ARM 2017 Features Since ARM 9.2014.8

Gylling Data Management, Inc.

Statistical Handbook 3rd Edition

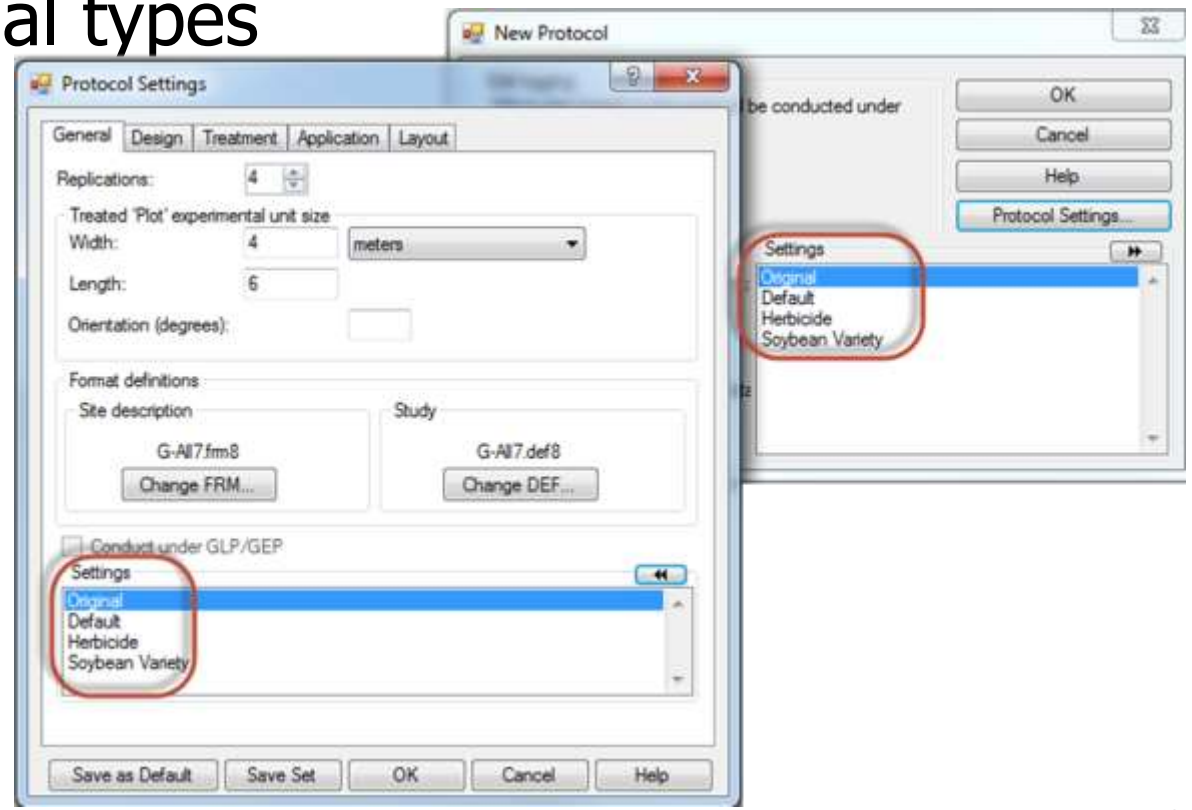
A Statistical Handbook for Agricultural Field Trials Specialists: A handy companion for use with ARM data management tools

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

"New Protocol" Option Sets

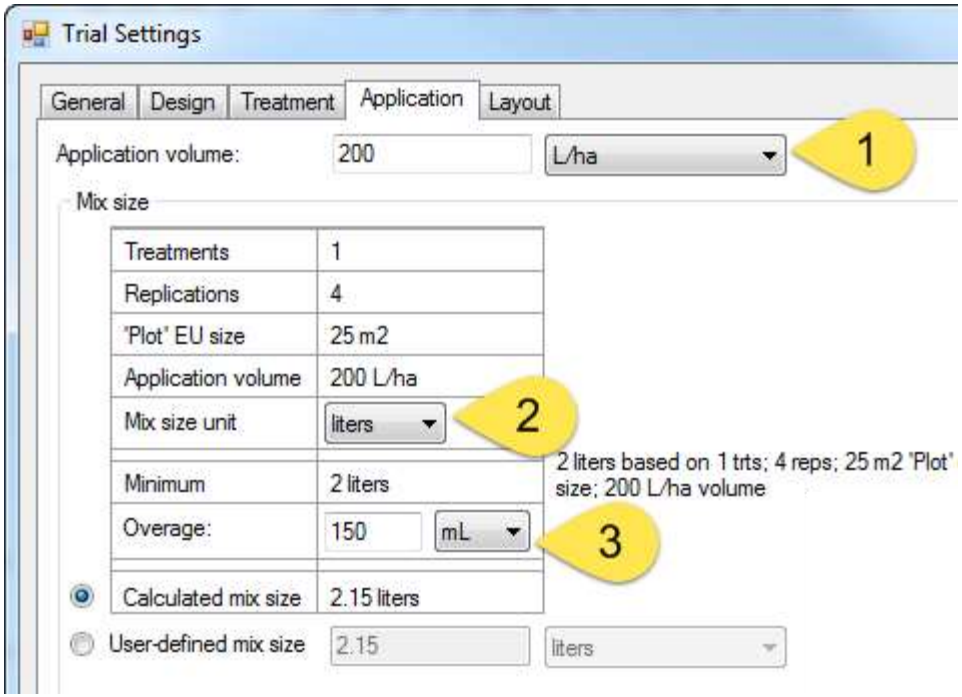
- "Save Set" button to create appropriate defaults for different trial types
- Select set in New Protocol dialog or General tab of Protocol Settings



Automatic Mix Size Calculator

On Settings - Application tab, to calculate mix for all plots of 1 liquid treatment application select:

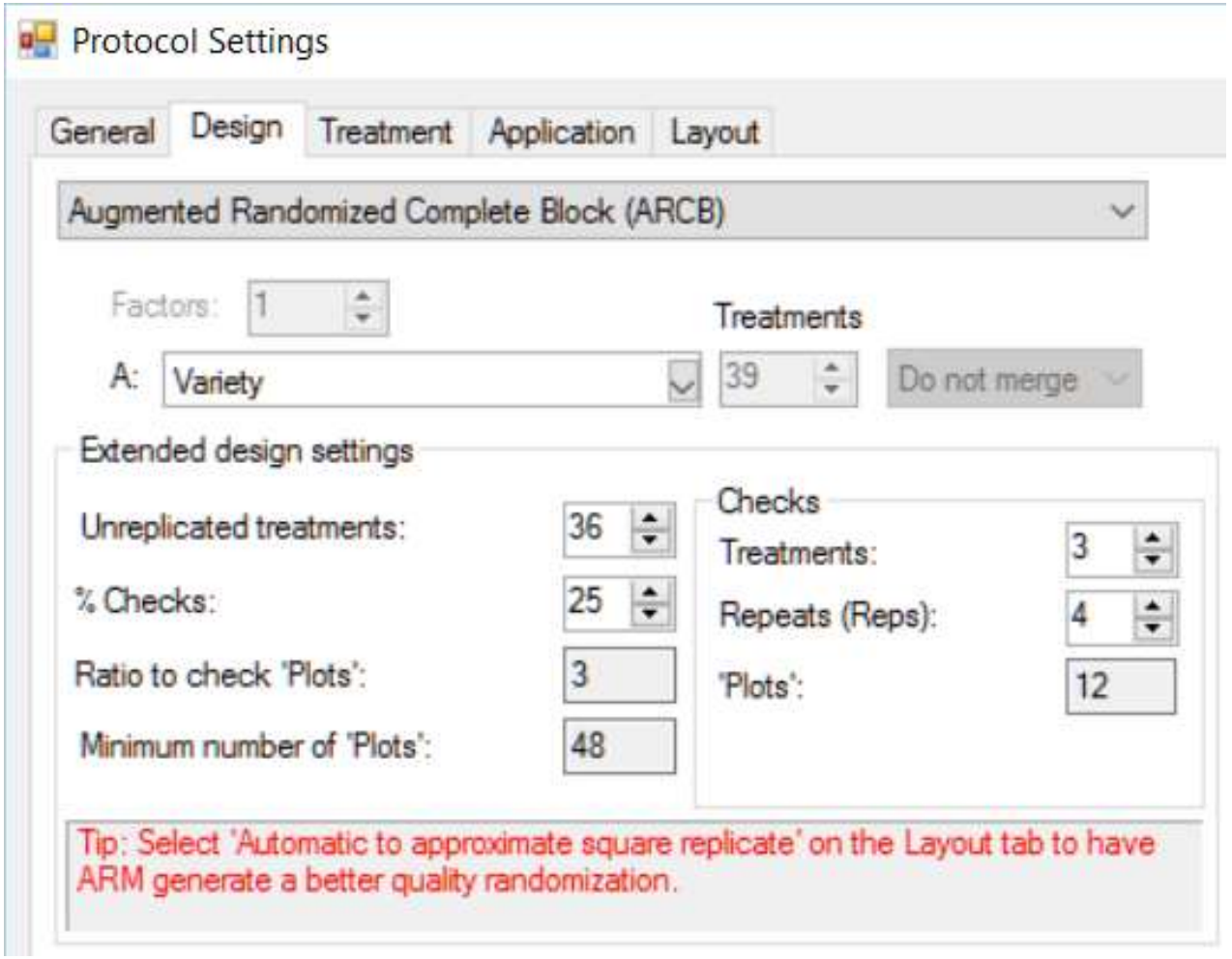
1. Volume unit
2. Mix unit
3. Overage to fill applicator lines per treatment + before/after plot



Augmented Designs

- Augmented Randomized Complete Block
- Augmented Completely Random Design
- On Design tab of Settings dialog
- Typically used when:
  - Experimental material for test treatments is scarce so not possible to replicate in the design
  - Enough control material to replicate

Augmented Designs



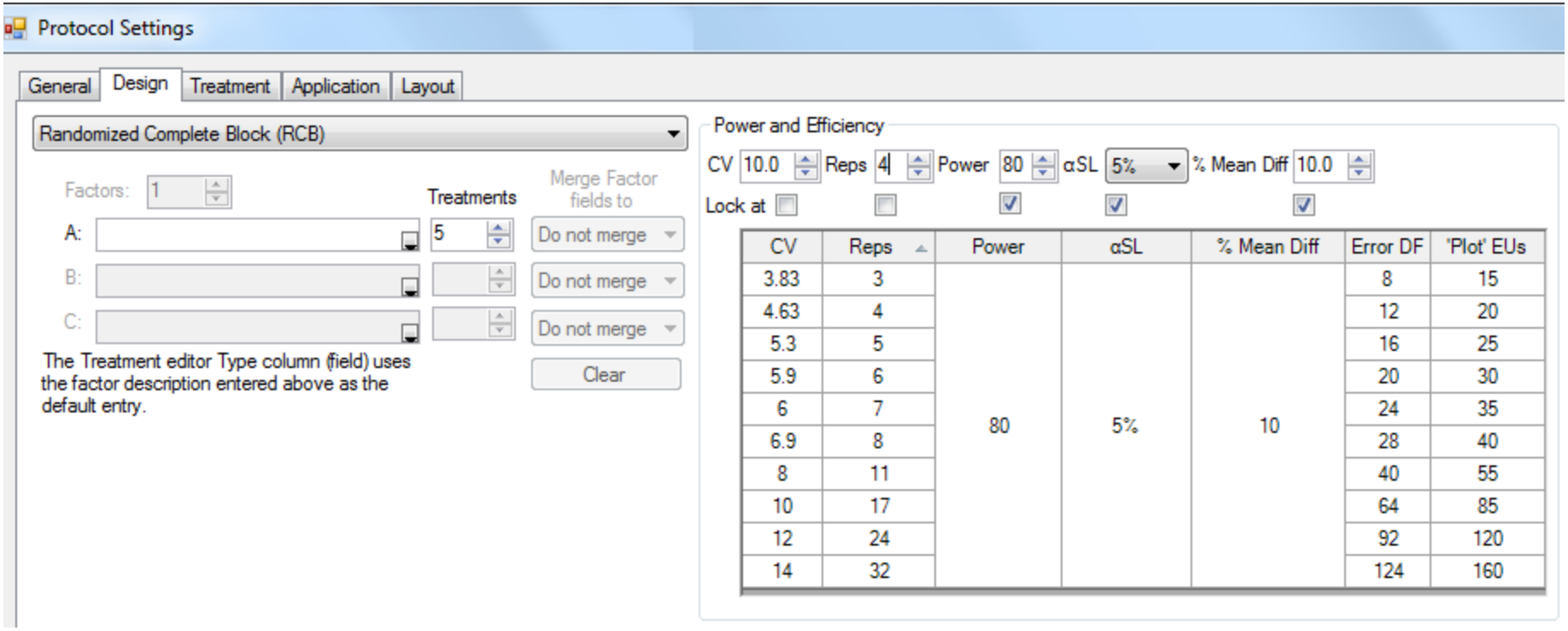
Power and Efficiency Planner, Plan Experiments to Have:

- 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



CV	Reps	Power	αSL	% 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

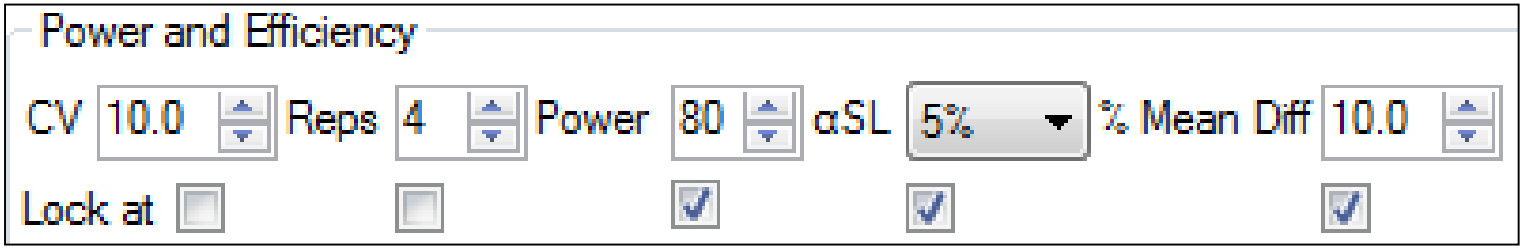
- Help plan experiments that successfully detect expected treatment differences
- Available in both protocols and trials so:
  - Protocol writers can more effectively plan experiments
  - Trialists can verify whether CV expectations are realistic based on local experience for specified crop(s)

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

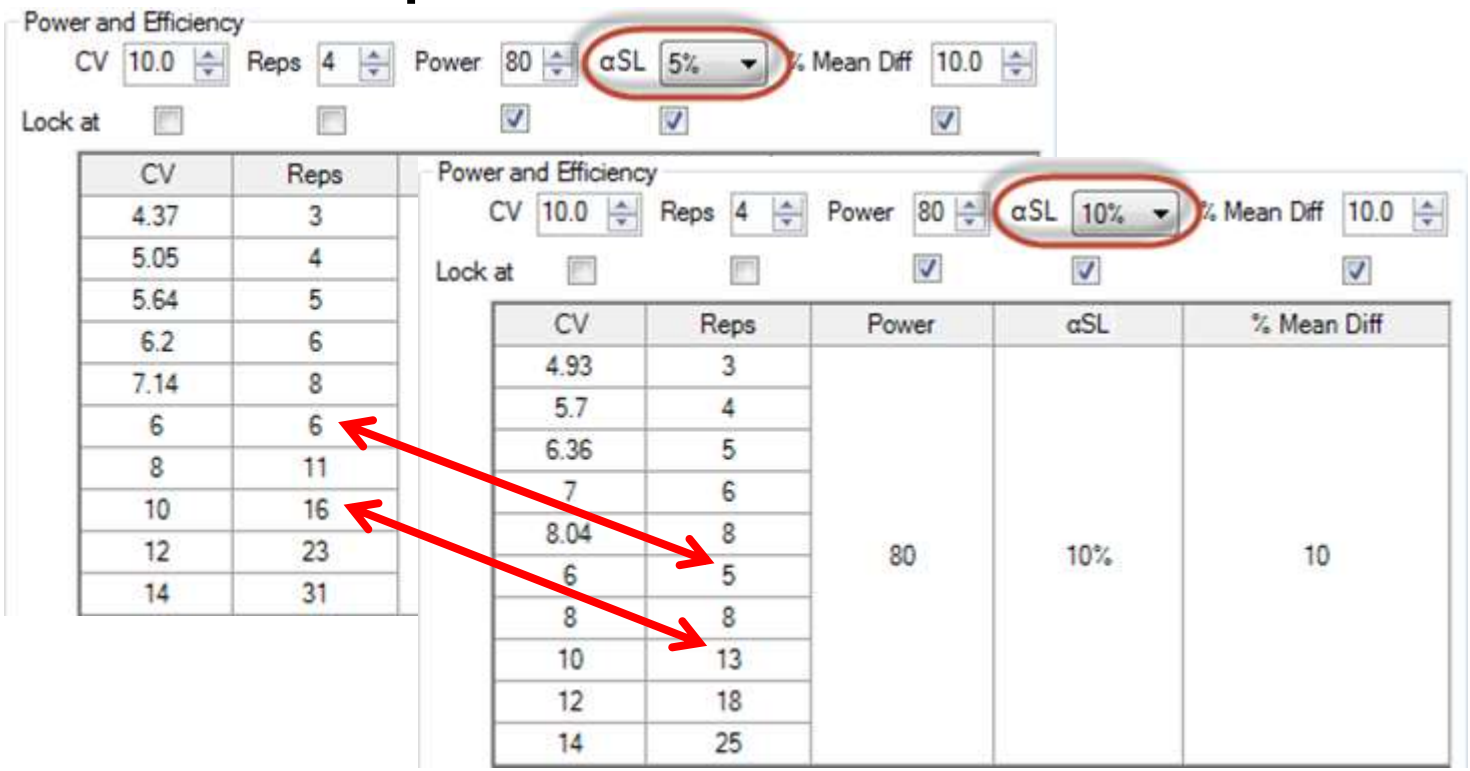
Power and Efficiency Planner



- "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 Planner

Consider impact of Replicates on precision to detect treatment differences

Click on column heading to sort

Power and Efficiency

CV 5.0 Reps 4 Power 80 αSL 5% % Mean Diff 5.0

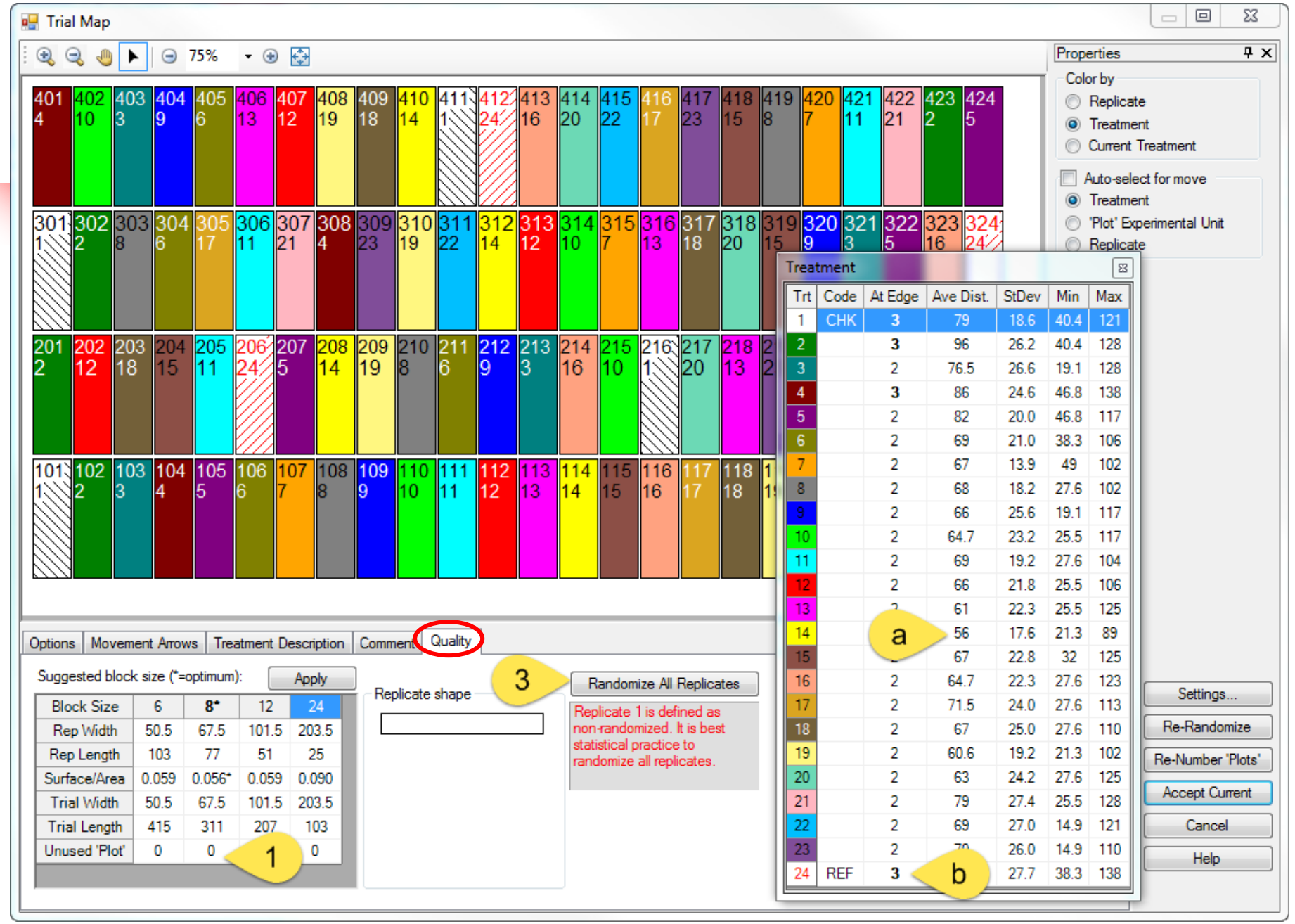
Lock at ☑ ☐ ☑ ☑ ☐

CV	Reps	Power	αSL	% 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

Randomization Quality Review

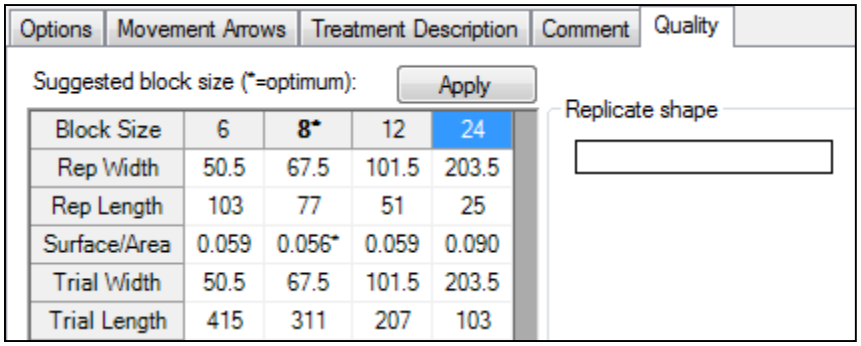
Goal is to improve experiment precision:

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

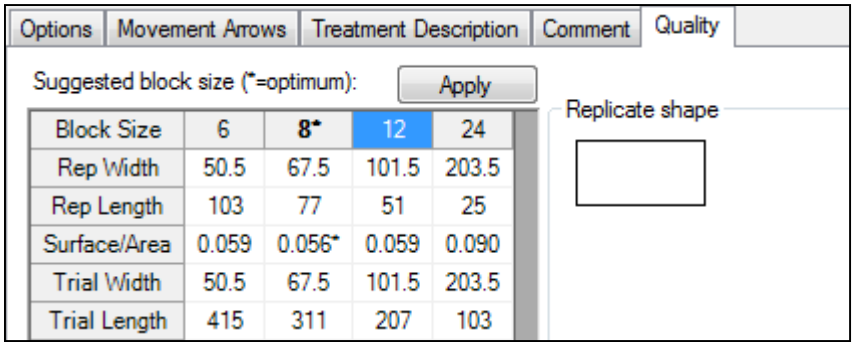

Trial Map
75%
Properties
Color by
Replicate
Treatment
Current Treatment
Auto-select for move
Treatment
'Plot' Experimental Unit
Replicate
Treatment
Trt Code At Edge Ave Dist. StDev Min Max
1 CHK 3 79 18.6 40.4 121
2 3 96 26.2 40.4 128
3 2 76.5 26.6 19.1 128
4 3 86 24.6 46.8 138
5 2 82 20.0 46.8 117
6 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 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 26.0 14.9 110
24 REF 3 27.7 38.3 138
a
b
Options
Movement Arrows
Treatment Description
Comment
Quality
Suggested block size (*=optimum):
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
Unused 'Plot' 0 0 0
1
Replicate shape
3
Randomize All Replicates
Replicate 1 is defined as non-randomized. It is best statistical practice to randomize all replicates.
Settings...
Re-Randomize
Re-Number 'Plots'
Accept Current
Cancel
Help

Arrange Replicates as Squares not Strips

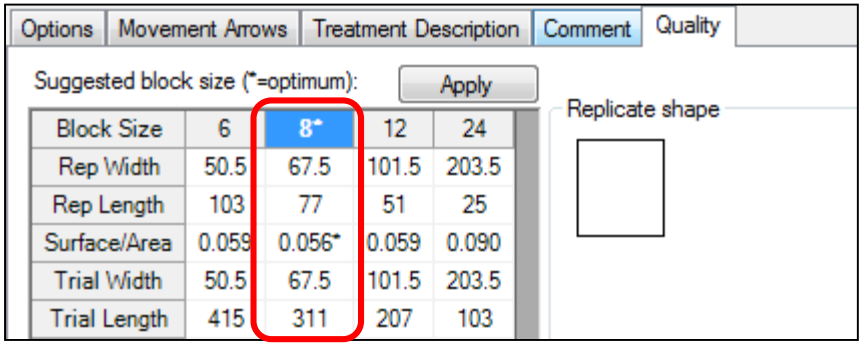
"Optimum" is smallest surface-to-area ratio



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



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



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Rep Width	50.5	67.5	101.5	203.5
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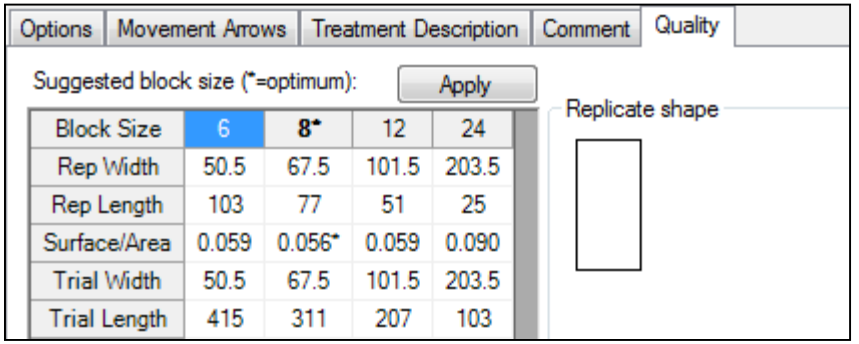
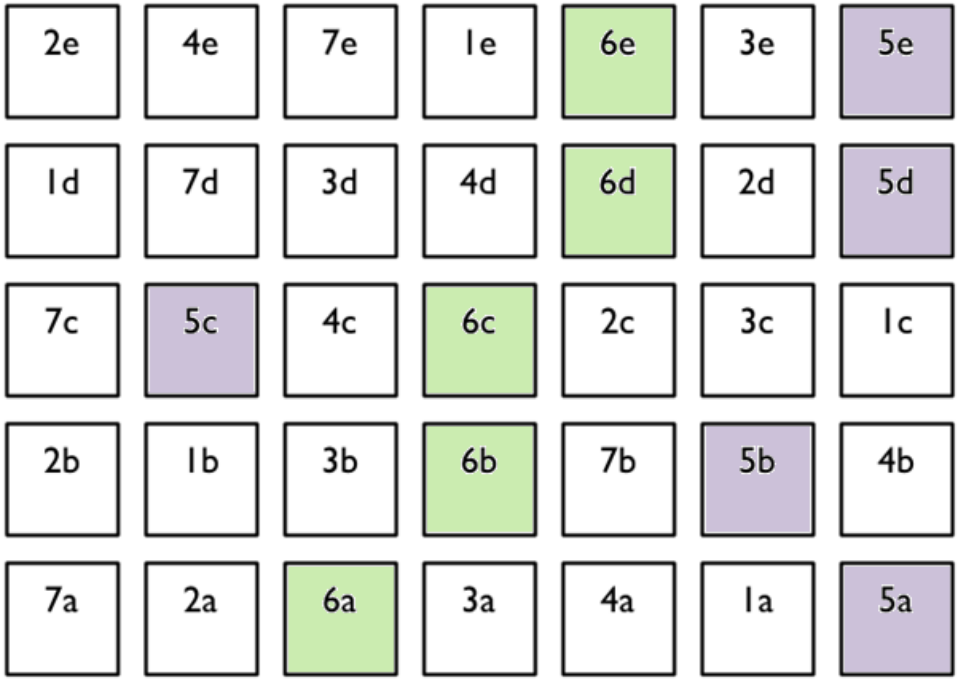


Block Size	6	8*	12	24
Rep Width	50.5	67.5	101.5	203.5
Rep Length	103	77	51	25
Surface/Area	0.059	0.056*	0.059	0.090
Trial Width	50.5	67.5	101.5	203.5
Trial Length	415	311	207	103

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

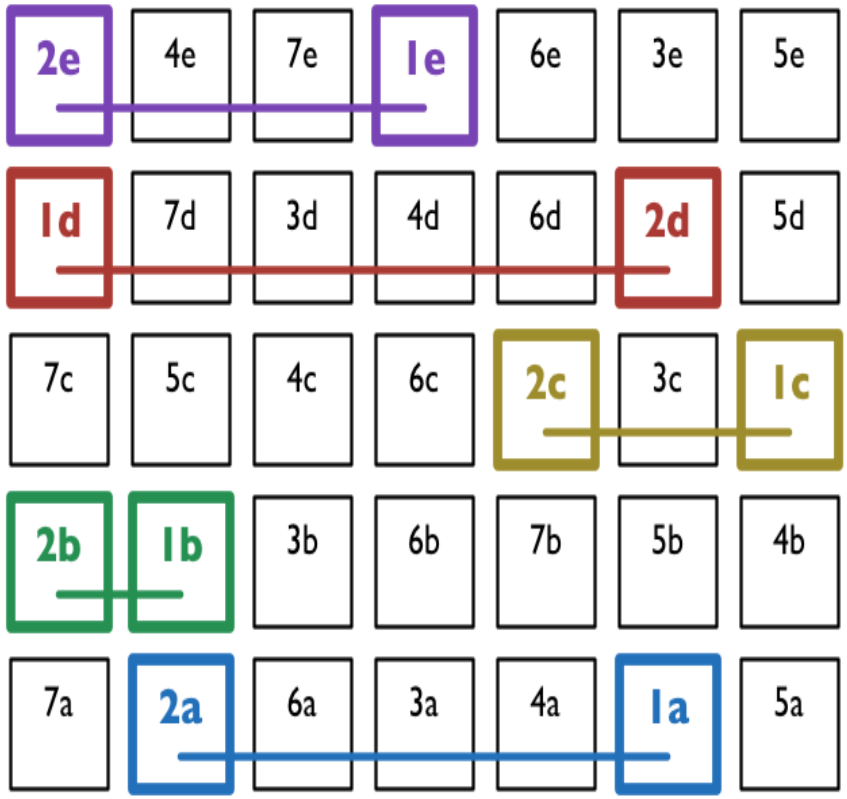


Uses "Average Distance of Treatment" Comparison (ADTC)

- 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

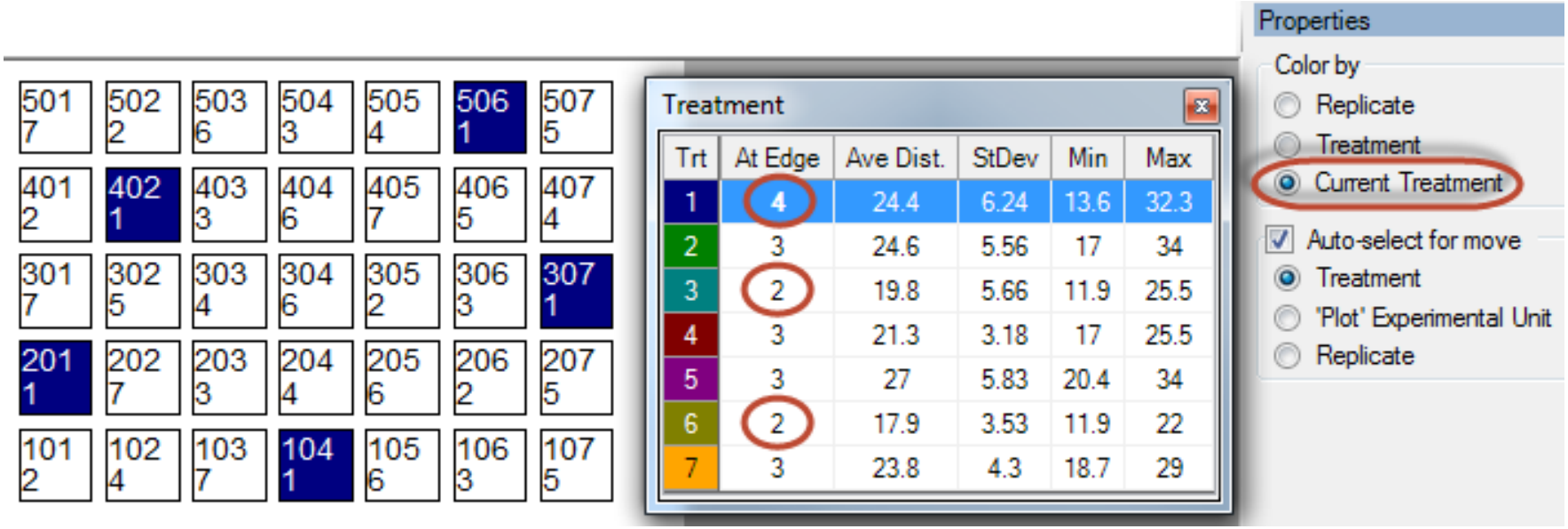
- Average distance from 17.9 to 24.6
- Ranges from 11.9(T3,T6) to 34(T2,T5)
- Error variances for treatments may not be homogeneous

Treatment

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



Balanced Treatment Distribution and Edge Effect

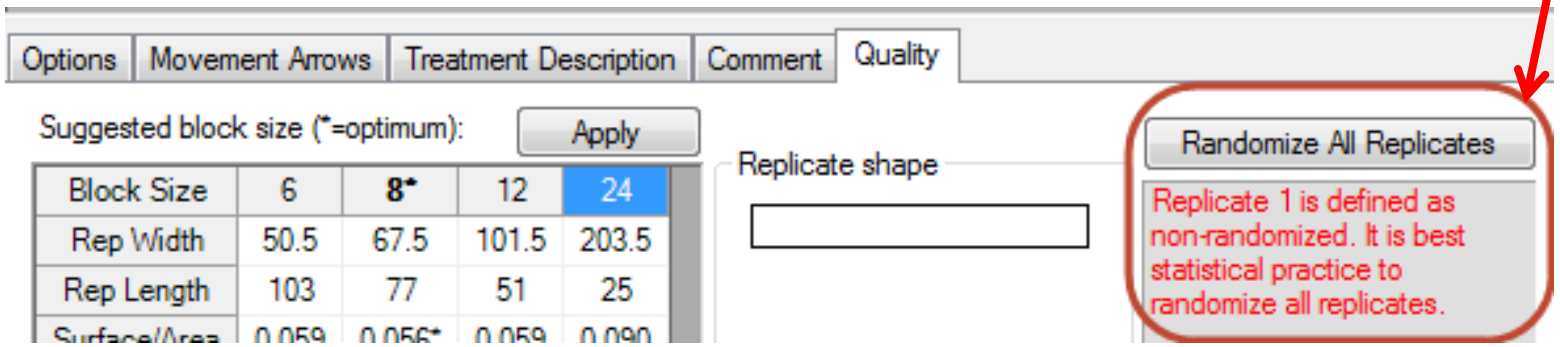
- Average distance from 21.3 to 24.4
- Distances range from 18.7 to 27.2
- "Edge effect" is balanced

Treatment

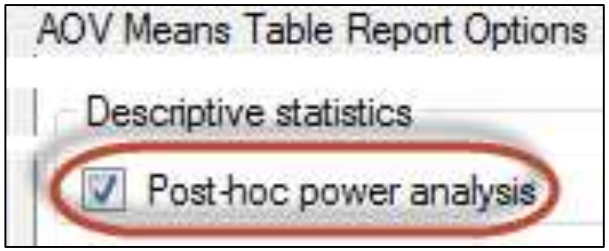
Trt	At Edge	Ave Dist.	StDev	Min	Max
1	2	22	2.15	20.4	25.5
2	3	23.8	3.57	18.7	27.2
3	3	24.4	1.76	22	27.2
4	3	22.4	3.47	18.7	25.5
5	3	22	3.4	18.7	27.2
6	3	21.3	2.58	18.7	25.5
7	3	22.7	2.56	18.7	25.5

Randomize All Replicates

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



Post-hoc Power Analysis



- 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

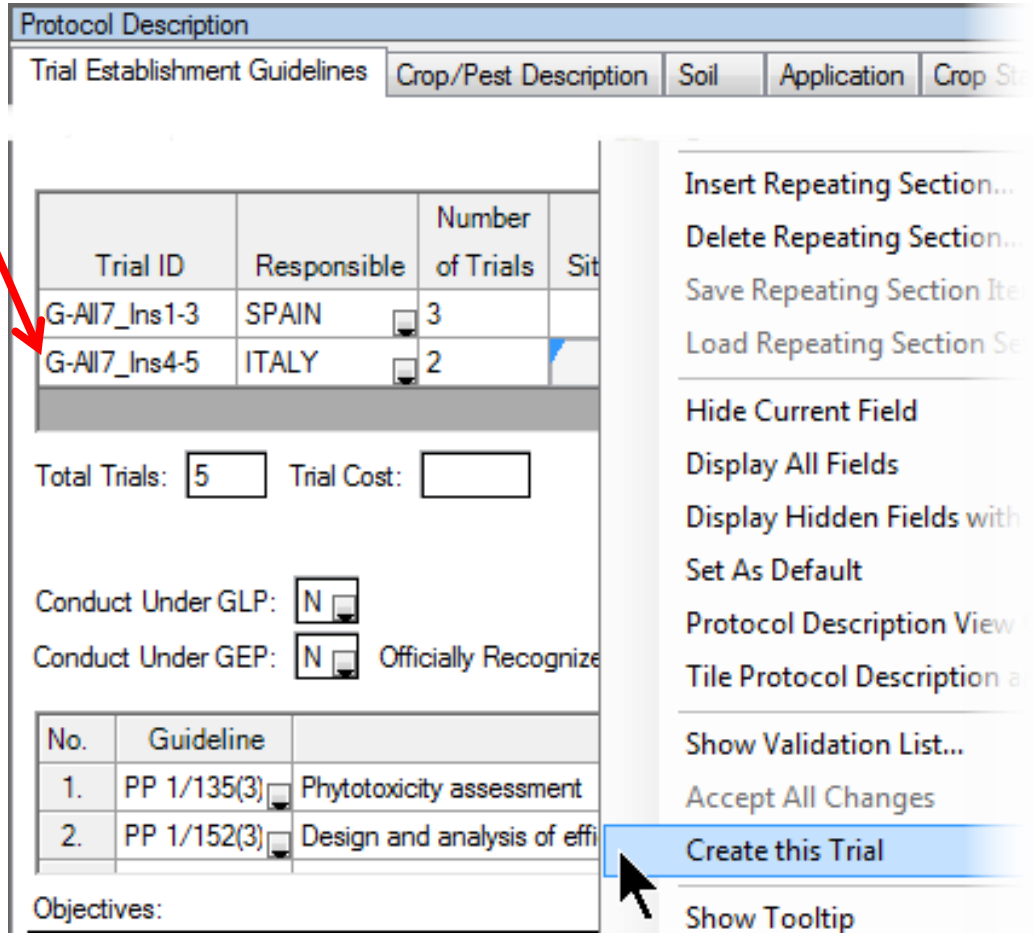
Post-hoc Power Analysis

- 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

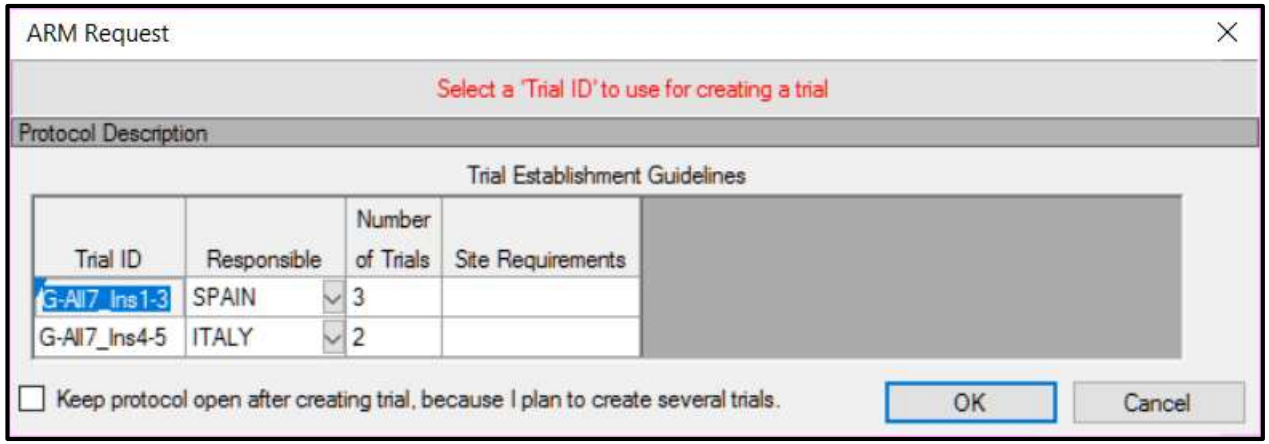
'Create this Trial' in Protocol

- Right-click on row of trial to create in planned trials grid of protocol
- Creates each trial using listed trial ID, opens in separate ARM sessions



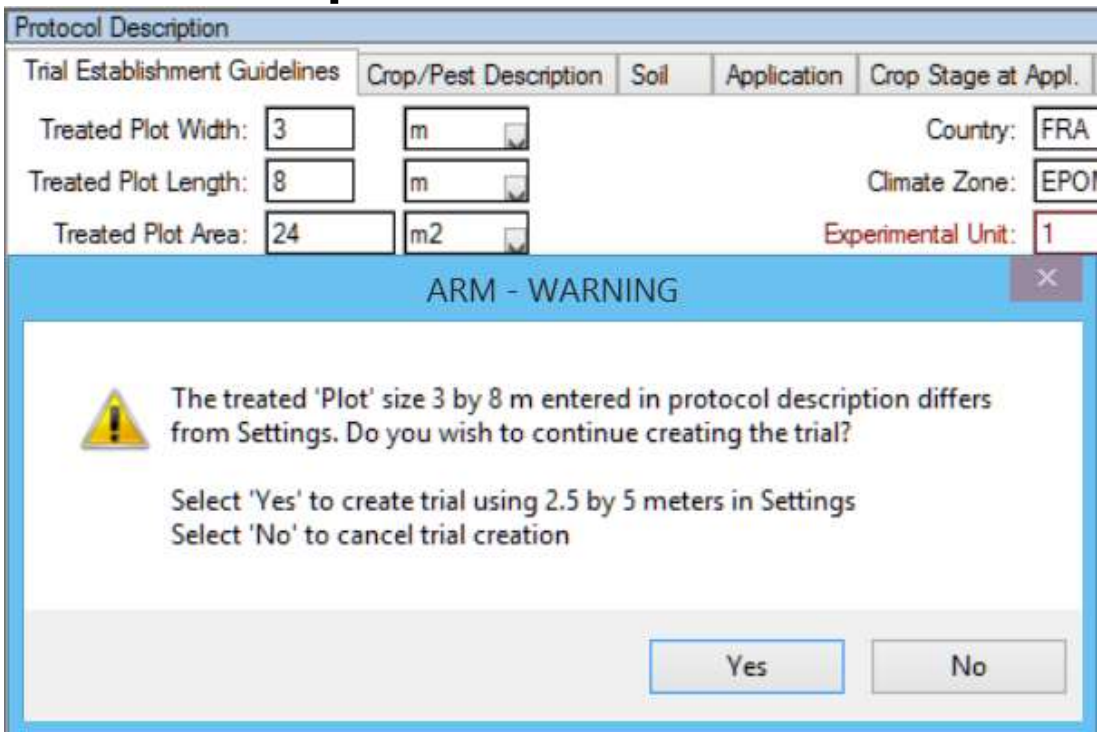
Create Trial

- Displays planned trials grid in protocol
- Click in grid row to select trials(s) to create
- Creates each trial using listed Trial ID, opens in separate ARM sessions
- Option to keep protocol open when finished



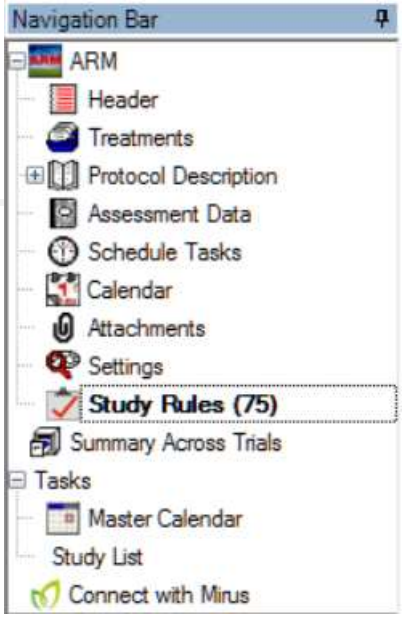
'Create Trial' Checks Plot Size

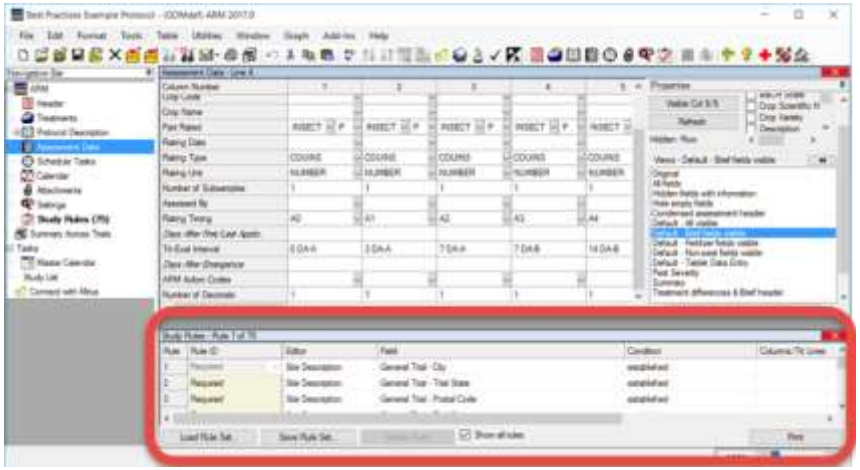
- Prompts if Treated Plot Width and Length in protocol description is different than in Settings

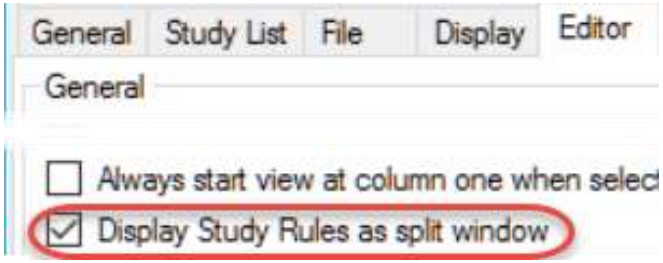


Study Rules

- Displays as separate study editor
- When a study contains rules:
  - Rule count lists on Navigation Bar
  - Rules panel opens as lower split window
  - New Editor option to hide

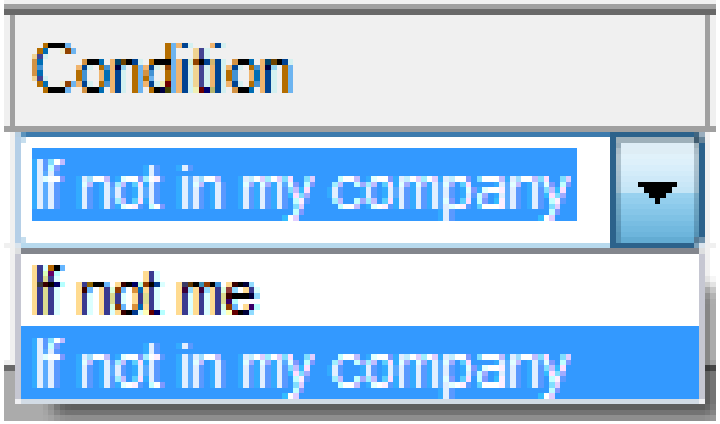






Study Rules

- Selectively hide protocol or site description fields according to person who opens study (based on ARM license information):
  - From everyone else
  - From everyone who is not in my company



Study Rules

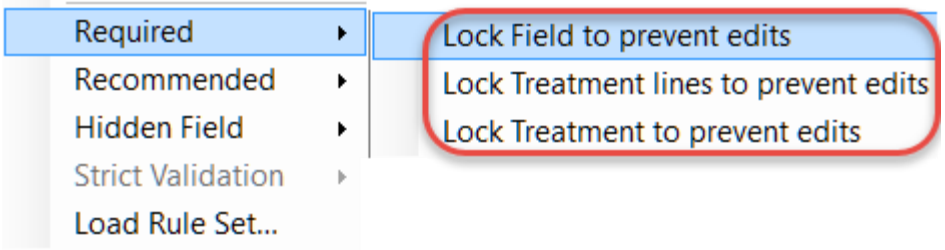
- Lock protocol or site description fields (such as Trial ID), to prevent modifying information in those fields by:
  - Everyone else
  - Everyone who is not in my company
- Display "All" for an assessment rule that applies to all data columns

Rule ID	Editor	Field	Condition	Columns/Trt Lines	Permissions
Strict Validation	Assessment Data	Rating Type	Always	All	All protocol owners
Strict Validation	Assessment Data	Rating Unit	Always	All	All protocol owners

Study Rules

'Lock Treatment line to prevent edits' will prevent changing an individual Treatment field or line: use to ***protect key treatment*** information

Trt Line	Trt No.	Type	Treatment Name	Form Conc	Form Unit	Form Type	Rate	Rate Unit
1	1	CHK	Untreated					
2	2	FUNG	Cyprodinil	750	G/KG	WG	0.20	kg/10000 m2 LWA
3	3	FUNG	Cyprodinil	750	G/KG	WG	0.30	kg/10000 m2 LWA



Study Rules

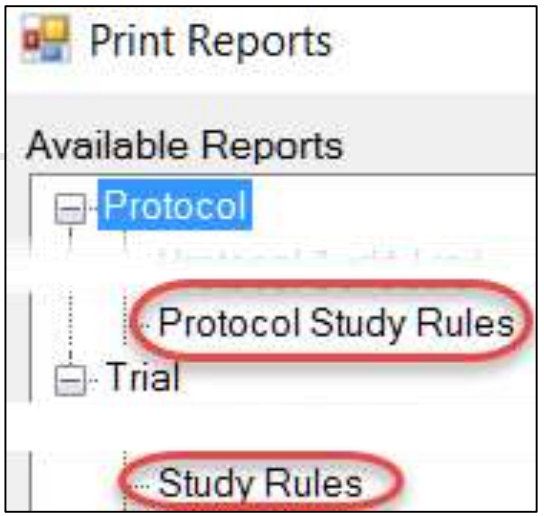
- Examples of new study rules:

Study Rules

Rule	Rule ID	Editor	Field	Condition
1	Required	Header	Trial Number	Lock field to prevent edits
2	Limit validation list	Assessment Data Header	Crop & Pest in Site Description	Always
3	Lock Trial ID as position 1	Assessment Data	Image Attachments	Always
4	Strict Validation	Treatments		
5	Required	Trial	Image Attachments	One or more Plots
6	Hidden Field	Protocol Description	Trial Establishment Guidelines - Responsible	If not in my company

Study Rules

- New Protocol and Trial 'Study Rules' reports on the Print Reports dialog

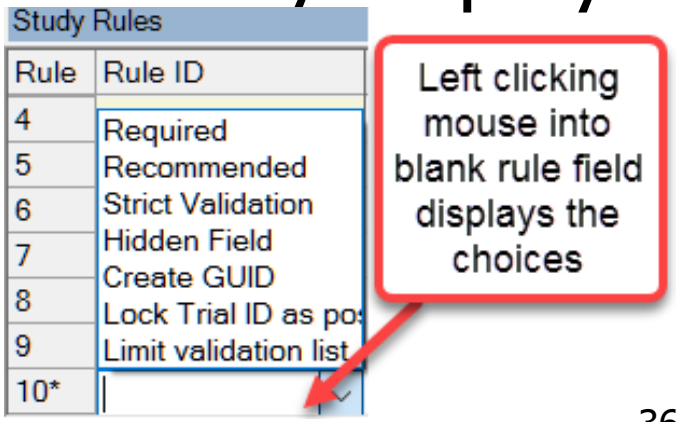


Study Rules

Rule	Rule ID	Editor	Field	Condition	Permissions
1	Required	Treatments	Rate	Lock Treatment line to prevent edits	All protocol owners
2	Required	Treatments	Rate Unit	Lock Treatment line to prevent edits	All protocol owners
3	Required	Treatments	Treatment Name	Lock Treatment line to prevent edits	All protocol owners
4	Required	Treatments	Form Conc	Lock Treatment line to prevent edits	All protocol owners
5	Required	Treatments	Form Unit	Lock Treatment line to prevent edits	All protocol owners
6	Required	Treatments	Form Type	Lock Treatment line to prevent edits	All protocol owners

Study Rules

- Asks if Study Rules should be copied to the new protocol after changing the protocol ID field (a method often used to create a similar protocol)
- Drop-down fields automatically display the choice list when clicked with mouse



Study Rules

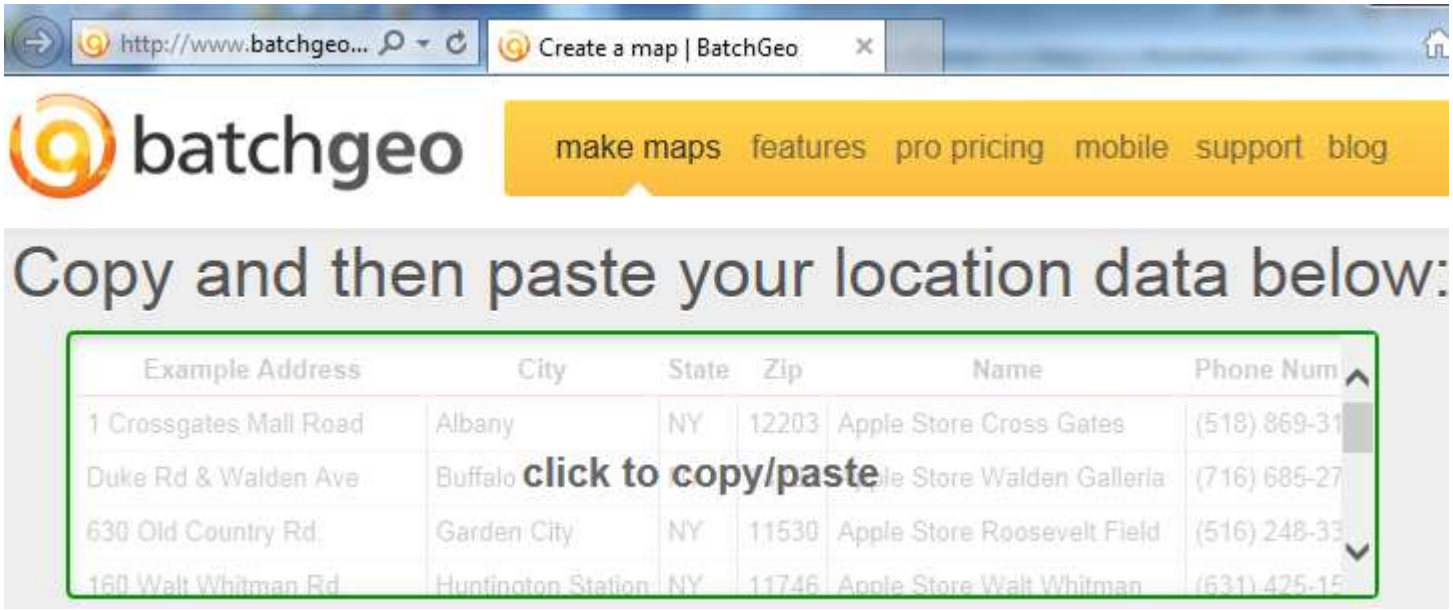
- Entire trial revalidates after adding new study rules to a validated trial
- Improved messages for invalid study rules, so it is clearer which fields need to be corrected
- Delete Rule button now removes a marked block of rules
- More right-click menus to add rules

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



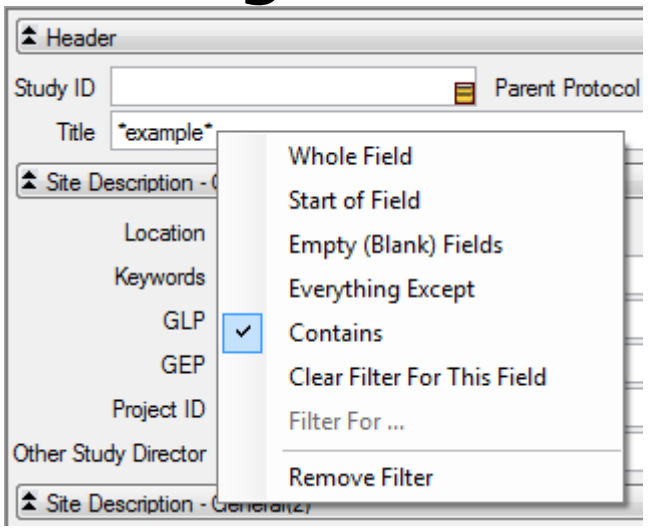
Map Trials from Study List 3 of 3

- Select "Map Now" button

Map Now

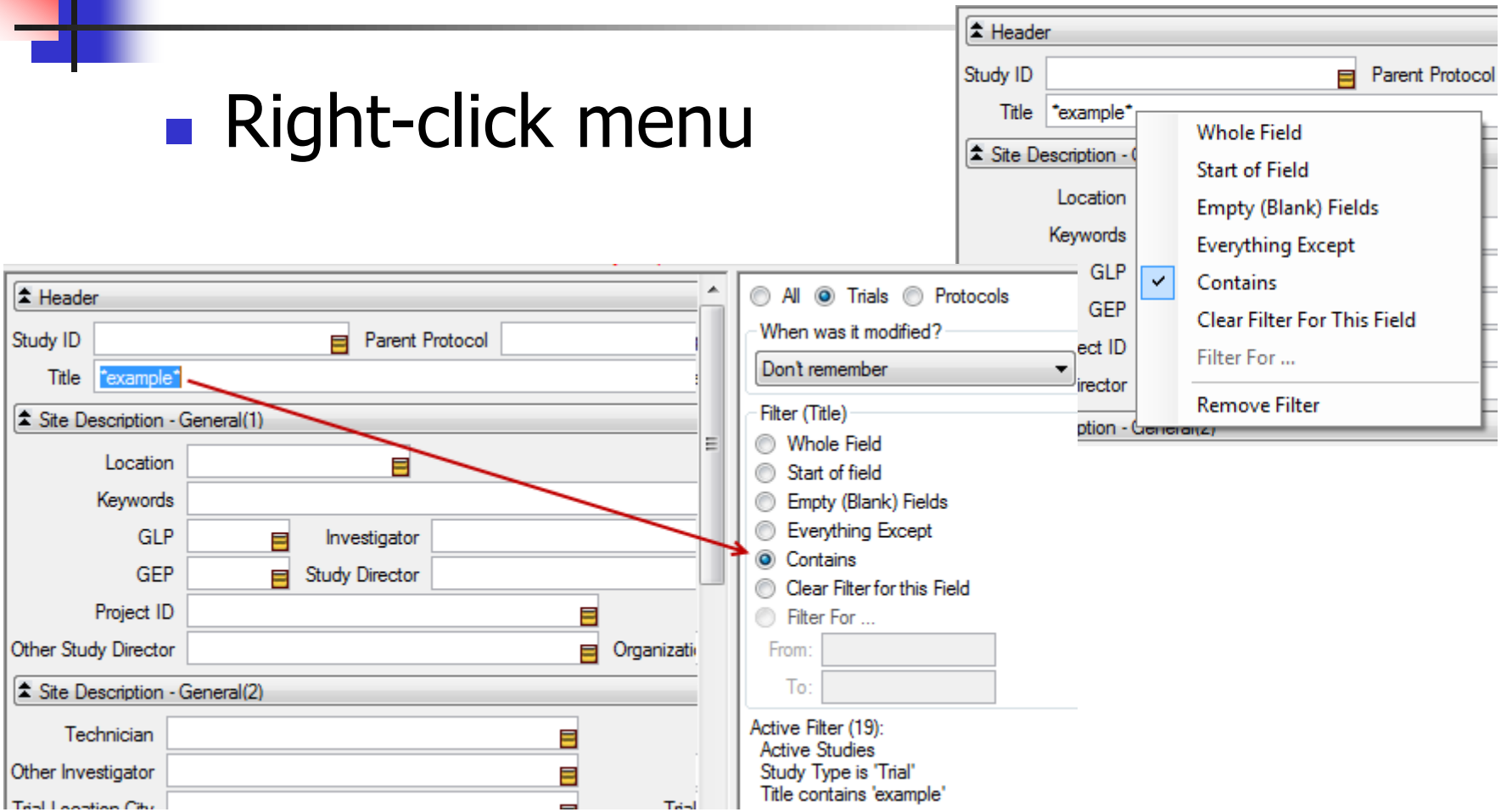
Study List Filter Form

- Clicking into a field on filter form automatically scrolls lower grid to the matching column
- Right-click menu
- Automatically save Study List filters the client has applied



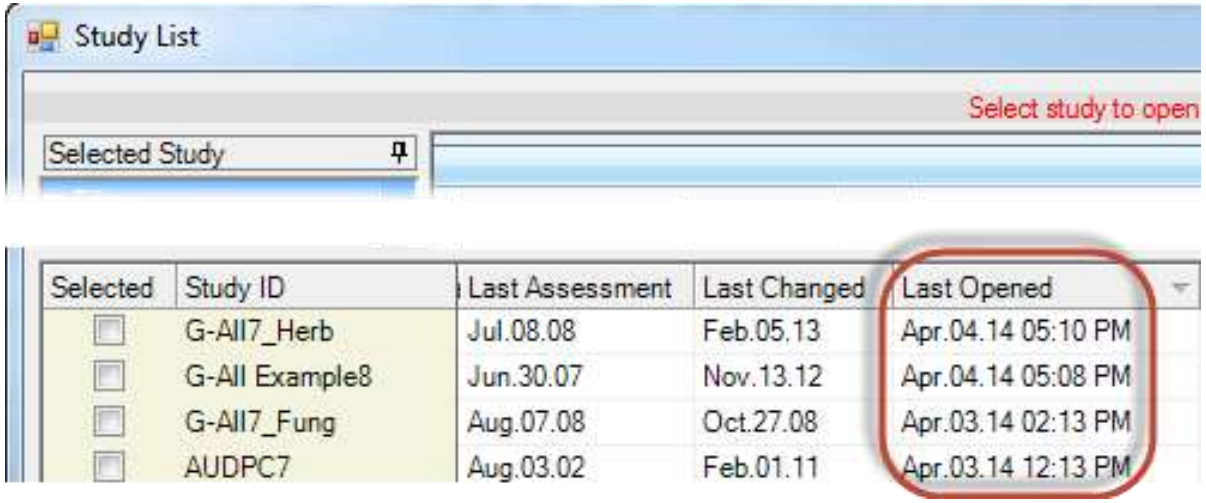
Study List Filter Form

- Right-click menu



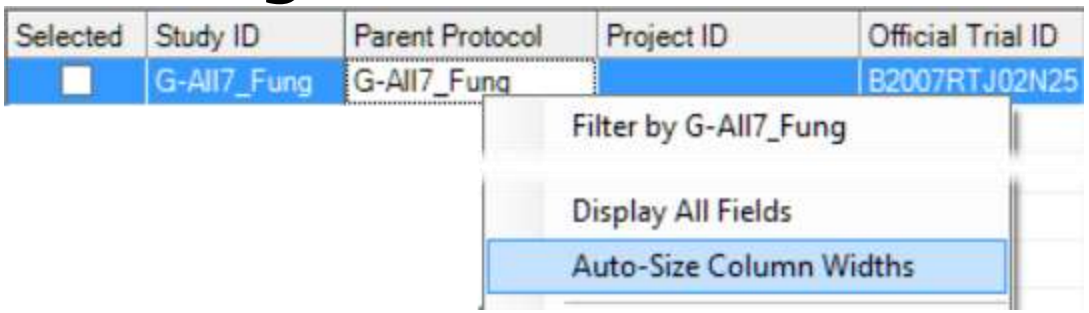
Study List, Recently Changed

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



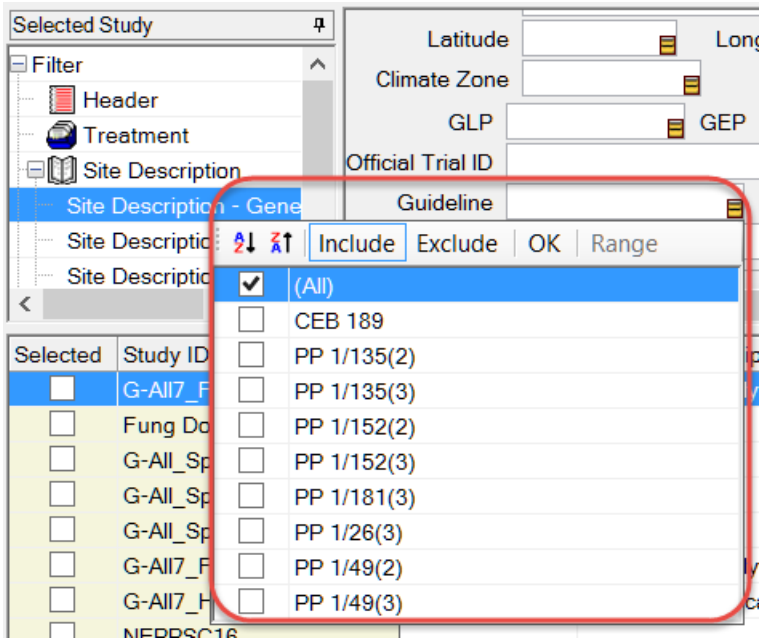
Study List Grid

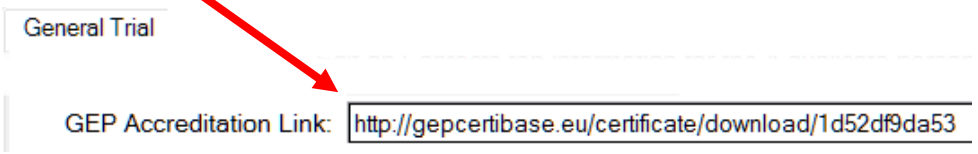
- 'Auto-Size Column Widths' right-click menu item sizes grid columns based on contents



Study List

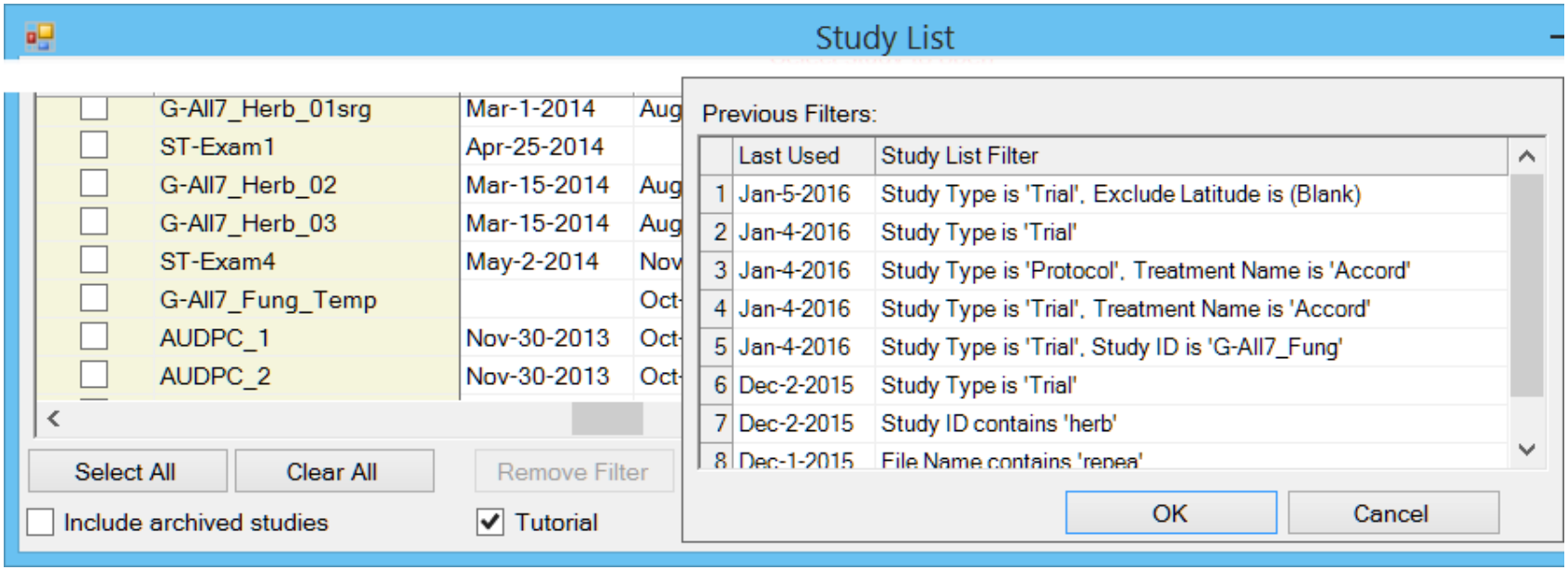
- Guidelines in study list are now listed separately in dropdown selection list, to more easily find suitable trials
- More indexed fields:
  - Trial Address
  - GEP Accreditation Link
  - Interval to Prev. Appl.
  - Crop Stage Majority
  - Artificial Population





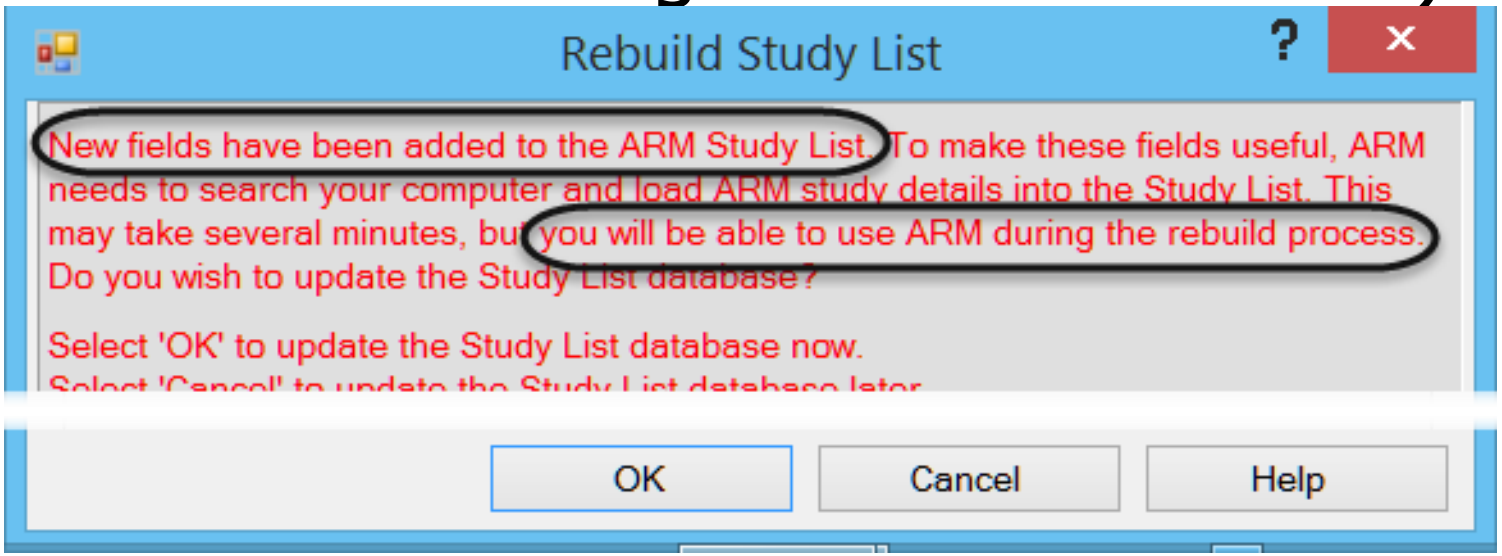
Study List

- Previous Filters list shows recent queries for locating studies of interest, to easily find and re-use past searches



Study List

- Asks to rebuild study list after installing an ARM update with new indexed fields
- Can continue using ARM during rebuild (which runs in a background ARM session)



New Study List Fields

- Treatment Type (TTT)
- Treatment Form. Type (TFD)
- Treatment Growth Stage (TGI)

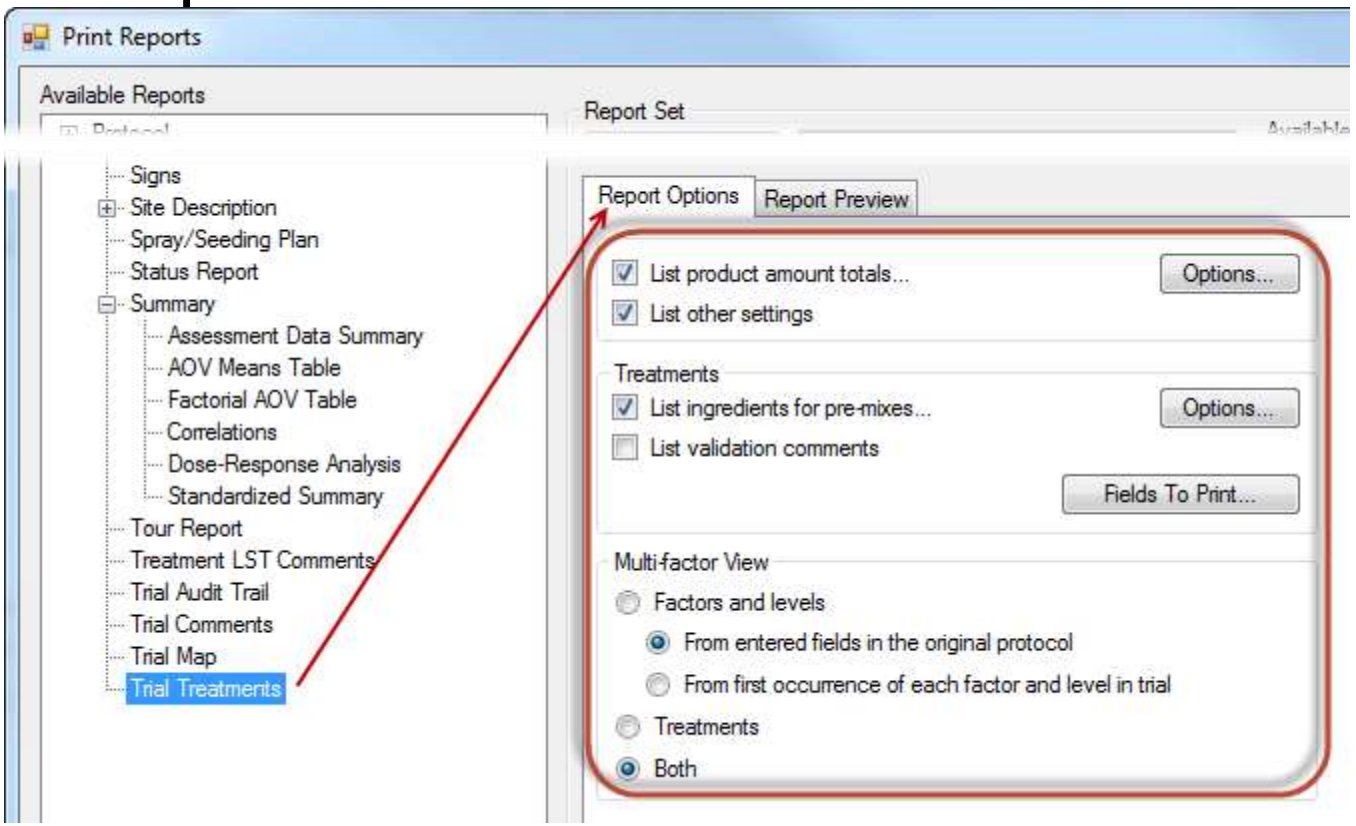
- Assessment Part Rated (ECP)
- Assessment Rating Type (EDT)
- Assessment Rating Unit (ERU)

- Crop Group (KF)
- Pest Type (~P)
- Pest Stage Majority (PS)
- Previous Crop (PC)

- Trial Region (~R)
- Reliability (TQ)
- Official Trial ID (OT)
- Climate Zone (VC)
- Study Design (ED)
- Trial Usage/Type (VU)
- Application Soil Moisture (SM)
- Rainfall/Irrigation Type (RT)
- Application Equipment (SZ)
- Nozzle Type (NT)
- Carrier (DC)
- Propellant (TP)

Report Options

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



Separate Option Reset Buttons

Separate "Reset" buttons for ARM Options and Report Options:

- Tools – Options: Reset program options to default settings without affecting your report changes

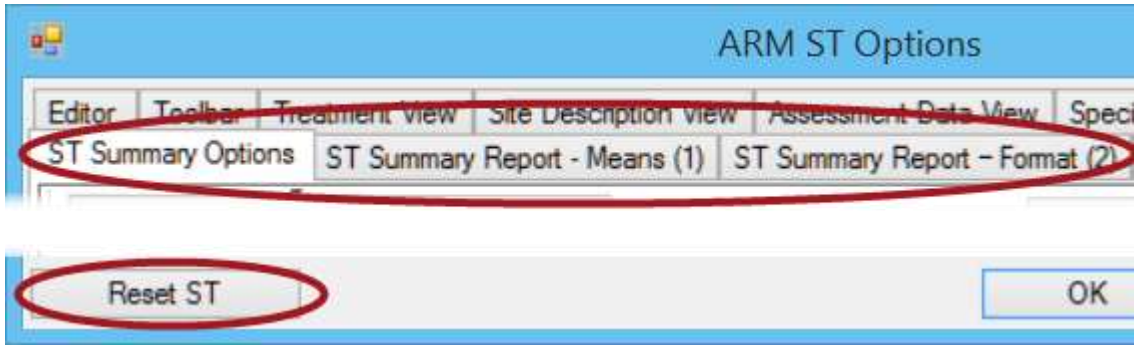
- Reset report options to default settings without changing other ARM program options

More Option Reset Buttons

Additional "Reset" buttons to restore original default options

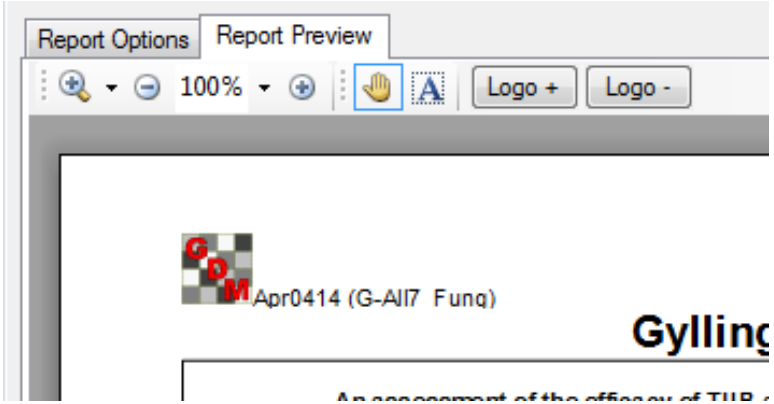
- Graph:

- ST:



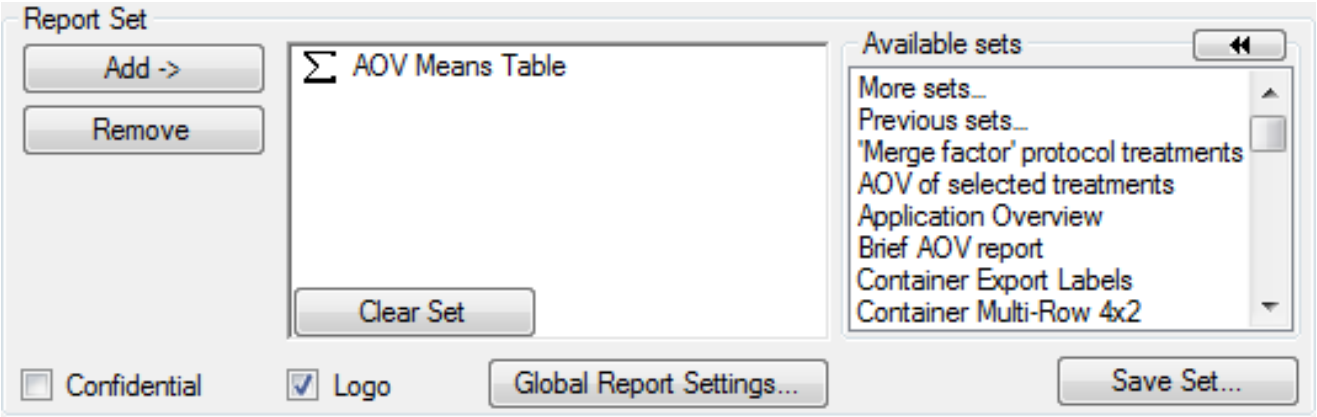
Report Preview

- 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



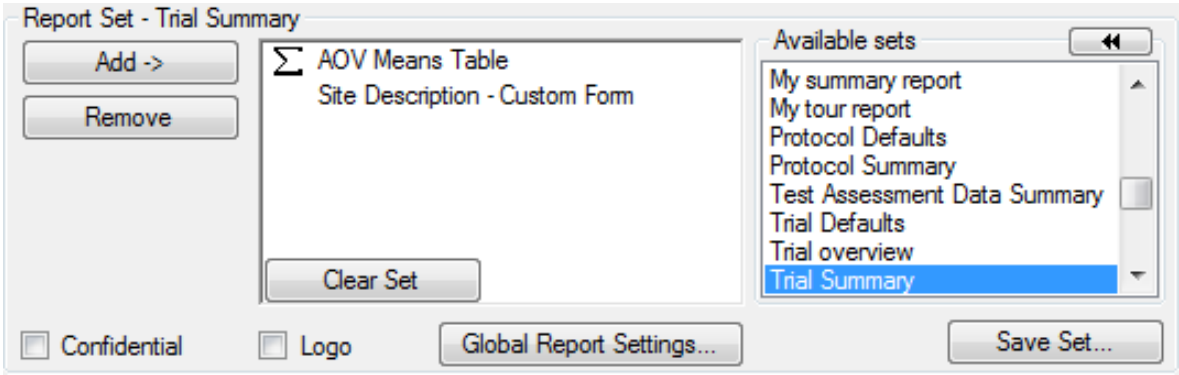
Report Sets

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

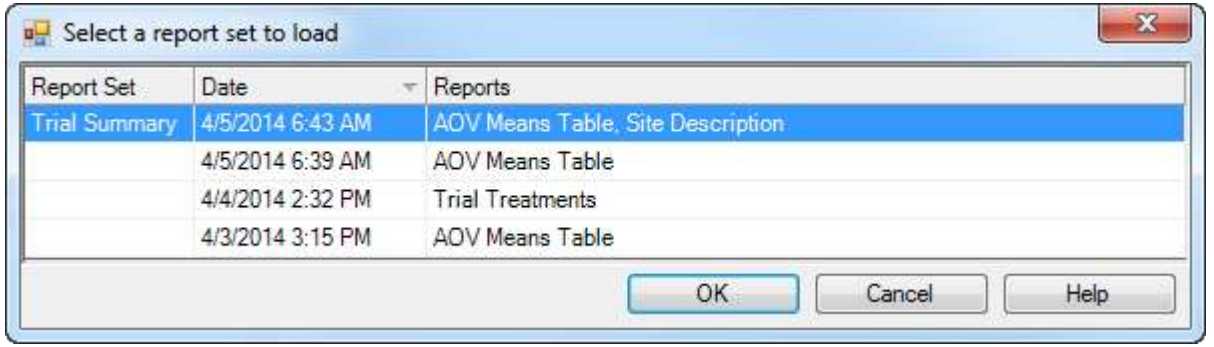


Report Sets

- Last selected set highlighted by default

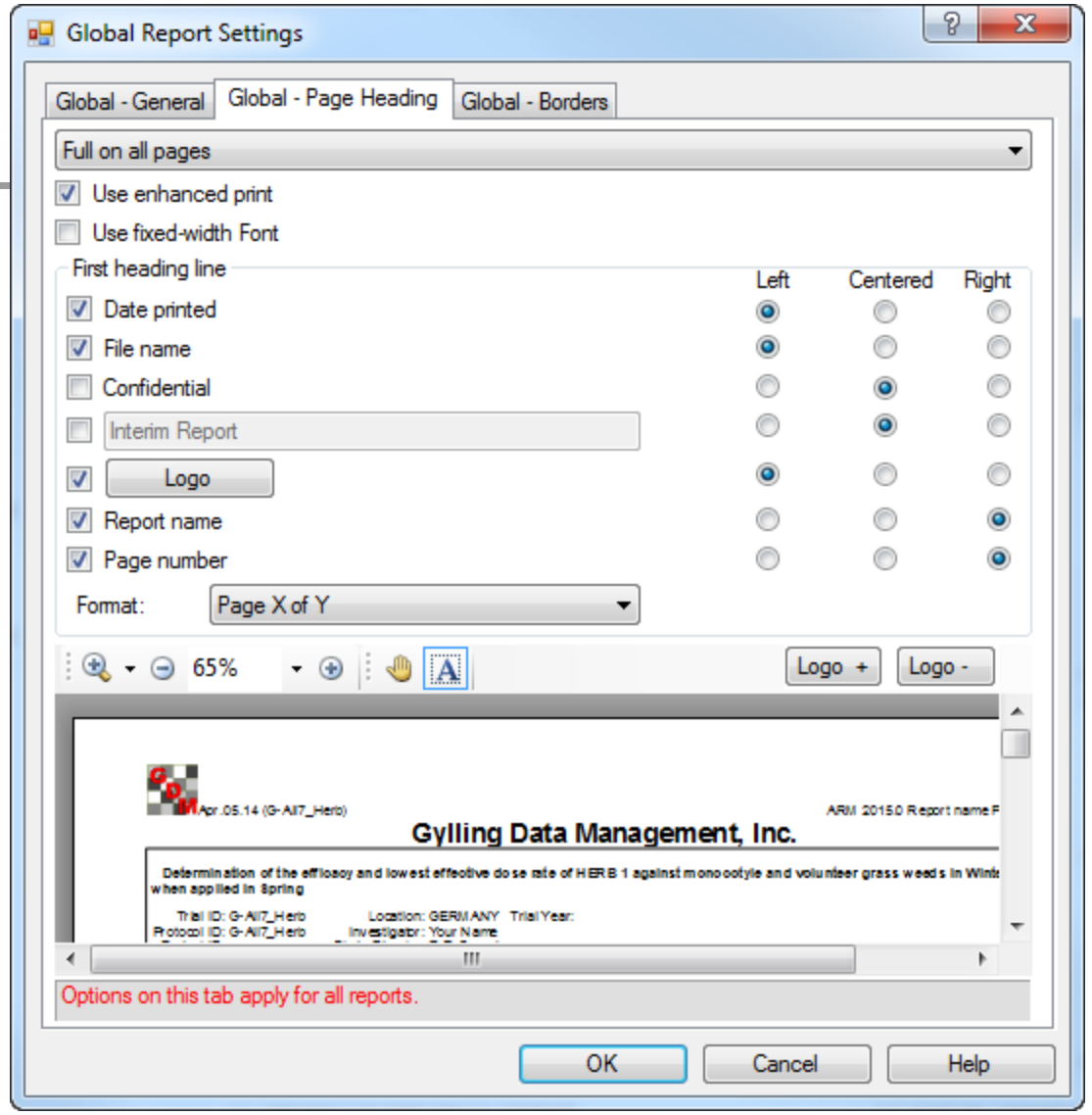


- "Previous sets" shows the report history



Page Heading

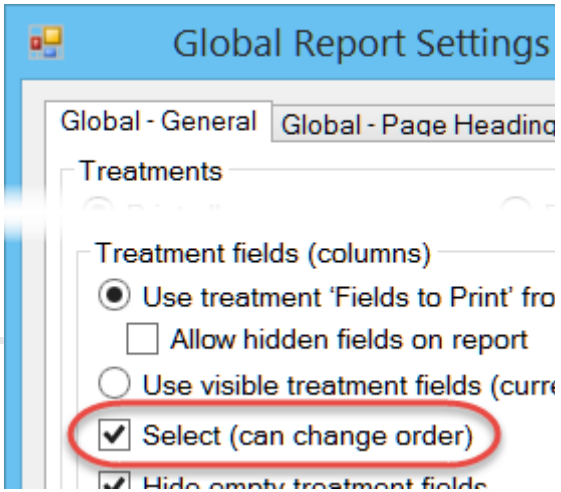
- Customize arrangement
- Simple way to add a logo and adjust logo size and position on report

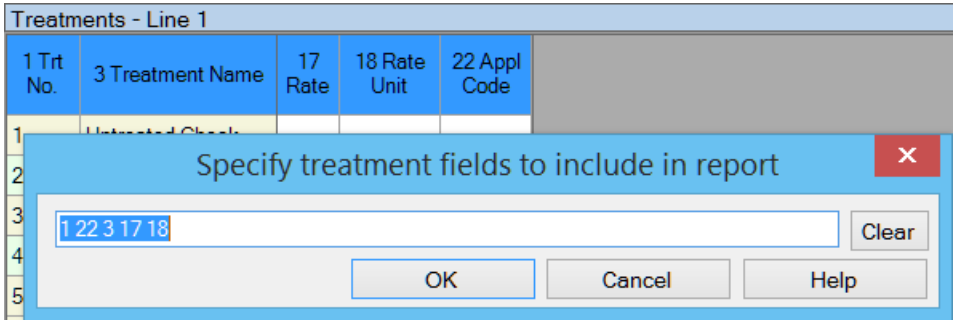


Reports

Option to:

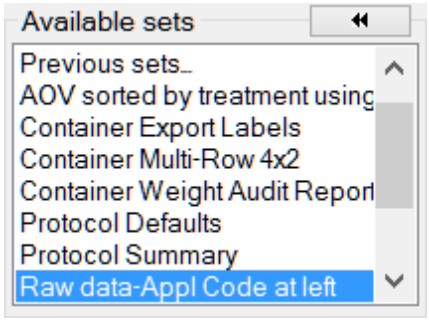
- Change the order of treatment fields on reports, and
- Save this order into report sets, to easily use the same treatment order in future reports





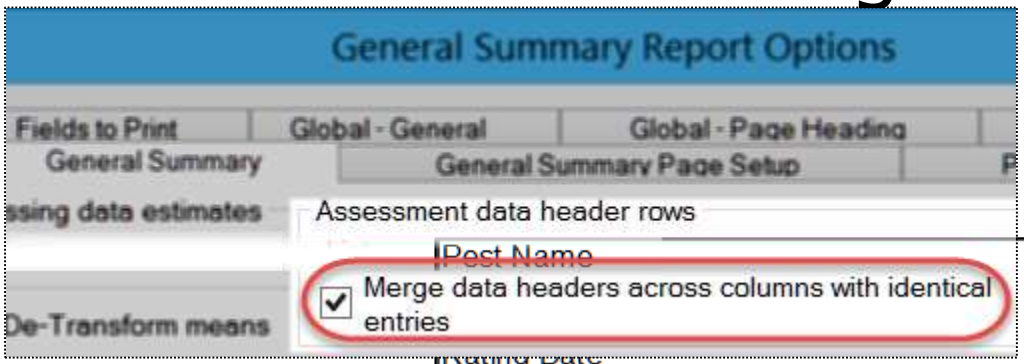
Trt No.	Treatment Name	Rate	Rate Unit	Appl Code	Plot	2
4	Tilt 250	0.5	l/ha	ABC	103	~~50.0~~

Trt No.	Appl Code	Treatment Name	Rate	Rate Unit	Plot	2
4	ABC	Tilt 250	0.5	l/ha	103	~~50.0~~



Summary Reports

Option to merge assessment data headers over columns having the same information



					Speckled leaf blotch of wheat	
					Winter wheat	
			LEAF C	PLANT C	LEAF3 P	
				Jul-15-2014	May-13-2014	
Rating Type			PHYGEN	VIGOR	PESSEV	
Rating Unit					%	%UNCK
Days After First/Last Applic.				91 7	28 28	
Trt-Eval Interval				7 DA-C	28 DA-A	
ARM Action Codes						TAB[3]
Trt No.	Appl Code	Treatment Name	Rate Rate Unit	Plot	1	2	3	4
4	ABC	Tilt 250	0.5 l/ha	102	0.0	100.0	5.00	0.00
				205	0.0	100.0	4.10	0.00
				303	0.0	100.0	4.60	0.00
				401	0.0	100.0	4.50	0.00
				Mean =	0.0	100.0	4.55	0.00

AOV Means Table Report

Prints range of LSD values used to compare the largest and smallest **non-zero** means for any log, arcsine SQR %, or square root transformed data (are **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	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

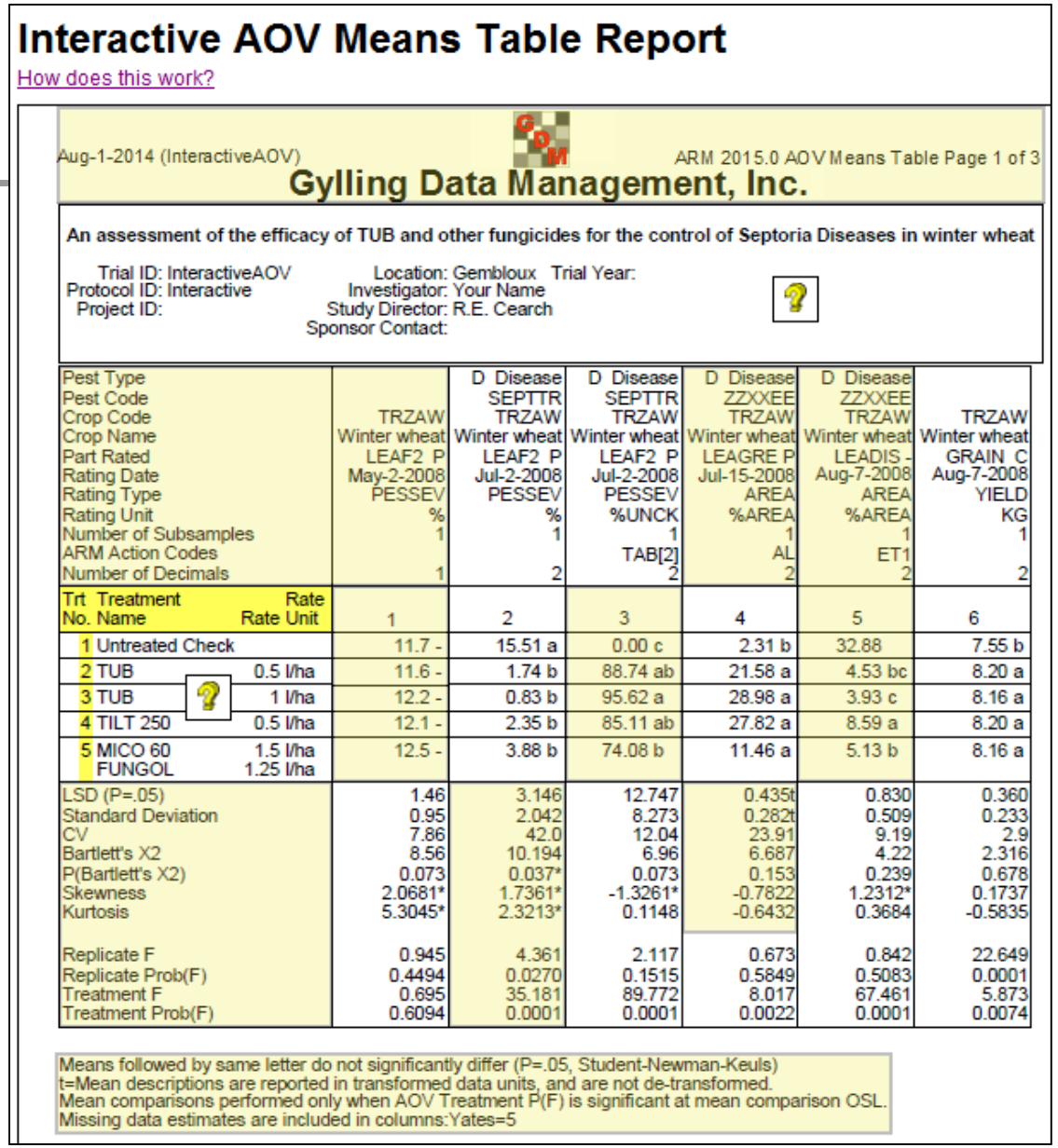
Example using this log transform:

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

Rating Type Rating Unit ARM Action	PESSEV % AL
Trt Treatm 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 6(Fungol	1.19 b
LSD P=.05	1.878 - 3.785

Help for AOV Means Table

New "Interactive AOV Means Table Report" help topic shows which options control various parts of the report



Interactive AOV Means Table Report

How does this work?

Aug-1-2014 (InteractiveAOV) ARM 2015.0 AOV Means Table Page 1 of 3

Gylling Data Management, Inc.

An assessment of the efficacy of TUB and other fungicides for the control of Septoria Diseases in winter wheat

Trial ID: InteractiveAOV Location: Gembloux Trial Year:
Protocol ID: Interactive Investigator: Your Name
Project ID: Study Director: R.E. Cearch
Sponsor Contact:

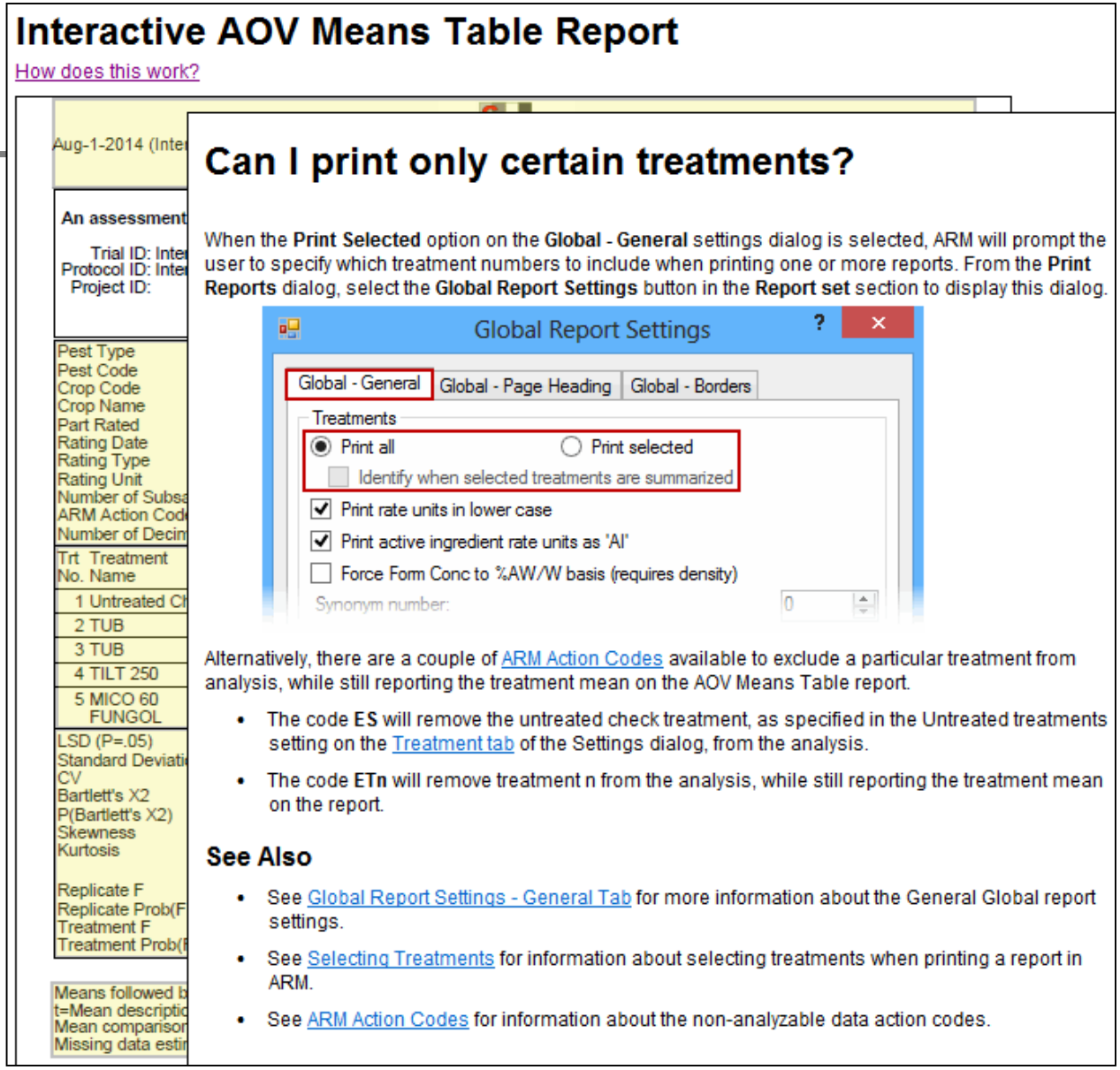
Trt No.	Treatment Name	Rate	Rate Unit	1	2	3	4	5	6
	Pest Type				D Disease	D Disease	D Disease	D Disease	
	Pest Code				SEPTTR	SEPTTR	ZZXXEE	ZZXXEE	
	Crop Code			TRZAW	TRZAW	TRZAW	TRZAW	TRZAW	TRZAW
	Crop Name			Winter wheat	Winter wheat	Winter wheat	Winter wheat	Winter wheat	Winter wheat
	Part Rated			LEAF2 P	LEAF2 P	LEAF2 P	LEAGRE P	LEADIS -	GRAIN C
	Rating Date			May-2-2008	Jul-2-2008	Jul-2-2008	Jul-15-2008	Aug-7-2008	Aug-7-2008
	Rating Type			PESSEV	PESSEV	PESSEV	AREA	AREA	YIELD
	Rating Unit			%	%	%UNCK	%AREA	%AREA	KG
	Number of Subsamples			1	1	1	1	1	1
	ARM Action Codes					TAB[2]	AL	ET1	
	Number of Decimals			1	2	2	2	2	2
1	Untreated Check			11.7 -	15.51 a	0.00 c	2.31 b	32.88	7.55 b
2	TUB	0.5	l/ha	11.6 -	1.74 b	88.74 ab	21.58 a	4.53 bc	8.20 a
3	TUB	1	l/ha	12.2 -	0.83 b	95.62 a	28.98 a	3.93 c	8.16 a
4	TILT 250	0.5	l/ha	12.1 -	2.35 b	85.11 ab	27.82 a	8.59 a	8.20 a
5	MICO 60 FUNGOL	1.5 l/ha 1.25	l/ha	12.5 -	3.88 b	74.08 b	11.46 a	5.13 b	8.16 a
	LSD (P=.05)			1.46	3.146	12.747	0.435t	0.830	0.360
	Standard Deviation			0.95	2.042	8.273	0.282t	0.509	0.233
	CV			7.86	42.0	12.04	23.91	9.19	2.9
	Bartlett's X2			8.56	10.194	6.96	6.687	4.22	2.316
	P(Bartlett's X2)			0.073	0.037*	0.073	0.153	0.239	0.678
	Skewness			2.0681*	1.7361*	-1.3261*	-0.7822	1.2312*	0.1737
	Kurtosis			5.3045*	2.3213*	0.1148	-0.6432	0.3684	-0.5835
	Replicate F			0.945	4.361	2.117	0.673	0.842	22.649
	Replicate Prob(F)			0.4494	0.0270	0.1515	0.5849	0.5083	0.0001
	Treatment F			0.695	35.181	89.772	8.017	67.461	5.873
	Treatment Prob(F)			0.6094	0.0001	0.0001	0.0022	0.0001	0.0074

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.
Missing data estimates are included in columns:Yates=5

Jan. 2017

Help for AOV Means Table

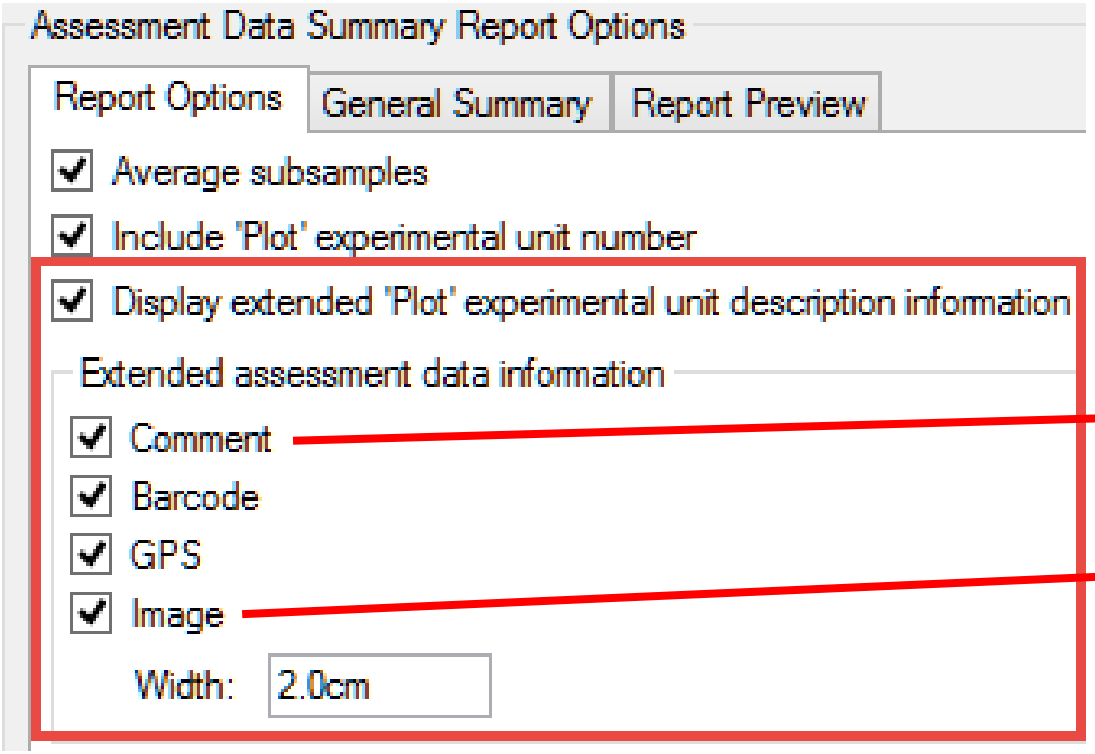
For example, click on treatments in help topic for options on treatments and treatments fields on report



Jan. 2017

Assessment
Data Summary Report

New options for displaying extended 'plot' experimental unit description on report

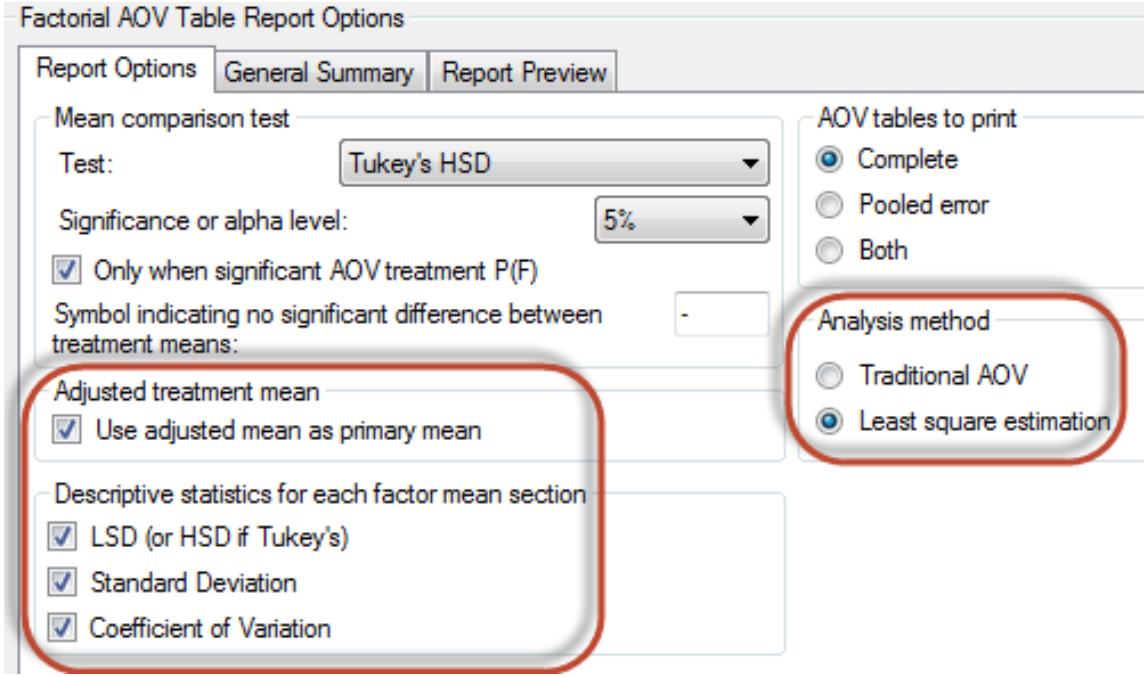


"Damaged" plot value - handled as missing data during analysis

Appl Code Plot	2
ABC 103	~~50.0~~ Animal damage to plot
204	100.0
305	100.0
404	100.0
Mean =	100.0

Factorial AOV Report Options

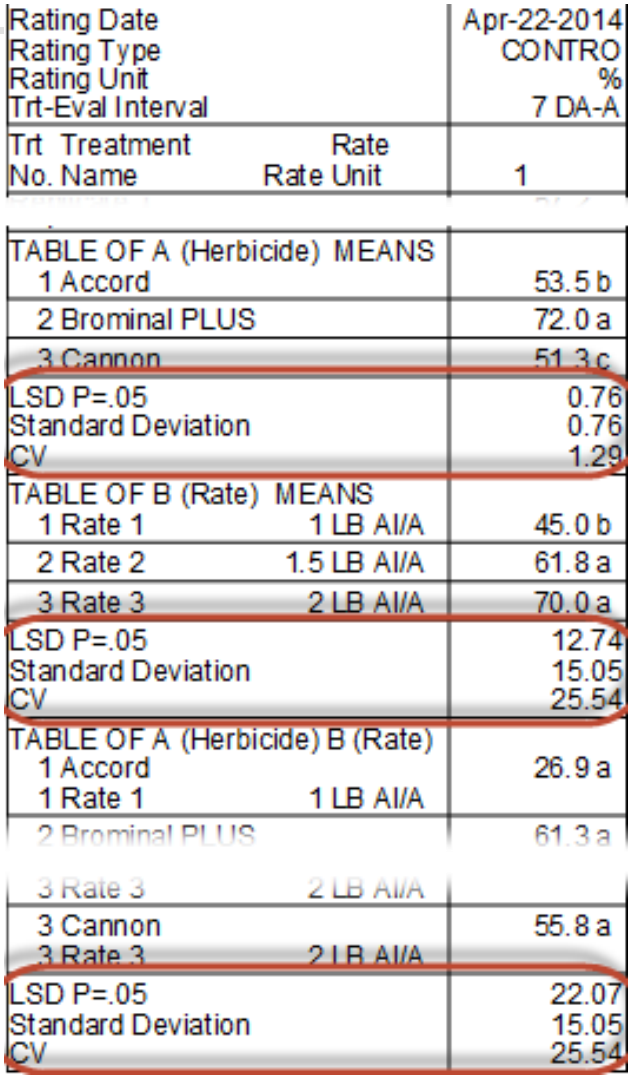
- "Analysis method" options:
  - Least squares analysis (like SAS GLM)
  - Print adjusted means (if missing data)



Factorial AOV Report Options

"Include descriptive statistics for each Factor means section" adds Descriptive statistics under each "Table of X" section:

- LSD (or Tukey's HSD)
- Standard Deviation
- CV



Rating Date		Apr-22-2014
Rating Type		CONTRO
Rating Unit		%
Trt-Eval Interval		7 DA-A
Trt Treatment No.	Rate Unit	1
TABLE OF A (Herbicide) MEANS		
1 Accord		53.5 b
2 Brominal PLUS		72.0 a
3 Cannon		51.3 c
LSD P=.05		0.76
Standard Deviation		0.76
CV		1.29
TABLE OF B (Rate) MEANS		
1 Rate 1	1 LB AI/A	45.0 b
2 Rate 2	1.5 LB AI/A	61.8 a
3 Rate 3	2 LB AI/A	70.0 a
LSD P=.05		12.74
Standard Deviation		15.05
CV		25.54
TABLE OF A (Herbicide) B (Rate)		
1 Accord		26.9 a
1 Rate 1	1 LB AI/A	
2 Brominal PLUS		61.3 a
3 Rate 3	2 LB AI/A	
3 Cannon		55.8 a
3 Rate 3	2 LB AI/A	
LSD P=.05		22.07
Standard Deviation		15.05
CV		25.54

Spray/Seeding Plan Report

Prints Settings Spray Volume and Mix Size for treatments lines where not specified:

Trt Line	Trt No.	Type	Treatment Name	Form Conc	Form Unit	Form Type	Rate	Rate Unit	Appl Code	Spray Volume	Volume Unit	Mix Size	Mix Unit
2	2	FUNG	Tub	250	G/L	EC	0.5	L/ha	ABC				
3	3	FUNG	Tub	250	G/L	EC	1	L/ha	ABC				
4	4	FUNG	Tilt 250	250	G/L	EC	0.5	L/ha	ABC				
5	5	FUNG	Mico 60	600	G/L	EC	1.5	L/ha	AB	250	L/HA	2.65	Liters

Reps: 4 Appl Code: A Plots: 2.5 by 10 meters

Trt No.	Treatment Name	Form Conc	Form Unit	Form Type	Rate	Rate Unit	Appl Code	Spray Volume	Mix Size	Amt Product to Measure	Rep 1	2	3	4
3	Tub	250	G/L	EC	1	l/ha	ABC	200 L/ha	2.15 liters	10.75 ml/mx	101	202	301	402
1	Untreated Check						ABC				102	205	303	401
4	Tilt 250	250	G/L	EC	0.5	l/ha	ABC	200 L/ha	2.15 liters	5.375 ml/mx	103	204	305	404
2	Tub	250	G/L	EC	0.5	l/ha	ABC	200 L/ha	2.15 liters	5.375 ml/mx	104	201	302	403
5	Mico 60	600	G/L	EC	1.5	l/ha	AB	250 L/HA	2.65 Liters	15.9 ml/mx	105	203	304	405

Spray/Seeding Plan Report

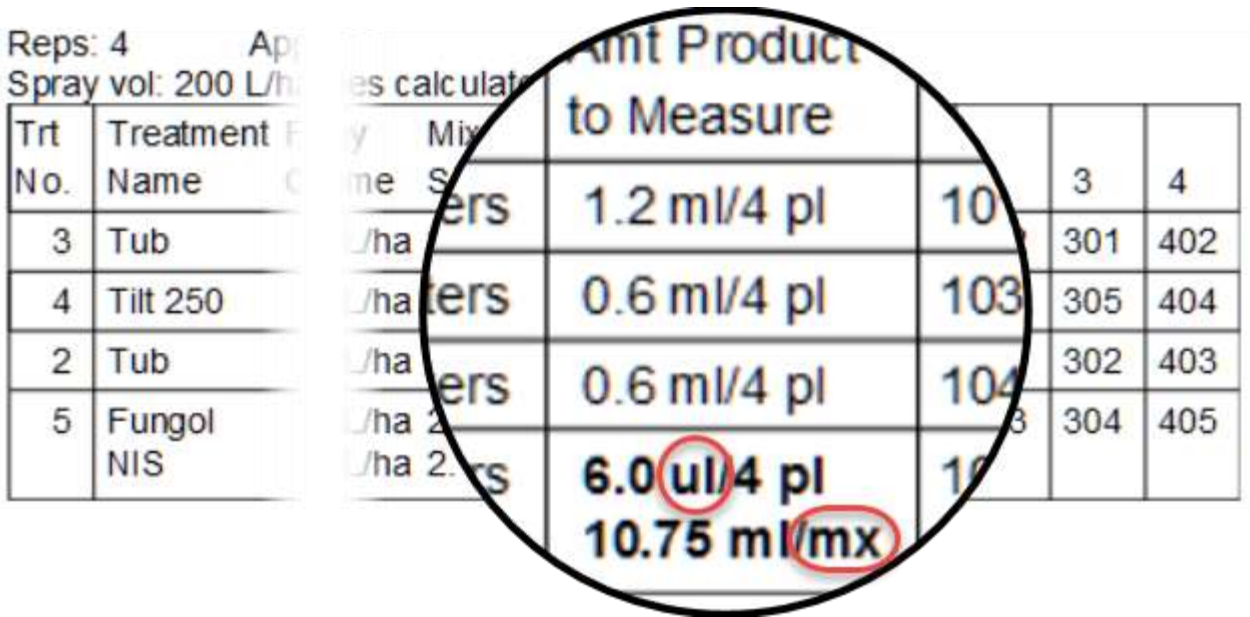
Canopy height rates

- Mix size printed for canopy height treatments is now multiplied by canopy height entered in Site Description
- Calculated mix size in the table heading is corrected for canopy height treatments

Spray/Seeding Plan Report

Product Amount is bold font when unit is:

- Scaled differently: ml vs. µl
- Has a different unit basis: /4 pl vs. /mx



Product Amount Totals

Form Unit also differentiates products in the Product Amount Totals table

Amount*	Unit	Treatment Name	Form Conc	Form Unit	Form Type	Lot Code
2.805	ml	Banvel 720	350	gA/L	L	
4.740	ml	FallowMaster	250	gA/L	SC	
2.814	ml	Marksman	385	gA/L	F	
0.584	ml	Clarity	58	%	SC	

Labels Report

- Adjusted margin defaults for Avery 3451, 5160, 5161, 5163, L6103, L6105 to better fit label sheets
- Added Avery 5162 and 5735 labels
- Single-click now loads label defaults
- Force right and bottom margins to 0 when printing
- Metric label margins are more accurate
- Last label row on page not skipped for labels with vertical buffer between rows

Print Reports

- Trial Status and Protocol Data Headers reports no longer print blank rows
- Technician license can print Data Collection, Map, and Trial Map reports
- Site Description Named View and Selected Tabs reports can be previewed using Report Preview tab

Print Reports

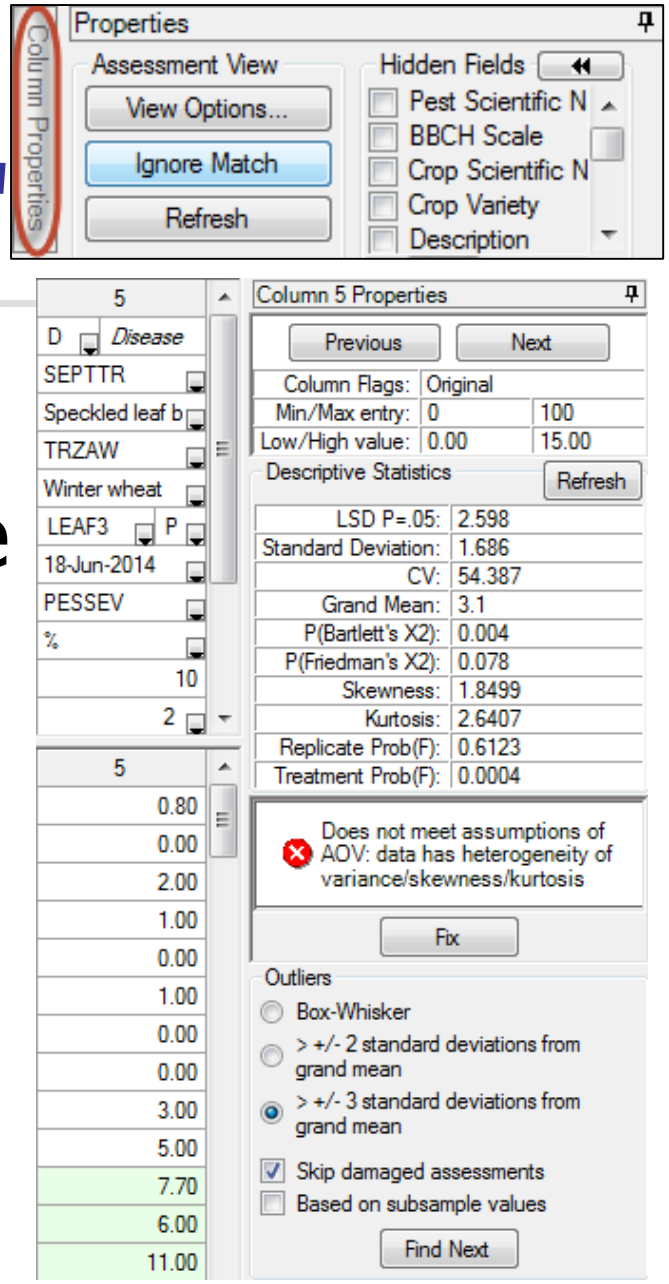
- Option to:
  - Include median with treatment mean on single trial AOV report, and
  - Also include median on multi-trial ST (Summary Across Trials) AOV reports
- Median helps identify when a single value is "distorting" the mean

Mean vs. Median Example

- Phytotoxicity data set: 0 0 0 5 20
  Mean 5
  Median 0
- % control data set: 50 90 90 90 95
  Mean 83
  Median 90
- "Balanced data set": 5 10 15 20 25
  Mean 15
  Median 15

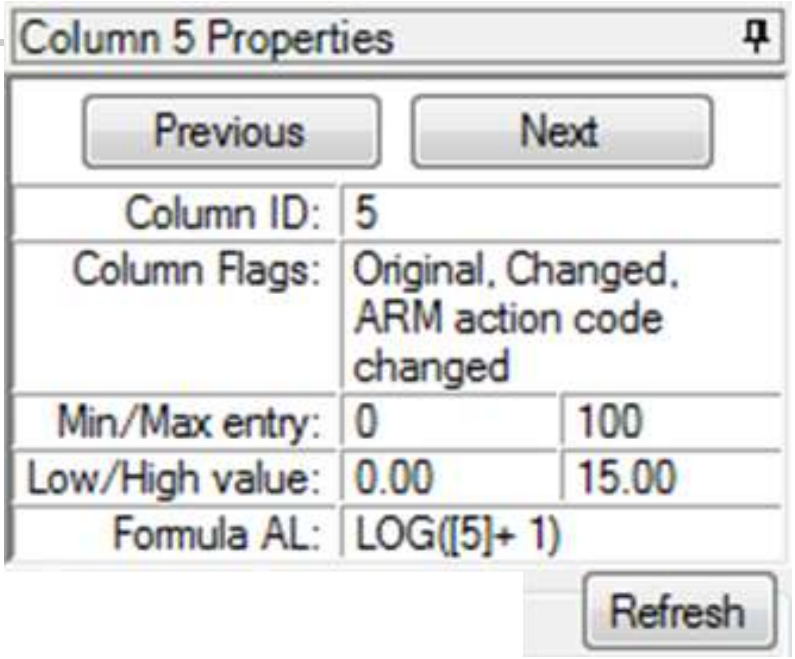
Assessment Data "Column Properties"

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



Assessment Data "Column Properties"

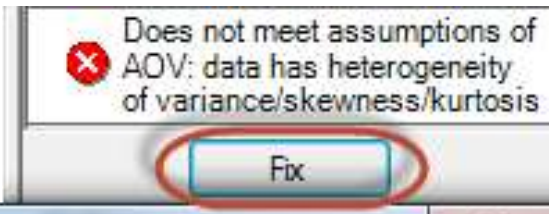
- Column navigation
- Column description
- Min, Max, Range
- Transformation formula description
- Click "Refresh" to update after changing current data column

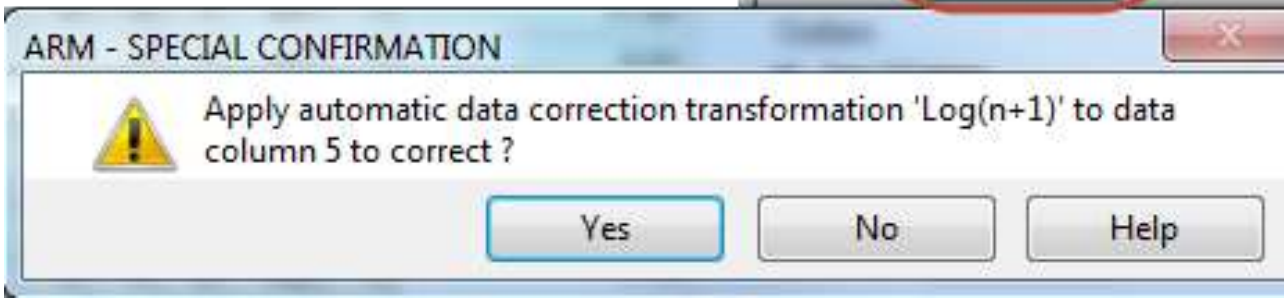


Assessment Data "Column Properties"

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

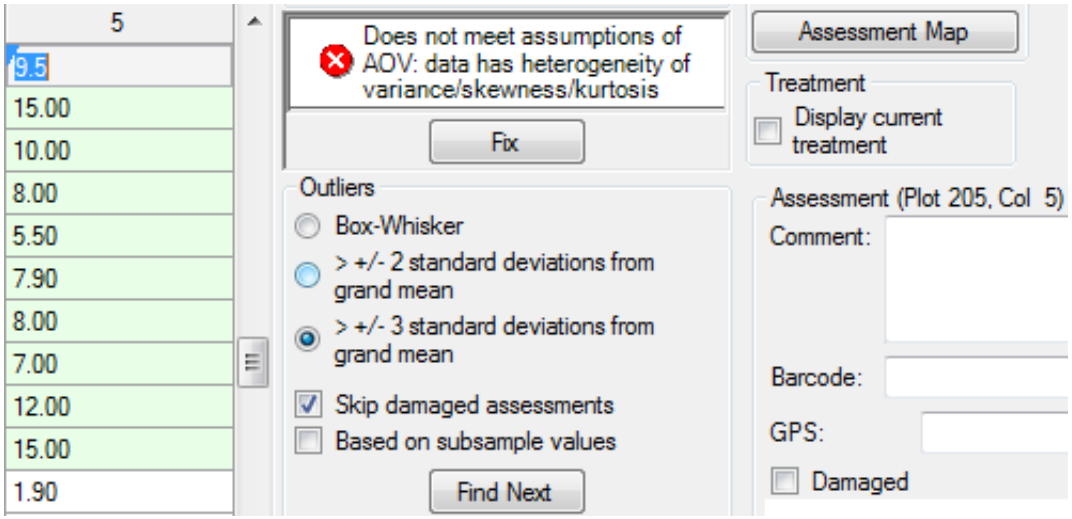
LSD P=.05:	2.598
Standard Deviation:	1.686
CV:	54.387
Grand Mean:	3.1
P(Bartlett's X2):	0.004
P(Friedman's X2):	0.078
Skewness:	1.8499
Kurtosis:	2.6407
Replicate Prob(F):	0.6123
Treatment Prob(F):	0.0004





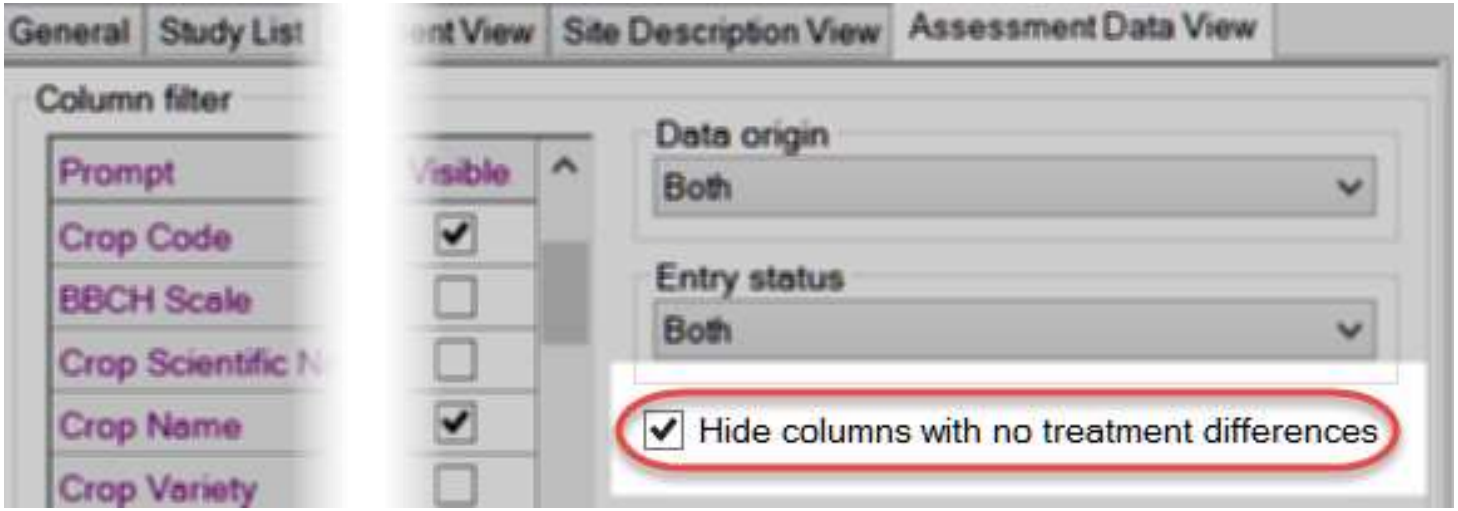
Assessment Data "Column Properties"

- 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



Assessment Data Editor

Assessment Data view to hide data columns in which there are no differences between treatments



Assessment Data Editor

Before:

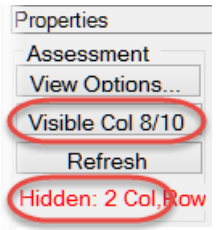
	1	2	3	4
			SEPTTR	SEPTTR
	LEAF C	PLANT C	LEAF3 P	LEAF3 P
	Jul-15-2014	Jul-15-2014	May-13-2014	Jun-18-2014
	PHYGEN	VIGOR	PESSEV	PESSEV
	%	%	%	%

Plot	Trt	1	2	3	4
101	3	0	100	1.00	0.80
102	1	0	100	10.00	7.70
103	4	0	~~50~~	1.00	1.10
104	2	0	100	0.00	1.20
105	5	0	100	10.00	1.70
201	2	0	100	0.00	1.20
202	3	0	100	2.00	0.90
203	5	0	100	0.00	3.30
204	4	0	100	5.00	1.70
205	1	0	100	3.00	9.50

After:

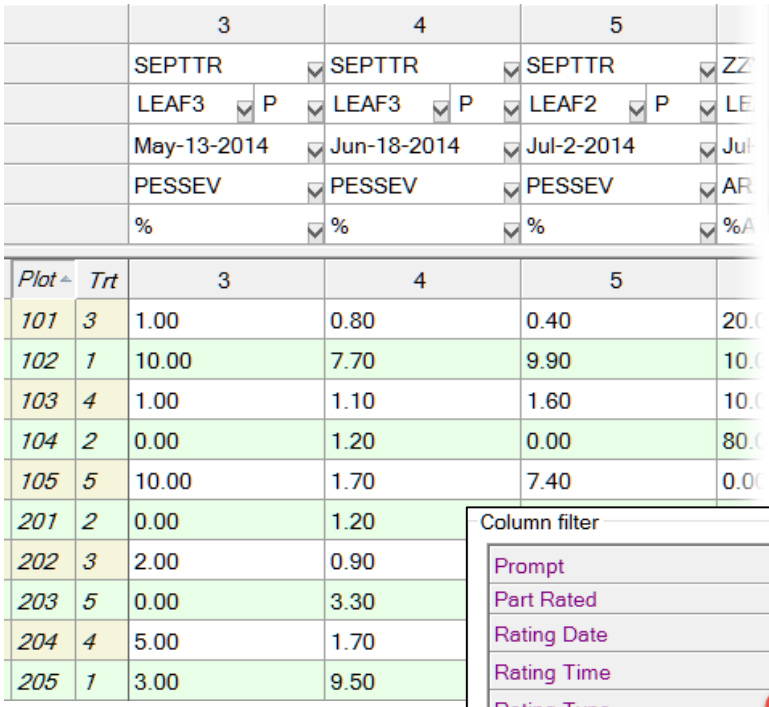
	3	4	5	
	SEPTTR	SEPTTR	SEPTTR	ZZ
	LEAF3 P	LEAF3 P	LEAF2 P	LE
	May-13-2014	Jun-18-2014	Jul-2-2014	Jul
	PESSEV	PESSEV	PESSEV	AR
	%	%	%	%A

Plot	Trt	3	4	5	
101	3	1.00	0.80	0.40	20.
102	1	10.00	7.70	9.90	10.
103	4	1.00	1.10	1.60	10.
104	2	0.00	1.20	0.00	80.
105	5	10.00	1.70	7.40	0.0
201	2	0.00	1.20	1.20	20.
202	3	2.00	0.90	0.10	20.
203	5	0.00	3.30	2.90	0.0
204	4	5.00	1.70	3.00	70.
205	1	3.00	9.50	16.00	0.0



All values the same or missing/blank (50 in column 2 is "damaged" so is missing)

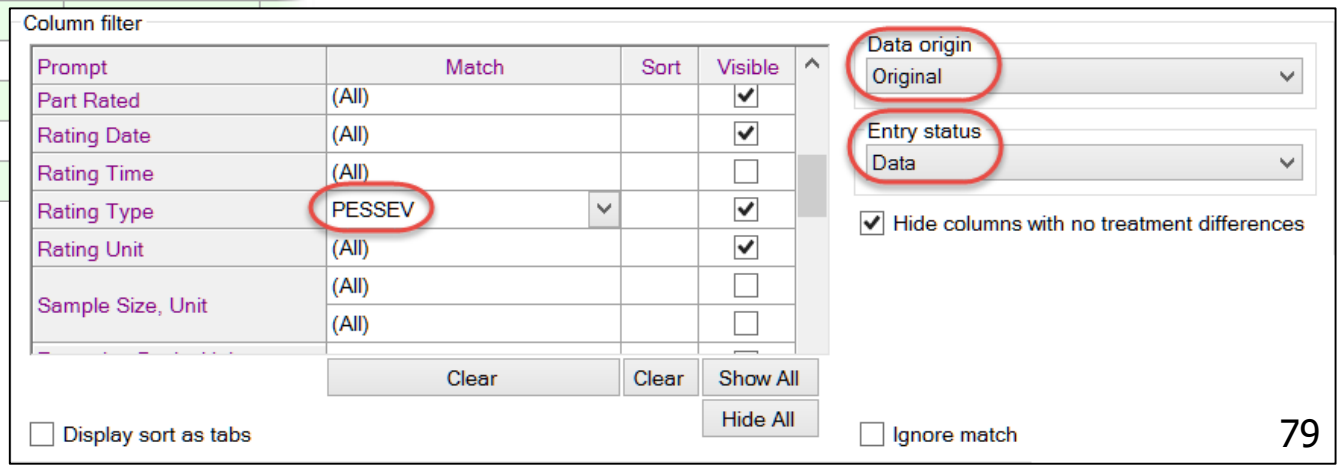
Assessment Data Editor



	3	4	5	
	SEPTTR	SEPTTR	SEPTTR	ZZ
	LEAF3 P	LEAF3 P	LEAF2 P	LE
	May-13-2014	Jun-18-2014	Jul-2-2014	Jul
	PESSEV	PESSEV	PESSEV	AR
	%	%	%	%A
Plot	Trt	3	4	5	
101	3	1.00	0.80	0.40	20.
102	1	10.00	7.70	9.90	10.
103	4	1.00	1.10	1.60	10.
104	2	0.00	1.20	0.00	80.
105	5	10.00	1.70	7.40	0.0
201	2	0.00	1.20		
202	3	2.00	0.90		
203	5	0.00	3.30		
204	4	5.00	1.70		
205	1	3.00	9.50		

Click this "Visible Col" button to choose between displaying:

- All data columns, or
- A view that temporarily hides some columns



Assessment Data Editor

SUMSUB ARM Action Code *sums* instead of *averages* subsamples when viewing 1 value per plot on editor or reports:

5 subsamples

Assessment Data - Line 8

Column Number	2
Part Assessed	FRUIT P
Assessment Date	05/17/2014
Assessment Type	COUINS
Assessment Unit	NUMBER
Number of Subsamples	5
Trt-Eval Interval	3 DA-A
ARM Action Codes	

+	Sub	Rep	Blk	Col	Plot	Trt	2
	1	1	1	1	101	2	108.0
	2	1	1	1	101	2	65.0
	3	1	1	1	101	2	48.0
	4	1	1	1	101	2	93.0
	5	1	1	1	101	2	76.0

First sub

	2
	FRUIT P
	05/17/2014
	COUINS
	NUMBER
	5
	3 DA-A

Plot	Trt	2
101	2	108.0
102	1	165.0
103	3	70.0
104	4	55.0
105	5	12.0

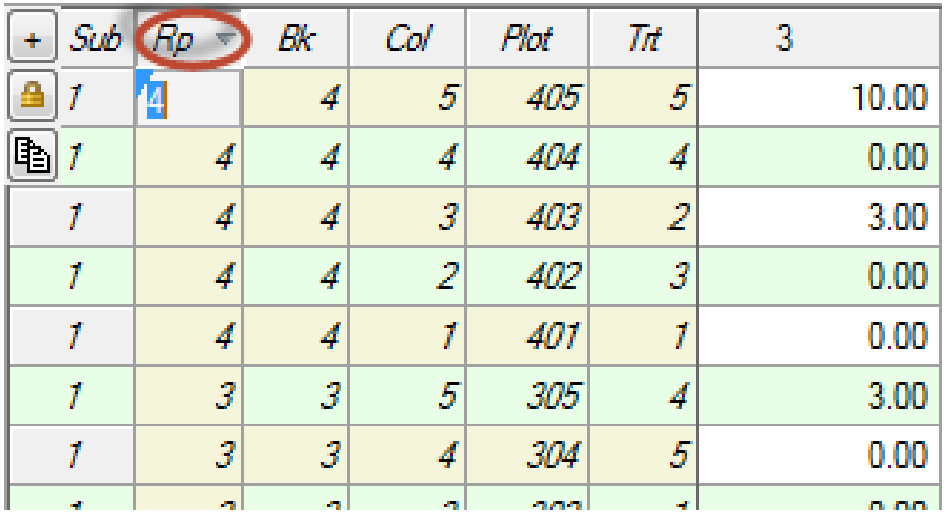
Sum of subs

	2
	FRUIT P
	05/17/2014
	COUINS
	NUMBER
	5
	3 DA-A
	SUMSUB

Plot	Trt	2
101	2	390.0
102	1	165.0
103	3	70.0
104	4	55.0
105	5	12.0

New Assessment Sorts

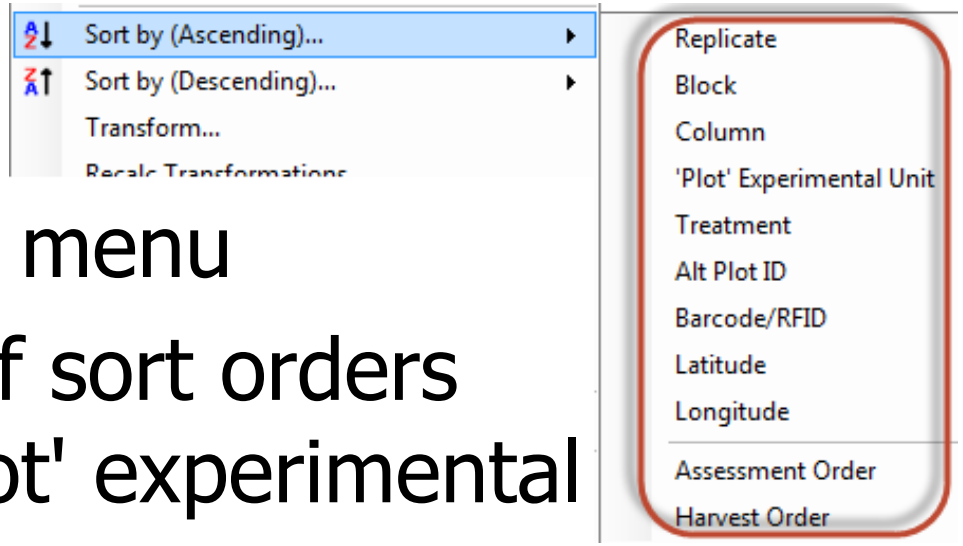
- Sort data by any 'plot' experimental unit description column
- Click heading once for ascending sort, click again for descending sort



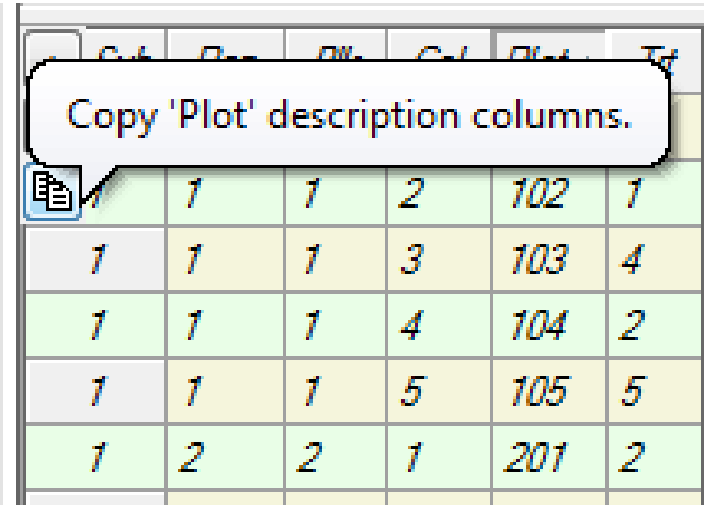
+	Sub	Rp	Bk	Col	Plot	Trt	3
	1	4	4	5	405	5	10.00
	1	4	4	4	404	4	0.00
	1	4	4	3	403	2	3.00
	1	4	4	2	402	3	0.00
	1	4	4	1	401	1	0.00
	1	3	3	5	305	4	3.00
	1	3	3	4	304	5	0.00

New Assessment Sorts

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



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 (shown pasted to Excel)

	A	B	C	D	E
1	Rep	Blk	Col	Plot	Trt
2	1	1	1	101	3
3	1	1	2	102	1
4	1	1	3	103	4
5	1	1	4	104	2
6	1	1	5	105	5
7	2	2	1	201	2
8	2	2	2	202	3

Assessment Editor

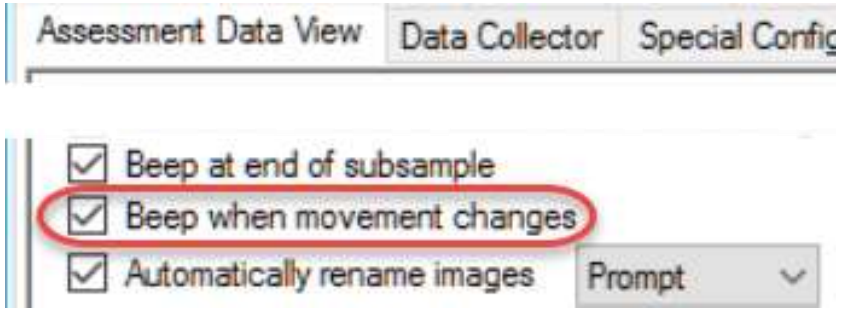
- New 'Across columns within subsample' cursor order
- Tablet Data Entry mode: "Subsamples" data header label displays more columns
- Undo Assessment Comment, Barcode, GPS coordinate, and Damaged field changes
- Clear 'Damaged' flag from marked blocks
- Several outlier search panel fixes

Assessment Editor

- When choose formula from ARM Action Code list, are now asked to select original column(s) to transform
- Range and Row columns are now copied when select Trial Map Plot Description copy button in range/row numbered trial
- New warning when cursor moves to top of a new column in current cursor order if a key press will overwrite existing data

Assessment Editor

- Warning when cursor moves to top of a new column in current cursor order if a key press will overwrite existing data
- Option to beep when cursor advances to a plot that changes movement direction for Assessment or Harvest sort order



Assessment Editor

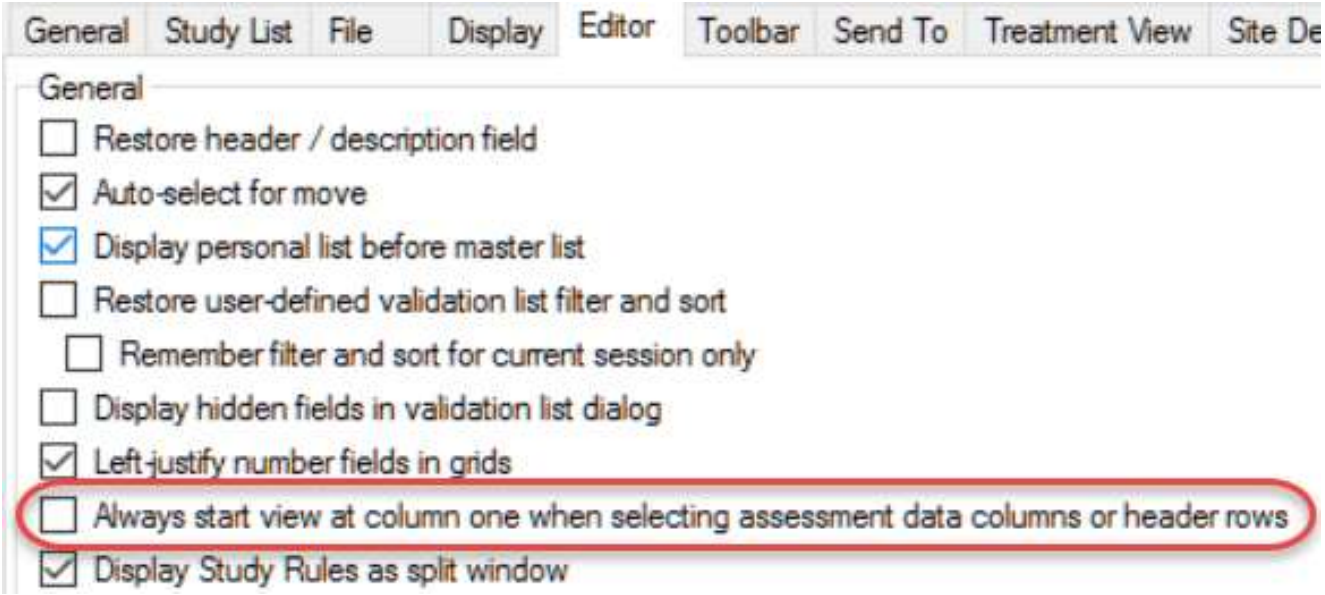
AUDPC/SAUDPC calculates when all planned assessments are defined, yet only some contain data:

Column Number	1	2	3	4	5	6 (Calculated)
Pest Name	Powdery milde	Powdery milde	Powdery milde	Powdery milde	Powdery milde	Powdery milde
Assessment Date	06/08/2016	06/22/2016	07/05/2016			
Assessment Type	COUDIS	COUDIS	COUDIS	COUDIS	COUDIS	
Assessment Unit	%	%	%	%	%	AUDPC
Trt-Eval Interval	38 DA-A	52 DA-A	65 DA-A	80 DA-A	95 DA-A	

+	Sub	Rep	Blk	Col	Plot	Trt	1	2	3	4	5	6 (Calculated)
	1	1	1	1	101	1	10	30	45			767.5
	1	1	1	2	102	2	0	40	60			930.0
	1	1	1	3	103	3	0	25	40			597.5

Assessment Editor

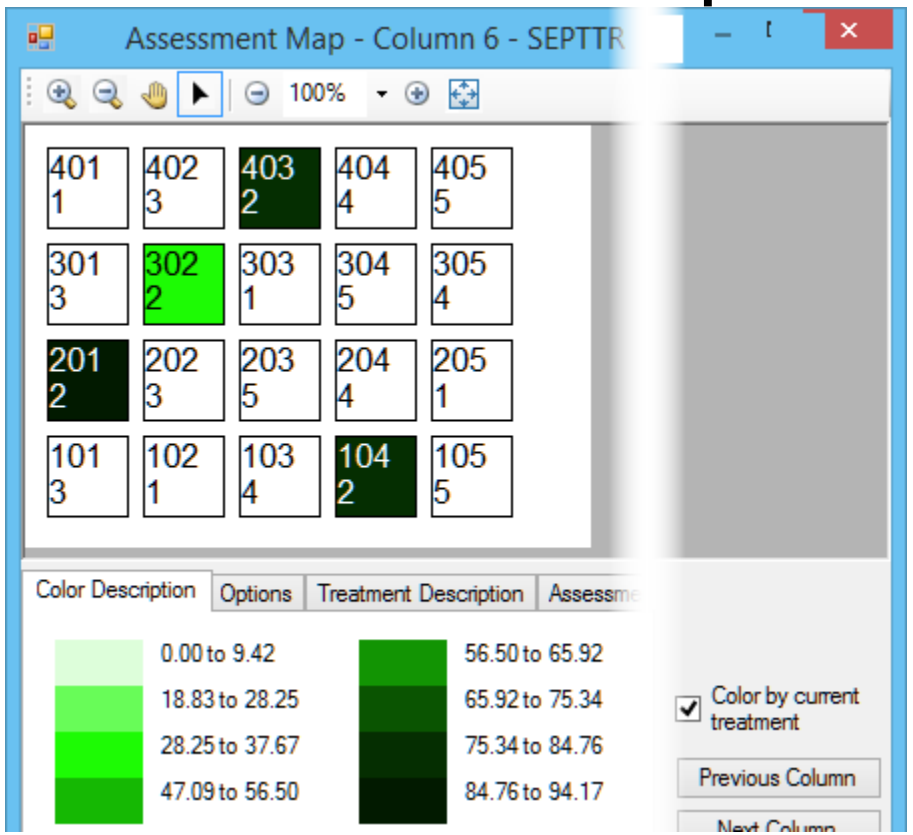
Editor option to always start at column or header row 1 when selecting data columns or header rows



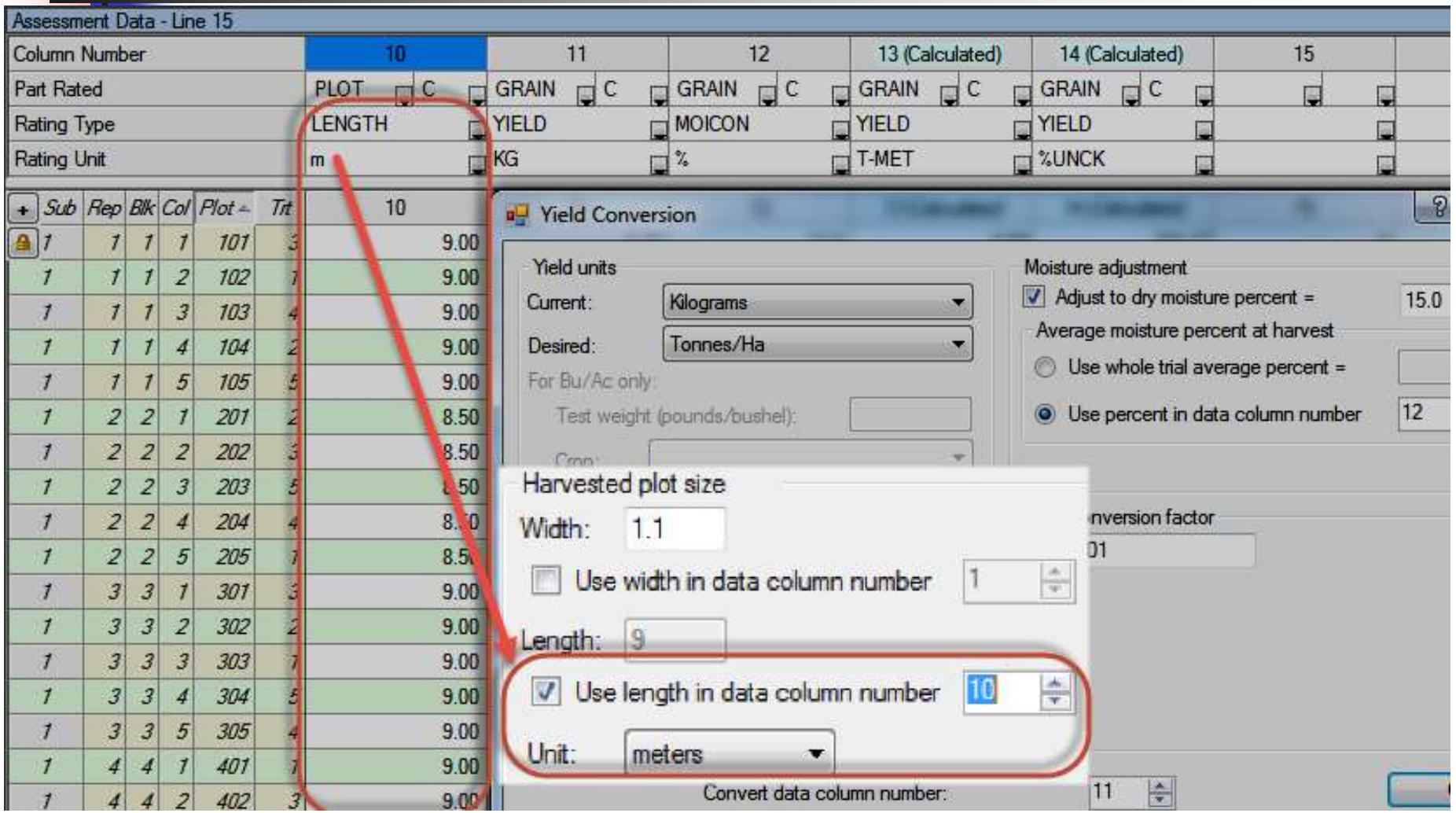
Assessment Map

New 'Color by current treatment' option

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



Convert Yield using Harvested Plot Length/Width per Plot 9.2014



Convert Yield Automations

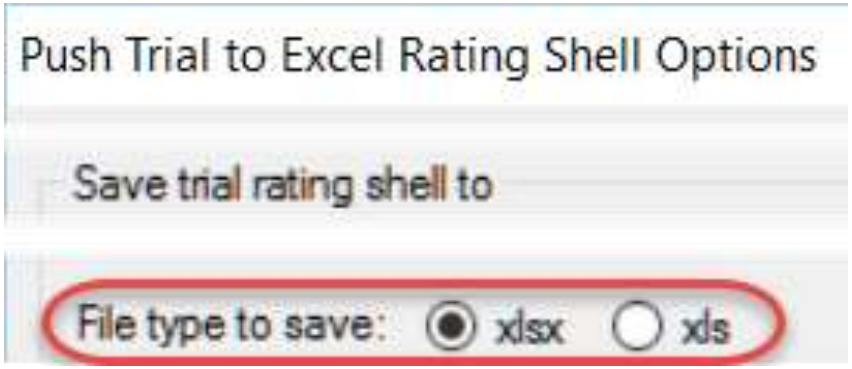
- Column to Convert:
  - 'Current' unit auto-selected from Rating Unit
  - Sample size auto-filled with 1 PLOT if blank
- Sample size in Converted column auto-filled based on selected Desired unit

Convert Yield

- Auto-fills 'Adjust to dry moisture percent' option from '% Standard Moisture' in Crop Description of the Site Description
- Converted yield is now 0 when original weight is 0 and adjusted moisture is missing

Excel Rating Shells

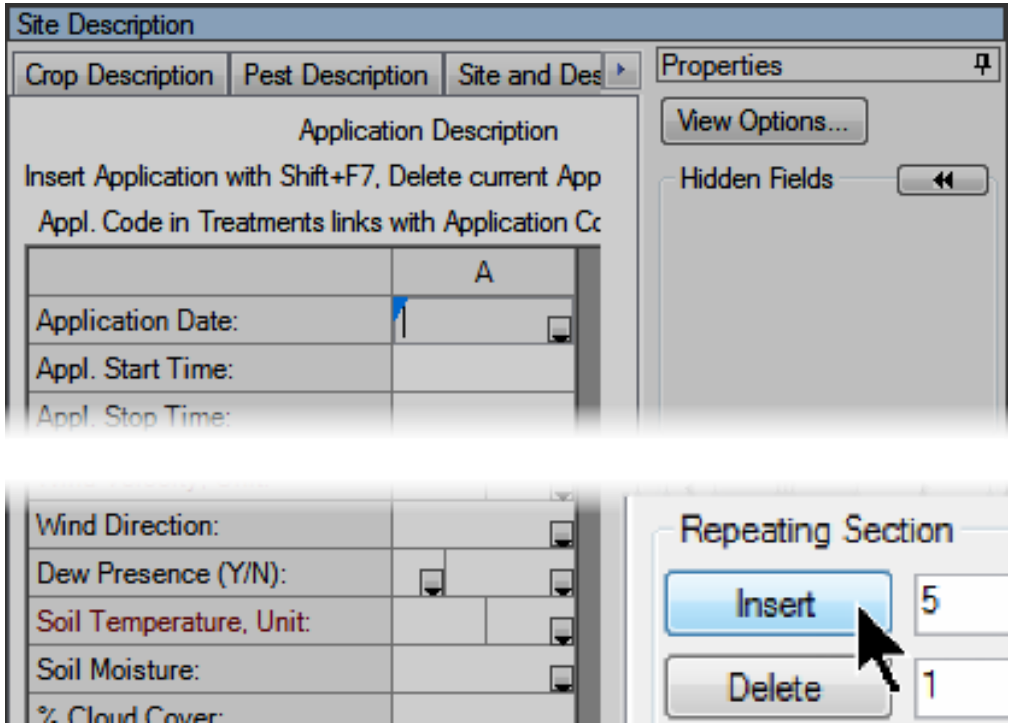
Can be Pushed and Pulled as Excel *.xlsx using 'File type to save' option:



Insert or Delete Multiple Repeating Sections at Once

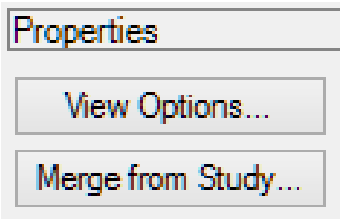
New option on Site/Protocol Description Properties panel

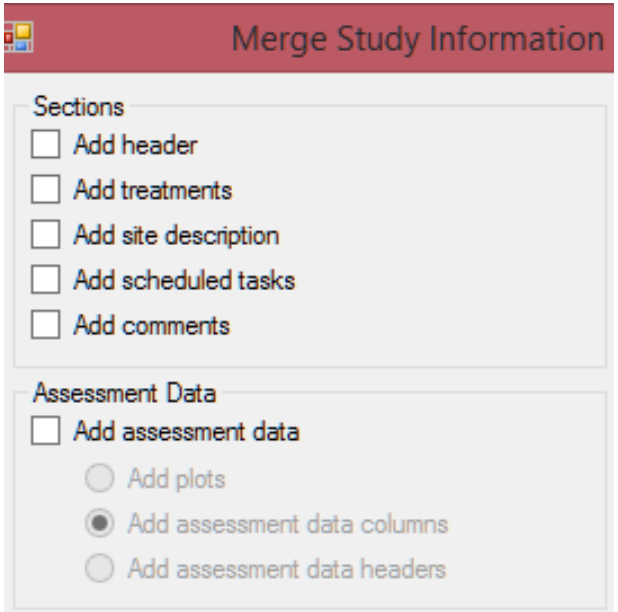
1. Define number to add or delete
2. Select 'Insert' or 'Delete' button

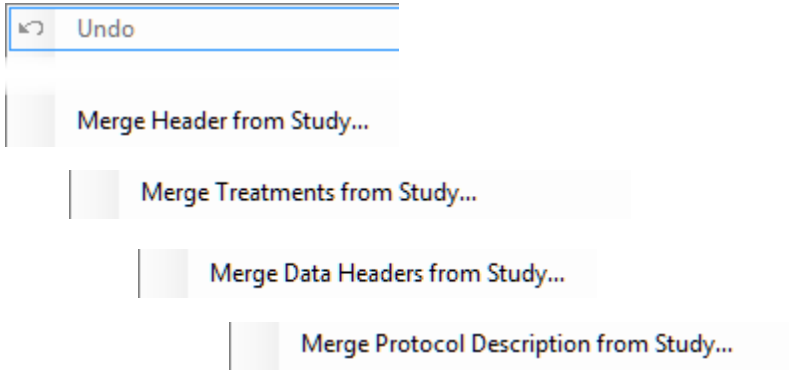


Merge from Study

- New button on properties panels
- Use to ***add*** matching information from another study into current study
- Also on right-click menus







Merge from Study - Use to:

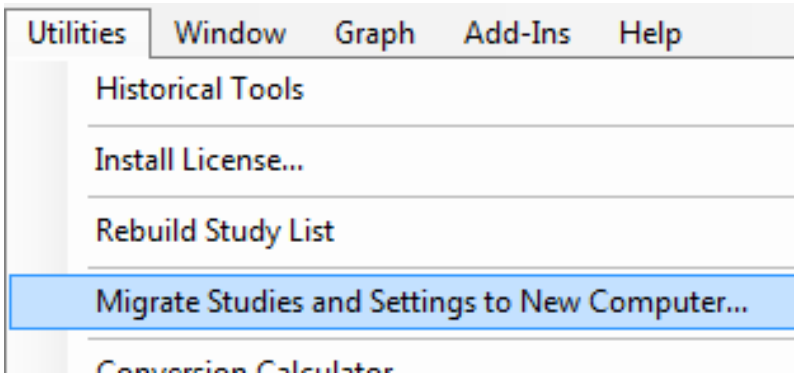
- Build new protocol (trial plan) from a similar existing study
  - Even from a sponsor's customized protocol
- Add assessment headers (description)
- Add location, soil, and/or moisture from another trial in same field
- Combine 2+ identical trials at different locations into split-plot trial

Merge Studies

- When merge protocol description, are now asked whether to update all merged dates to the current year
  - Simplifies using a previous year's protocol
- Select study to merge either from study list or by using Browse button

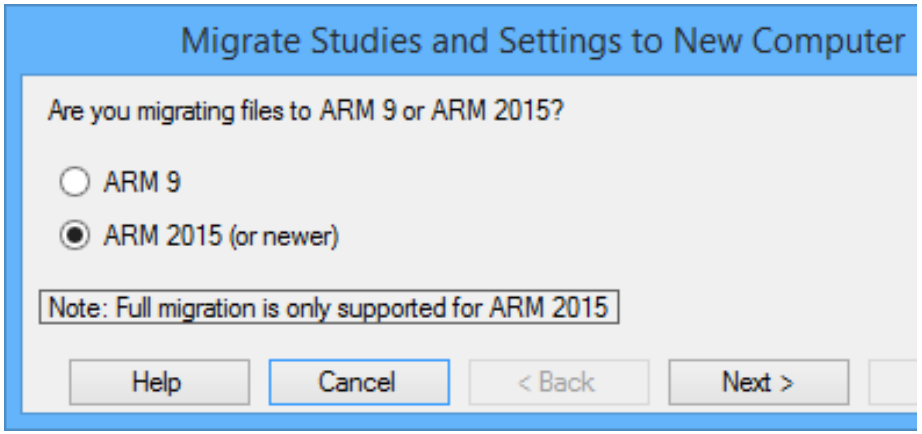
Assist Migration to a New PC

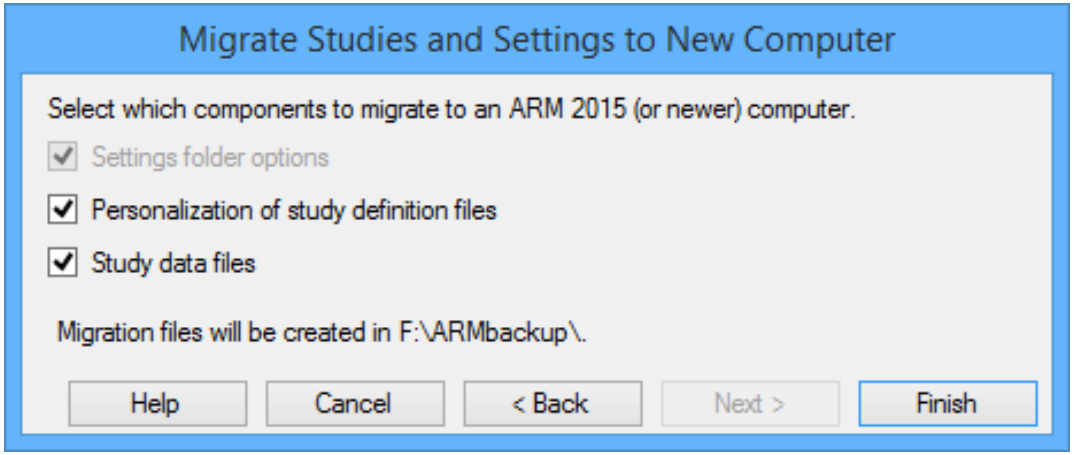
- Create migration package of original PC (in ARM 9.2014.2+) containing:
  - ARM studies
  - Personal lists
  - ARM and report options, report sets
  - ARMbackup folder contents (if package is stored on ARM's backup device)



Migration Wizard

- Select ARM version that will be installed on the new PC
- Select items to include in the package

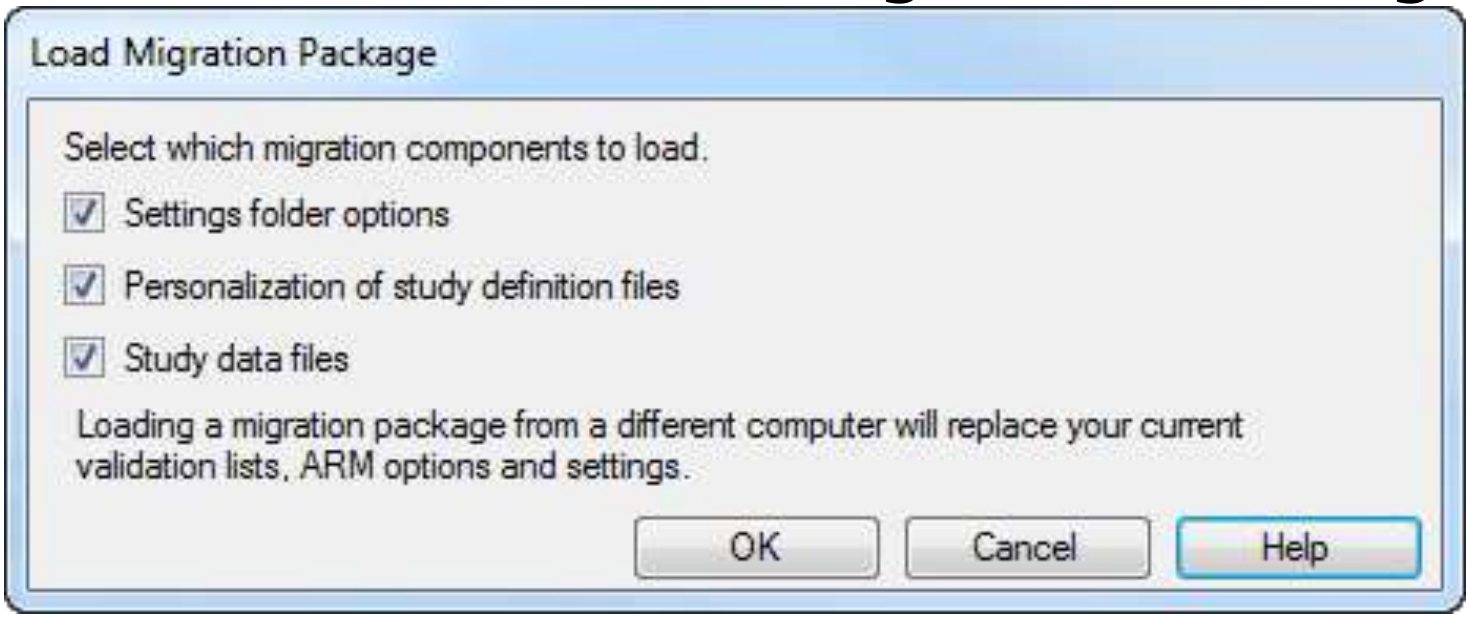




Import Migration in ARM

On the new PC with ARM, either:

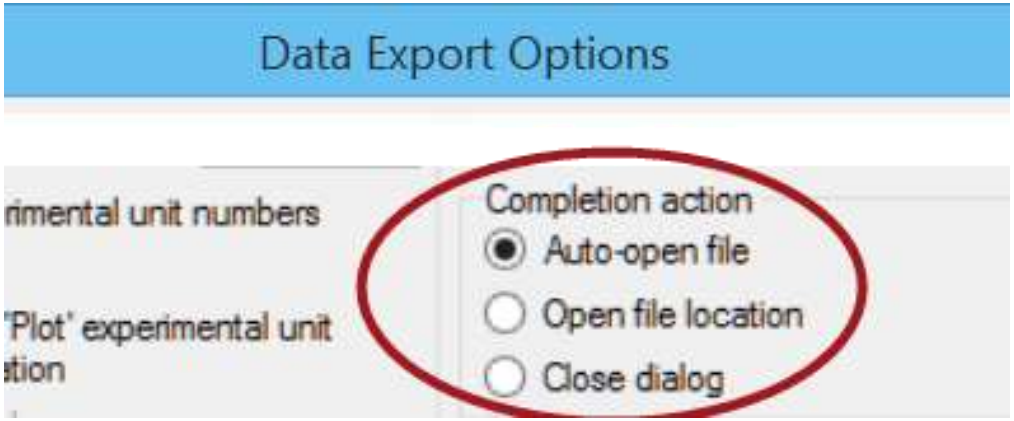
- Use migration package when installing ARM
- Use Utilities menu "Load Migration Package"



Data Export

New 'Completion action" options:

- Auto-open exported data in the registered Windows program for selected file type (such as Excel for *.csv exports)
- Auto-open in Windows Explorer the folder containing exported data



Data Export

Export extended 'Plot' description:

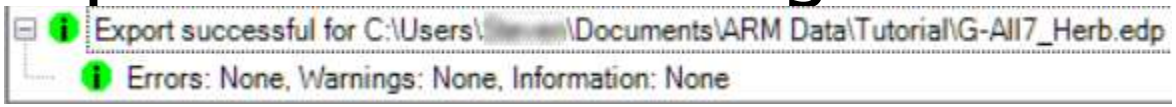
-	Sub	Rep	Blk	Col	Plot	Trt	Alt Plot ID	Barcode/RFID	Lat	Long
	1	1	1	1	101	2				
	1	1	1	2	102	5				

- New format option
- Use to include plot IDs and location information when exporting to other programs

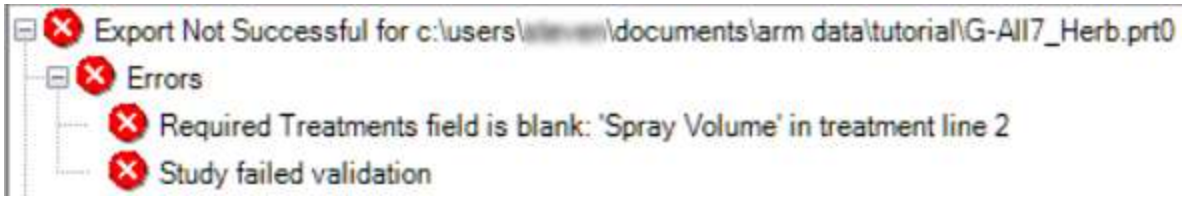
Export Success Messages

Message color indicates success

- 'Export Successful' is green



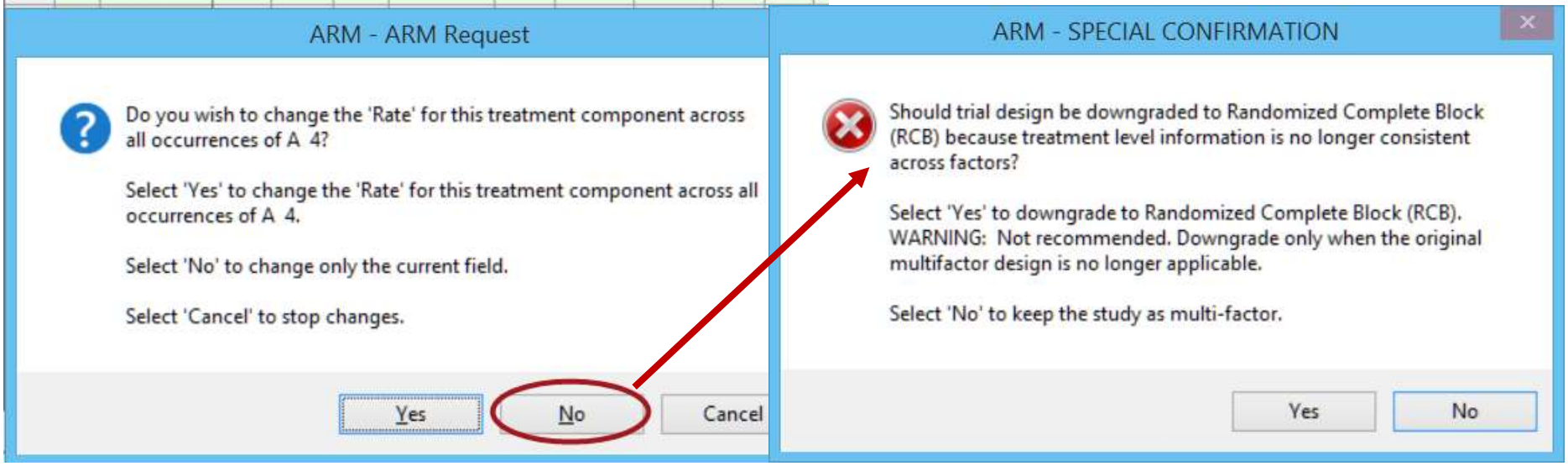
- 'Export not Successful' is red



Treatments

- Clearer message when trial treatments change will unbalance multi-factor trial:

13	7	Hyvar X	80	WP	4	KG A/HA	A					A
14	7	1 MAP										B
15	8	Hyvar X	80	WP	5	KG A/HA	A					A
16	8	2 MAP										B



Treatments

- 'Mixed' formulation concentration unit for pre-mixed products that contain different concentration units, such as g AI/L + BCFU/mL.
- Calculate Other Rate for Units ending in 'Row-m' or 'Row-FT'
- Calculate Other Rate even when 'Calculated Mix Size' in Settings is 0

Edit - Delete Treatments

Selected treatments are marked to better show which treatments will be deleted

Treatments

- Calculate Other Rate for Units ending in 'Row-m' or 'Row-FT'
- Calculate Other Rate even when 'Calculated Mix Size' in Settings is 0

Site/Protocol Description

- Grid columns auto-size to fit text in repeating section grids after pasting, such as when paste weather data
- Read-only grid fields display in italic font

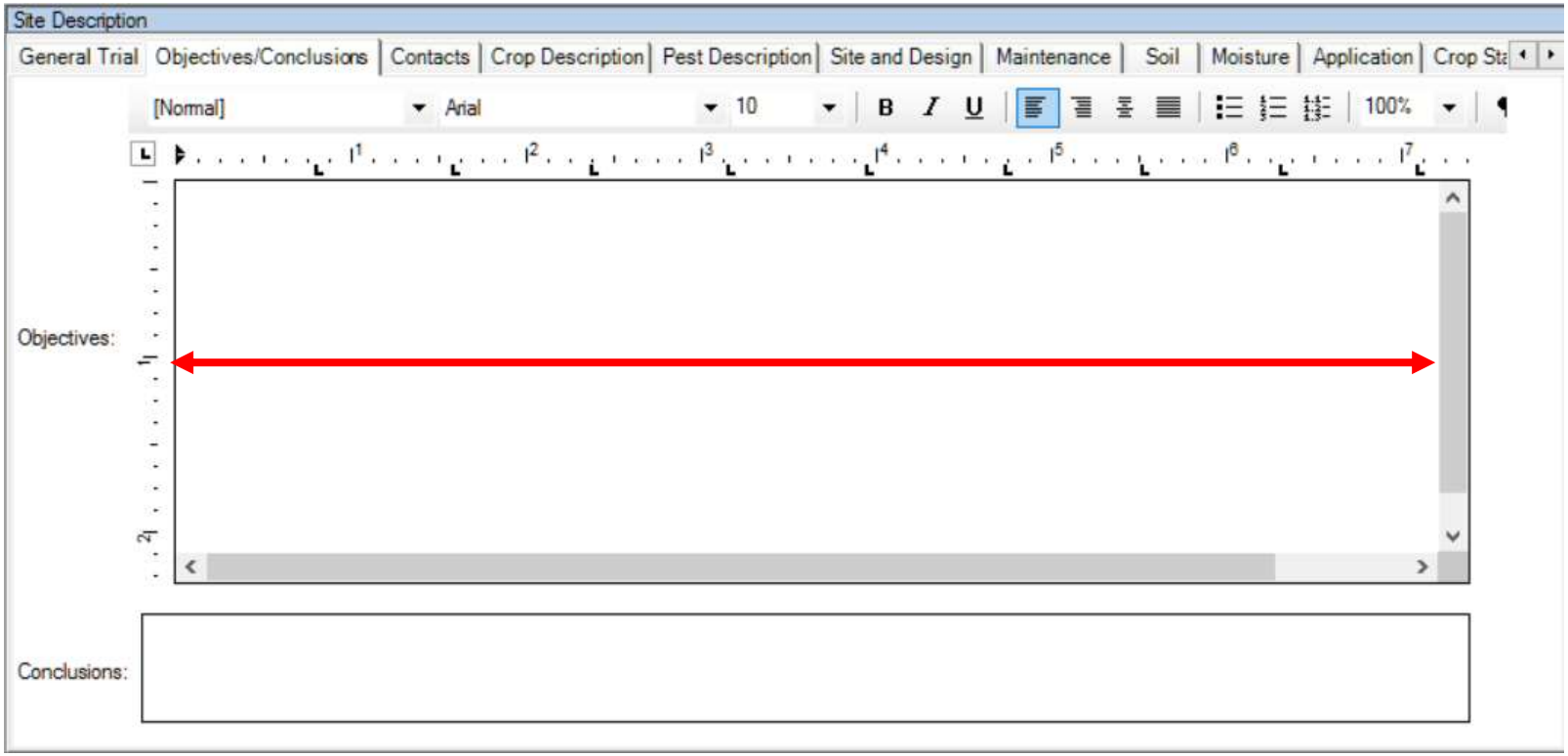
	A		B		C		D	
Application Date:	*04/02/2014*		*04/12/2014*		*04/23/2014*		*05/03/2014*	
Crop 1 Code, BBCH Scale:	*MABSD*	*BPOM*	*MABSD*	*BPOM*	*MABSD*	*BPOM*	*MABSD*	*BPOM*
Leaf Wall Area, Unit:	*12903*	*m2/ha*	*16129*	*m2/ha*	*16129*	*m2/ha*	*16129*	*m2/ha*
LWA Formula:	*10000/3.1*2*2*		*10000/3.1*2.5*2*		*10000/3.1*2.5*2*		*10000/3.1*2.5*2*	

Site/Protocol Description Application Equipment tab

- Message to enter Mix Size per '/10000 m2 LWA' when Application Volume is 'L/10000 m2 LWA'
- Mix Size auto-copied from Settings only when Application Volume in Site Description is same as Settings
- 'Application Volume Unit' and 'Mix Size Unit' fields auto-filled only when associated value field contains an entry

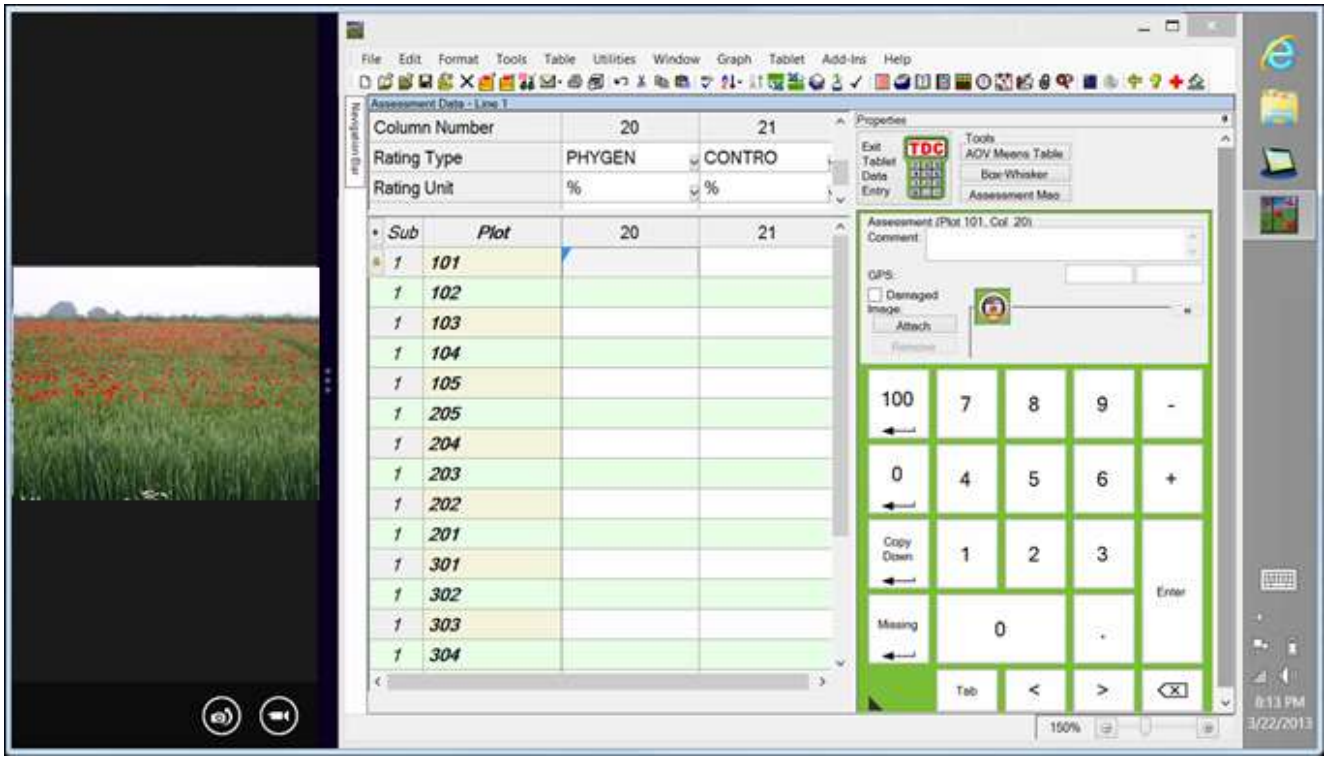
Site/Protocol Description Rich Text Comments

Automatically sized to match print margins



Tablet Data Collector

Pinch-to-zoom, for easier screen resizing on Windows touch tablets



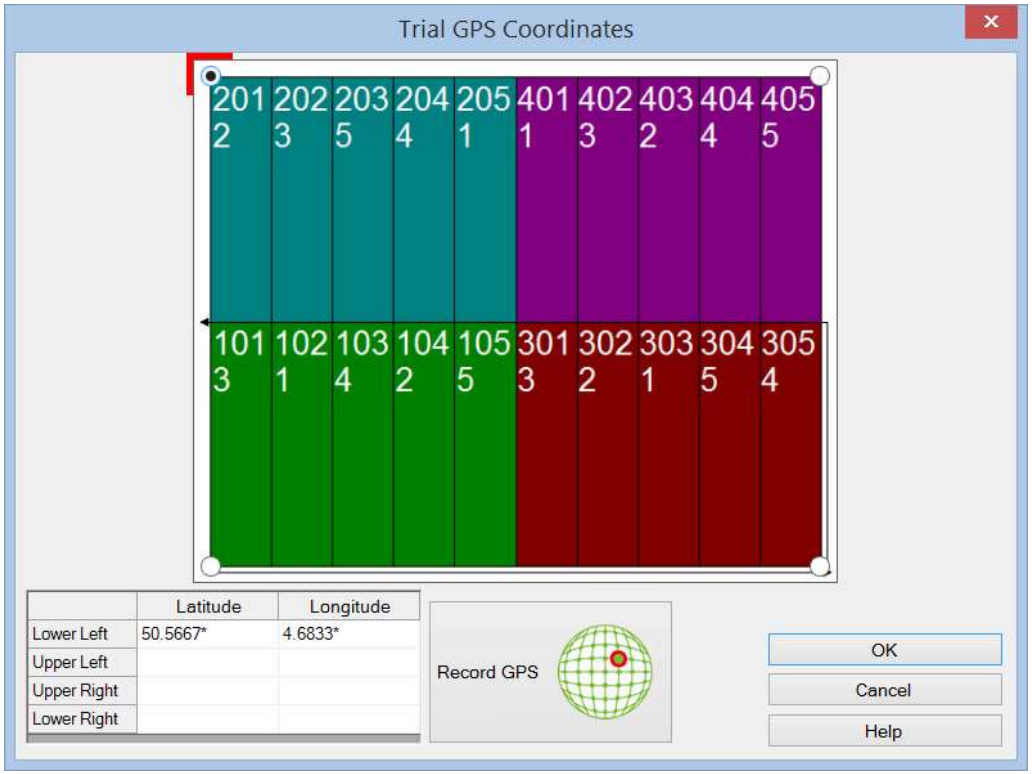
Tablet Data Collector

'Set GPS' button records location of:

- Current data value
- Current plot

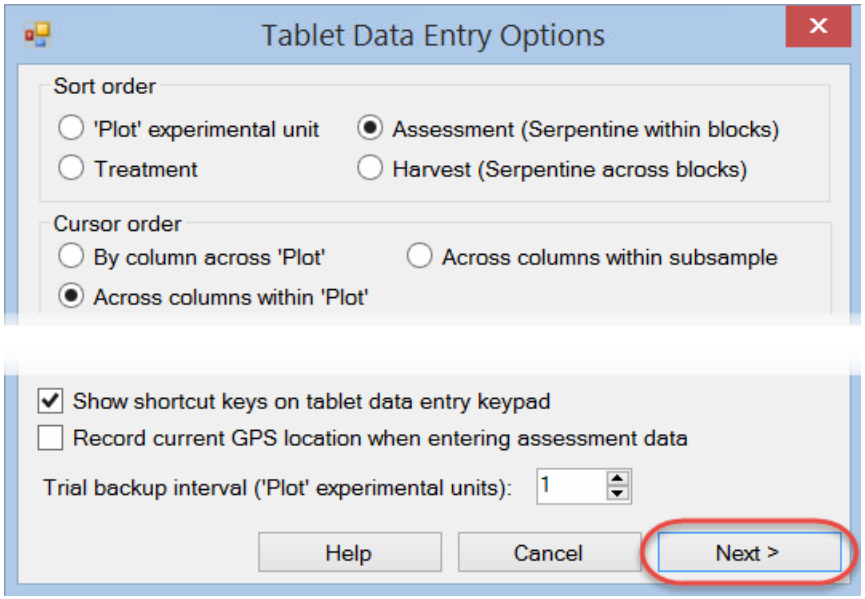
Tablet Data Collector - GPS

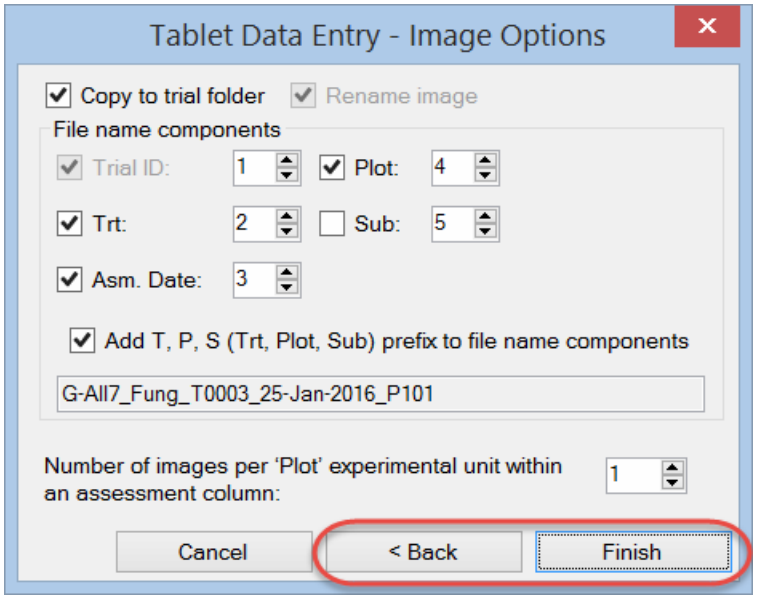
Displays Trial Map to show actual trial shape when recording GPS for trial corners



Tablet Data Collector 2016.1

Starting 'Tablet Data Entry' mode displays a wizard to also define 'Image Auto-Capture', reducing number of steps to take pictures

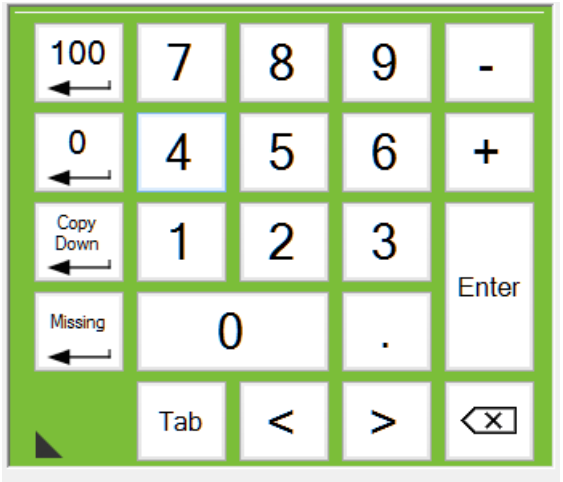


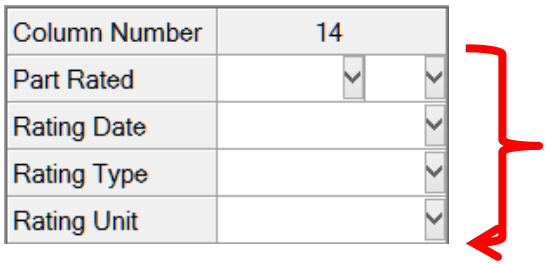


Tablet Data Collector 2016.1

Further touch interface improvements:

- Study List fits on 7" tablet
- Touchpad:
  - Text auto-sizes for button size
  - Tab and arrow keys are larger
- Larger 'display list' buttons are easier with fingers
- Auto-closes Study Rules tab



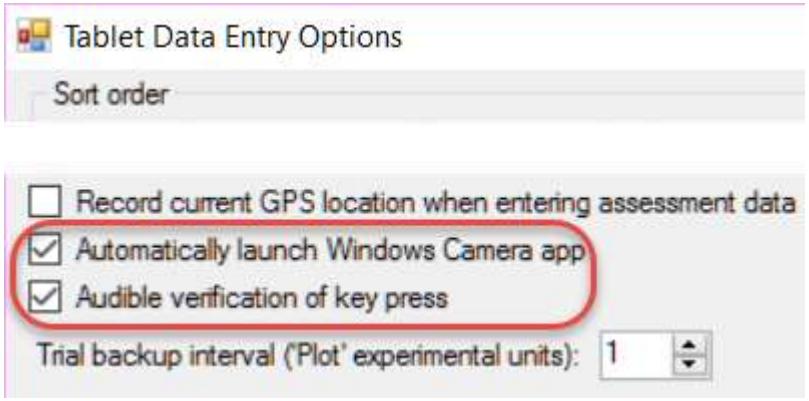


Tablet Data Collector 2016.2

- Starting Tablet Data Entry automatically starts camera app in Windows 10
- Remembers ARM + camera app size and position for both landscape & portrait mode
- Larger text on 'Copy Down', 'Missing', 'Enter', and 'Tab' keypad buttons
- Several more data column and editor sizing and scrolling enhancements

Tablet Data Collector

- Auto-open Camera app (Windows 10+)
- 'Audible verification of key press' makes a 'click' sound when each TDC keypad button is pressed



New Tablet Hardware

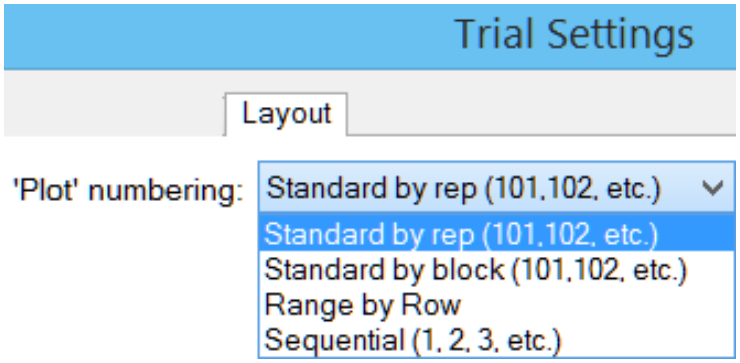
HarvestMaster Mesa²

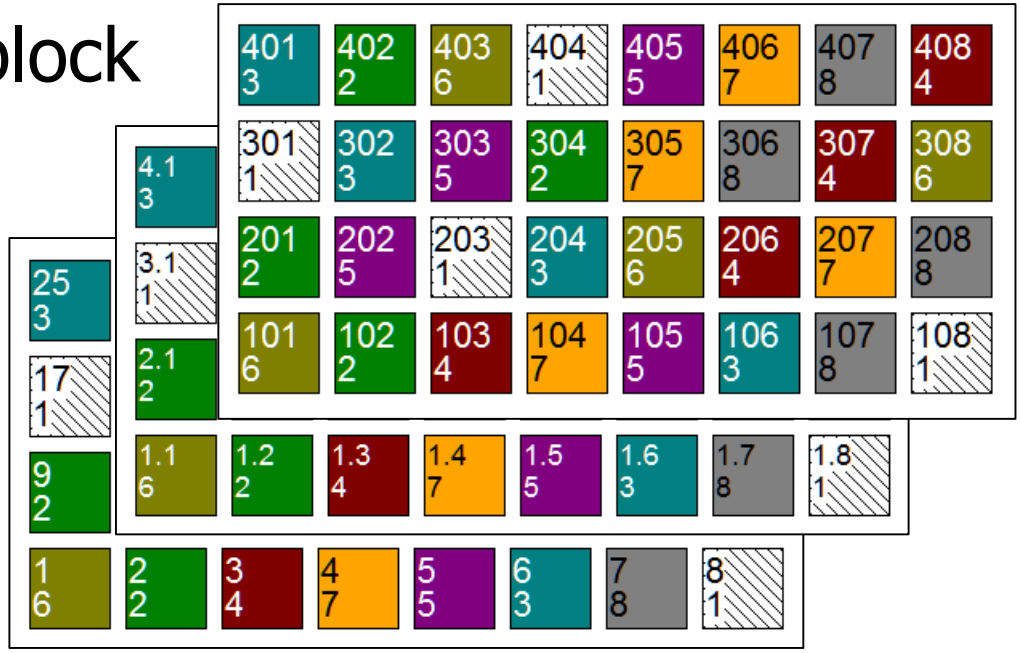
- 7 inch Windows 10 tablet
- Waterproof, dustproof
- Released 2Q2016

Trial Map

Change plot number format at any time without re-randomizing the trial:

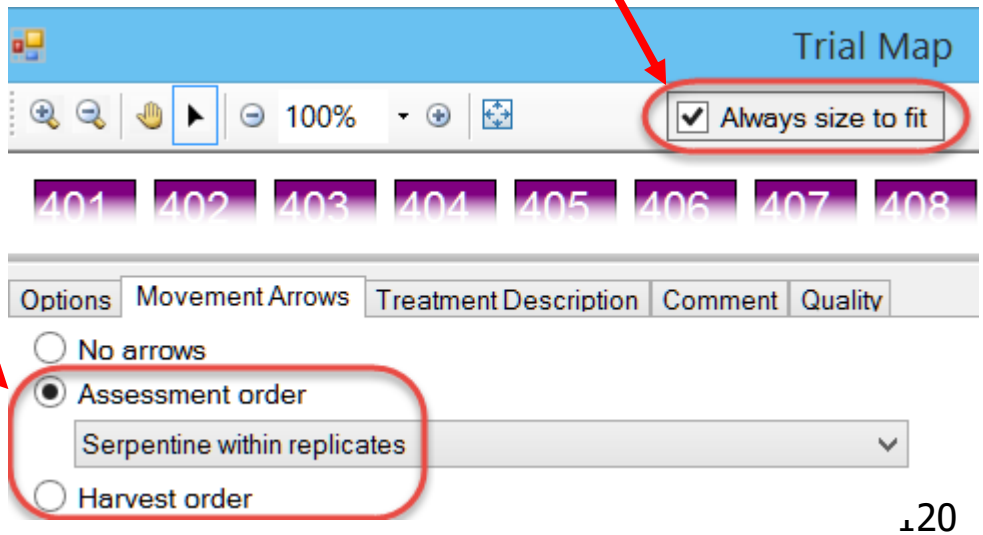
- Standard by rep/block
- Range by Row
- Sequential





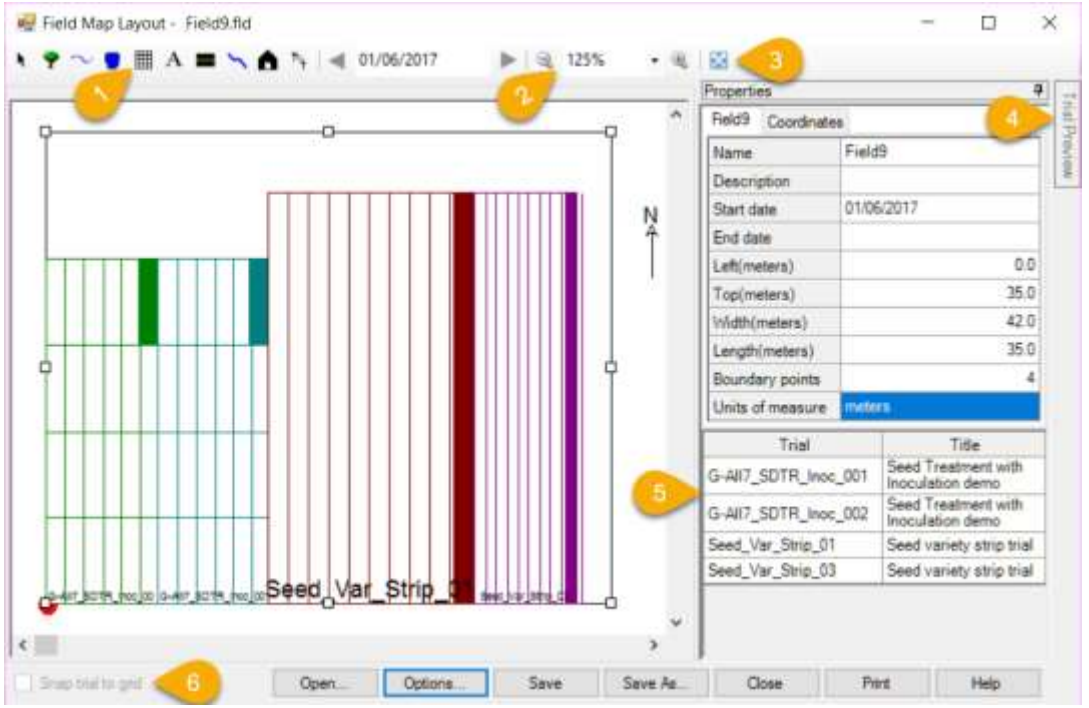
Trial Map

- Dynamically auto-resize map and zoom level so entire trial always fits into trial map dialog
- New movement arrow choices:
  - Serpentine within replicates
  - Reversed serpentine within replicates
  - Within replicates
  - Reversed within replicates

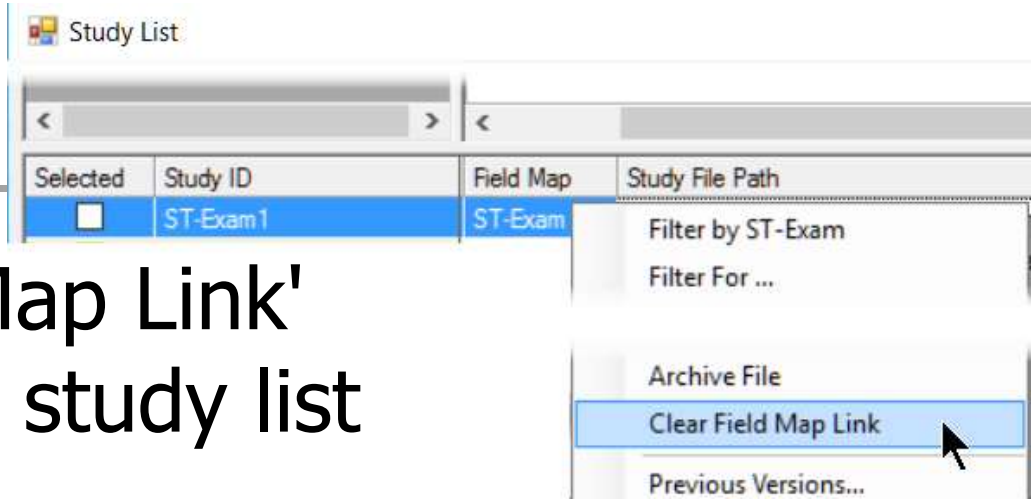


Field Map

1. Add trials from study list
2. Larger zoom range, or manually type a value
3. Size-to-Fit button
4. Trial Preview tab
5. Trial legend grid
6. Snap trial to grid

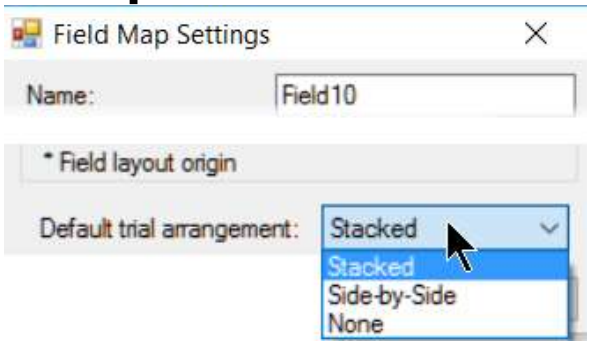


Field Map



- 'Clear Field Map Link' right-click on study list

- 'Default trial arrangement' option on Field Map Settings, to auto-arrange trials when added to field map



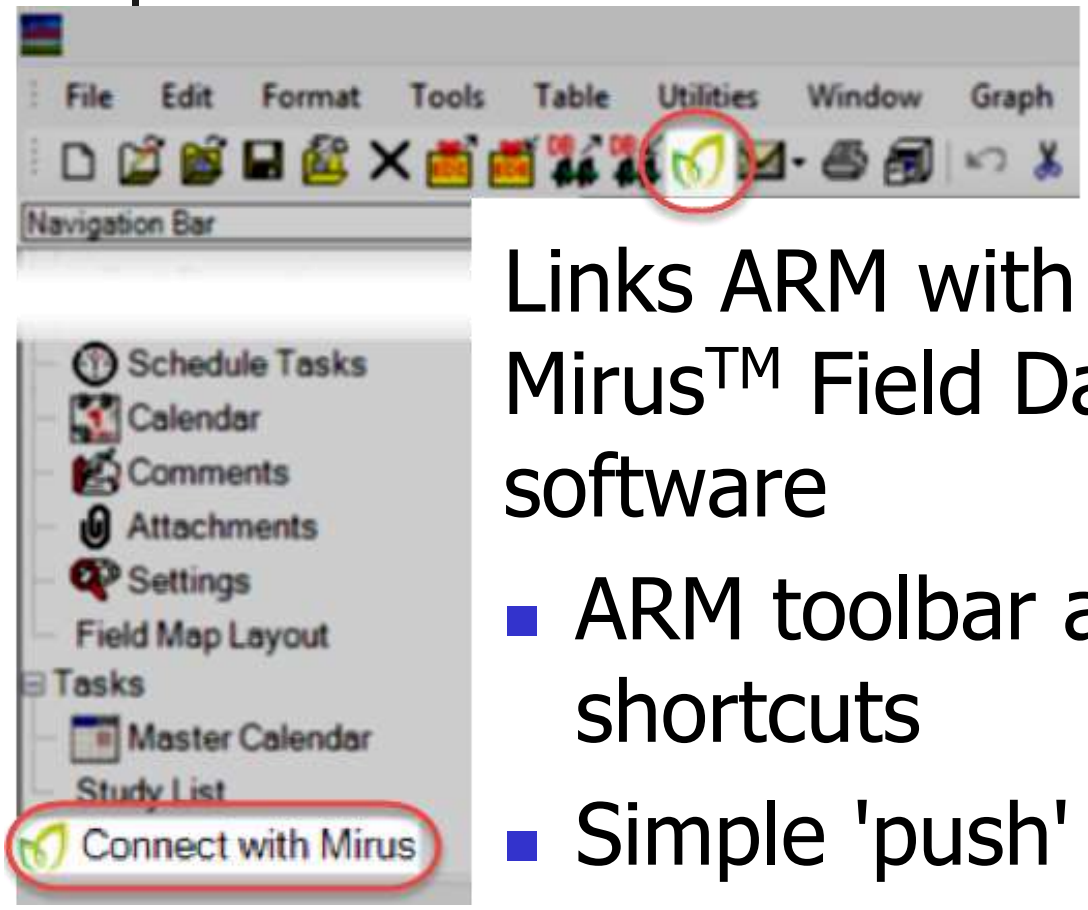
GDM and HarvestMaster

ARM Connect to HarvestMaster Mirus Software:

- ARM pushes field or trial map to Mirus
- Mirus uses with:
  - HarvestMaster Harvest Data Systems
  - Research sprayers
  - Other research equipment
- Mirus pushes harvest results to ARM

Details at GDM and HarvestMaster booths in exhibit hall

Connect with Mirus

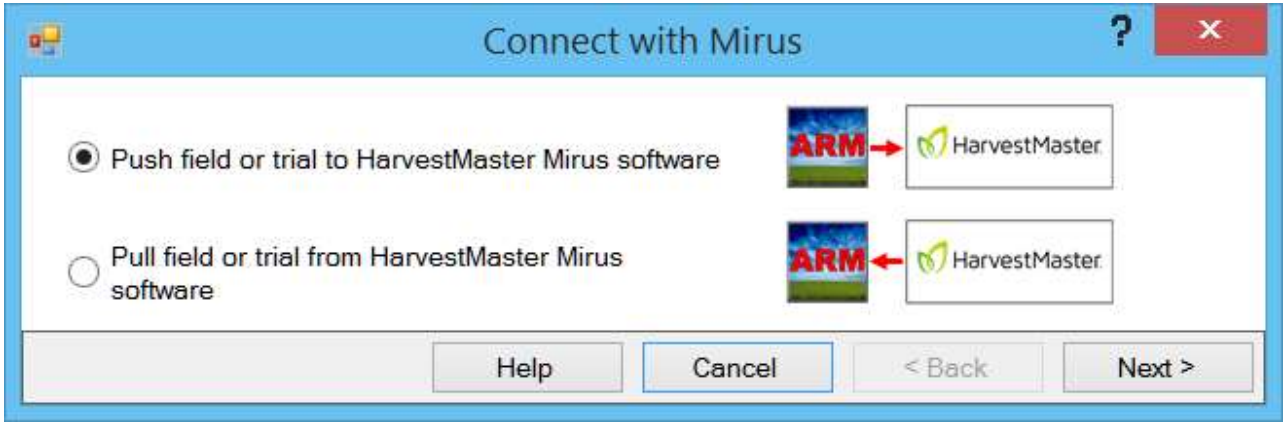


Links ARM with HarvestMaster's Mirus™ Field Data Collection software

- ARM toolbar and Navigation Bar shortcuts
- Simple 'push' and 'pull' connector

Connect with Mirus

- Wizard interface for simplicity

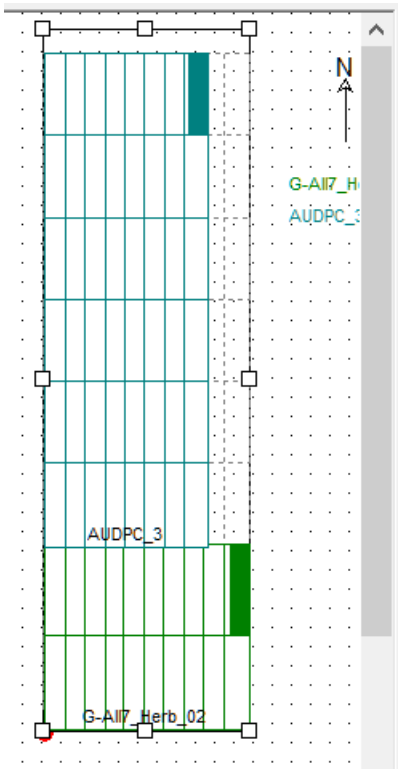


- Choose field or trial(s) from Study List

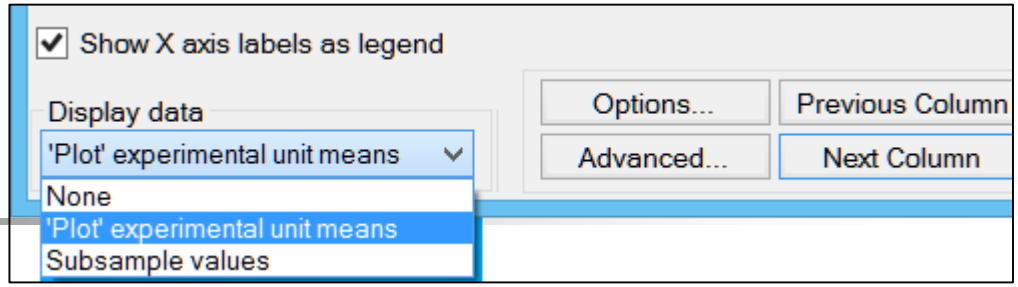
Connect with Mirus

Major improvements to ARM field map to support layout and harvest of multi-trial fields, such as:

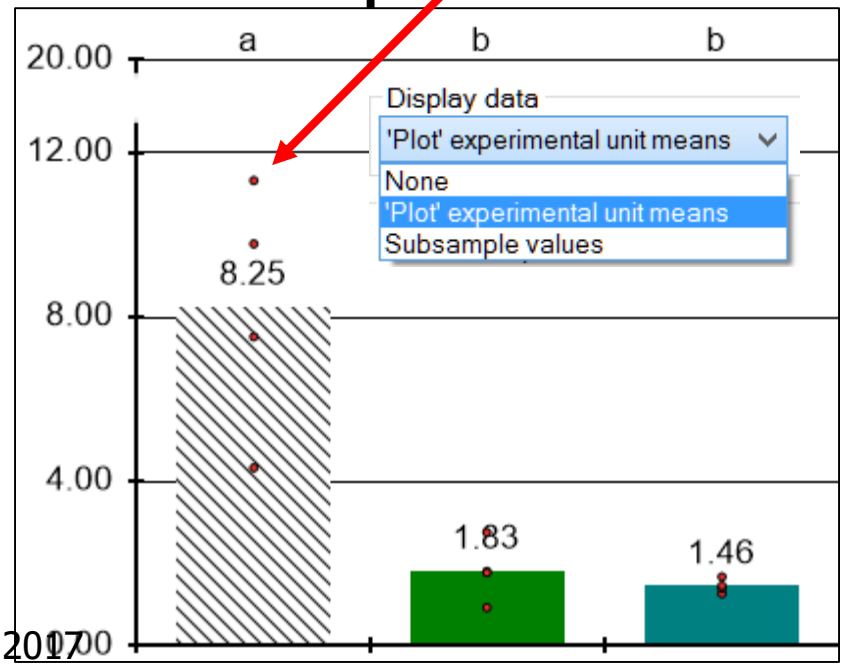
- Plot grid for trial layout
- Drag to arrange trials
- Use GPS trial coordinates

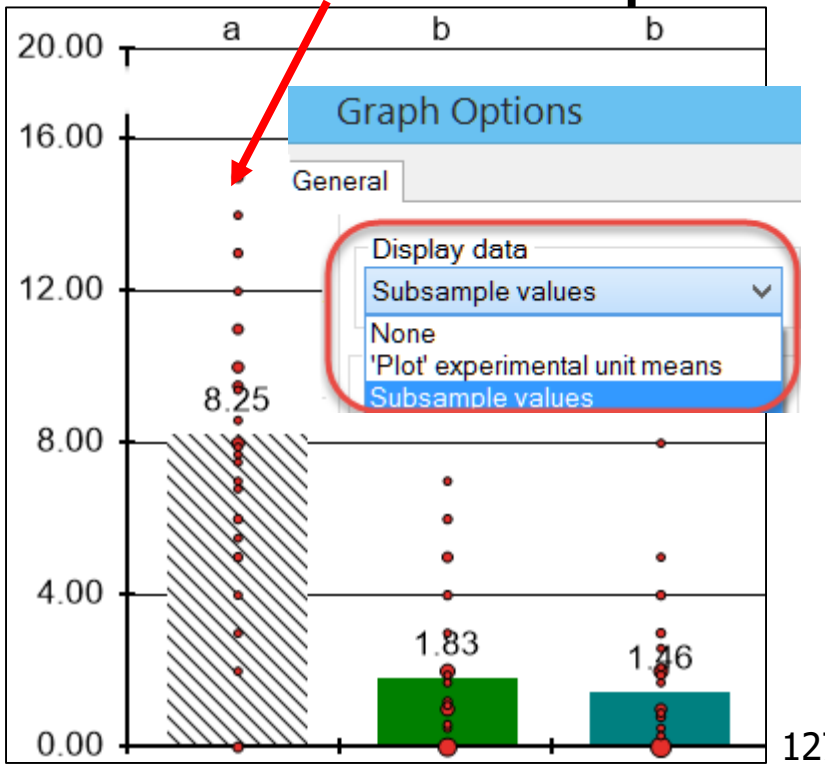


Graphs



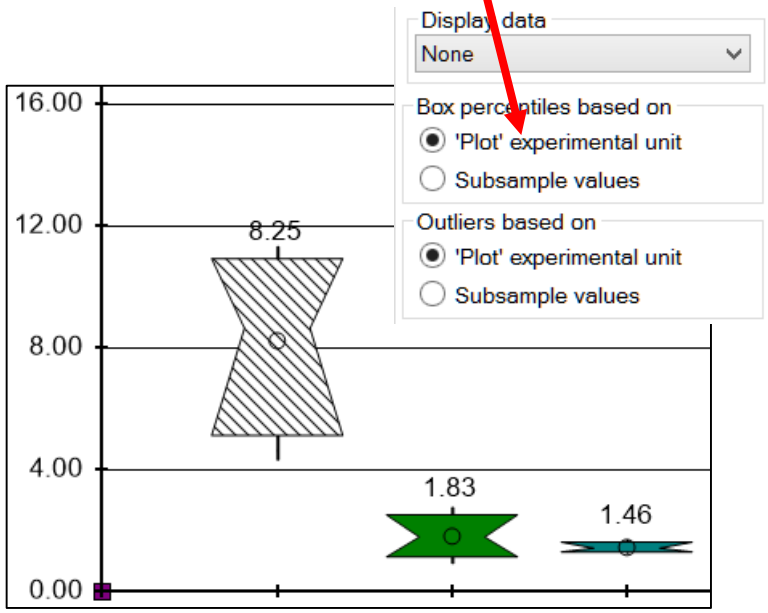
'Display data' option on viewer adds scatter graph showing plot or individual subsample values as points

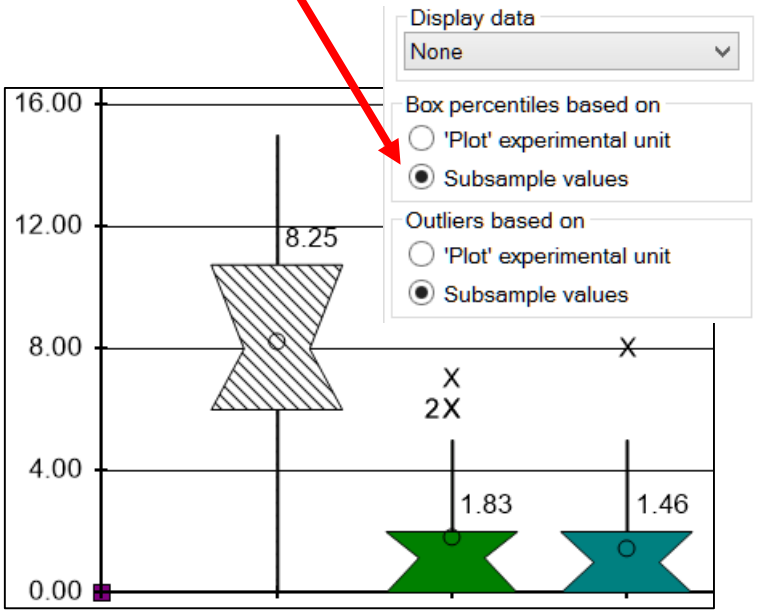




Box-Whisker Graph

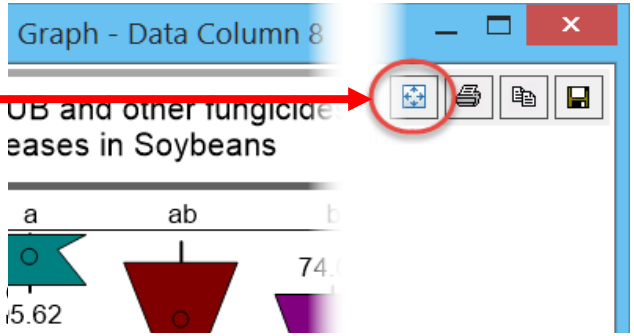
'Box percentiles' and 'Outliers based on' options of 'Plot' or 'Subsamples' for box-whisker



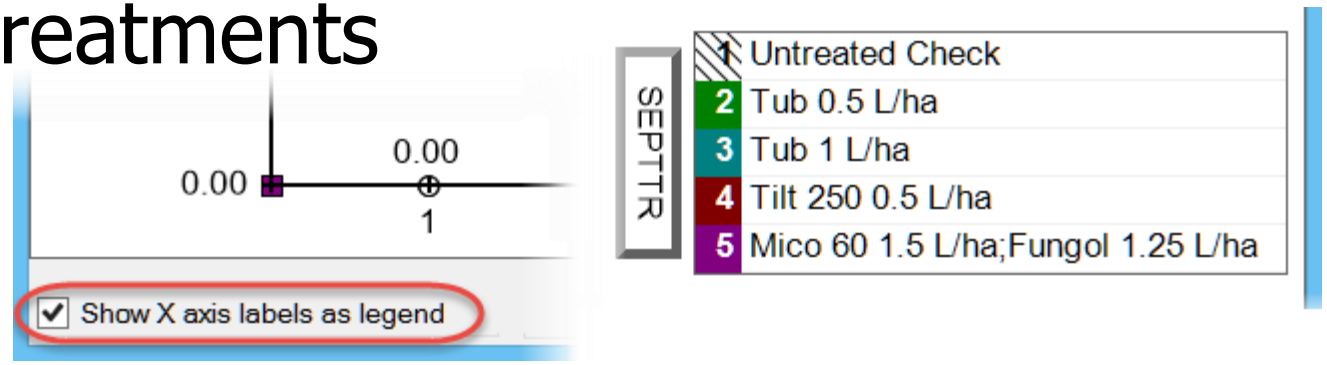


Graphs

- New 'Size to Fit' button re-sizes and re-positions graph to fit current window

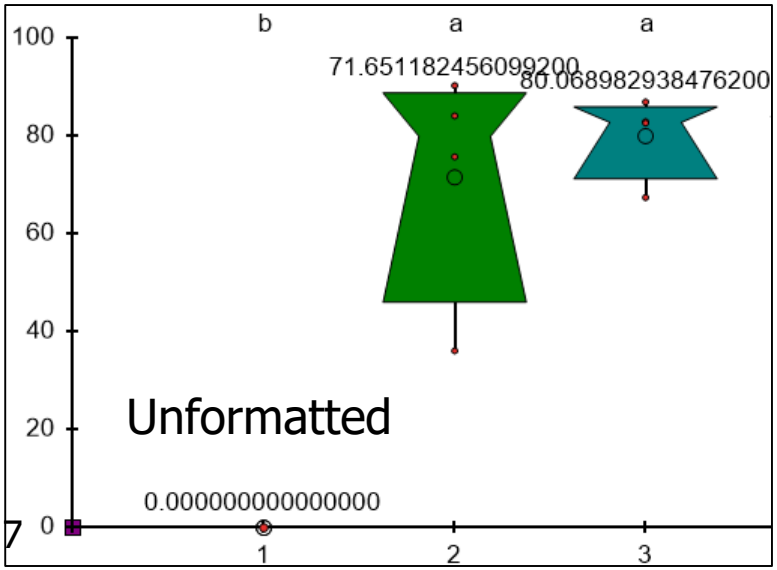


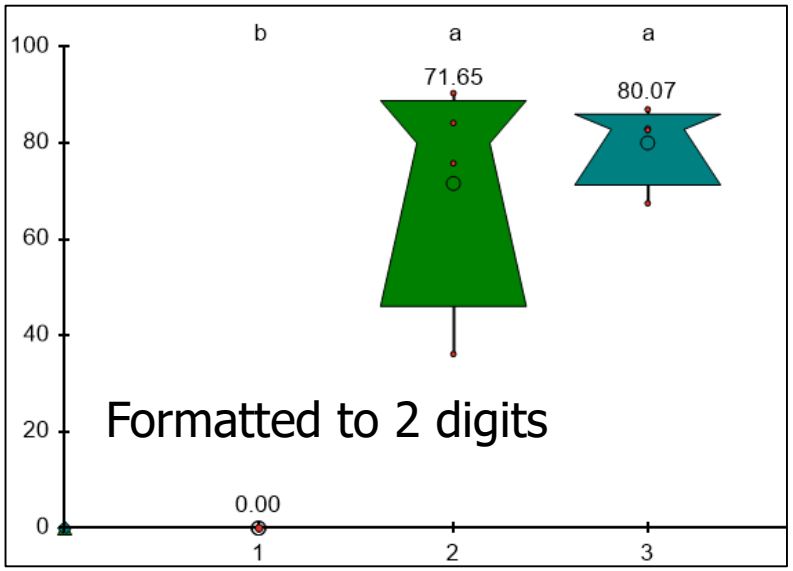
- Use 'Show X axis labels as legend' to better display detailed treatment information or many treatments



Graphs

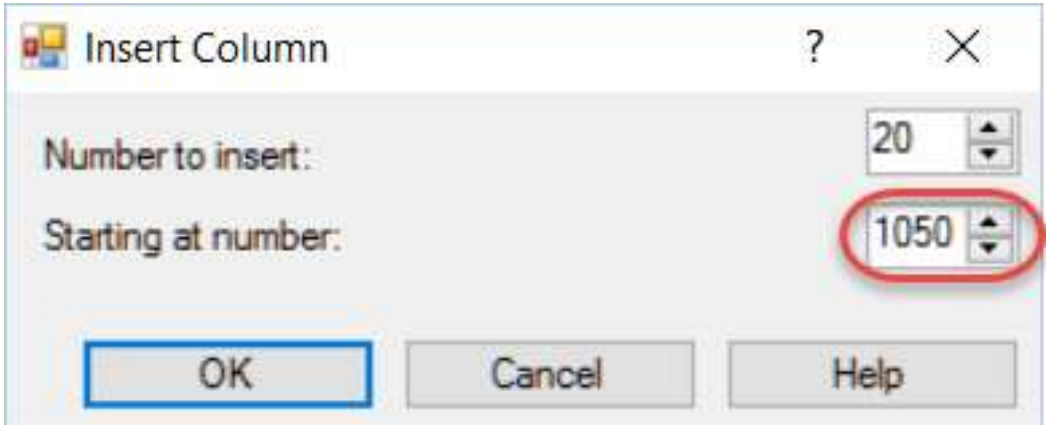
Format data labels on Bar and Line graphs based on 'Number of Decimals' specified in the Assessment column - avoids displaying too many decimal digits for calculated data columns





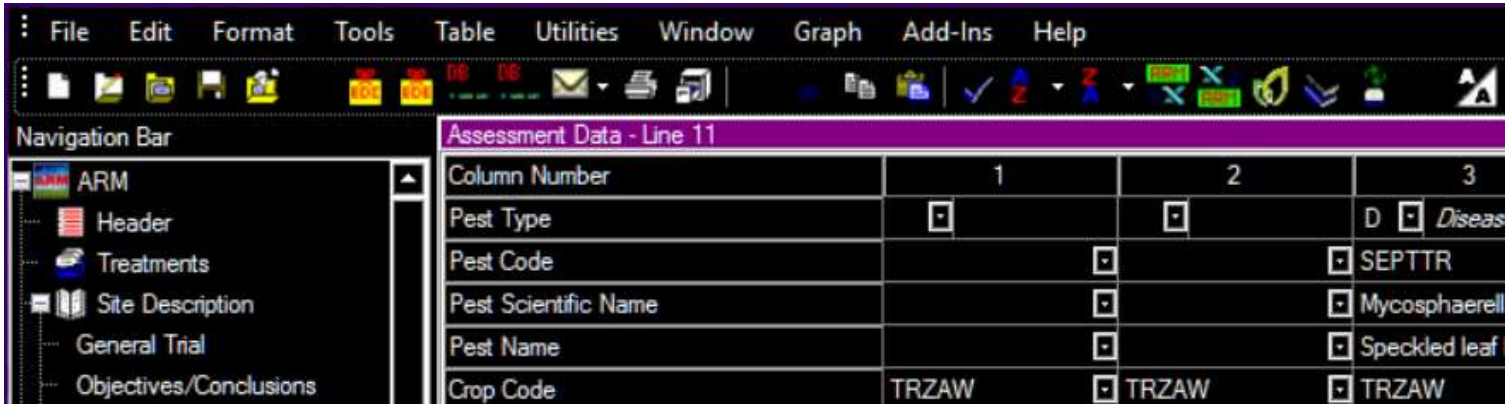
Supports Larger Trials

- Up to 9999 treatments per trial (previously 999, then 2500)
- Up to 32,767 data columns per trial (previously limited to 999 on some dialogs, such as when inserting data columns



High Contrast Display Button

- High contrast display button on ARM toolbar, changes between:
  - Standard display colors, and
  - Windows High Contrast colors
- Can improve readability in bright sunlight



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- Protect study rules supported only in ARM 2016/2015 or newer by preventing saving in ARM 9 format*
- No longer prompts about overwriting existing study file when keeping the same name and changing version
- Defaults to .prt0/.dat0 in ARM 2017+

* ARM 9 becomes obsolete and unsupported after December 31, 2016

GDMdef Study Definitions

- Trial Year field in Header
  - Is auto-filled with current year
  - Is validated to help avoid invalid entries
- Changed Appl. Start Time and Moisture Time fields to time format, not free text
- Renamed 'Density' to 'Specific Gravity' in treatments editor

GDMdef Study Definitions

- New GPS Precision field in General Trial tab of Site Description
- 'CFU/g' displays in the Rate Unit list
- More rate units in Other Rate Unit list

GDMdef Study Definitions

'LWA Formula' Crop Stage at Appl field shows values for Leaf Wall Area calculations *

	A		B		C	
Application Date:	02/04/2014		12/04/2014		23/04/2014	
Crop 1 Code, BBCH Scale:	*MABSD*	*BPOM*	*MABSD*	*BPOM*	*MABSD*	*BPOM*
Treated Canopy Height, Unit:	2	m	2.1	m	2.2	m
Leaf Wall Area, Unit:	*12903*	*m2/ha*	*13548*	*m2/ha*	*14194*	*m2/ha*
LWA Formula:	10000/3.1*2*2		10000/3.1*2.1*2		10000/3.1*2.2*2	

= 1 ha / 3.1 m row width * 2.1 m treated height * 2 row sides

* Leaf Wall Area is used in EU for all crop protection product applications to 3-D crops such as orchards and vines - see EPPO Guideline 1/239

GDMdef Study Definitions

- GEP Accreditation Link field on General Trial tab of site description: click on arrow to display certificate

- Crop & Pest code lists include links to EPPO species database: click link to open

Crop Code Master List (Crops)

Crop Code	Crop Scientific Name	Crop Name	Language	Online Reference
TRZAW	wheat (winter)	Winter wheat	IE	https://gd.eppo.int/taxon/TRZAW
TRZAX	Triticum aestivum	Soft wheat	IE	https://gd.eppo.int/taxon/TRZAX
TRZDU	Triticum durum	Durum wheat	IE	https://gd.eppo.int/taxon/TRZDU

GDMdef Study Definitions

Added Köppen-Geiger climate zones to new Climate Zone master list

Climate Zone Master List (SART)

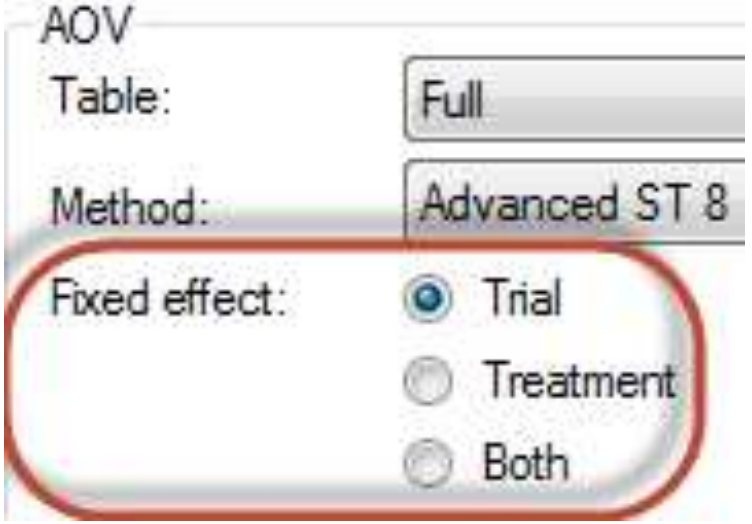
Climate Zone	Climate Zone	Type	Online Reference
Aw	Tropical Savannah	Köppen-Geiger	http://koeppen-geiger.vu-wien.ac.at
BSh	Arid Steppe Hot	Köppen-Geiger	http://koeppen-geiger.vu-wien.ac.at
BSk	Arid Steppe Cold	Köppen-Geiger	http://koeppen-geiger.vu-wien.ac.at
BWh	Arid Desert Hot	Köppen-Geiger	http://koeppen-geiger.vu-wien.ac.at
BWk	Arid Desert Cold	Köppen-Geiger	http://koeppen-geiger.vu-wien.ac.at
Cfa	Temperate, Perennial Rain, Hot Summer	Köppen-Geiger	http://koeppen-geiger.vu-wien.ac.at
Cfb	Temperate, Perennial Rain, Warm Summer	Köppen-Geiger	http://koeppen-geiger.vu-wien.ac.at
Cfc	Temperate, Perennial Rain, Cold Summer	Köppen-Geiger	http://koeppen-geiger.vu-wien.ac.at
Csa	Temperate, Dry, Hot Summer	Köppen-Geiger	http://koeppen-geiger.vu-wien.ac.at
Csb	Temperate, Dry, Warm Summer	Köppen-Geiger	http://koeppen-geiger.vu-wien.ac.at
Cwa	Temperate, Dry Winter, Hot Summer	Köppen-Geiger	http://koeppen-geiger.vu-wien.ac.at
Cwb	Temperate, Dry Winter, Warm Summer	Köppen-Geiger	http://koeppen-geiger.vu-wien.ac.at
Cwc	Temperate, Dry Winter, Cold Summer	Köppen-Geiger	http://koeppen-geiger.vu-wien.ac.at

Sponsor Customizations May be Set to Expire

- Sponsors may 'expire' their customized study definitions for contractors:
  - ARM displays warning messages when customization is expiring
  - Are identified as 'obsolete' in About ARM
  - Cannot create protocol or trial
  - Can request customization again from sponsor after expired

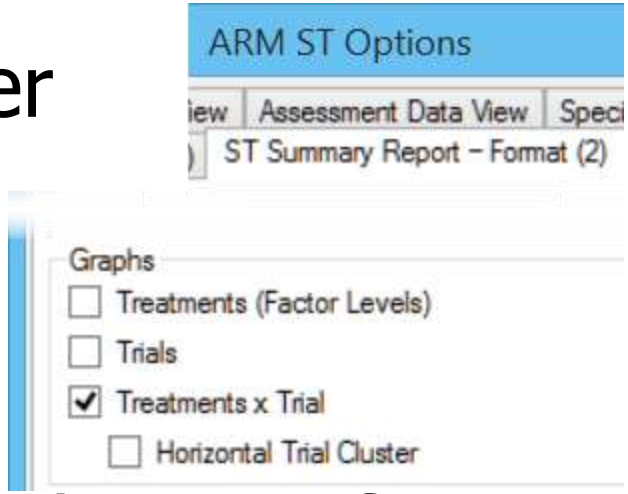
Summary Across Trials

- ST Report option to print Mean Level CV
- Identify on ST Report the error term used for mean comparison tests when either Trial or Treatment is random, as defined on ST Summary Options dialog



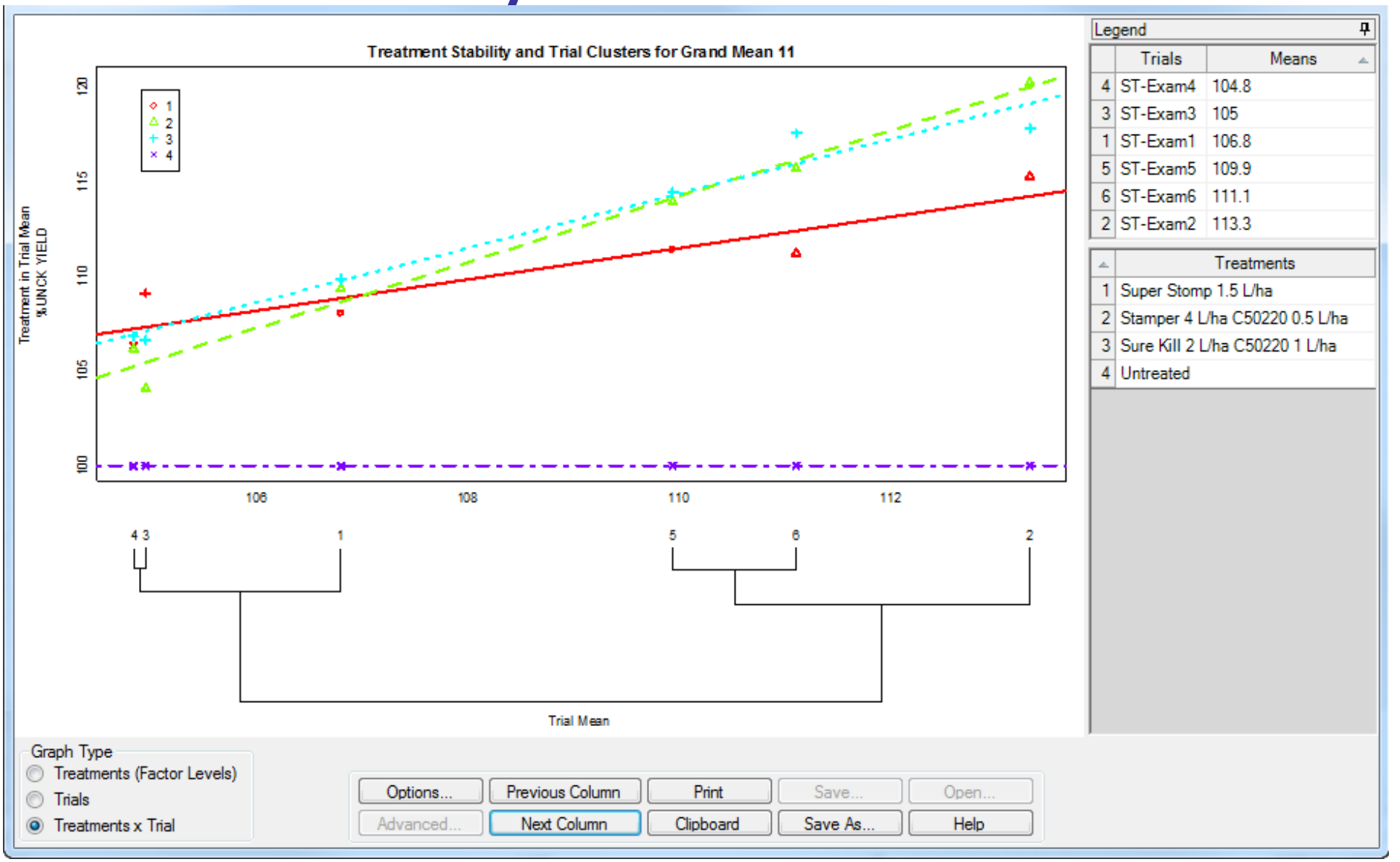
Summary Across Trials

- Graph helps identify "location" (trial) groups when evidence of location effect (treatment x trial interaction) is detected
- Option to rotate the cluster analysis dendogram, useful when analyzing many trials



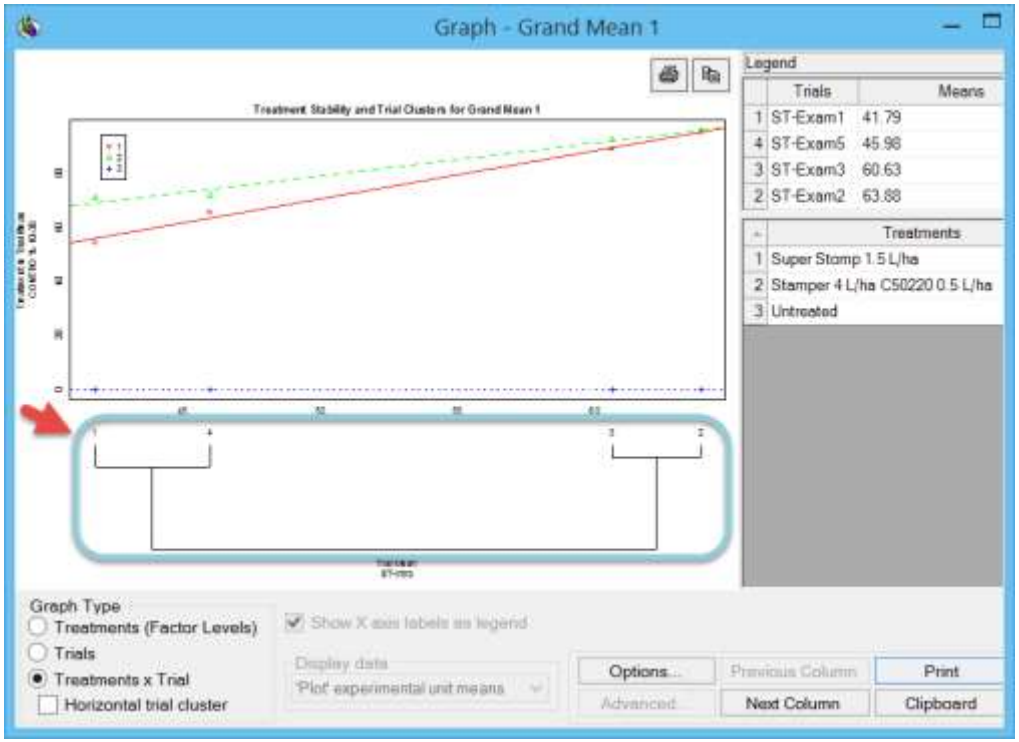
- 'Print ST Summary' dialog displays faster

Summary Across Trials

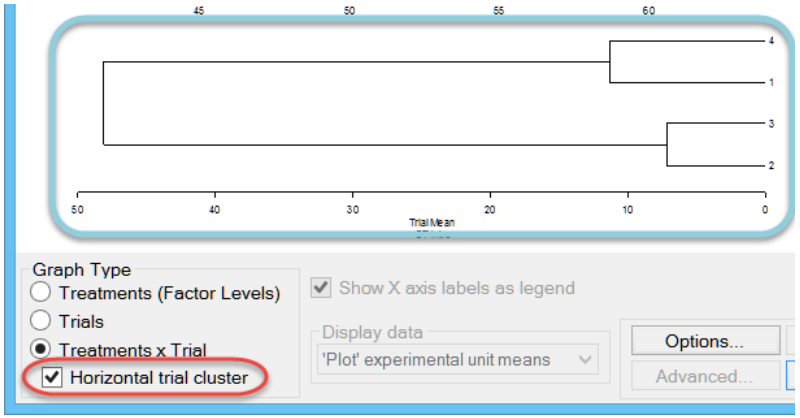


ST Graph

'Horizontal Trial Cluster' option shortcut on graph viewer for a Treatment x Trial graph



- Better displays large number of trials
- Includes its own X-axis



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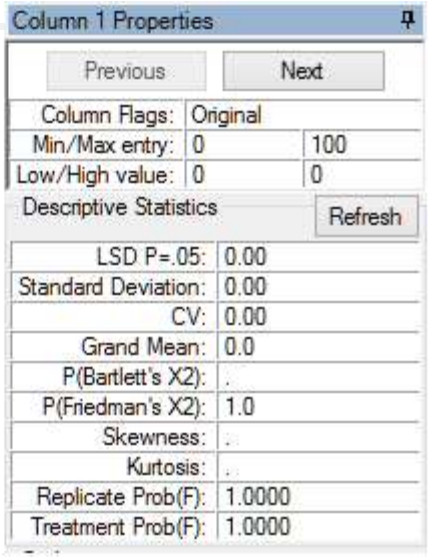
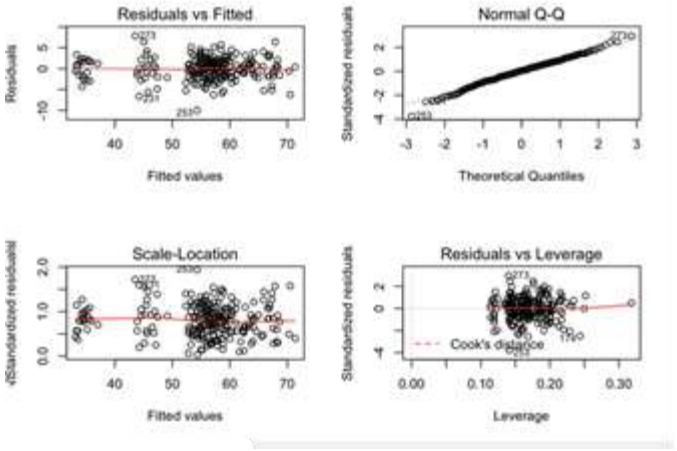
- Protect study rules supported only in ARM 2016/2015 or newer by preventing saving in ARM 9 format*
- No longer prompts about overwriting existing study file when keeping the same name and changing version
- Defaults to .prt0/.dat0 in ARM 2017+

* ARM 9 became obsolete and unsupported after December 31, 2016

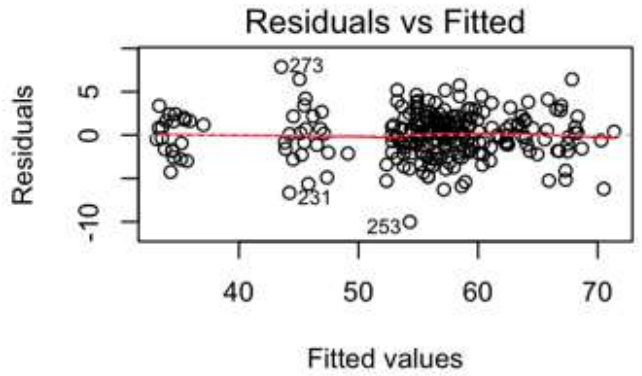
Residuals Graphs (Coming soon)

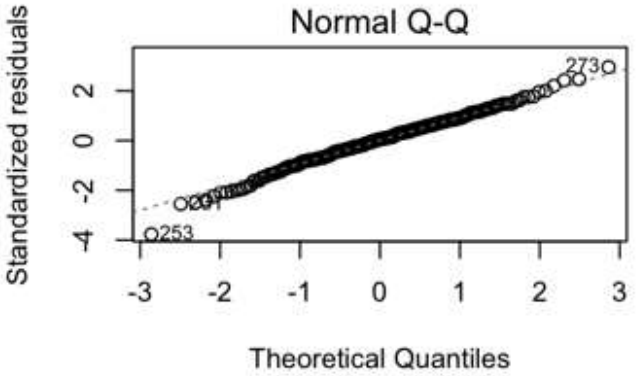
- On assessment editor
- Shows unexplained variability after removing treatment and replicate effects from analysis
- Can indicate when using a data correction trans-formation may help meet AOV assumptions

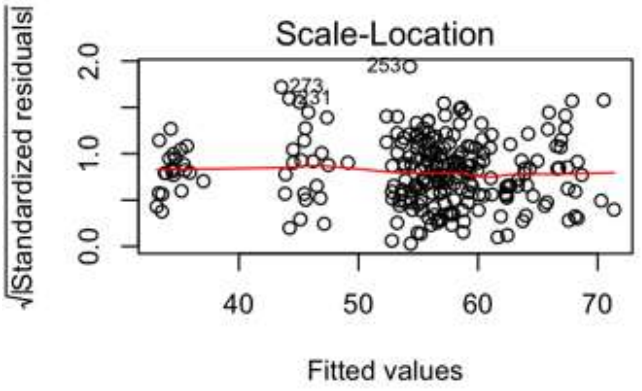


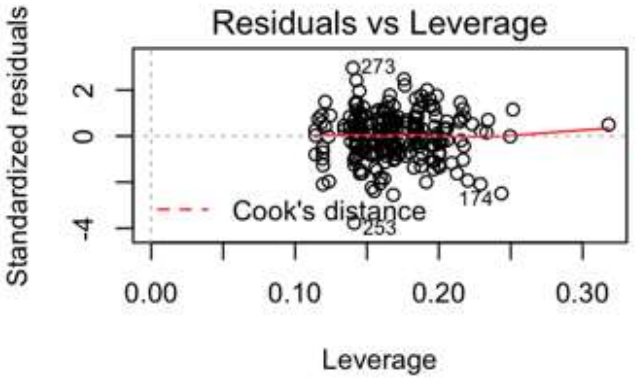


Residuals Graphs (Coming soon)



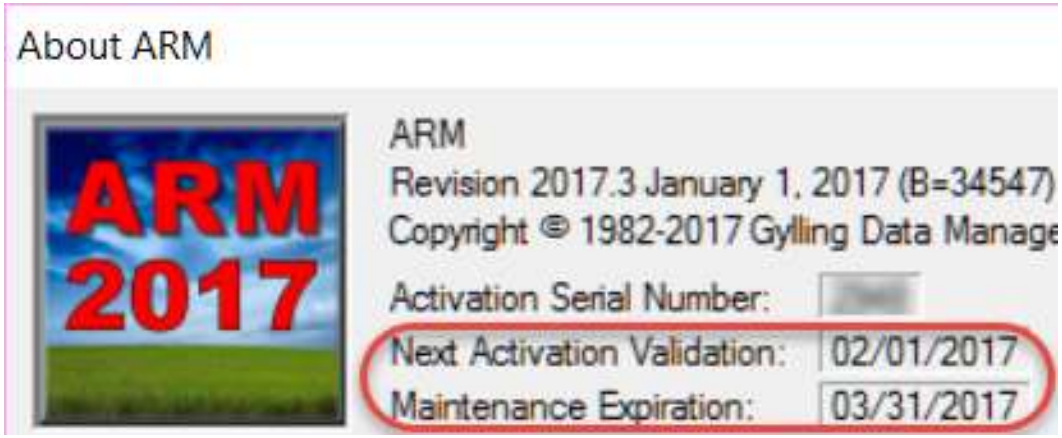






Licensing

- Less frequent internet connect to verify license information
- More license information on About ARM



ARM 2017

- Is available now
- Is a key benefit of the new Annual Software Maintenance payment
- Automatically provided to clients using ARM 2016/2015 via electronic download by ARM Check for Updates program