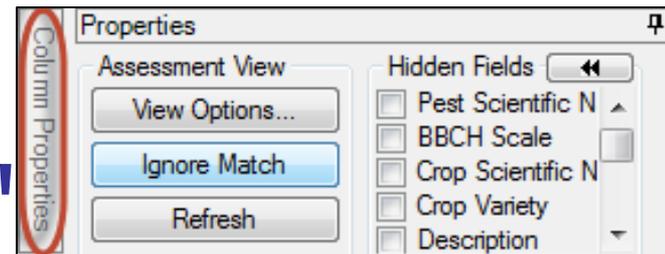
The 'Tools' button group, also highlighted with a red box, includes the following options:

- AOV Means Table
- Box-Whisker
- Assessment Map

The 'Properties' panel on the right shows the 'Assessment View' section with buttons for 'View Options...', 'Visible Col 13/13', and 'Refresh'. The 'Hidden: Row' section is also visible.

Assessment Data "Column Properties"

- "Pop-out" editor panel
- Presents analysis of the current data column
- Offers to attempt auto-fix for any violations of AOV assumptions
- Find statistical outliers



5
D Disease
SEPTR
Speckled leaf b
TRZAW
Winter wheat
LEAF3 P
18-Jun-2014
PESSEV
%
10
2

5
0.80
0.00
2.00
1.00
0.00
1.00
0.00
0.00
3.00
5.00
7.70
6.00
11.00

Assessment "Column Properties"

- Column navigation
- Column description
- Min & Max limits
- Actual value **range**
- Transformation formula description
- Click "Refresh" to update after changing current data column

Column 5 Properties		
<input type="button" value="Previous"/> <input type="button" value="Next"/>		
Column ID:	5	
Column Flags:	Original, Changed, ARM action code changed	
Min/Max entry:	0	100
Low/High value:	0.00	15.00
Formula AL:	LOG([5]+ 1)	
<input type="button" value="Refresh"/>		

Assessment "Column Properties"

- **Descriptive statistics** from full AOV of data
- Displays **violations** of AOV assumptions
- **"Fix"** prompts if can resolve violations

LSD P=.05:	2.598
Standard Deviation:	1.686
CV:	54.387
Grand Mean:	3.1
P(Bartlett's X2):	0.004
P(Friedman's X2):	0.078
Skewness:	1.8499
Kurtosis:	2.6407
Replicate Prob(F):	0.6123
Treatment Prob(F):	0.0004

Does not meet assumptions of AOV: data has heterogeneity of variance/skewness/kurtosis

Fix

ARM - SPECIAL CONFIRMATION

Apply automatic data correction transformation 'Log(n+1)' to data column 5 to correct ?

Yes No Help

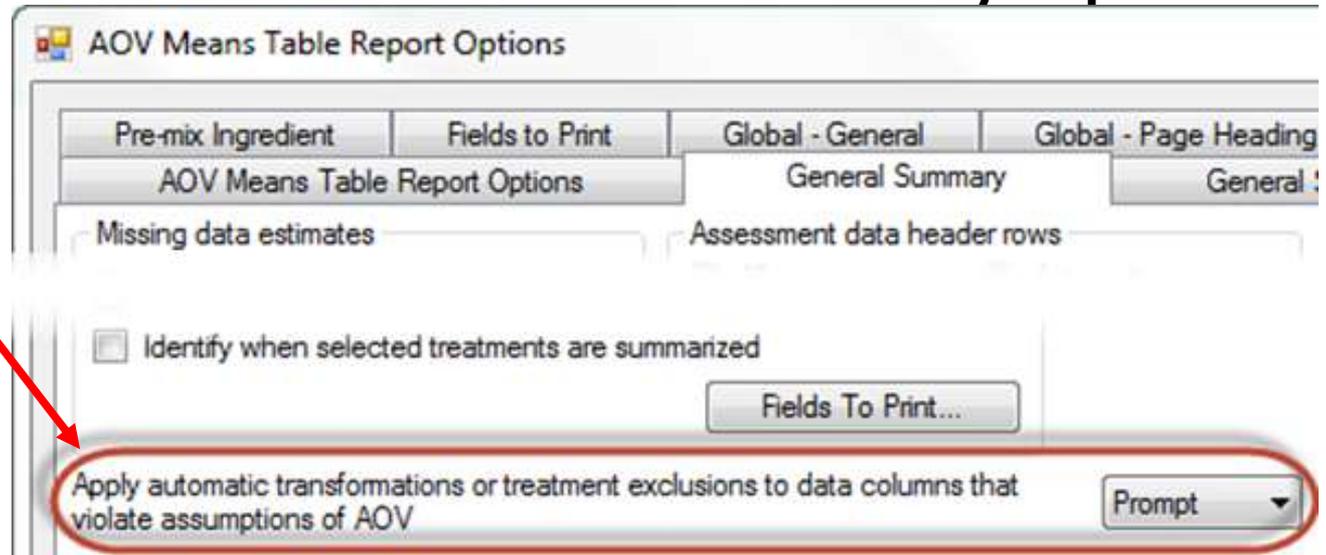
Assessment "Column Properties"

- **Search for outliers** in current data column using a standard outlier test
- "Find Next" locates each statistical outlier
- "Damaged" drops value from outlier test and AOV

The screenshot shows a data column with the following values: 9.5, 15.00, 10.00, 8.00, 5.50, 7.90, 8.00, 7.00, 12.00, 15.00, and 1.90. The value 9.5 is highlighted in blue. To the right, a dialog box displays a warning: "Does not meet assumptions of AOV: data has heterogeneity of variance/skewness/kurtosis". Below the warning is a "Fix" button. Under the "Outliers" section, the following options are visible: "Box-Whisker" (unselected), "> +/- 2 standard deviations from grand mean" (selected), "> +/- 3 standard deviations from grand mean" (selected), "Skip damaged assessments" (checked), and "Based on subsample values" (unchecked). A "Find Next" button is located at the bottom of the dialog box.

Assessment "Column Properties"

- **If** you will **consistently** review every assessment using Column Properties
- **Then** it is safe to set this summary option to 'No':



Assessment Data Review Tools

- Column Properties panel

- Tools button group

The screenshot displays the 'Assessment Data - Line 1' window. The 'Column 9 Properties' panel is highlighted with a red box. It contains the following information:

Column Number	9
Column Flags:	Original
Min/Max entry:	0 100
Low/High value:	0.00 90.00
Descriptive Statistics	
LSD P=.05:	19.666
Standard Deviation:	12.765
CV:	61.074
Grand Mean:	20.9
P(Bartlett's X2):	0.016
P(Friedman's X2):	0.072
Skewness:	0.3594
Kurtosis:	-1.0412
Replicate Prob(F):	0.6121
Treatment Prob(F):	0.0421

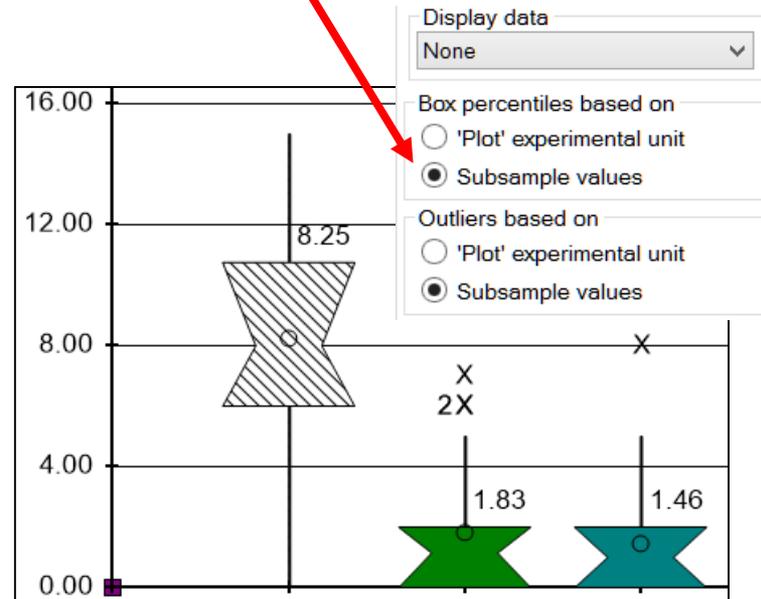
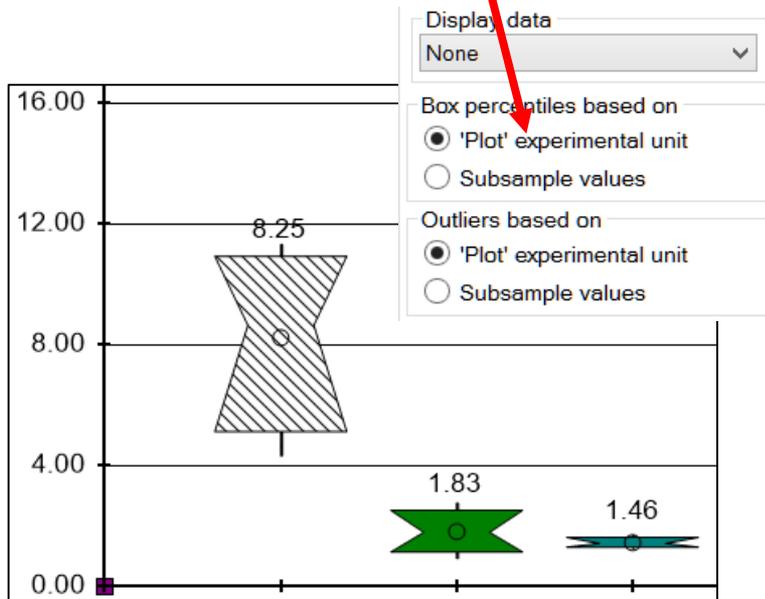
Below the statistics, a warning message is displayed: 'Does not meet assumptions of AOV: data has heterogeneity of variance'. A 'Fix' button is located below this message.

The 'Tools' button group is also highlighted with a red box. It includes the following buttons: 'AOV Means Table', 'Box-Whisker', and 'Assessment Map'.

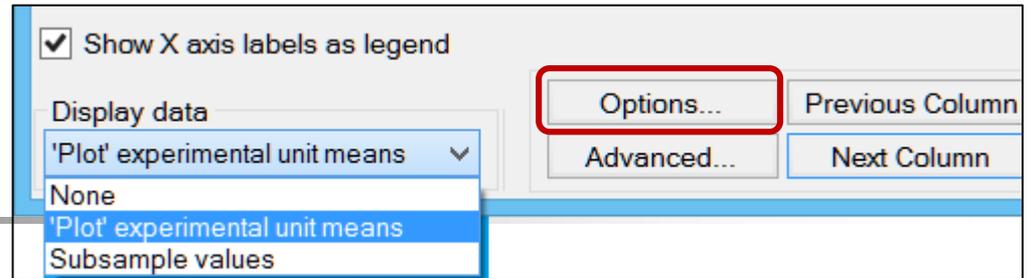
The 'Properties' panel on the right side of the window shows the 'Assessment View' section with buttons for 'View Options...', 'Visible Col 13/13', and 'Refresh'. Below this, the 'Hidden: Row' section is visible, along with a 'Views - Default - Brief field' section containing several view options, including 'Default - Brief fields visible' which is currently selected.

Box-Whisker Graph

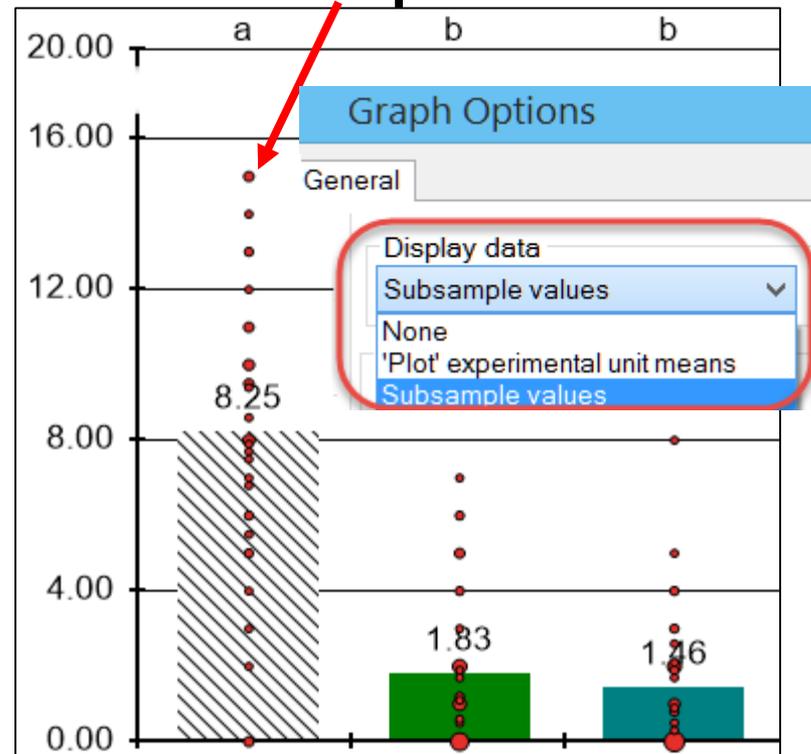
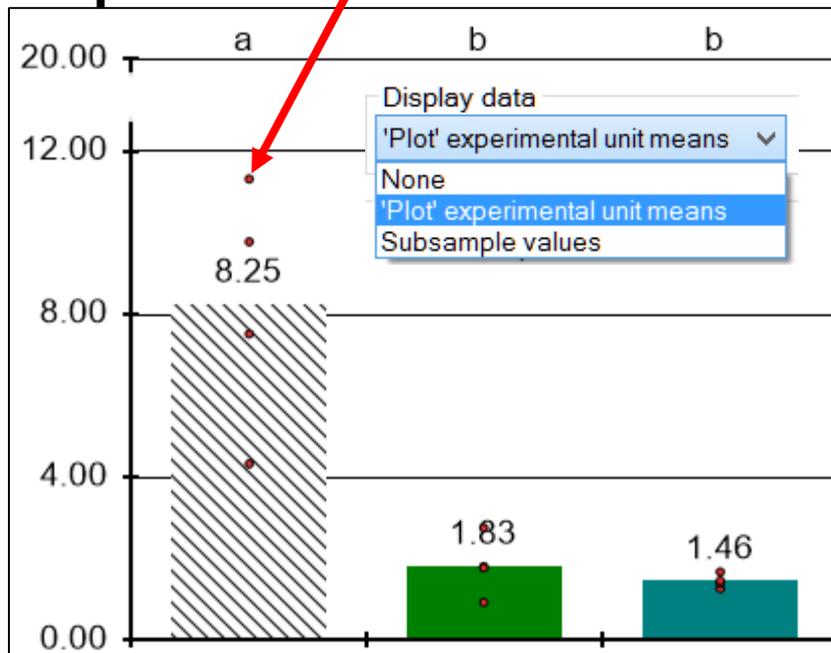
'Box percentiles' and 'Outliers based on' options of '**Plot**' or 'Subsamples' for box-whisker



Graphs



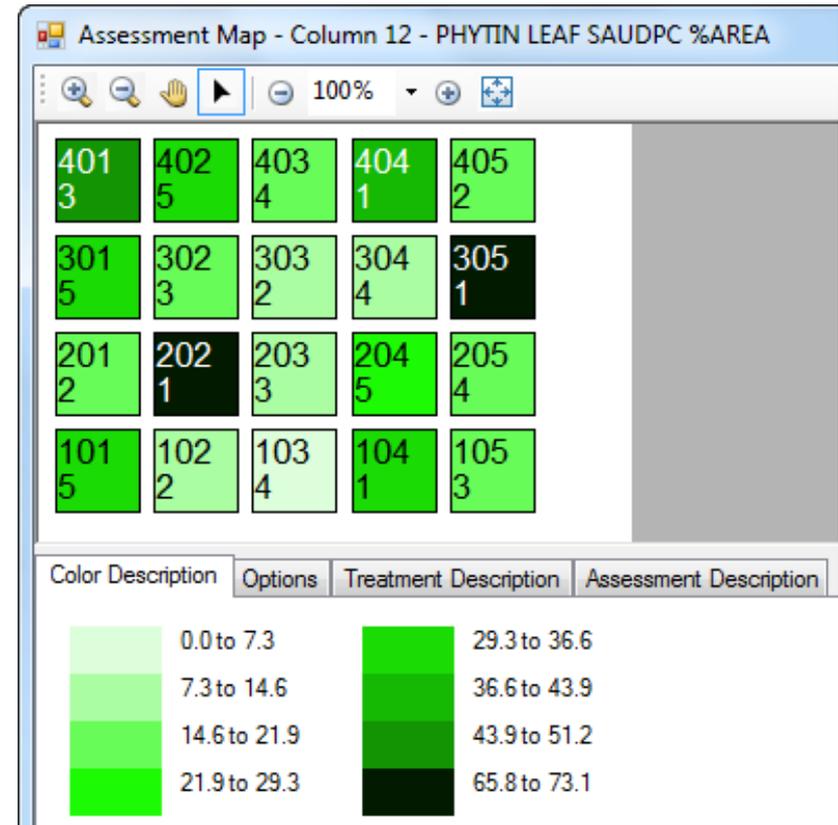
Use 'Display data' option to add scatter graph showing plot or individual subsample values as points



Assessment Map

"Heat map" shows response differences per assessment data column by color intensity:

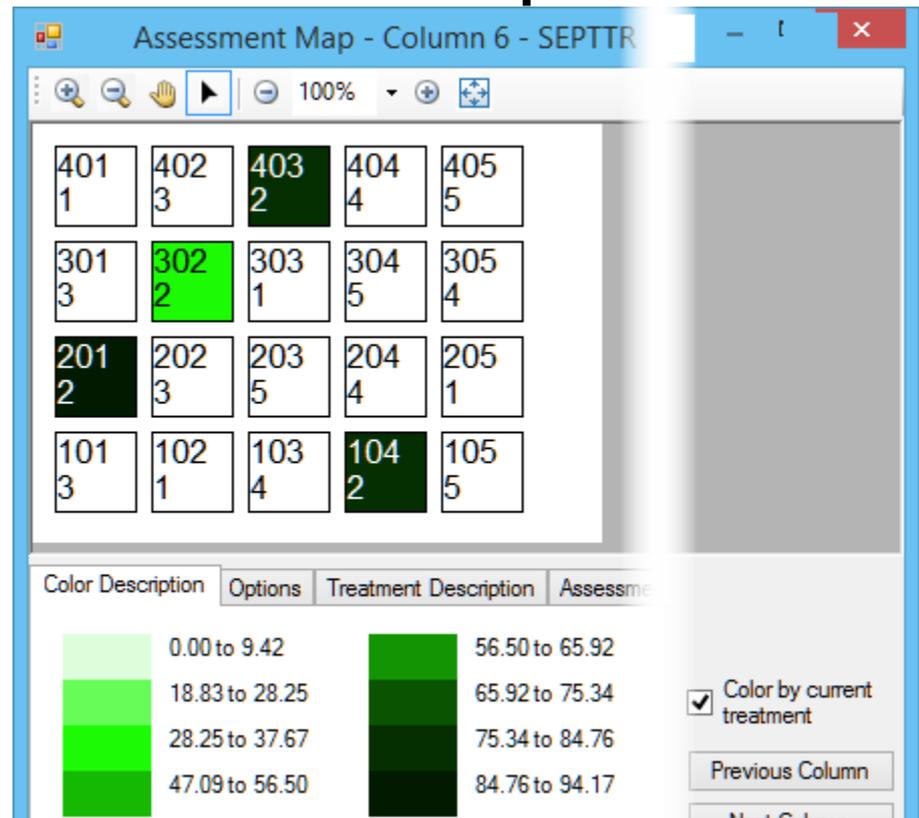
- Treatment consistency
- Possible site variations as dark or light zones
- Plot problems



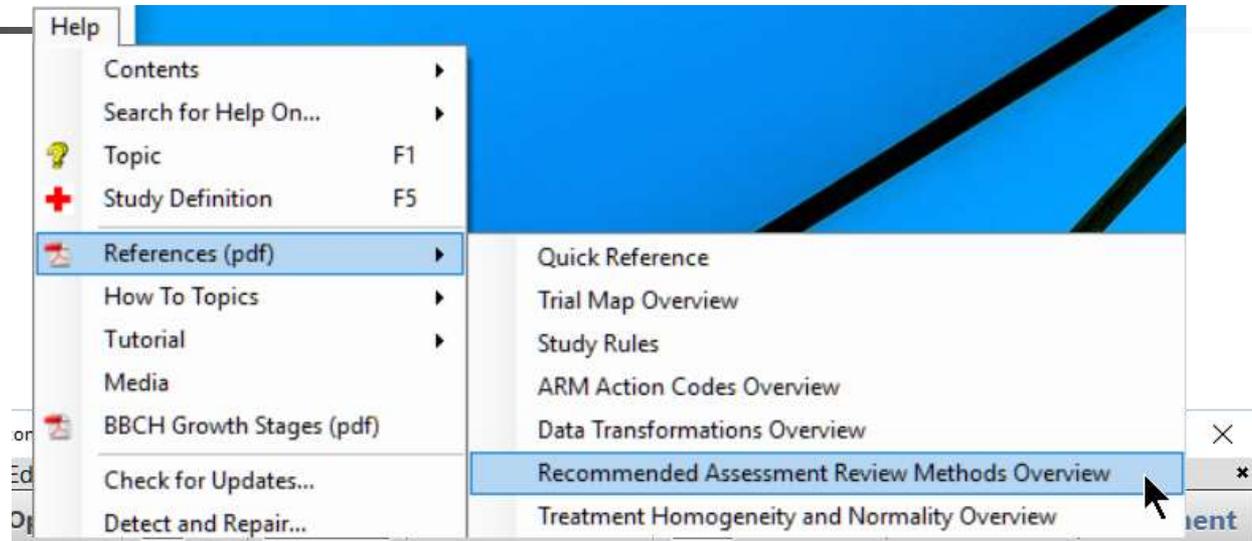
Assessment Map

'Color by current treatment' option:

- Easily review variation in each treatment
- Simpler to find position in each replicate for trial with many treatments



More Information in ARM Help



Recommended Assessment Review Methods

Recommended methods to review assessment data columns are located in **Properties** panel of the Assessment Data editor:

- **Column Properties** sub-panel
- **Tools** section of **Properties** panel

Recommended practices are to:

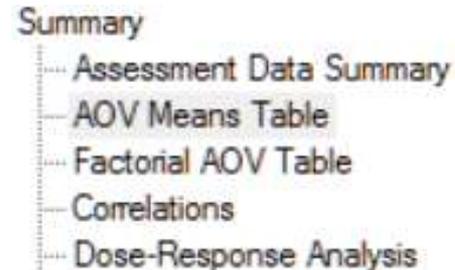
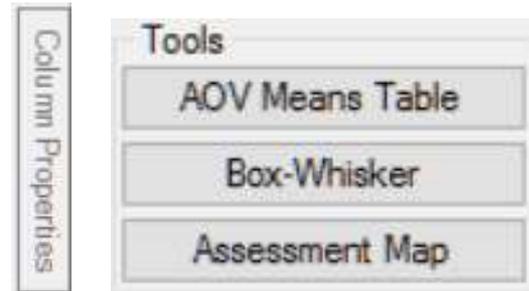
- Review new assessments while still **at trial site**, to most efficiently verify whether any unusual values may be from a data entry mistake or a possible site (non-treatment) effect.
- Use **Column Properties** to review for entry mistakes or violations of AOV assumptions
- Use **Tools** for detailed review:

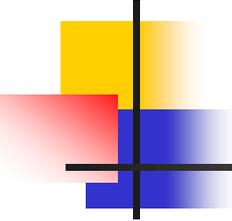
The screenshot shows the 'Assessment Data - Line 1' editor. The main table has columns for 'Sub', 'Rep', 'Blk', 'Col', 'Plot', and 'Trt'. The 'Col' column is selected, and the 'Column Properties' panel is open on the right. The 'Column Properties' panel has a 'Properties' section with 'Assessment View' and buttons for 'View Options', 'Ignore Match', and 'Refresh'. Below that is a 'Hidden: Row' section and a 'Views' section. The 'Tools' section at the bottom of the panel has buttons for 'AOV Means Table', 'Box-Whisker', and 'Assessment Map'. The 'Assessment Map' button is circled in red.

Sub	Rep	Blk	Col	Plot	Trt
1	1	1	1	101	3
2	1	1	1	101	3
3	1	1	1	101	3

ARM Tools Can Assist With Important Trial Activities

- Planning
- Trial Layout
- Data Review
- **Statistical Analysis**





Statistical Analysis Best Practices

- Use "**Least squares**" analysis options on AOV and Factorial AOV Reports
- Use "**Post-hoc power analysis**" to better plan follow-up experiments
- Do "**protected**" mean comparison tests
- **Be careful** using LSD to hand-compare treatment pairs on AOV Means when a data correction transformation is applied

AOV Means Table Report Options

"Analysis method" options:

- Least square estimation (like SAS GLM)
- Print adjusted means

AOV Means Table Report Options

Pre-mix Ingredient	Fields to Print	Global - General	Global - Page Heading
AOV Means Table Report Options		General Summary	General Summ

Adjusted treatment mean

Use adjusted mean as primary mean

Analysis method

Traditional AOV

Least square estimation

Factorial AOV Report Options

"Analysis method" options:

- Least square estimation (like SAS GLM)
- Print adjusted means (if missing data)

Factorial AOV Table Report Options

Report Options | General Summary | Report Preview

Mean comparison test

Test: Tukey's HSD

Significance or alpha level: 5%

Only when significant AOV treatment P(F)

Symbol indicating no significant difference between treatment means: -

Adjusted treatment mean

Use adjusted mean as primary mean

Descriptive statistics for each factor mean section

LSD (or HSD if Tukey's)

Standard Deviation

Coefficient of Variation

AOV tables to print

Complete

Pooled error

Both

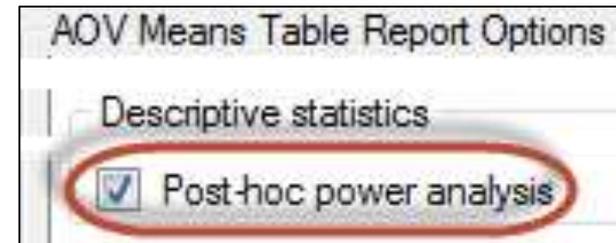
Analysis method

Traditional AOV

Least square estimation

Post-hoc Power Analysis (for Follow-Up Experiments)

- Optional descriptive statistic on AOV Means Table report
- Lists, for each assessment column, the minimum number of replicates required to statistically separate treatment means based on Treatment P(F) and current significance level
- Use for planning future trials



Post-hoc Power Analysis (for Follow-Up Experiments)

- In example, LSD can distinguish a 25% mean difference, yet largest existing difference is 18%
- Current AOV Trt P(F) is 0.2979, so use 0.30+ significance level to separate treatment means
- Need 8+ replicates to reject null hypothesis at 0.05 significance

Crop Variety	CEZANNE
Trt No.	24
	2 85.33 a
	3 81.67 a
	4 98.00 a
	5 95.33 a
LSD P=.05 (% mean diff)	21.808 (25%)
Standard Deviation	10.915
CV	12.12
Grand Mean	90.083
Minimum Replicates (power = 80)	8
Largest Mean Difference (% mean diff)	16.333 (18%)
Treatment F	1.541
Treatment Prob(F)	0.2979

"Protected" Mean Comparison Test

Mean comparison test is only performed on assessment data columns when the α Signif. Level \geq AOV Treatment Prob(F)

α SL=0.05

Trt No.	g*
1	2.50 b
2	22.50 ab
3	33.00 a
4	29.00 ab
5	17.50 ab
LSD P=0.05	19.666
CV	61.07
Replicate F	0.626
Replicate Prob(F)	0.6121
Treatment F	3.466
Treatment Prob(F)	0.0421

α SL=0.01

Trt No.	g*
1	2.50 -
2	22.50 -
3	33.00 -
4	29.00 -
5	17.50 -
LSD P=0.01	27.570
CV	61.07
Replicate F	0.626
Replicate Prob(F)	0.6121
Treatment F	3.466
Treatment Prob(F)	0.0421

AOV Means Table Report

If data is transformed by square root, log, or arcsine SQR %: shows range of LSD values used to compare the largest and smallest **non-zero** means - is a range because they are all **non-linear** transformations

Pest Code		SEPTTR	SEPTTR
Part Rated		LEAF3 P	LEAF2 P
Rating Date		Jun-18-2014	Jul-2-2014
Rating Type		PESSEV	PESSEV
Rating Unit		%	%
Days After First/Last Applic.		64 15	78 29
ARM Action Codes		AL	AA
Trt No.	Treatment Name	Rate	Rate
		Unit	Unit
		5*	7*
1	Untreated Check		
		6.89 a	15.14 a
2	Tub	0.5 l/ha	
		1.28 b	1.23 bc
3	Tub	1 l/ha	
		1.04 b	0.40 c
4	Tilt 250	0.5 l/ha	
		1.60 b	1.51 bc
5	Mico 60 Fungol	1.5 l/ha 1.25 l/ha	
		1.19 b	3.09 b
LSD P=.05		1.878 - 3.785	1.218 - 4.299
CV		39.69t	23.81t

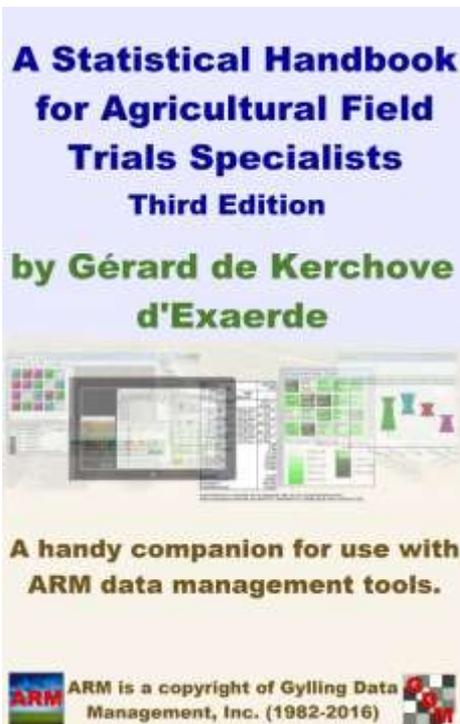
AOV Means Table Report

Example using this log transform:

- Compare 6.89 vs. 1.60 using $LSD \approx 3.785$
(largest mean vs. next largest)
- Compare 1.04 vs. 1.19 using $LSD \approx 1.878$
(smallest mean vs. next smallest)

Rating Type	PESSEV
Rating Unit	%
ARM Action	AL
Trt Treatment No. Name	5*
1 Untreat	6.89 a
2 Tub	1.28 b
3 Tub	1.04 b
4 Tilt 250	1.60 b
5 Mico 60 Fungol	1.19 b
LSD P=.05	1.878 - 3.785

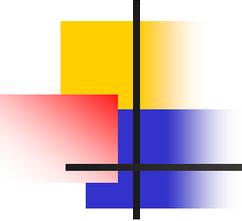
Additional Information, See Statistical Handbook 3rd Edition



A Statistical Handbook for Agricultural Field Trials Specialists: A handy companion for use with ARM data management tools

Available as an eBook from:

- Amazon: <https://www.amazon.com/Statistical-Handbook-Agricultural-Trials-Specialists-ebook/dp/B01KIHJRWQ/> also offered in Print
- Kobo: <https://store.kobobooks.com/en-us/ebook/a-statistical-handbook-for-agricultural-field-trials-specialists>



Thank You

Contact us with questions at
GDM.ARM.Support@gdmdata.com

