IPM of Date Palm Insect Pests and Diseases

Training Course

Statistical Designs and Analysis of IPM data of Date Palm Pests

(Basics, RCBD and Incomplete Block Designs)

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Venue: Muscat, Oman

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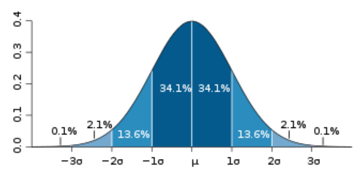
Fisher's Principles of Experimentation

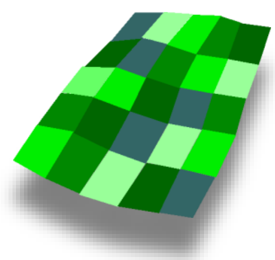
The 3 “R’s”

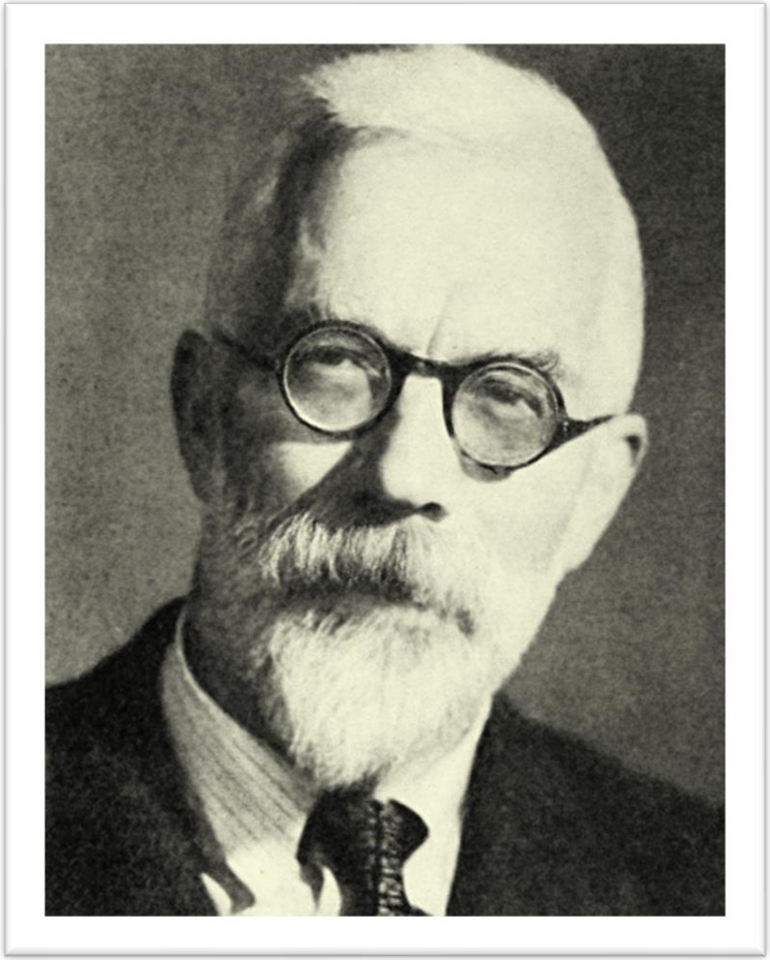
- Randomization 

- Replication



- Local Control
  (Reduce noise)





Sir Ronald Fisher

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Randomized Complete Block Design (RCBD)

- ***Randomization***
  Representative unbiased responses.

- ***Replication***
  No replication, no estimation of experimental error.

$$SE(mean) = \frac{\sigma}{\sqrt{r}}$$

- ***Local Control***
  Homogeneity at design stage.

Fertility gradient

High	Medium	Low
Rep 1	*Rep 2*	*Rep 3*
1	6	2
2	3	5
3	1	6
4	4	1
5	2	4
6	5	3

{1, 2, 3, 4, 5, 6}

Randomization Test

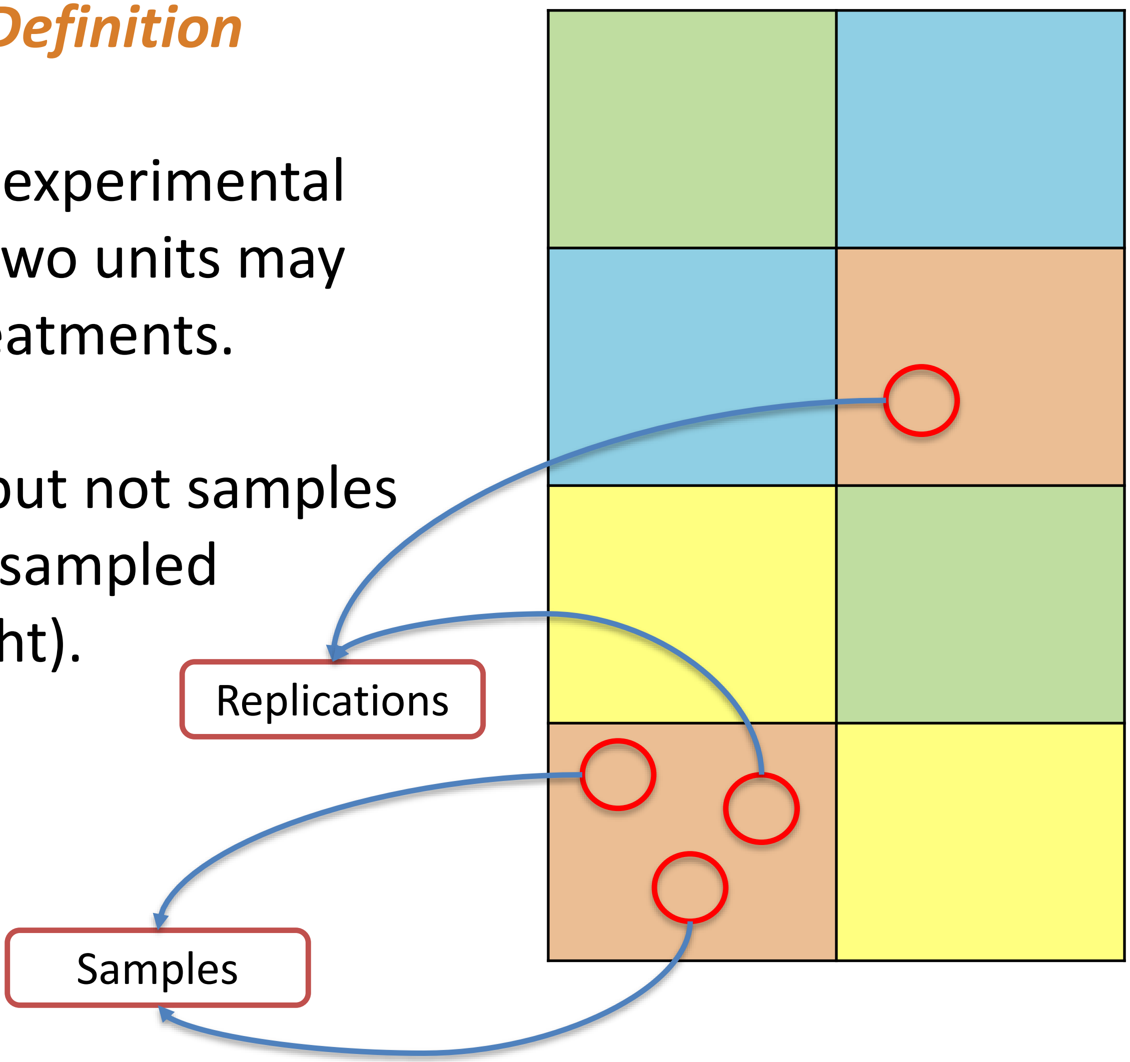
List numbers from 1 to 12 in random order!

Sample vs. Replication

- ***Experimental Unit Definition***

  Smallest division of experimental area such that any two units may receive different treatments.

  For example, plots but not samples in a plot (e.g. dates sampled to get average weight).



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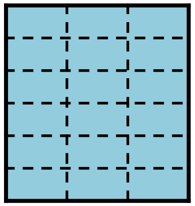
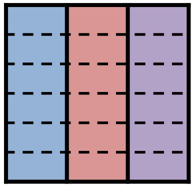
CRD, RCBD, and Alpha Designs

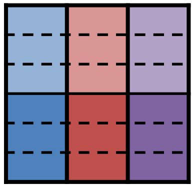
$$\text{Response} = \mu + \tau + \xi \qquad \text{(CRD)}$$



$$\text{Response} = \mu + \tau + \pi + \xi \qquad \text{(RCBD)}$$



$$\text{Response} = \mu + \tau + \pi + \beta + \xi \qquad \text{(Alpha)}$$



μ) grand mean τ) effect of treatments π) effect of replicates β) effect of blocks ξ) experimental error

Replication vs. Block

- ***Replication:***

  "Experimental units represents all treatment levels"

- ***Block:***

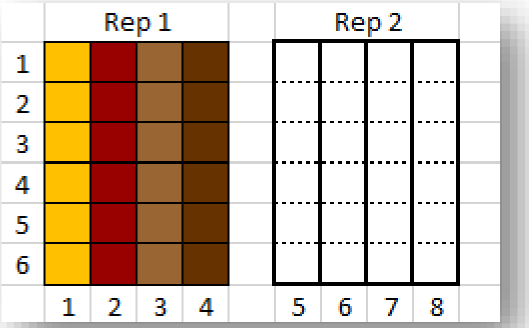
  "Homogeneous group of experimental units"

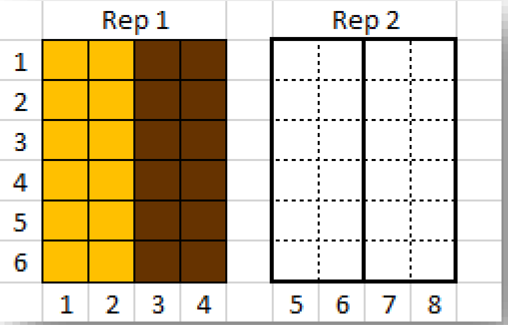
In *RCB* Design, Replication = Block

In *Alpha* Design, Replication > Block

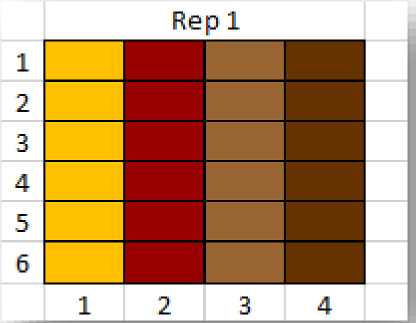
What is the Right Block Size?

Do ***NOT*** ask biometrician that question! It is constrained by the physical arrangement of plots in the field, for example:



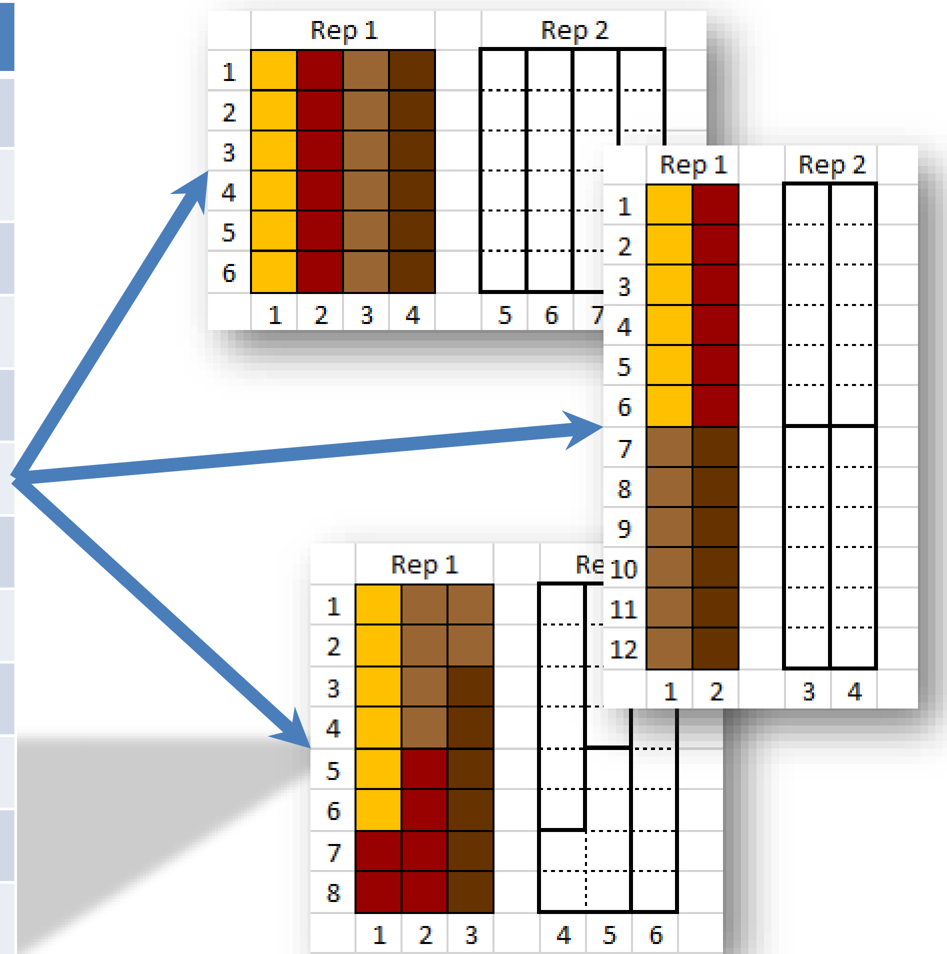


- Total number of treatments
- Field homogeneity
- Plot size
- Field layout *(i.e. rows & columns)*



Alpha Design Implementation (1)

Rep	*Block*	*Plot*
1	1	1
1	1	:
1	1	6
1	2	7
1	2	:
1	2	12
1	3	13
1	3	:
1	3	18
1	4	19
1	4	:
1	4	24



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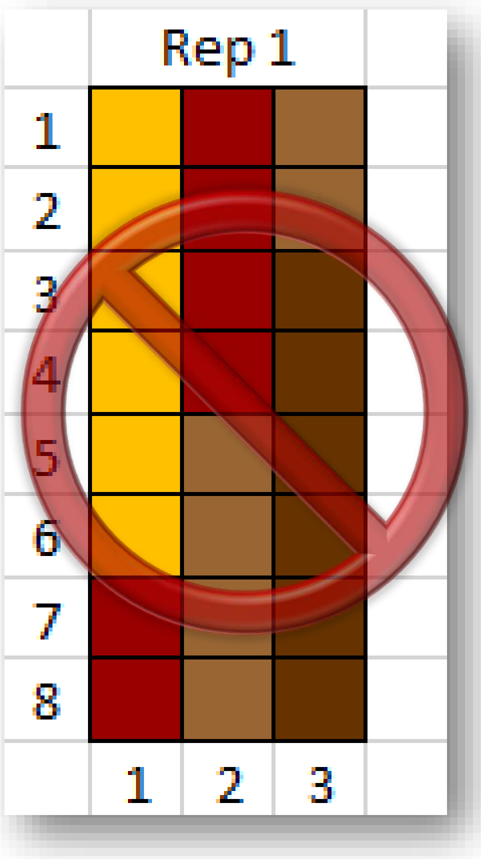
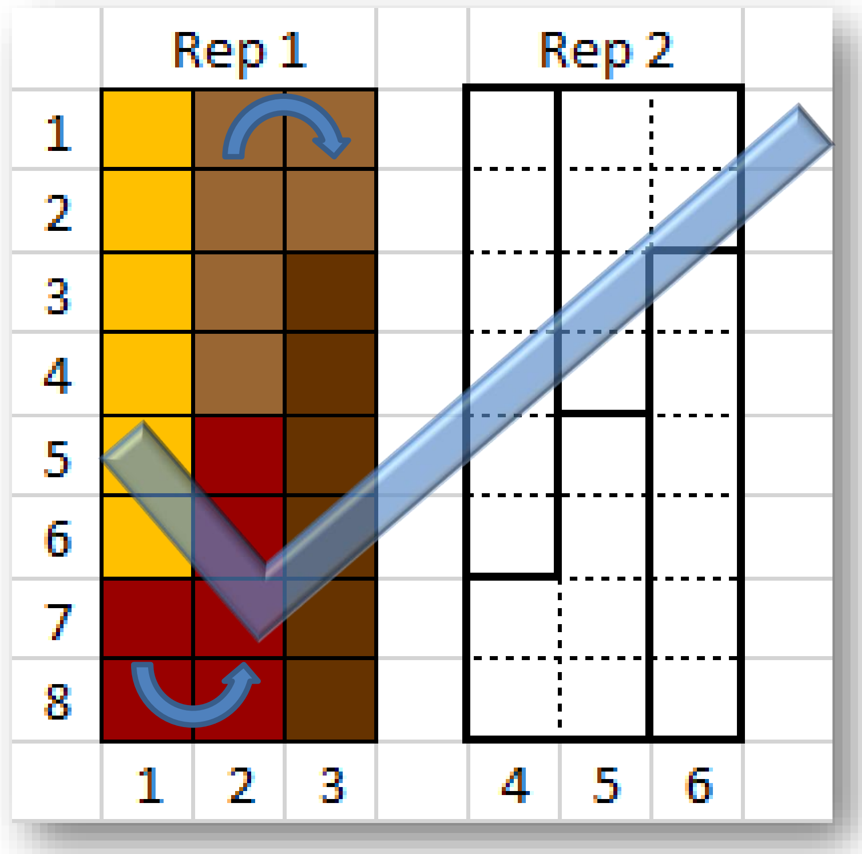
Alpha Design Implementation (2)





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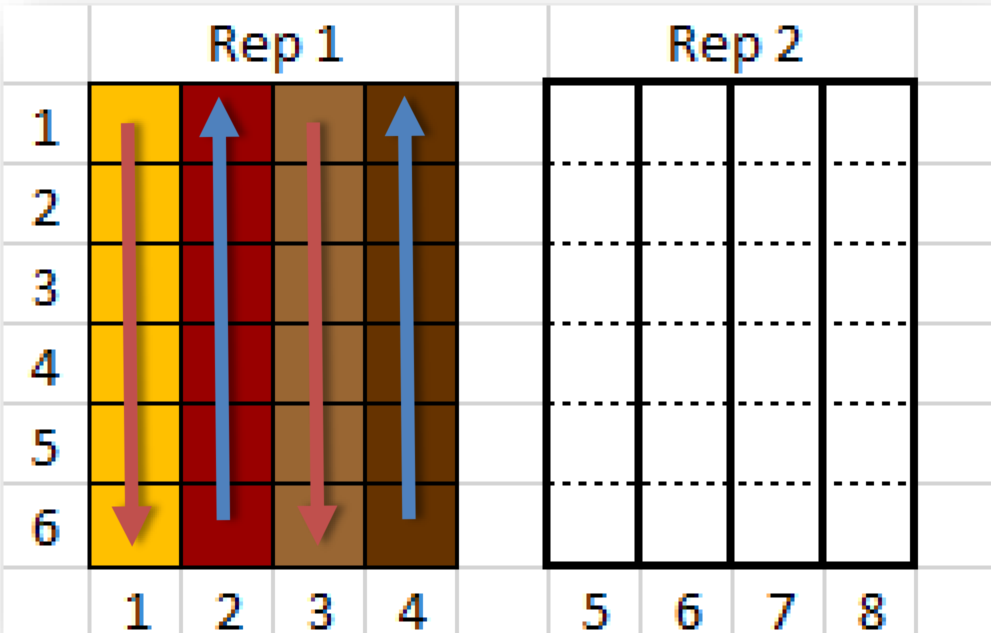
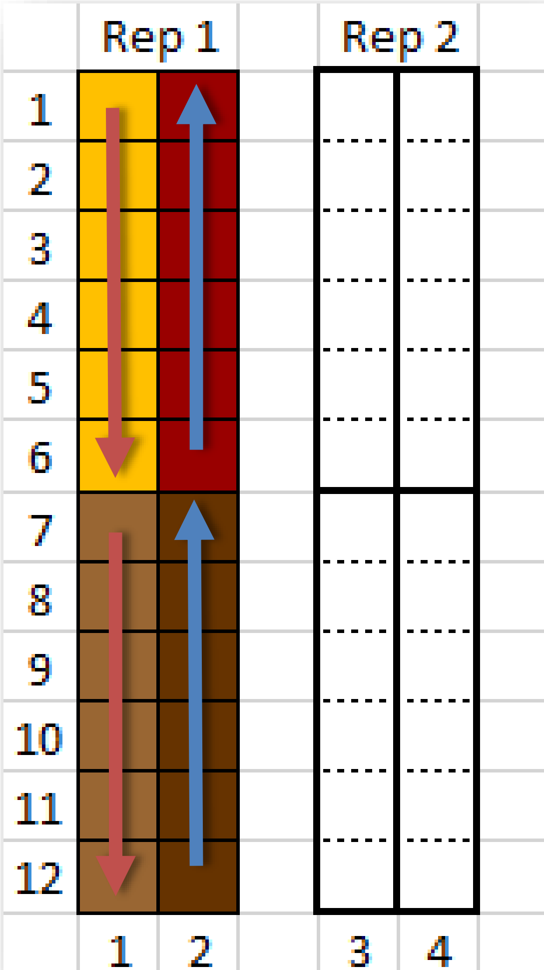
Layout Information (1)



Rep	Block	Col	Row	Plot
1	1	1	1	1
1	1	1	:	:
1	1	1	6	6
1	2	2	6	7
1	2	2	:	:
1	2	2	1	12
1	3	3	1	13
1	3	3	:	:
1	3	3	6	18
1	4	4	6	19
1	4	4	:	:
1	4	4	1	24

Layout Information (2)



Rep	Block	Col	Row	Plot
1	1	1	1	1
1	1	1	:	:
1	1	1	6	6
1	2	1	7	7
1	2	1	:	:
1	2	1	12	12
1	3	2	12	13
1	3	2	:	:
1	3	2	7	18
1	4	2	6	19
1	4	2	:	:
1	4	2	1	24

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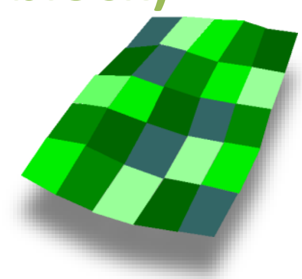
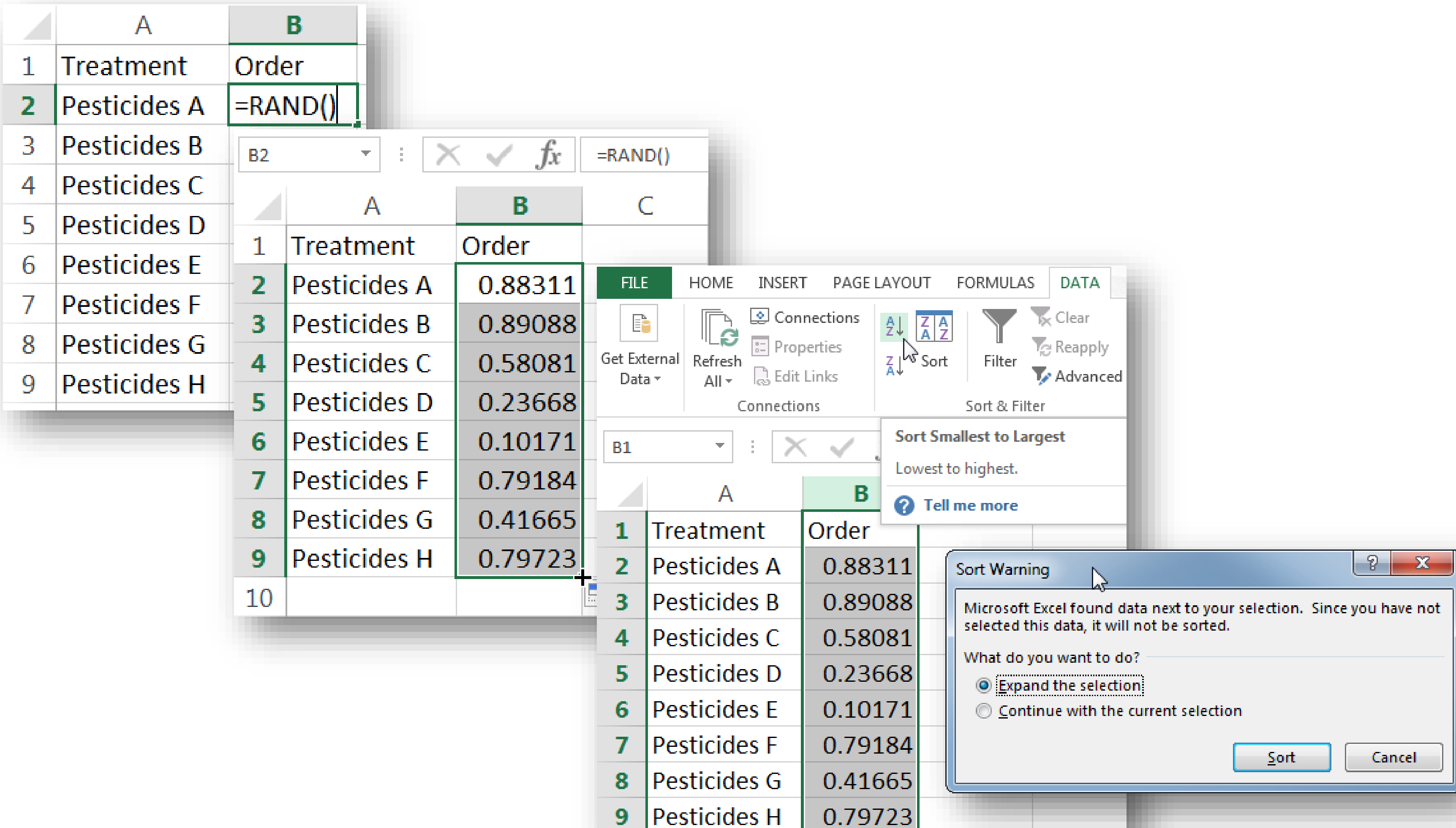
Meta Data

- Experiment name
- Description
- Coordinator name
- Coordinator institute
- Coordinator contact information
- Location
- Province (state)
- Country
- Latitude
- Longitude

- Crop / genotypes
- List of treatments
- Season and cycle
- Experiment design
- Total number of entries
- Total number of plots
- Number of replications
- Block size (plots per block)
- Number of rows
- Number of columns



Excel - Generate RCB Design

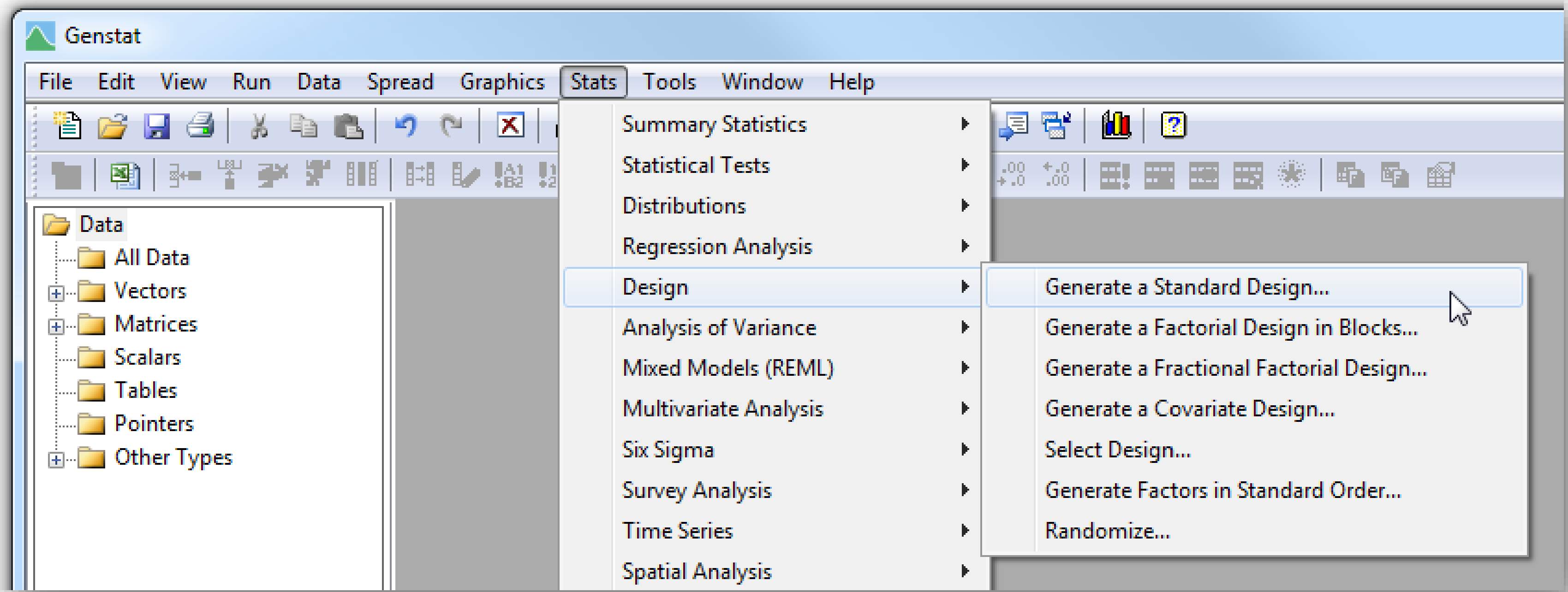


Excel - Generate RCB Design *(continue)*

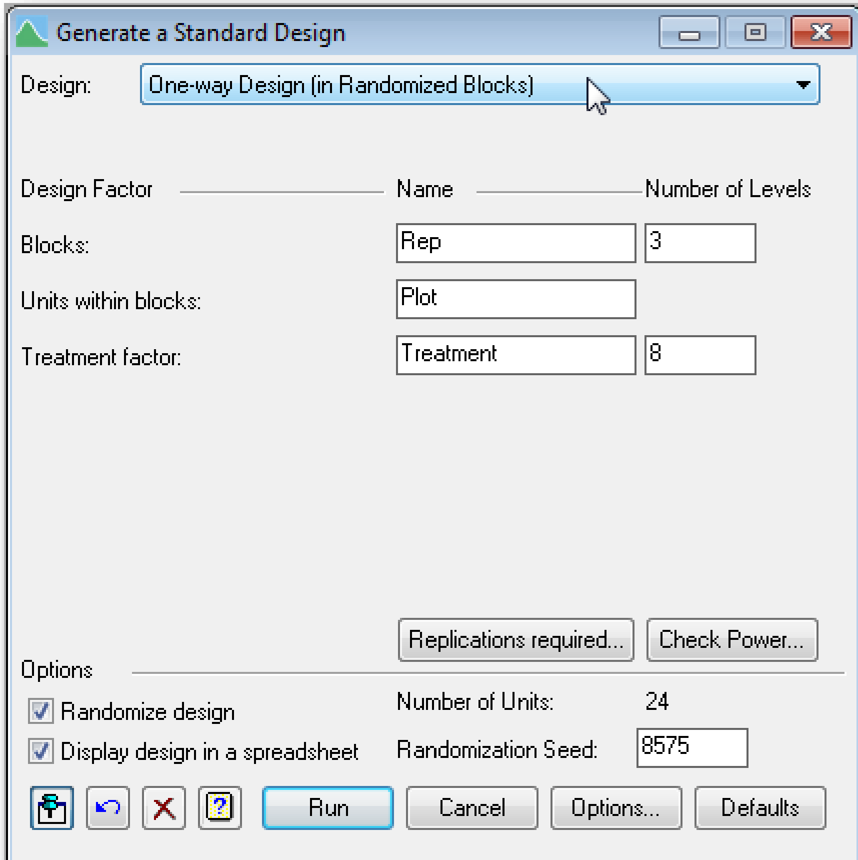
	A	B	C
1	Treatment	Order	Plot
2	Pesticides E	0.07183	1
3	Pesticides A	0.27052	2
4	Pesticides F	0.35682	3
5	Pesticides H	0.61784	4
6	Pesticides B	0.63138	5
7	Pesticides G	0.87106	6
8	Pesticides C	0.87696	7
9	Pesticides D	0.89878	8

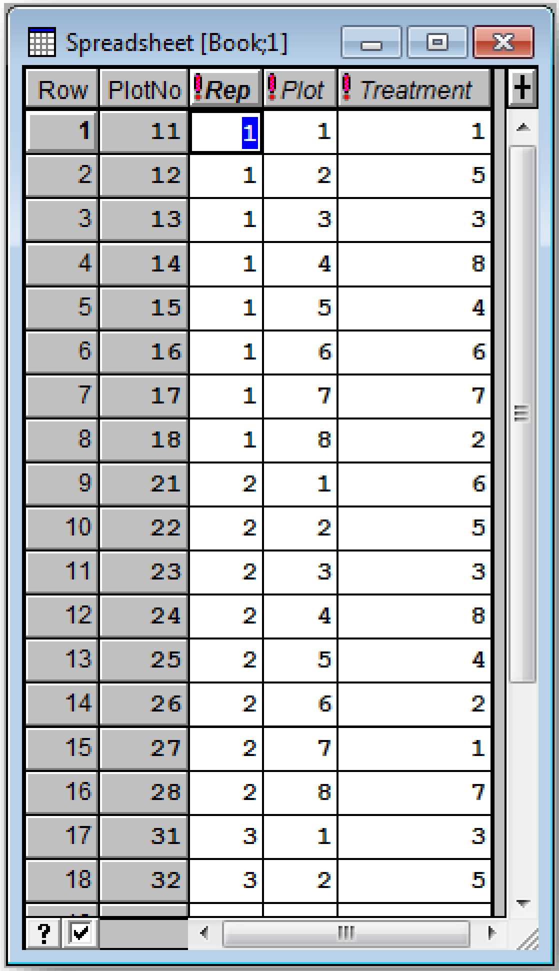
	A	B	C
1	Treatment	Rep	Plot
2	Pesticides E	1	1
3	Pesticides A	1	2
4	Pesticides F	1	3
5	Pesticides H	1	4
6	Pesticides B	1	5
7	Pesticides G	1	6
8	Pesticides C	1	7
9	Pesticides D	1	8

GenStat – Generate RCB Design



GenStat – Generate RCB Design *(continue)*





Row	PlotNo	Rep	Plot	Treatment
1	11	1	1	1
2	12	1	2	5
3	13	1	3	3
4	14	1	4	8
5	15	1	5	4
6	16	1	6	6
7	17	1	7	7
8	18	1	8	2
9	21	2	1	6
10	22	2	2	5
11	23	2	3	3
12	24	2	4	8
13	25	2	5	4
14	26	2	6	2
15	27	2	7	1
16	28	2	8	7
17	31	3	1	3
18	32	3	2	5

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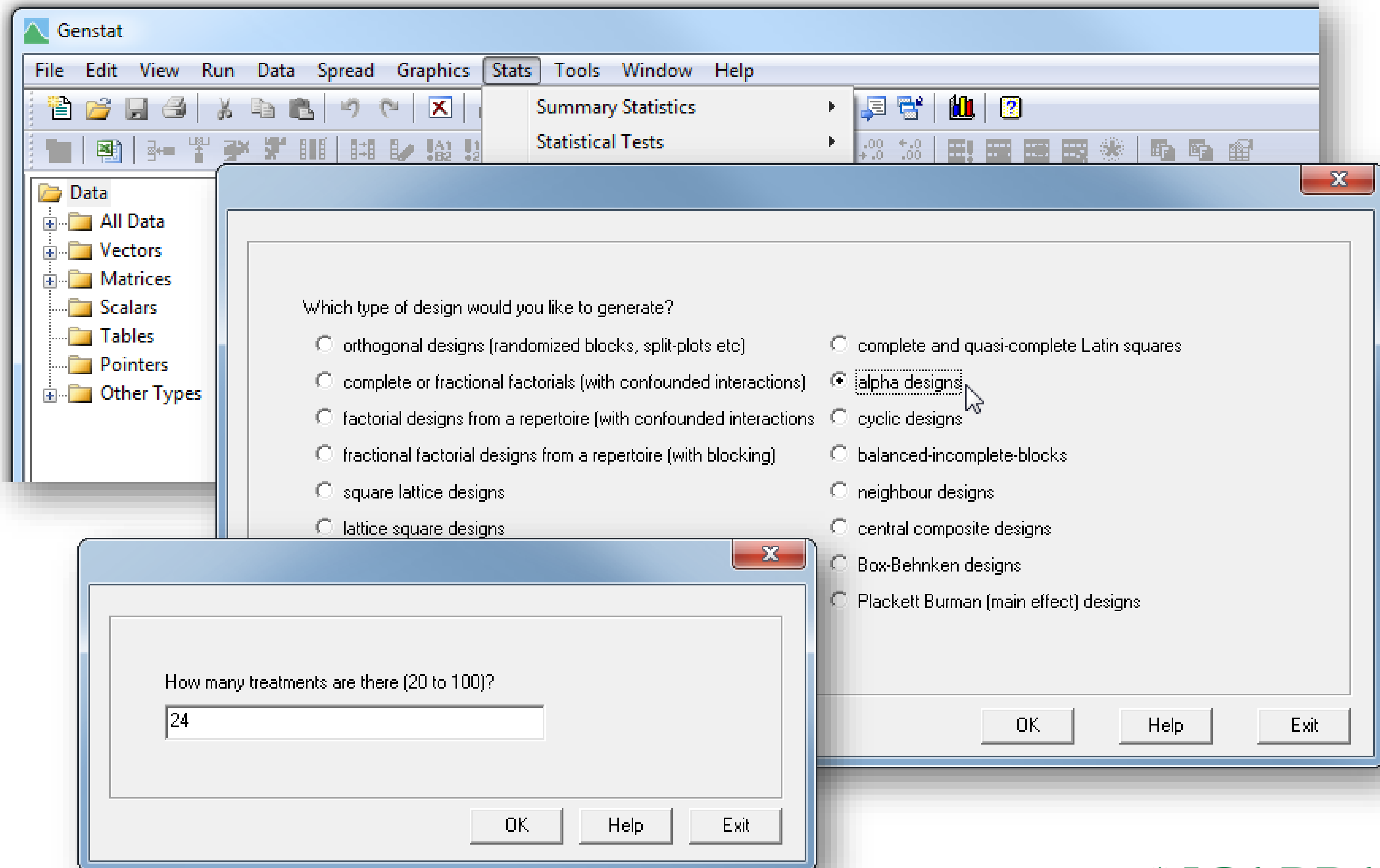
GenStat – Generate Alpha Design



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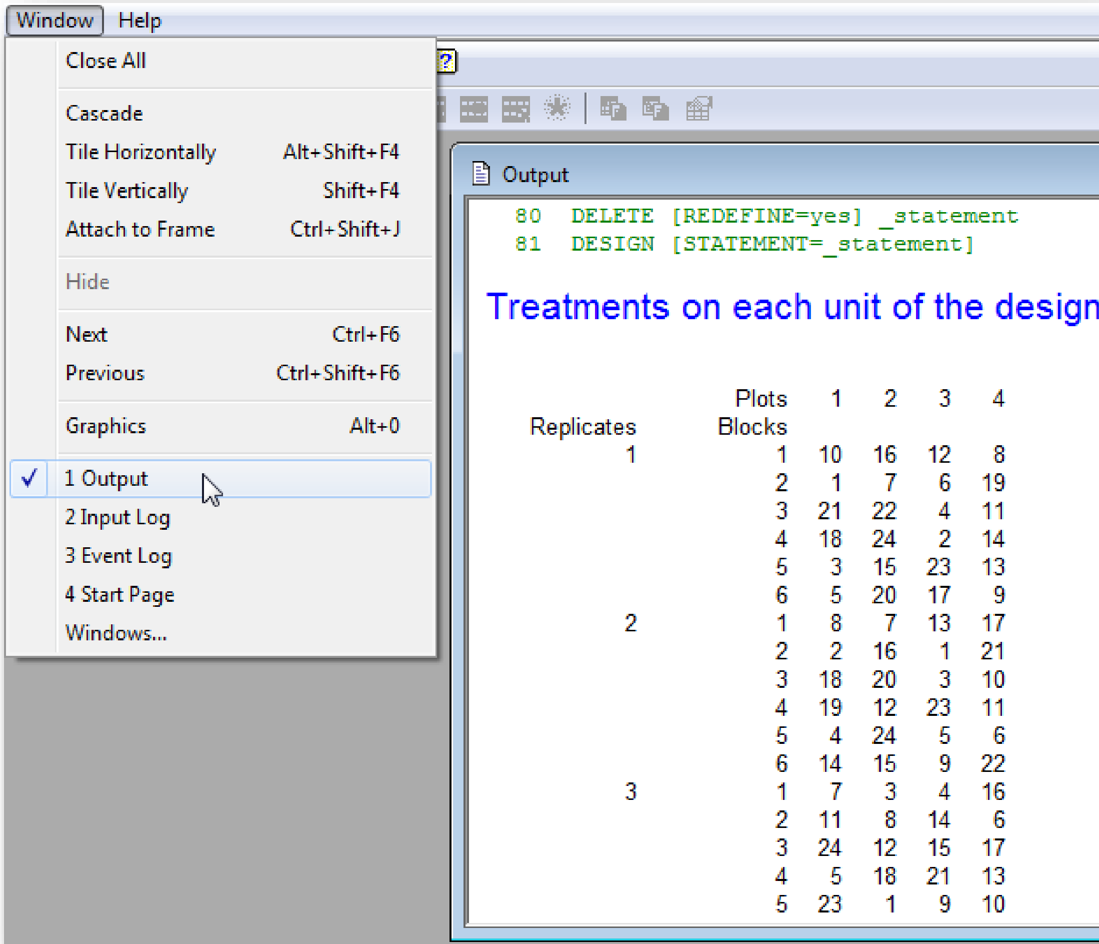
GenStat – Generate Alpha Design *(continue)*

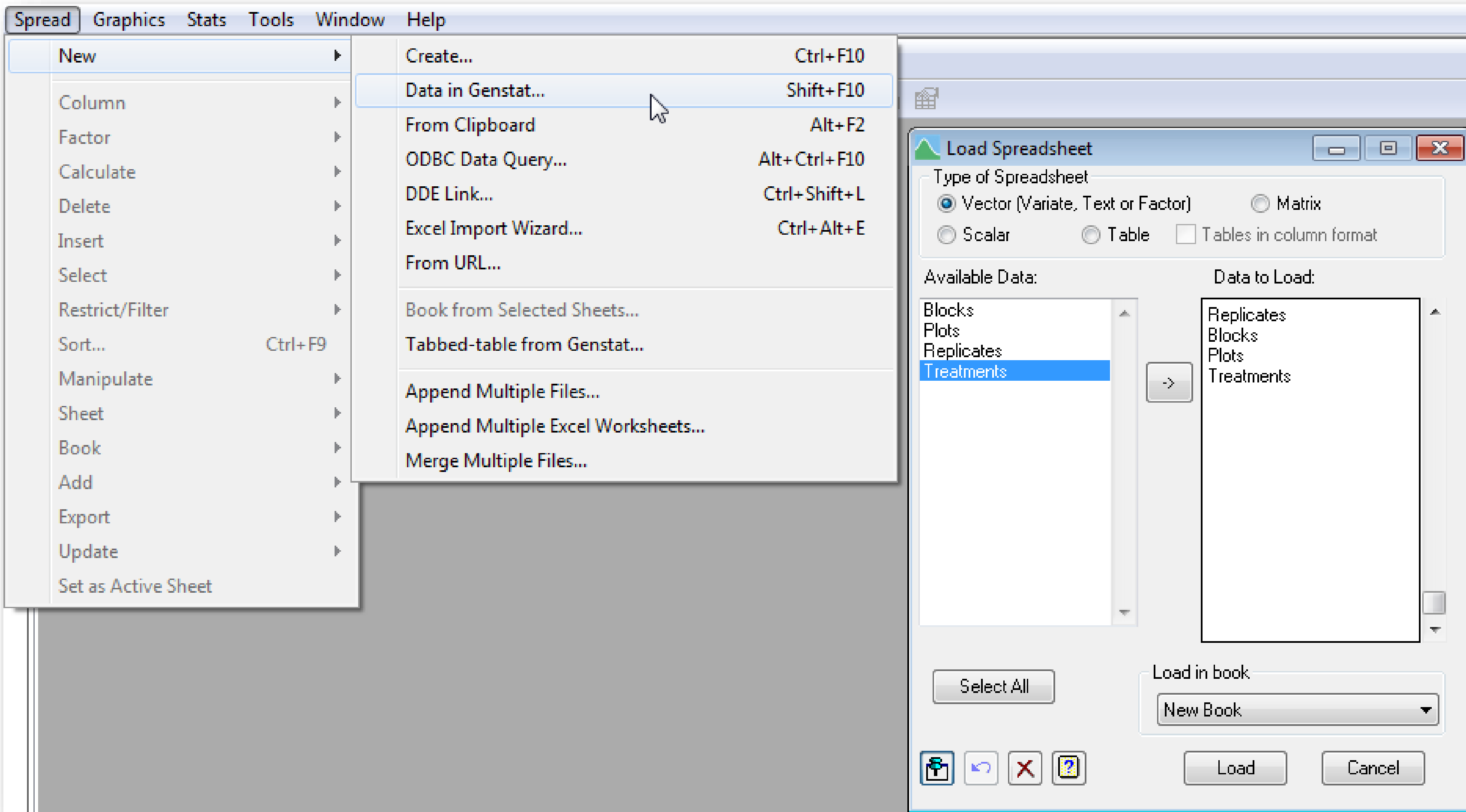
- How many blocks in each replicate? **6**
- How many replicates? **3**
- What would you like to call the treatment factor? **Treatments**
- What would you like to call the replicates factor? **Replicates**
- What would you like to call the block factor? **Blocks**
- What would you like to call the unit-within-block factor? **Plots**
- Seed for randomization (-1 for none)? **25185**
- Do you want to print the generator for the design? **No**
- Do you want to print the design? **Yes**

GenStat – Generate Alpha Design *(continue)*



Replicates	Blocks \ Plots	1	2	3	4
1	1	10	16	12	8
	2	1	7	6	19
	3	21	22	4	11
	4	18	24	2	14
	5	3	15	23	13
	6	5	20	17	9
2	1	8	7	13	17
	2	2	16	1	21
	3	18	20	3	10
	4	19	12	23	11
	5	4	24	5	6
	6	14	15	9	22
3	1	7	3	4	16
	2	11	8	14	6
	3	24	12	15	17
	4	5	18	21	13
	5	23	1	9	10

GenStat – Generate Alpha Design *(continue)*



GenStat – Generate Alpha Design *(continue)*

Spreadsheet [Book;1]

Row	Replicates	Blocks	Plots	Treatments
1	1	1	1	10
2	1	1	2	16
3	1	1	3	12
4	1	1	4	8
5	1	2	1	1
6	1	2	2	7
7	1	2	3	6
8	1	2	4	19
9	1	3	1	21
10	1	3	2	22
11	1	3	3	4
12	1	3	4	11
13	1	4	1	18
14	1	4	2	24
15	1	4	3	2
16	1	4	4	14
17	1	5	1	3

Output

Treatments on each unit of the design

	Plots	1	2	3	4
Replicates	Blocks				
1	1	10	16	12	8
	2	1	7	6	19
	3	21	22	4	11
	4	18	24	2	14
	5	3	15	23	13
	6	5	20	17	9
2	1	8	7	13	17
	2	2	16	1	21
	3	18	20	3	10
	4	19	12	23	11
	5	4	24	5	6
	6	14	15	9	22
3	1	7	3	4	16
	2	11	8	14	6
	3	24	12	15	17
	4	5	18	21	13
	5	23	1	9	10
	6	2	20	22	19

Thank You

Questions?

Japanese attitude for work:

If one can do it, I can do it. If no one can do it, I must do it.

Middle Eastern attitude for work:

Wallahi... if one can do it, let him do it.
If no one can do it, ya-habibi how can I do it?

Statistical Details (Skip if you'd like)

$$x_1, x_2, \ldots, x_n \qquad \sim N(\mu, \sigma^2)$$

$$\bar{x} = \frac{\sum x_i}{n}$$

$$Var(x) = \frac{\sum(x_i - \bar{x})^2}{n}$$

$$SD(x) = \sigma = \sqrt{Var(x)}$$

$$Z_i = \frac{x_i - \bar{x}}{SD(x)} \qquad \sim N(0,1)$$

$$t = \frac{\bar{x} - \mu}{SD(x)/\sqrt{n}} \qquad \sim t(n-1)$$