

ARM 10.2015

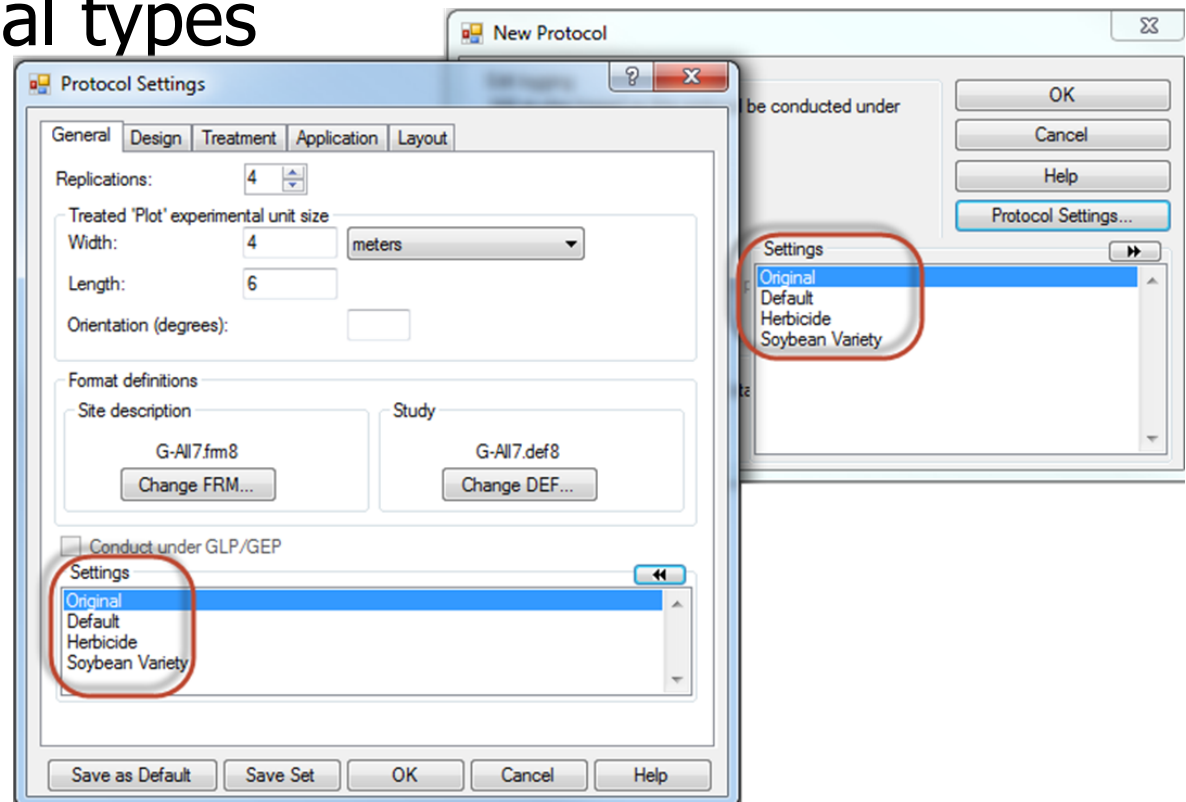
Features



Gylling Data Management, Inc.

"New Protocol" Option Sets

- "Save Set" button to create appropriate defaults for different trial types
- Select set in New Protocol dialog or General tab of Protocol Settings





Power and Efficiency Planner, Plan Experiments to Have:

- A reasonable chance of distinguishing anticipated treatment differences
- The optimum number of replicates required to meet objectives
- An efficient experimental design and randomization for desired precision
- Cost-effective utilization of the available experimental area



Why is Planning Critical?

- Can reduce costs by selecting optimum number of replicates and samples
- Expected treatment differences are typically $< 10\%$, and frequently $< 5\%$, so small precision gains can help to:
 - Distinguish an actual treatment difference (reject null hypothesis H_0)
 - Strengthen evidence of no treatment diff.) (do not reject null hypothesis H_0)

Power and Efficiency Planner

Protocol Settings

General Design Treatment Application Layout

Randomized Complete Block (RCB)

Factors: 1

Treatments

A: 5

B:

C:

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

Power and Efficiency

CV 10.0 Reps 4 Power 80 OSL 5% % Mean Diff 10.0

Lock at

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

Save as Default Save Set OK Cancel Help



Power and Efficiency Planner

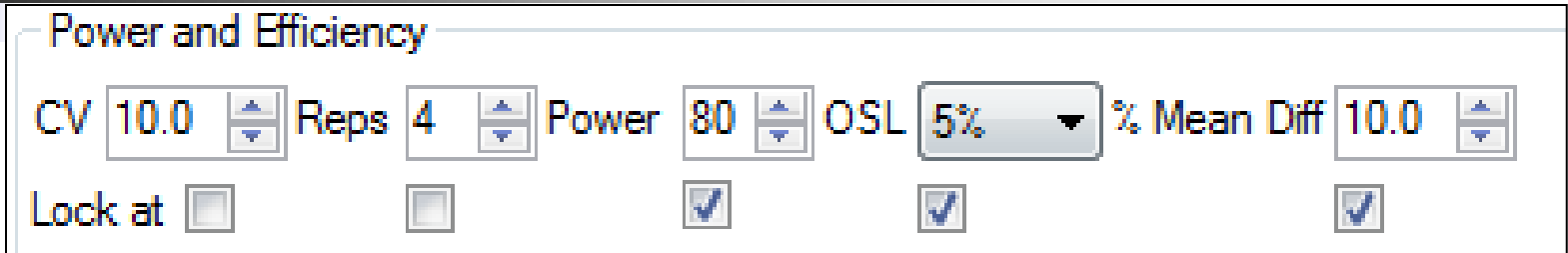
- Help plan experiments that successfully detect expected treatment differences
- Available in both protocols and trials so:
 - Protocol writers can more effectively plan experiments
 - Trialists can verify whether CV expectations are realistic based on local experience for specified crop(s)



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%)
 - Observed 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

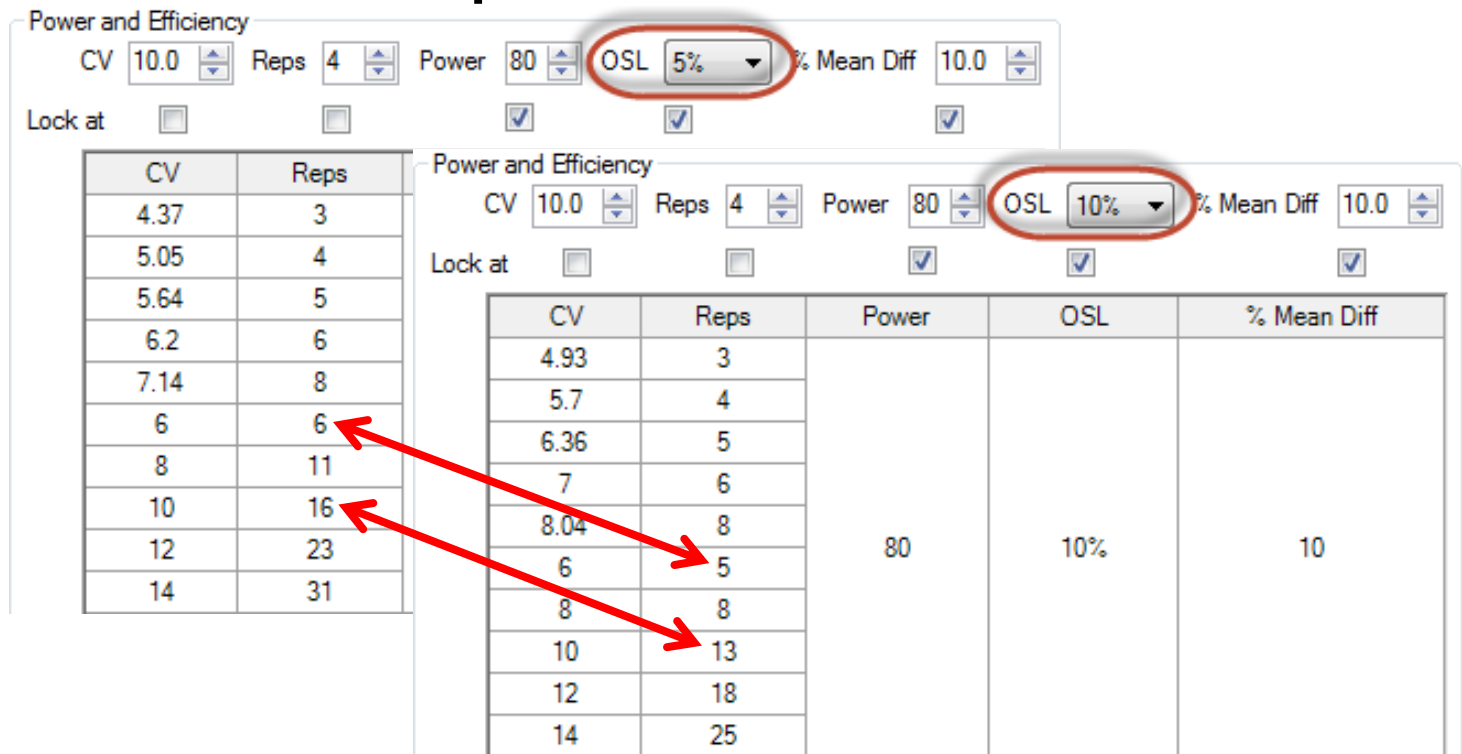
CV 10.0 Reps 4 Power 80 OSL 5% % Mean Diff 10.0

Lock at

- "Lock at" to keep 3-4 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 a CV



Power and Efficiency Planner

- Consider impact of Reps on precision to detect treatment differences

Power and Efficiency

CV 5.0 Reps 4 Power 80 OSL 10% % Mean Diff 5.0

Lock at

CV	Reps	Power	OSL	% Mean Diff
5	3	80	10%	10.2
	4			8.8
	5			7.9
	6			7.2
	7			7
	8			6.2
	9			6
	13			5
	20			4
	35			3

Click on column heading to sort



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		2	61	22.3	25.5	125
14		2	56	17.6	21.3	89
15		2	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	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

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
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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

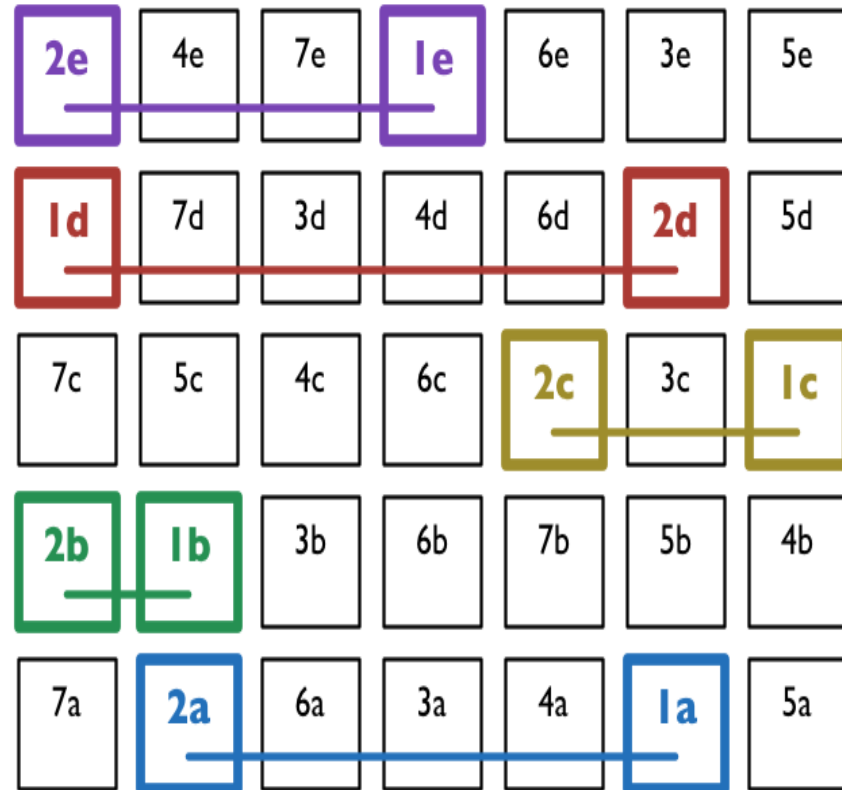


Uses “Average Distance of Treatment” Comparison (ATDC)

- van Es and van Es, “Spatial Nature of Randomization and Its Effect on the Outcome of Field Experiments”, *Agron J*, 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

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

Replicate shape

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



Post-hoc Power Analysis

- Optional descriptive statistic printed 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

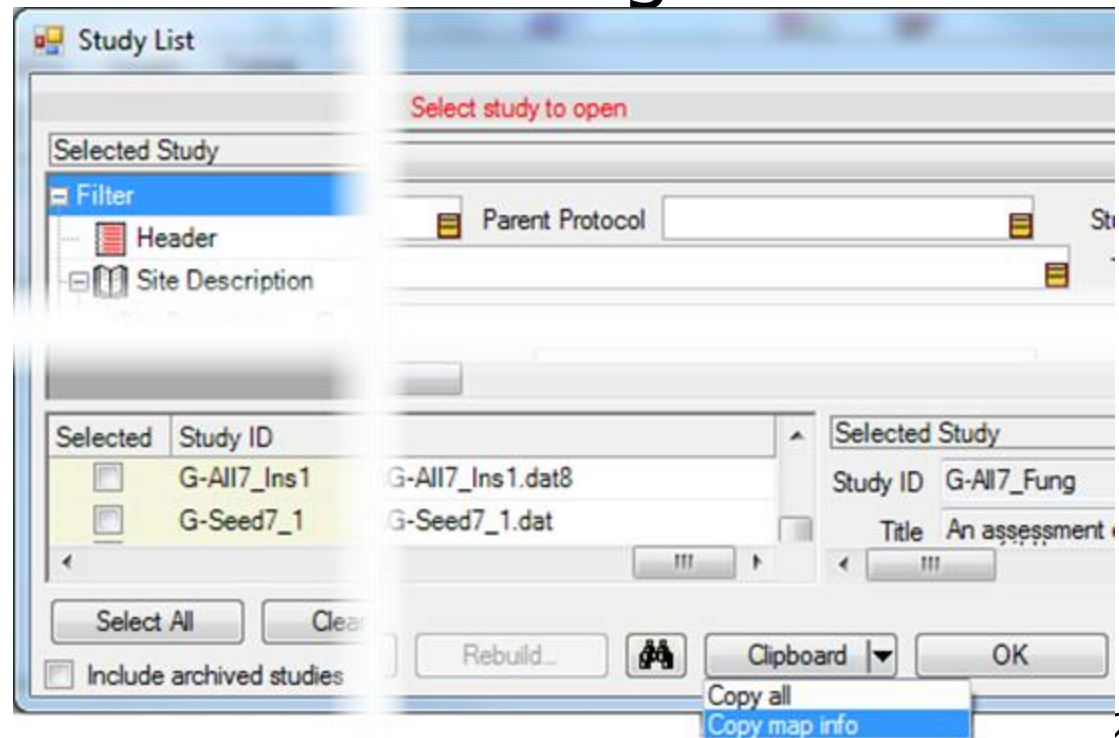
Post-hoc Power Analysis

- In example, LSD can distinguish 25% mean difference (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

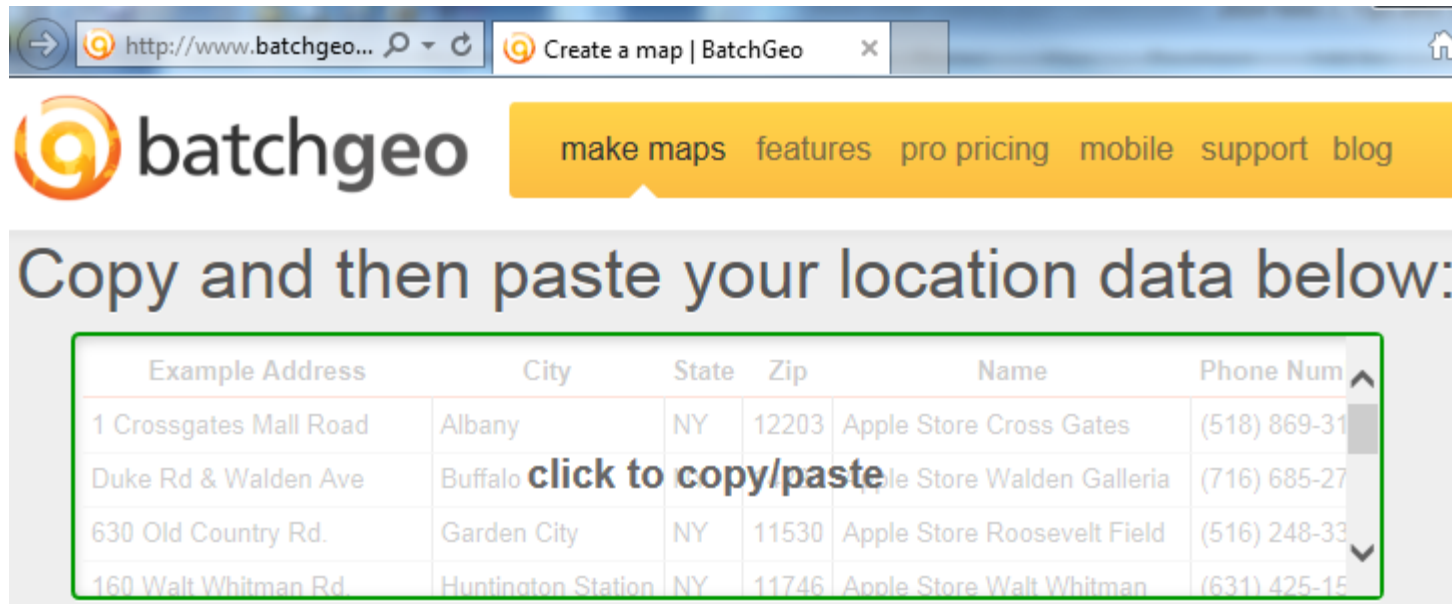
Map Trials from Study List 1 of 3

- Select trials of interest
- Copy map latitude and longitude to clipboard



Map Trials from Study List 2 of 3

- ARM opens batchgeo.com website
- Right-click in batchgeo.com location grid, and then paste



The screenshot shows a web browser window with the URL <http://www.batchgeo.com>. The page features the batchgeo logo and a navigation menu with links for "make maps", "features", "pro pricing", "mobile", "support", and "blog". Below the navigation is a heading that reads "Copy and then paste your location data below:". Underneath this heading is a table with a green border. The table has six columns: "Example Address", "City", "State", "Zip", "Name", and "Phone Num". The first row is highlighted in light blue. A text overlay "click to copy/paste" is positioned over the second row of the table.

Example Address	City	State	Zip	Name	Phone Num
1 Crossgates Mall Road	Albany	NY	12203	Apple Store Cross Gates	(518) 869-31
Duke Rd & Walden Ave	Buffalo	NY	14222	Apple Store Walden Galleria	(716) 685-27
630 Old Country Rd.	Garden City	NY	11530	Apple Store Roosevelt Field	(516) 248-33
160 Walt Whitman Rd.	Huntington Station	NY	11746	Apple Store Walt Whitman	(631) 425-15

Map Trials from Study List 3 of 3

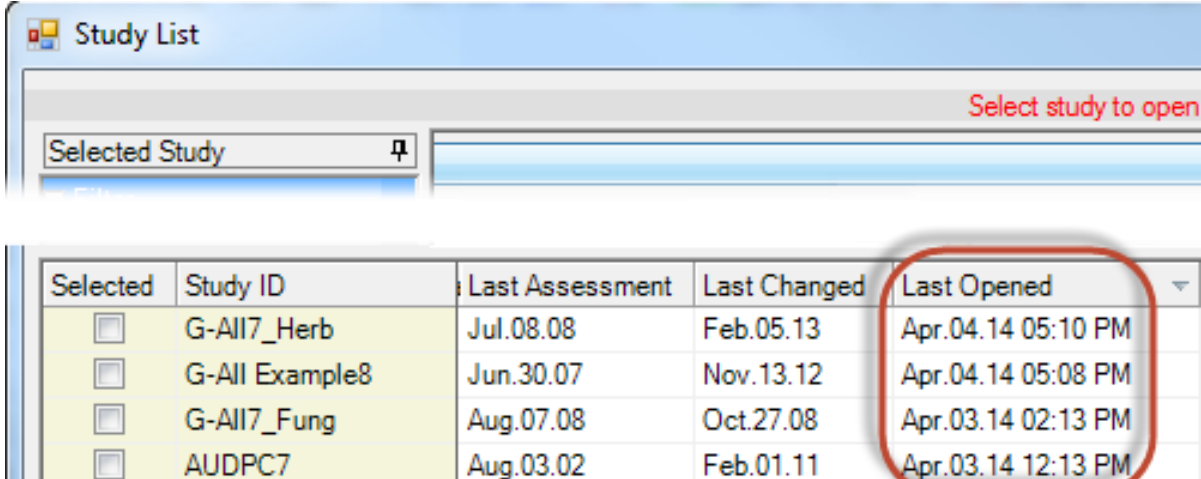
- Select "Map Now" button

Map Now



Study List, Recently Changed

- 'Last Opened' column in study list includes time
- Most recent study is always the top row until default sort order is changed

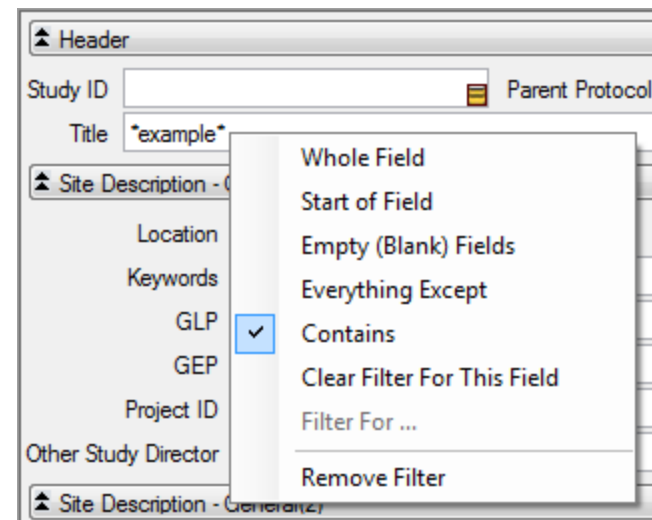


The screenshot shows a window titled "Study List" with a search bar and a table. The table has the following data:

Selected	Study ID	Last Assessment	Last Changed	Last Opened
<input type="checkbox"/>	G-All7_Herb	Jul.08.08	Feb.05.13	Apr.04.14 05:10 PM
<input type="checkbox"/>	G-All Example8	Jun.30.07	Nov.13.12	Apr.04.14 05:08 PM
<input type="checkbox"/>	G-All7_Fung	Aug.07.08	Oct.27.08	Apr.03.14 02:13 PM
<input type="checkbox"/>	AUDPC7	Aug.03.02	Feb.01.11	Apr.03.14 12:13 PM

Study List Filter Form

- Clicking into a field on filter form automatically scrolls lower grid to the matching column
- Right-click menu



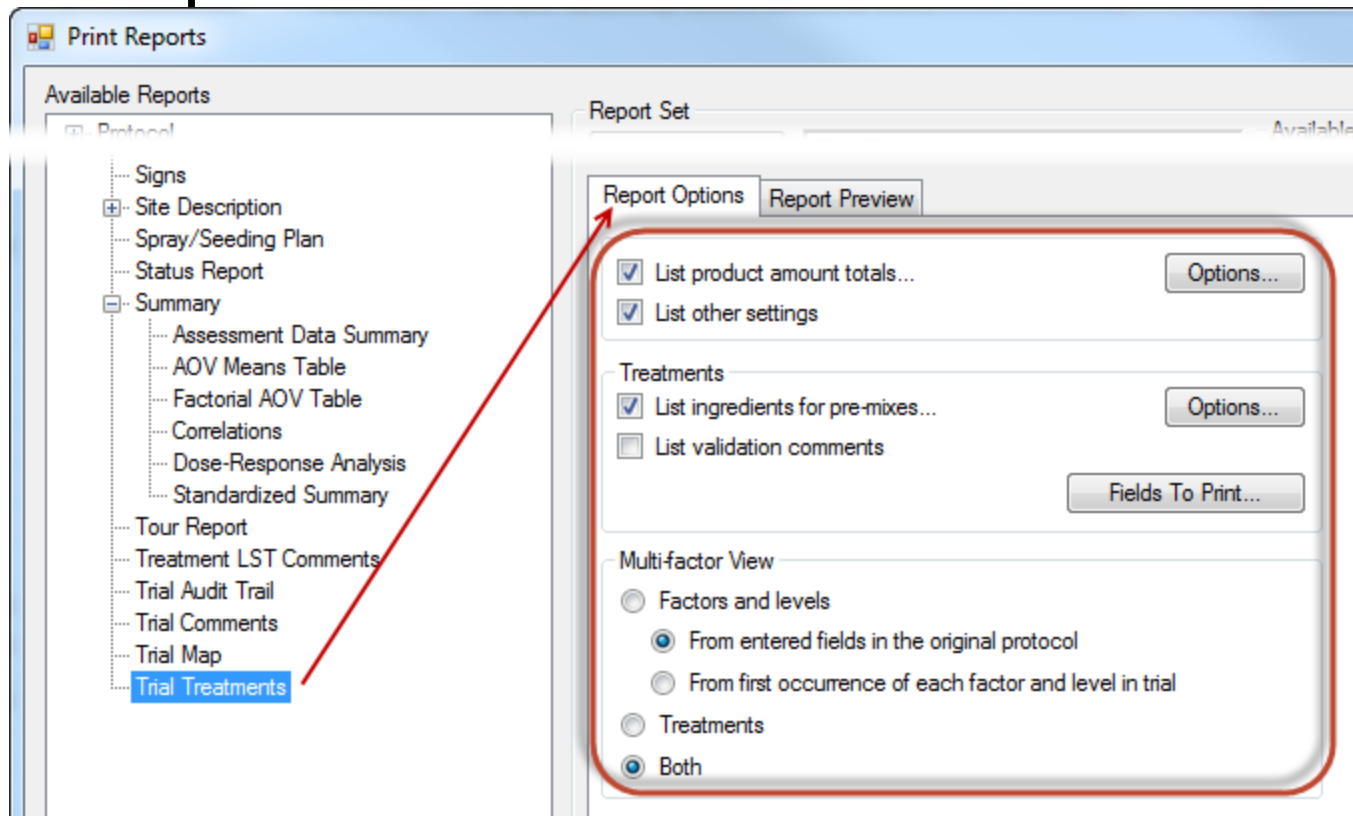
Study List Filter Form

- Right-click menu

The screenshot displays the 'Study List Filter Form' interface. The main form includes sections for 'Header' (Study ID, Parent Protocol, Title), 'Site Description - General(1)' (Location, Keywords, GLP, Investigator, GEP, Study Director), and 'Site Description - General(2)' (Project ID, Other Study Director, Organization, Technician, Other Investigator, Trial Location City). A right-click context menu is open over the 'Title' field, which contains the text '*example*'. The menu options are: 'Whole Field', 'Start of Field', 'Empty (Blank) Fields', 'Everything Except', 'Contains' (highlighted with a blue checkmark), and 'Clear Filter For This Field'. Below the main form, a detailed view of the 'Filter (Title)' section is shown, listing radio button options: 'All', 'Trials' (selected), 'Protocols', 'er For ...', 'When was it modified?' (set to 'Don't remember'), 'Remove Filter', 'Filter (Title)', 'Whole Field', 'Start of field', 'Empty (Blank) Fields', 'Everything Except', 'Contains' (selected), 'Clear Filter for this Field', and 'Filter For ...'. At the bottom, it shows 'From:' and 'To:' input fields, and an 'Active Filter (19):' summary listing 'Active Studies', 'Study Type is 'Trial'', and 'Title contains 'example''.

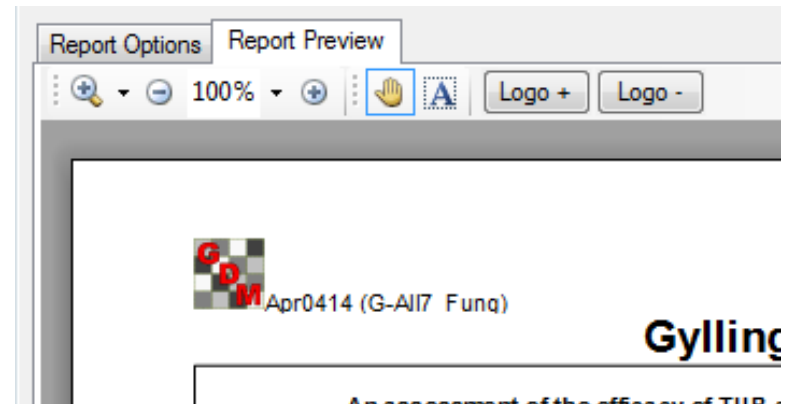
Report Options

- Directly set report options on option tab - simple and intuitive



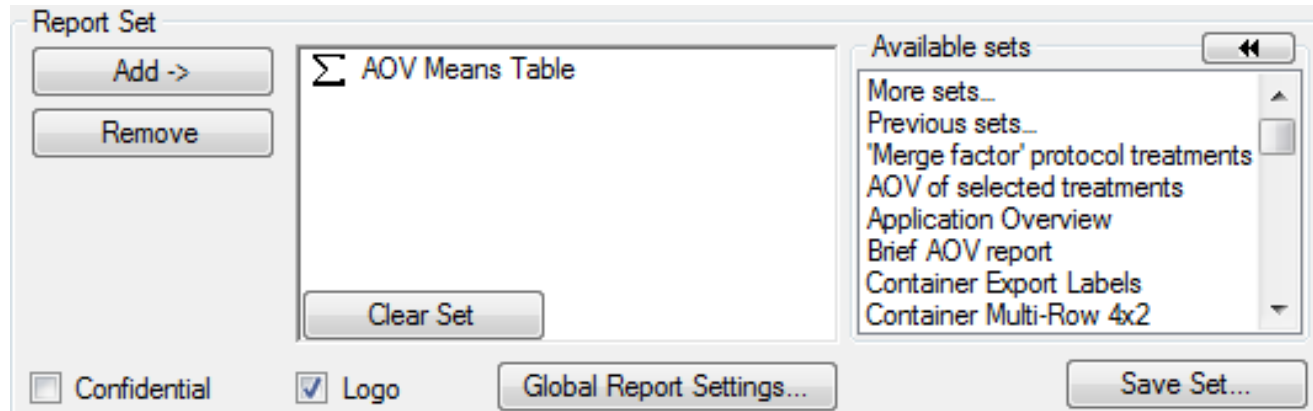
Report Preview

- Report Preview tab stays open
 - One-click preview of reports
 - Zoom in/out
 - Adjust logo size
 - Quickly find a label by clicking through list of available labels



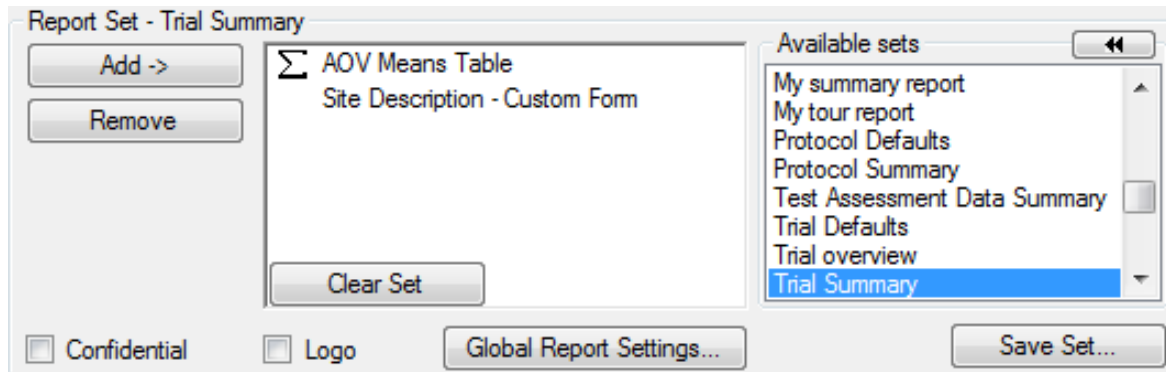
Report Sets

- New list box displays available sets
 - Click once to select a set from list
 - “More sets” to browse
 - Shows lists across all language subfolders

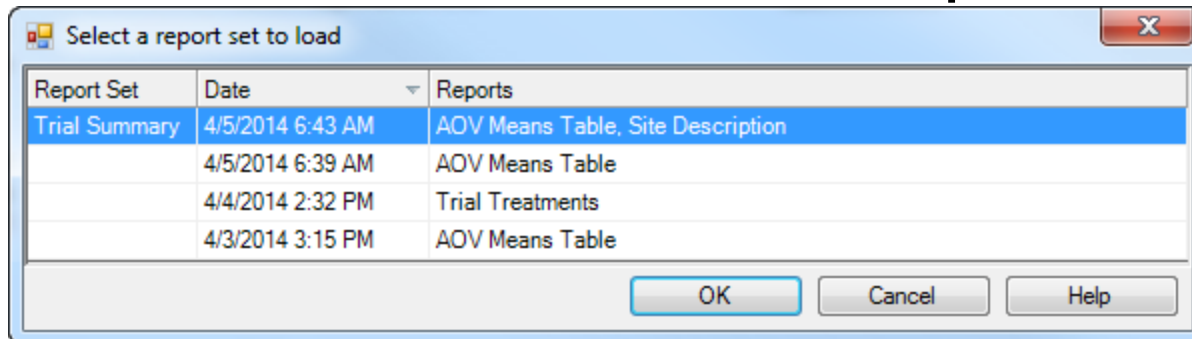


Report Sets

- Last selected set highlighted by default

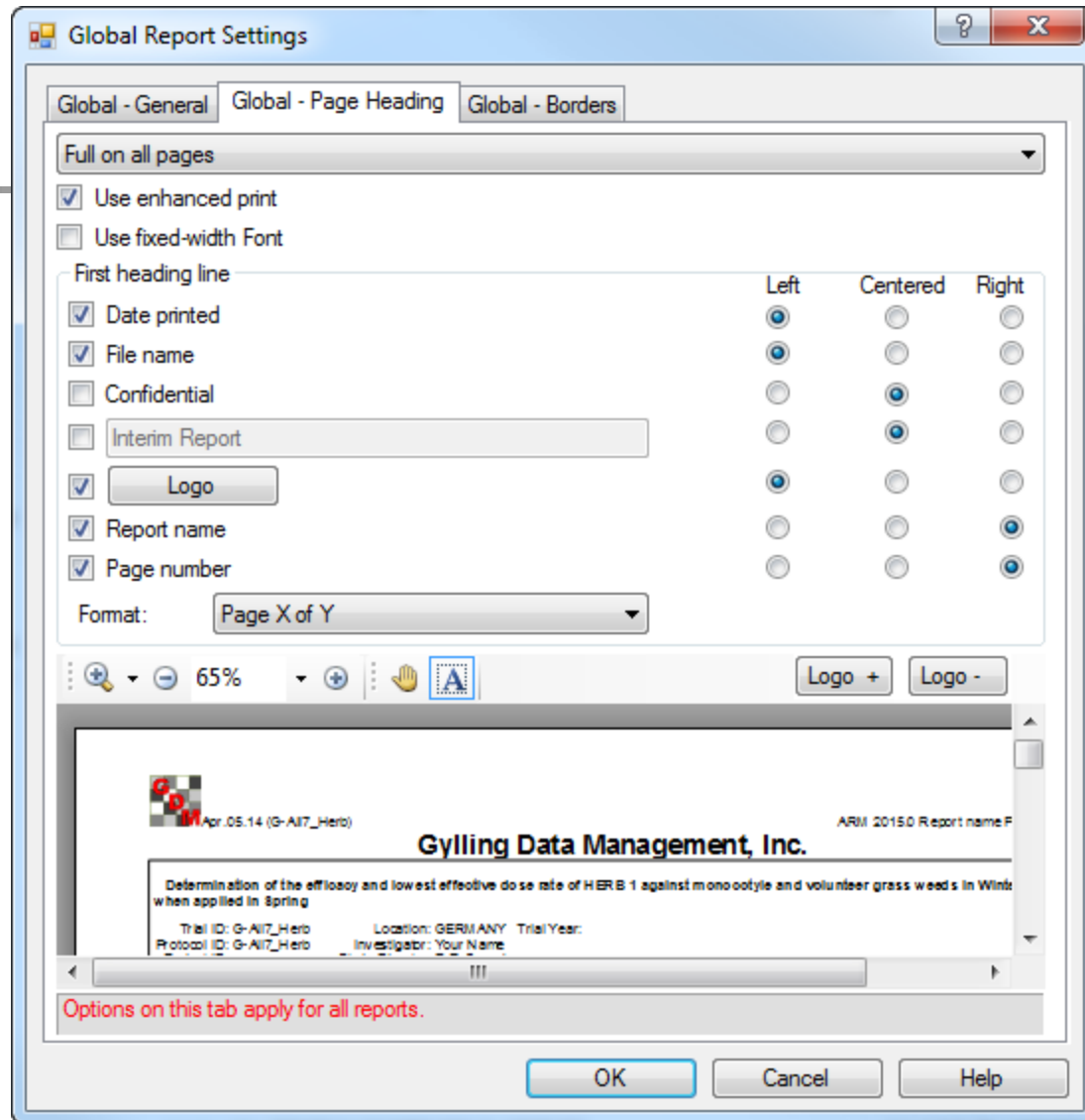


- “Previous sets” shows the report history

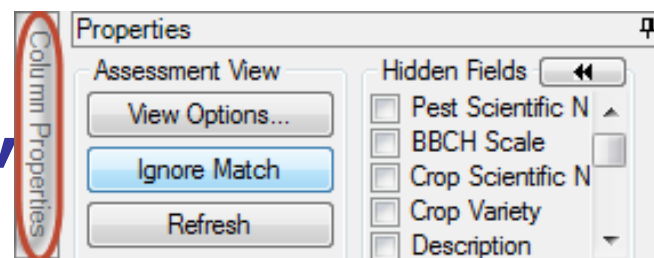


Page Heading

- Customize arrangement
- Simple way to add a logo and adjust logo size and position on report



Assessment Data "Column Properties"



- New editor panel
- Summarizes the current assessment data column
- Presents analysis results
- Fix violations of AOV assumptions
- Find statistical outliers

Column 5 Properties

Previous Next

Column ID: 5

Column flags: Original

Min/Max entry: 0 100

Low/High value: 0.00 15.00

Descriptive Statistics Refresh

LSD	2.598
Standard Deviation	1.686
CV	54.387
Grand Mean	3.1
Bartlett's X ²	15.5
P(Bartlett's X ²)	0.004
Friedman's X ²	8.4
P(Friedman's X ²)	0.078
Skewness	1.8499
Kurtosis	2.6407
Replicate F	0.625
Replicate Prob(F)	0.6123
Treatment F	11.778
Treatment Prob(F)	0.0004

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

Fix

Outliers

Box-Whisker

> +/- 2 standard deviations from grand mean

> +/- 3 standard deviations from grand mean

Skip damaged assessments

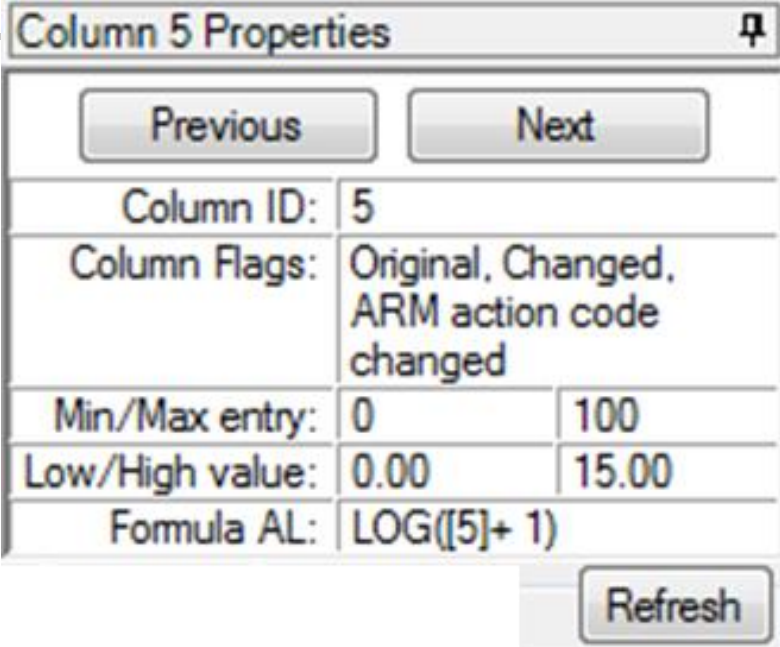
Based on subsample values

Find Next

Assessment Data

“Column Properties”

- Column navigation
- Column description
- Min, Max, Range
- Transformation formula description
- Click “Refresh” to update after changing current data column



Column 5 Properties		
Previous 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)	
Refresh		

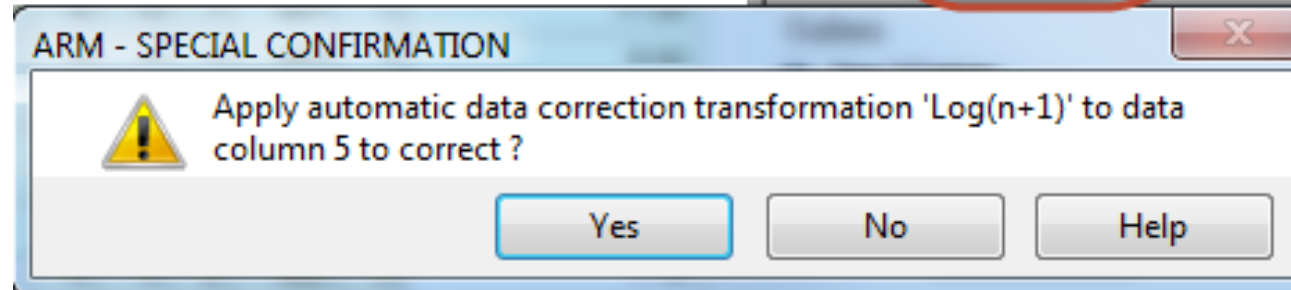
Assessment Data "Column Properties"

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

Column 5 Properties	
Descriptive Statistics Refresh	
LSD	2.598
Standard Deviation	1.686
CV	54.387
Grand Mean	3.1
Bartlett's X2	15.5
P(Bartlett's X2)	0.004
Friedman's X2	8.4
P(Friedman's X2)	0.078
Skewness	1.8499
Kurtosis	2.6407
Replicate F	0.625
Replicate Prob(F)	0.6123
Treatment F	11.778
Treatment Prob(F)	0.0004

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

Fix



Assessment Data

“Column Properties”

- Search for outliers in current data column using a standard outlier test
- “Find Next” locates each statistical outlier
- “Damaged” drop from outlier test and AOV

The screenshot displays a software interface for data analysis. On the left, a vertical list of data points is shown for column 5: 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 of the data list is a control panel. At the top, a red warning icon and text state: "Does not meet assumptions of AOV: data has heterogeneity of variance/skewness/kurtosis". Below this is a "Fix" button. Under the heading "Outliers", there are three radio button options: "Box-Whisker", "> +/- 2 standard deviations from grand mean", and "> +/- 3 standard deviations from grand mean". The third option is selected. There are also two checked checkboxes: "Skip damaged assessments" and "Based on subsample values". A "Find Next" button is located at the bottom of the outlier options. To the right of the main control panel is a sidebar with an "Assessment Map" button, a "Treatment" section with a "Display current treatment" checkbox, and an "Assessment (Plot 205, Col 5)" section with a "Comment:" text field, a "Barcode:" field, a "GPS:" field, and a "Damaged" checkbox.

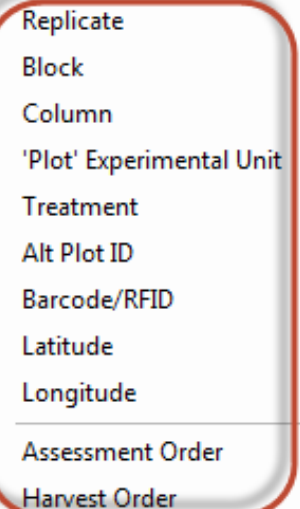
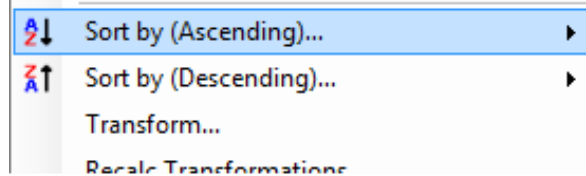
New Assessment Sorts

- Sort data by any 'plot' experimental unit description column
- Click heading once for ascending sort, click again for descending sort

+ Sub	Rp	Bk	Col	Plot	Tit	3
1	4	4	5	405	5	10.00
1	4	4	4	404	4	0.00
1	4	4	3	403	2	3.00
1	4	4	2	402	3	0.00
1	4	4	1	401	1	0.00
1	3	3	5	305	4	3.00
1	3	3	4	304	5	0.00
1	3	3	3	303	4	0.00

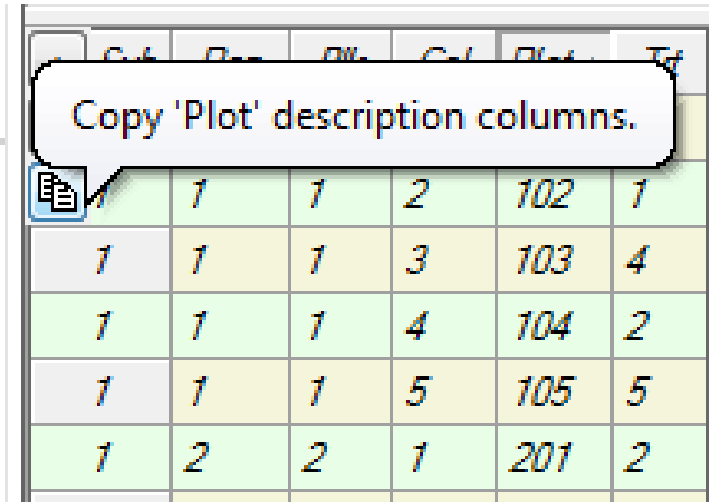
New Assessment Sorts

- New sorts are also on right-click menu
- Provides full list of sort orders from available 'Plot' experimental unit descriptors

A screenshot of a right-click context menu with a white background and a rounded border. The menu items are: 'Replicate', 'Block', 'Column', ''Plot' Experimental Unit', 'Treatment', 'Alt Plot ID', 'Barcode/RFID', 'Latitude', 'Longitude', 'Assessment Order', and 'Harvest Order'. A horizontal line is positioned between 'Longitude' and 'Assessment Order'.

Copy 'Plot' Assessment Unit Description

- New shortcut button in assessment editor
- Copies entire plot description, including column headings
- Simple transfer of ARM randomization to planting, application, or harvest software



Sub	Rep	Blk	Col	Plot	Trt
1	1	1	2	102	1
1	1	1	3	103	4
1	1	1	4	104	2
1	1	1	5	105	5
1	2	2	1	201	2

	A	B	C	D	E	F	G	H	I	J
1	Sub	Rep	Blk	Col	Plot	Trt	Alt Plot ID	Barcode/RFID	Lat	Long
2	1	1	1	1	101	3				
3	1	1	1	2	102	1				
4	1	1	1	3	103	4				
5	1	1	1	4	104	2				
6	1	1	1	5	105	5				
7	1	2	2	1	201	2				

Convert Yield using Harvested Plot Length/Width per Plot 9.2014

Assessment Data - Line 15

Column Number	10	11	12	13 (Calculated)	14 (Calculated)	15
Part Rated	PLOT <input type="checkbox"/> C <input type="checkbox"/>	GRAIN <input type="checkbox"/> C <input type="checkbox"/>	GRAIN <input type="checkbox"/> C <input type="checkbox"/>	GRAIN <input type="checkbox"/> C <input type="checkbox"/>	GRAIN <input type="checkbox"/> C <input type="checkbox"/>	
Rating Type	LENGTH <input type="checkbox"/>	YIELD <input type="checkbox"/>	MOICON <input type="checkbox"/>	YIELD <input type="checkbox"/>	YIELD <input type="checkbox"/>	
Rating Unit	m <input type="checkbox"/>	KG <input type="checkbox"/>	% <input type="checkbox"/>	T-MET <input type="checkbox"/>	%UNCK <input type="checkbox"/>	

Sub	Rep	Blk	Col	Plot #	Trt	Yield
1	1	1	1	101	3	9.00
1	1	1	2	102	7	9.00
1	1	1	3	103	4	9.00
1	1	1	4	104	2	9.00
1	1	1	5	105	5	9.00
1	2	2	1	201	2	8.50
1	2	2	2	202	3	8.50
1	2	2	3	203	5	8.50
1	2	2	4	204	4	8.50
1	2	2	5	205	7	8.50
1	3	3	1	301	3	9.00
1	3	3	2	302	2	9.00
1	3	3	3	303	7	9.00
1	3	3	4	304	5	9.00
1	3	3	5	305	4	9.00
1	4	4	1	401	7	9.00
1	4	4	2	402	3	9.00

Yield Conversion

Yield units
Current: Kilograms
Desired: Tonnes/Ha

Moisture adjustment
 Adjust to dry moisture percent = 15.0
Average moisture percent at harvest
 Use whole trial average percent =
 Use percent in data column number 12

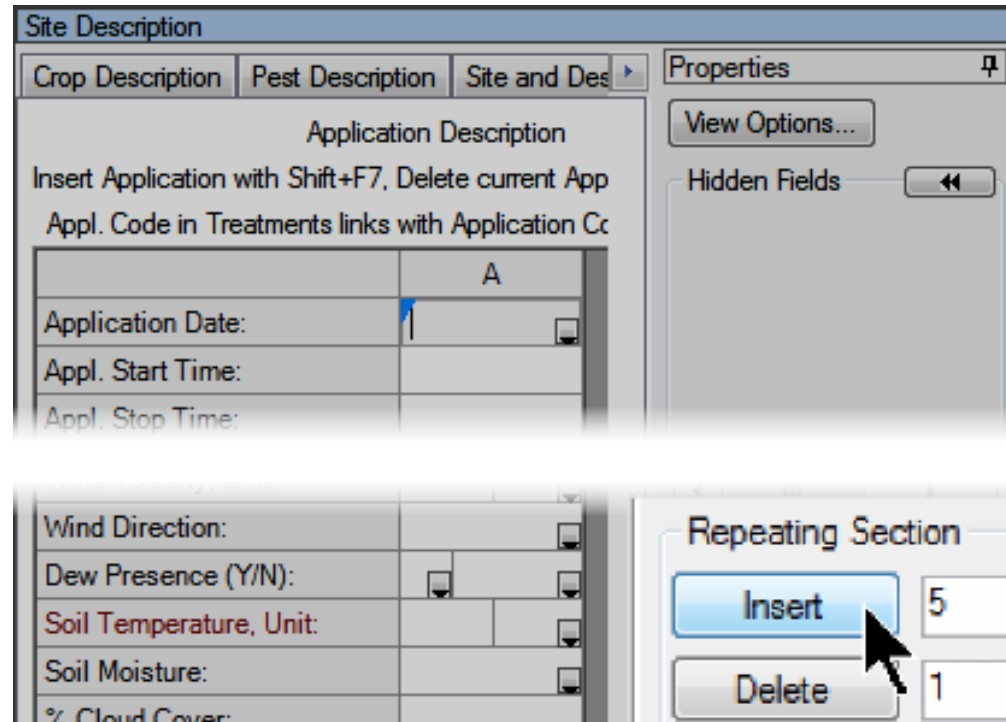
Harvested plot size
Width: 1.1
 Use width in data column number 1
Length: 9
 Use length in data column number 10
Unit: meters

Convert data column number: 11

Insert or Delete Multiple Repeating Sections at Once

New option on Site/Protocol Description Properties panel

1. Define number to add or delete
2. Select 'Insert' or 'Delete' button





Summary

New ARM 10.2015 tools can help improve trial quality and efficiency:

- Plan appropriate number of replicates
- Improve quality of randomizations
- Analyze results to improve planning of follow-up experiments



Summary

- ARM 10.2015 release 4th quarter 2014
- Upgrade from ARM 9/8 for reduced cost