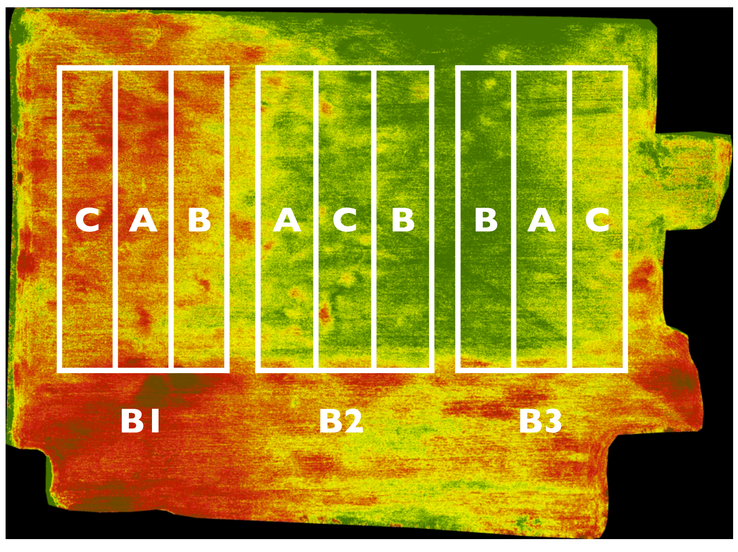
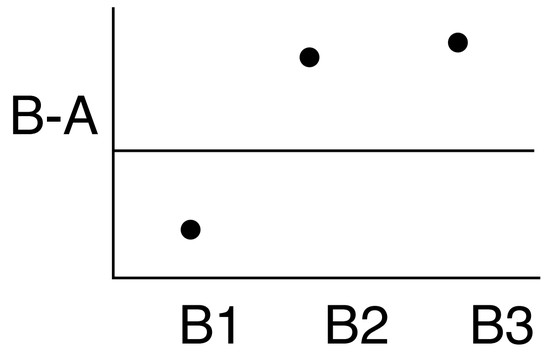
What happens if the Insecticide effects change across the field?



RCBD

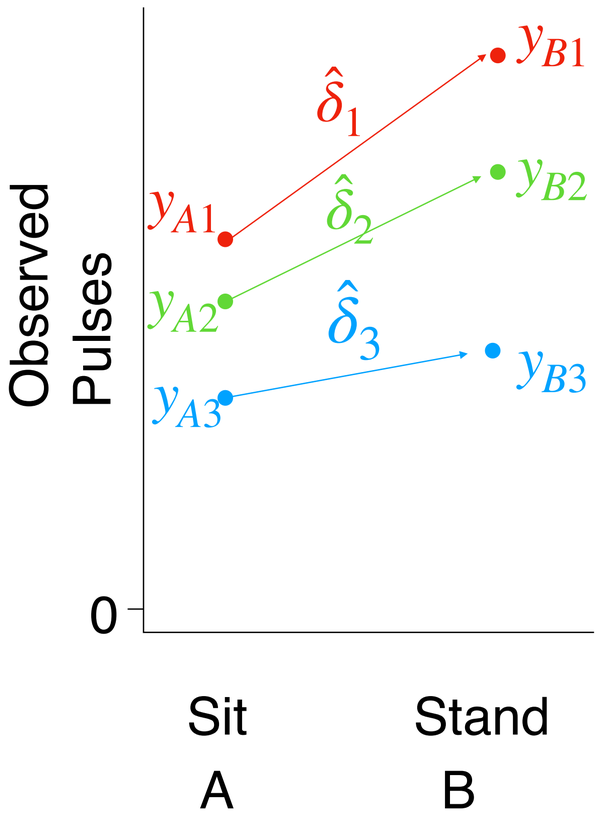


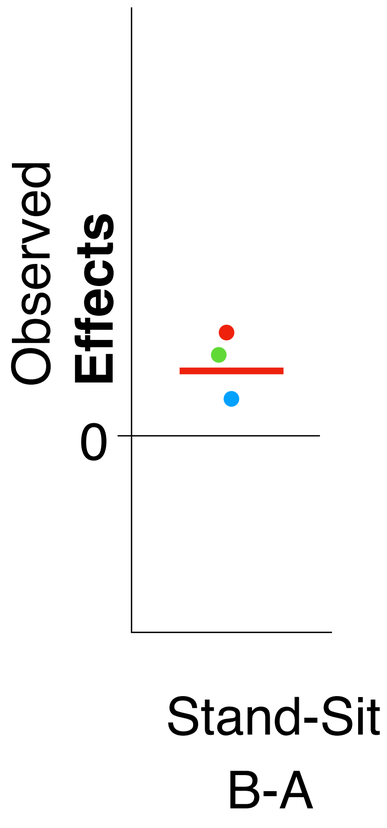
This **always** occurs!

To what degree?

Does it matter?

ind. people





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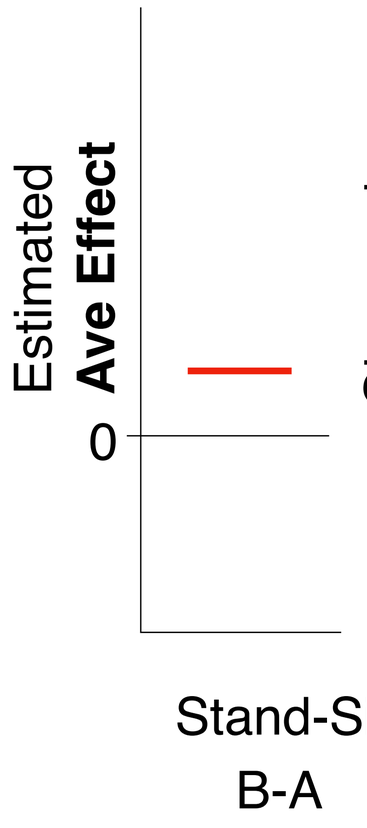
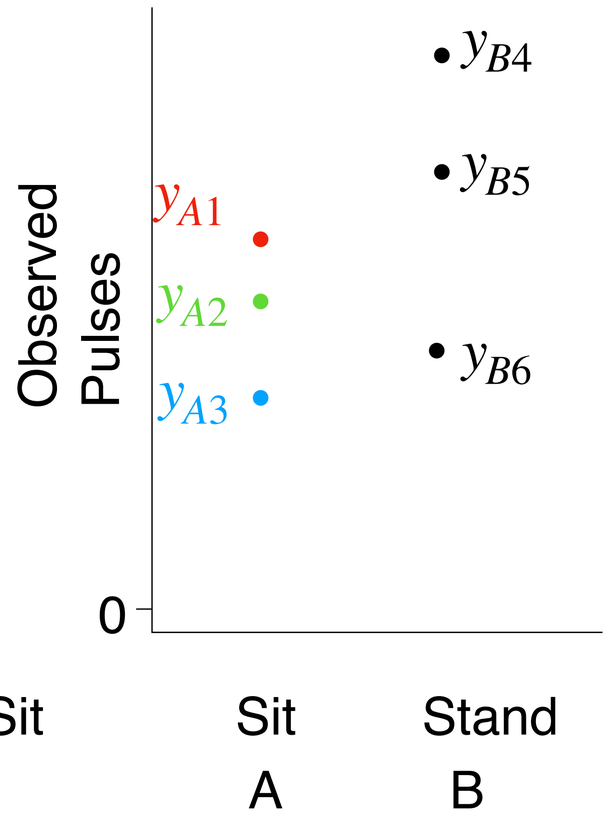


ind. people



We always study the **average effect** in a population

Indirect design: only can estimate the **average effect**

Direct design: estimate individual effects directly, combine into an average

What happens if different people have different effects of standing?

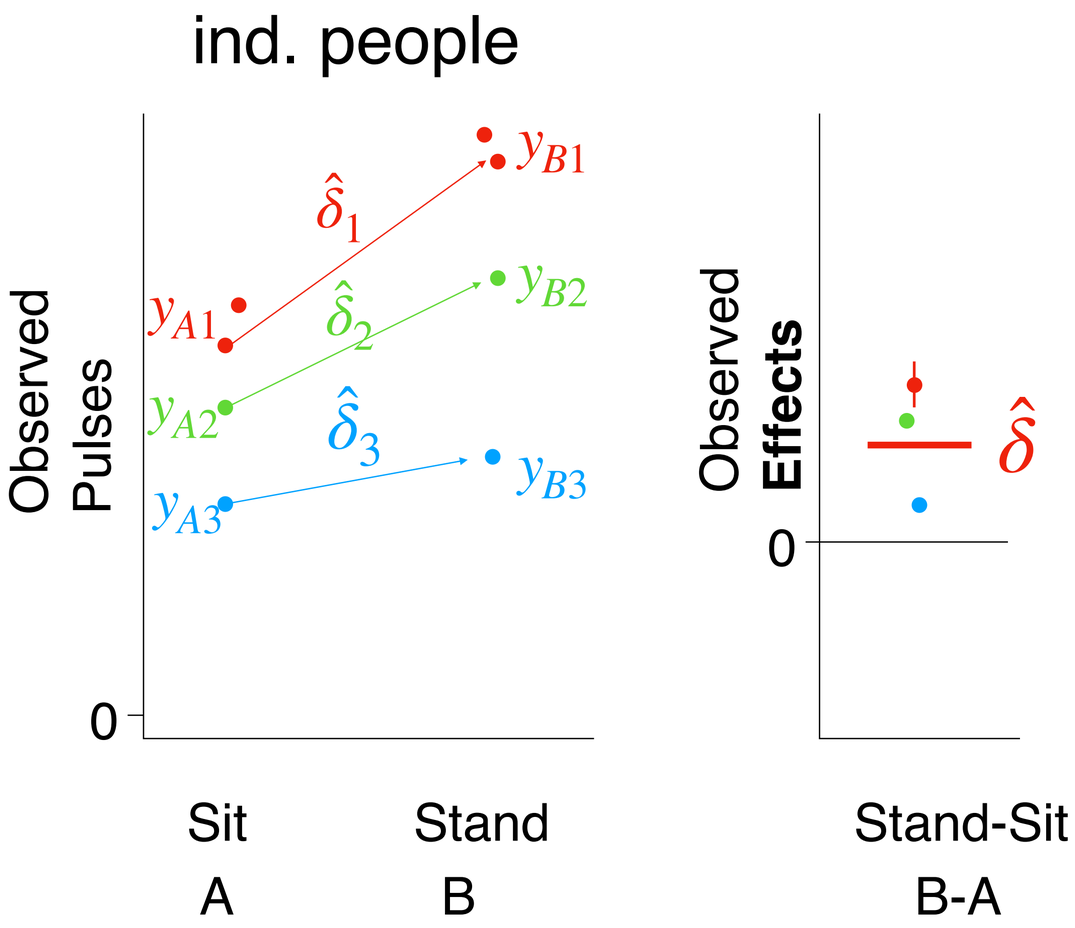
Indirect design: Increases s_i^2 in some treatments vs others (bad CIs)

Direct design: Increases s_{effect}^2 which increases SED

We are less confident about the **average effect**

because it is not consistent among people

What **do we do** if people differ in their responses to standing?



1) Are we **sure** people differ in their responses to standing?

We need replicates to compare effects between people

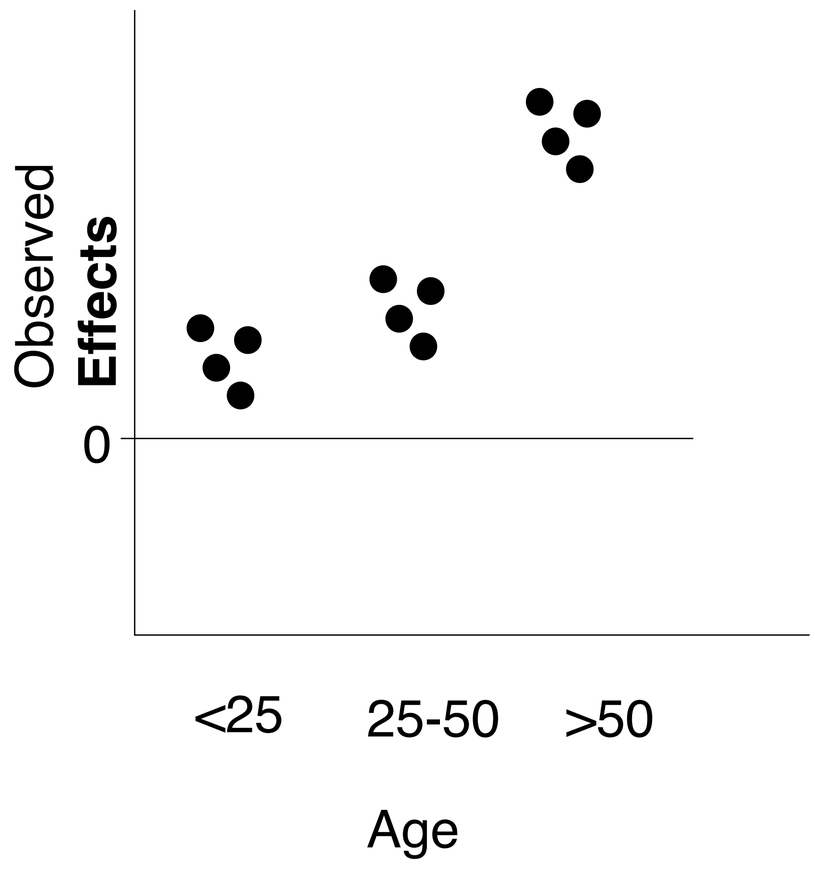
2) If people **do** have different effects, can we explain why?

Person is a Block, not a (manipulative) Treatment

Replicate measures are **not interspersed** (among people)

We care about generalizing to **new people**

3) What if we group people by Age and look for differences in effects



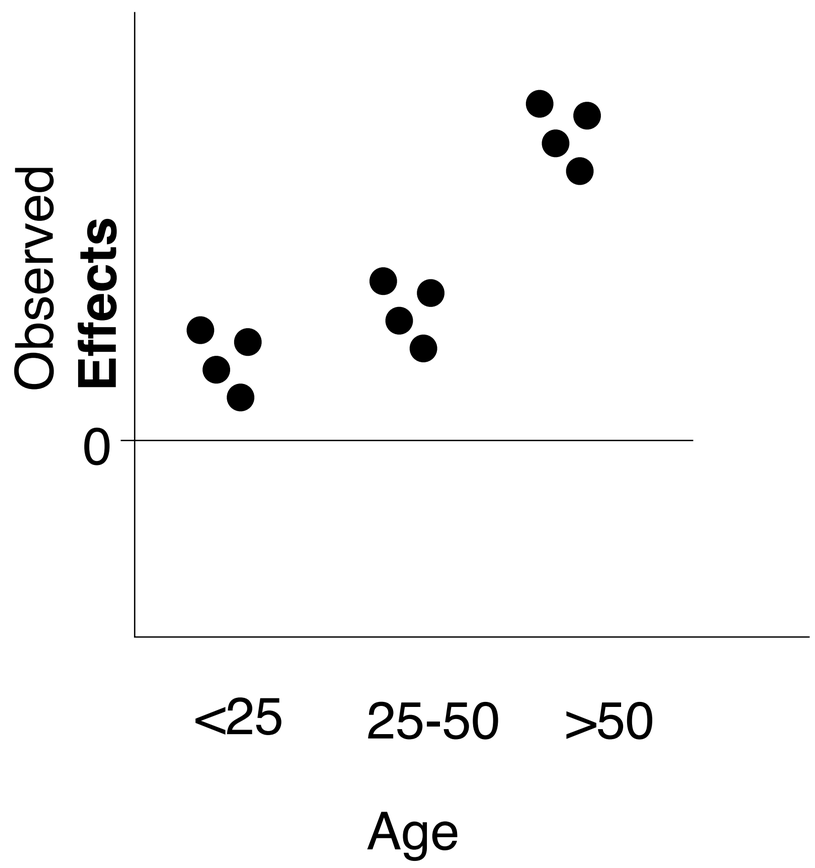
Each point represents an estimated effect on a **single person** (measured both standing and sitting)

A) Is this a **direct** or **indirect** experiment?

B) Did we learn **if** people differ in their responses to standing?

C) Did we learn **why** people differ in their responses to standing?

3) What if we group people by Age and look for differences in effects



Each point represents an estimated effect on a **single person** (measured both standing and sitting)

A) Is this a **direct** or **indirect** experiment?

We measure each person in both, so Person is a block

At each Age, we measure people sitting and standing so Age is a block

Therefore it is **Direct**

B) Did we learn **if** people differ in their responses to standing?

If responses are different among people of different ages, they must differ among people

C) Did we learn **why** people differ in their responses to standing?

Age is not a (manipulative) treatment

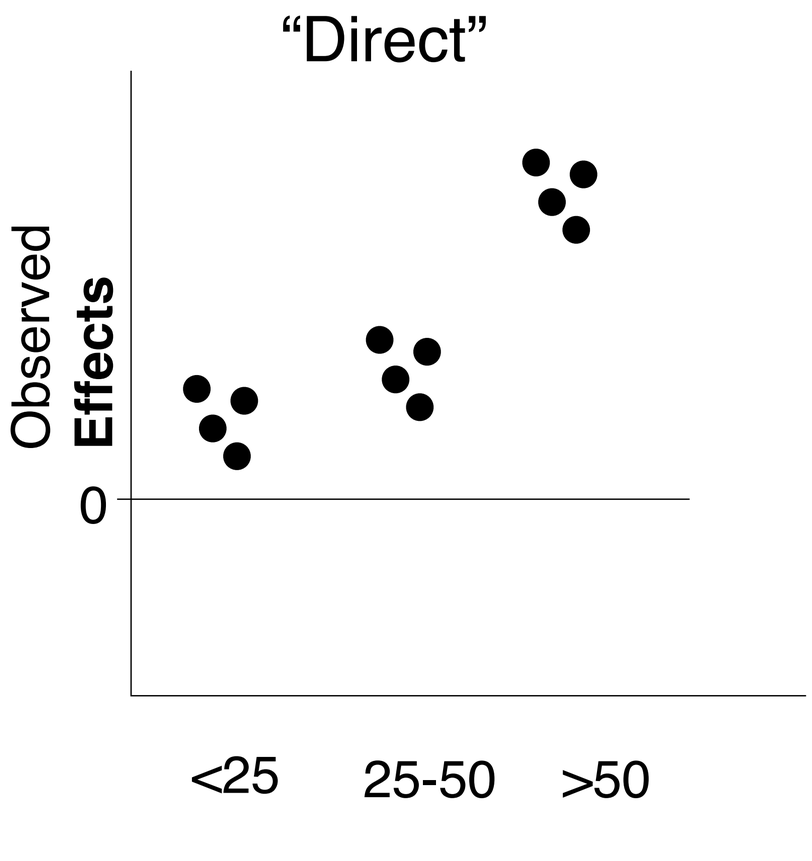
Best considered a **mensurative treatment**

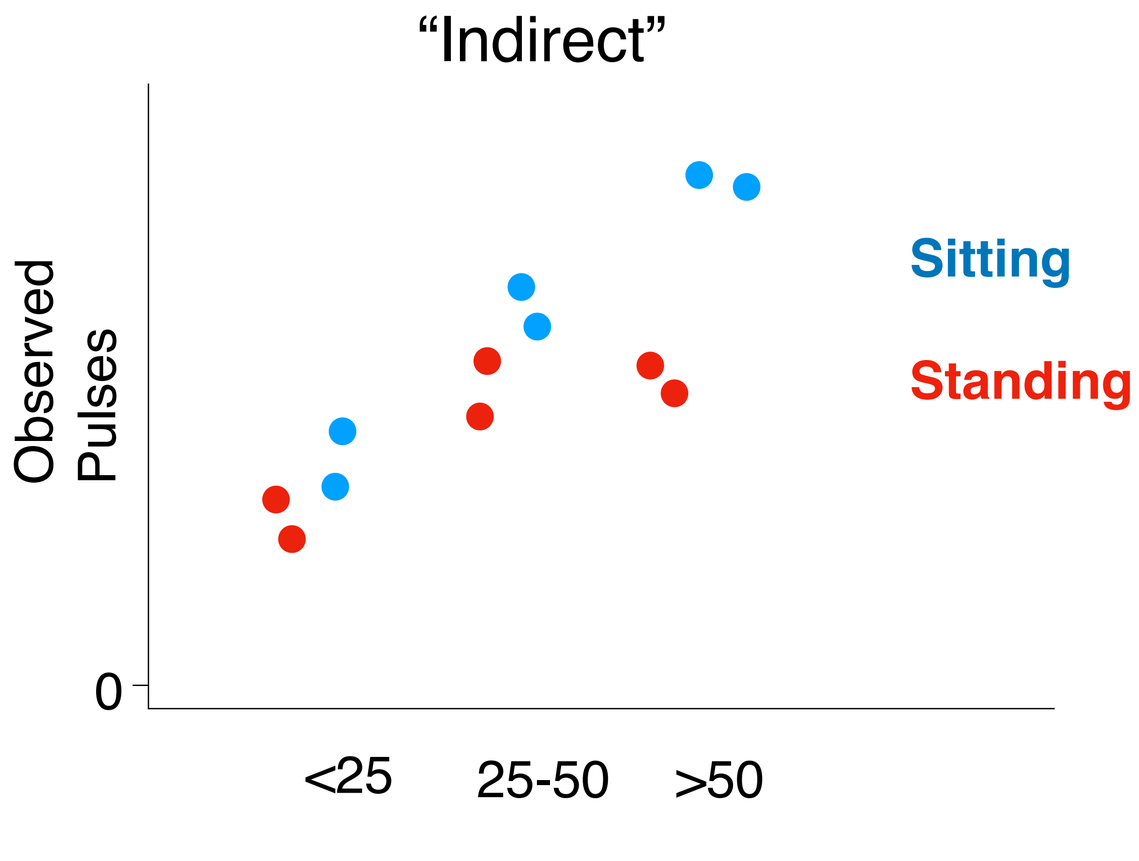
We can describe differences in standing effects among ages

We cannot **conclude** increase age causes increased responses to standing

D) Did we need to block by **Person** if we're also blocking by **Age**?

Person **is nested** in Age





Each point represents an estimated effect on a **single person** (measured both standing and sitting)

Each point represents a measurement fro a **different person**

In both we can conclude that responses differ among people

In both we can observe that responses are bigger in the older group

Both are **direct**, even though the right design is indirect at the person level

Key Ideas

Blocks help us look for **variation** in treatment effects (Direct experiment)

We can't **explain** / **predict** this variation (need **manipulative treatments**)

This requires **replication** of each treatment within each block

Interpretation:

Average treatment effects differ among Blocks

And among the units that make up the blocks

e.g. among **people** or **plots in the field**

Rules for making Design Table

1) Response: One Variable, always numeric

2) Treatments: Variables we want to study

Focal, Moderator, in a factorial

List Blocks and EUs for every treatment variable

Don’t list Focal as a Block

3) Create Treatment:Block variables

If both “Treatment” and “Block” are treatments, include these as Combo treatment

Otherwise, Treatment:Block is a Design variable

4) Design: All other variables necessary to describe the experiment

Must be random → Every EU variable

Every Block variable that **is not a Treatment**

Can be random → Every Treatment:Block variable that **is not a Combo Treatment**

A variable to describe each unique observation
(same # levels as the response)

5) Check **variable relationships** and simplify if possible

EU Variable must be **nested** in the Treatment variable

If two variables are **aliased**, keep only 1 of them

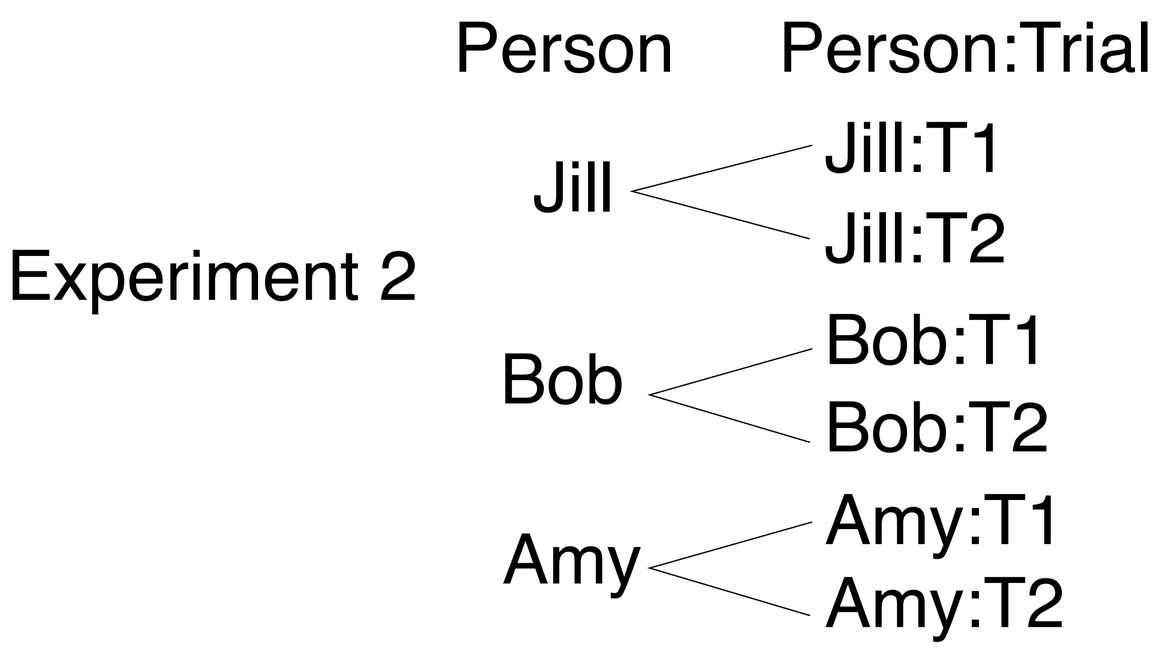
If two variables are **crossed**, keep both

order of variables does not matter

Relationships among variables

nested one:many Keep both, if first is random, so is second

2nd has more levels

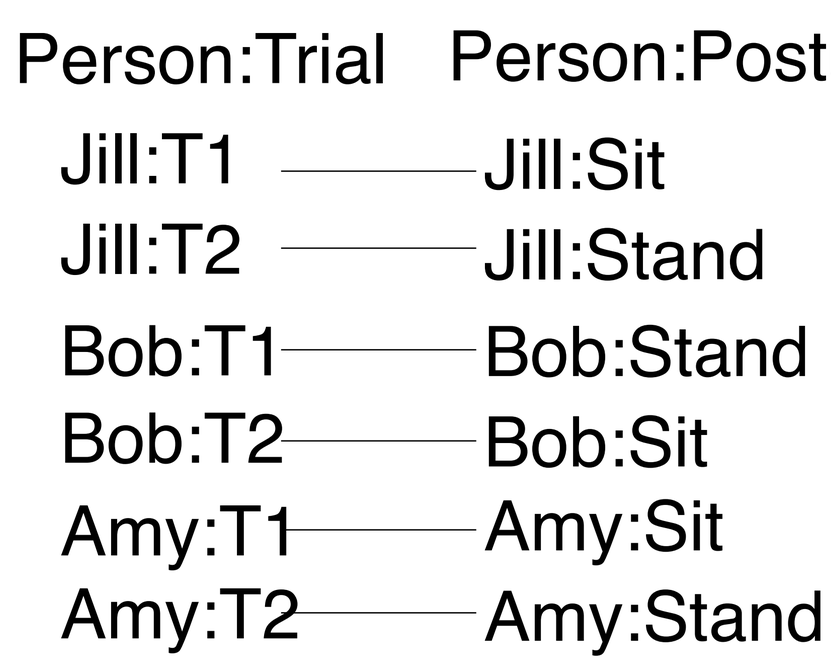


Experiment 2

is_nested(Person~Person:Trial)

aliased one:one Keep one, particularly Treatment:Block

always same # levels

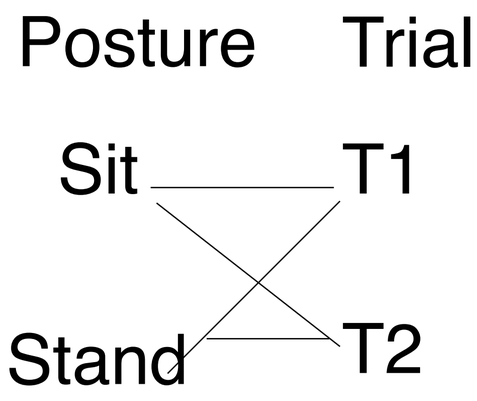


Experiment 2

is_aliased(A~B)

crossed many:many Keep both

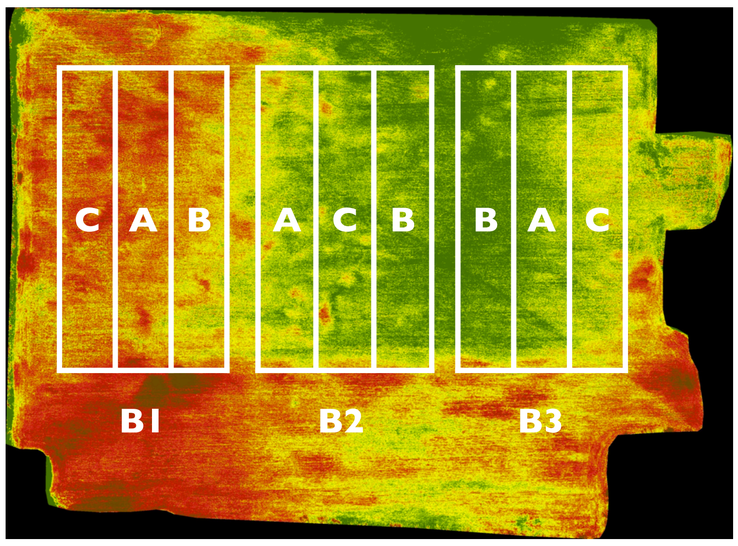
at least 1 level of A matched with 2+ levels of B and vice versa



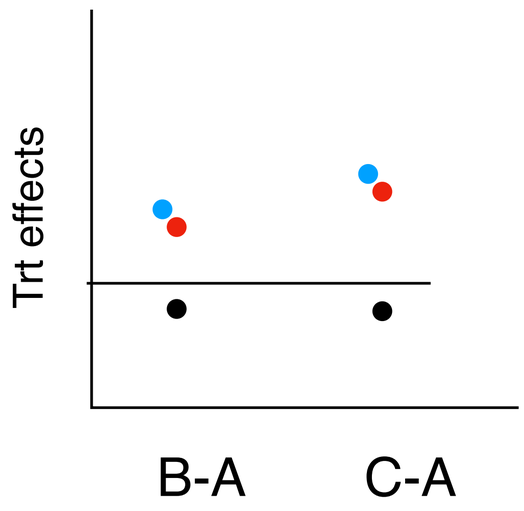
Experiment 2

Experiment 3

is_crossed(A~B)



RCBD



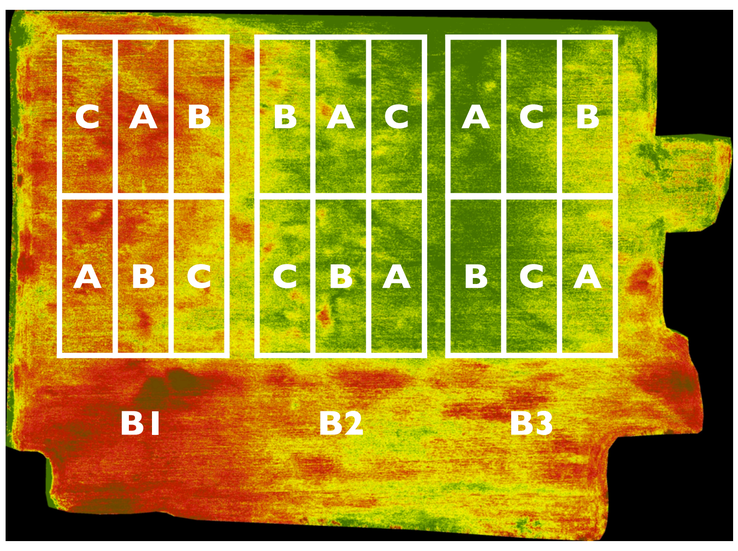
RCBD

Describe **main effects**

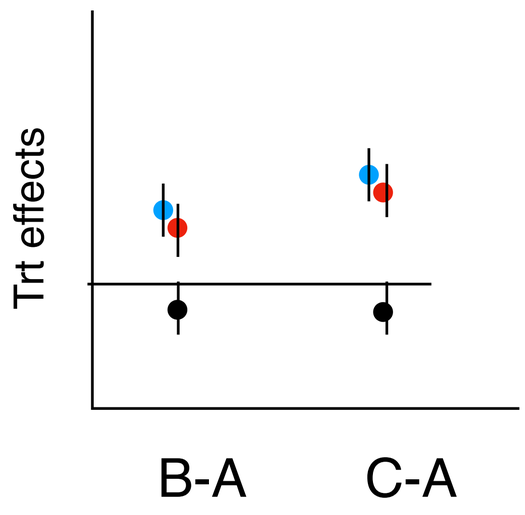
Average over blocks

“Best guess” for a future block

Observe, but **can’t test** specific effects



RCBD with Reps



RCBD with Reps

Describe **main effects**

Average over blocks

“Best guess” for a future block

Test for Block:Insecticide interactions

Describe specific effects / block

Structure	Variable	Type	#levels	Block	EU
Treatment	Insecticide	Categ	3	Block	Plot
Design	Block	Categ	3		
	Ins:Block	Categ	9		
	Plot	Categ	18		
Response	Yield	Num	18		

Describe **main effects** Treatment:Block **is random**

lmer(Yield ~ Insecticide + Block + (1|Insecticide:Block))

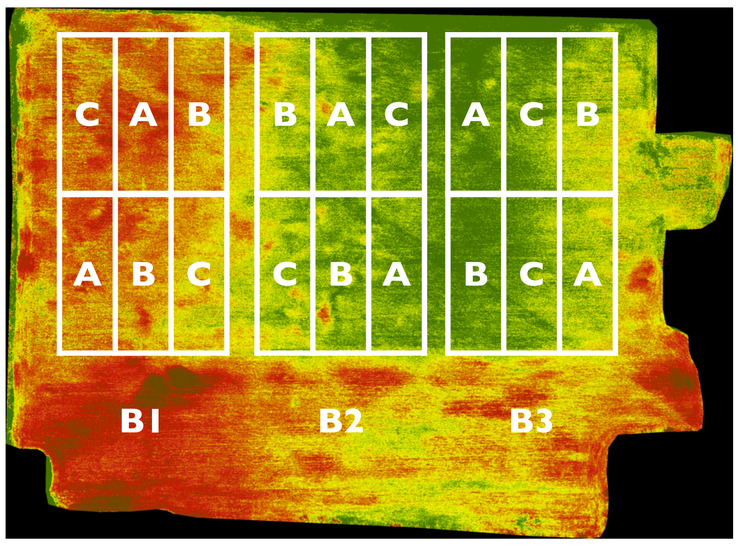
Test for Block:Insecticide interactions Analyze Block as a **mensurative treatment**

lm(Yield ~ Insecticide + Block + Insecticide:Block) Treatment:Block is **not random**

Describe specific effects in each block Analyze Block as a **mensurative treatment**

lm(Yield ~ Block + Insecticide:Block) Treatment:Block is **not random**

Practice



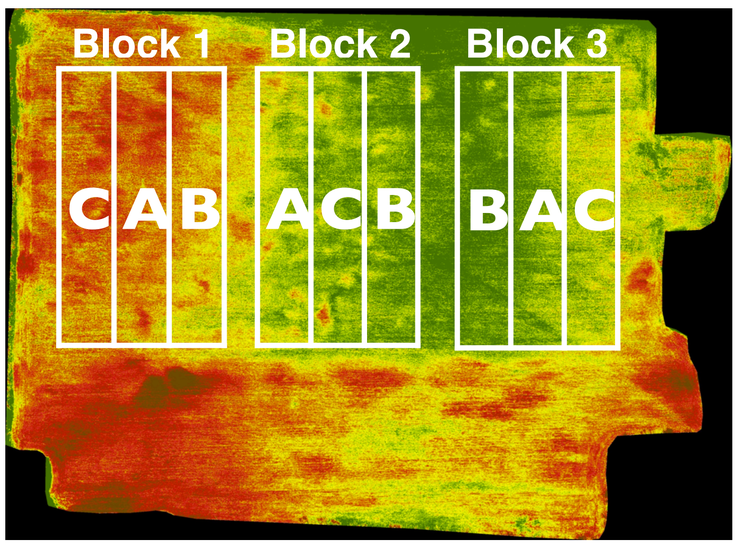
Structure	Variable	Type	#levels	Block	EU
Treatment	Insecticide	Categ	3	Block	Plot
Design	Block	Categ	3		
	Ins:Block	Categ	9		
	Plot	Categ	18		
Response	Yield	Num	18		

Describe these relationships: nested / aliased / crossed

Insecticide ~ Block — crossed

Insecticide ~ Plot — nested

Insecticide:Block ~ Plot — nested



Structure	Variable	Type	#levels	Block	EU
Treatment	Insecticide	Categ	3	Block	Plot
Design	Block	Categ	3		
	Ins:Block	Categ	9		
	Plot	Categ	9		
Response	Counts	Num	9		

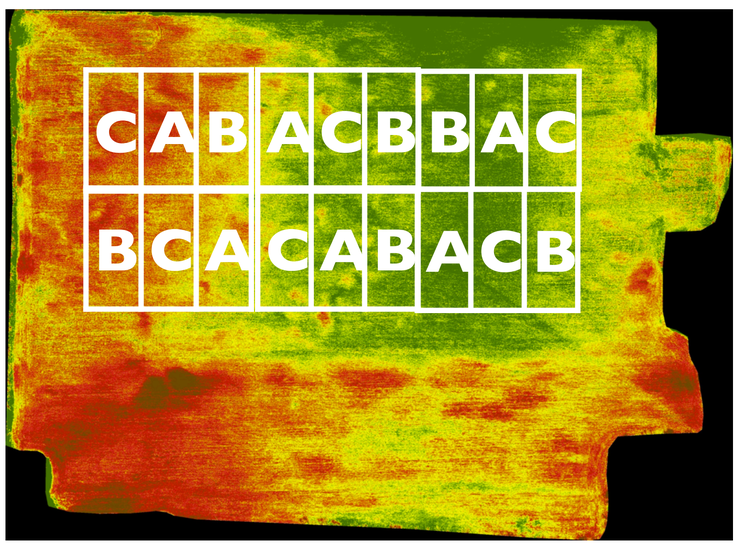
Describe these relationships: nested / aliased / crossed

Insecticide ~ Block — crossed

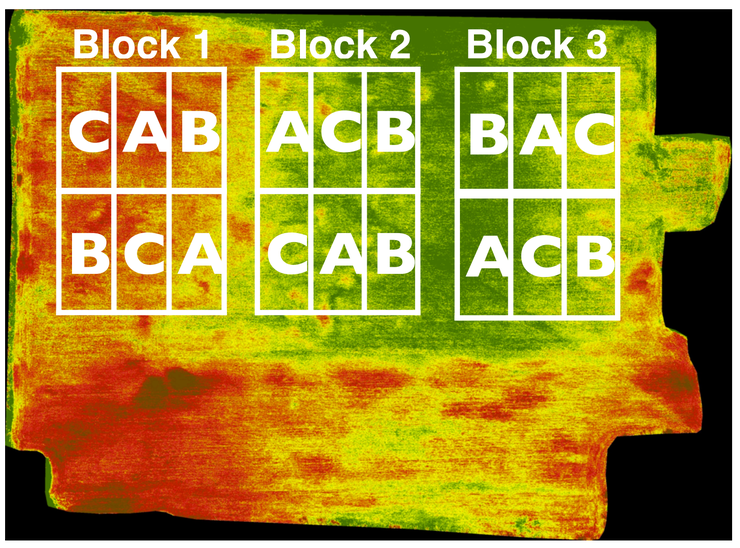
Insecticide ~ Plot — nested

Insecticide:Block ~ Plot — aliased

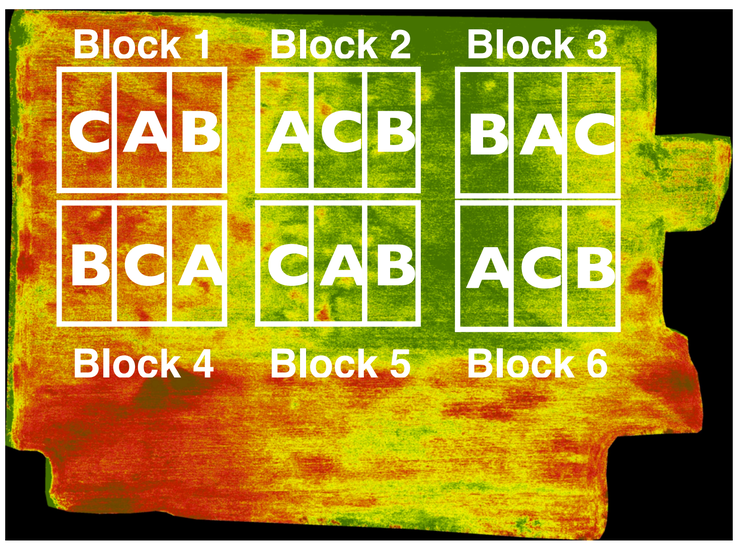
Optimal number of blocks



No Blocks



3 Blocks



6 Blocks

Compare similar EU s^2_{pooled} or s^2_{error}

Worst → Best

Degrees of Freedom - average effect (main effect)

$k*(n_i - 1) = 15$	$(k-1)*(b-1) = 4$	$(k-1)*(b - 1) = 10$

Degrees of Freedom - specific effects

0	$b*k*(n_{ij}-1) = 9$	0

Variability of treatment effects across the field

Violates assumptions Detect through diagnostics	Test Treatment:Block interactions	Increases s^2, SED

More replicates per block means:

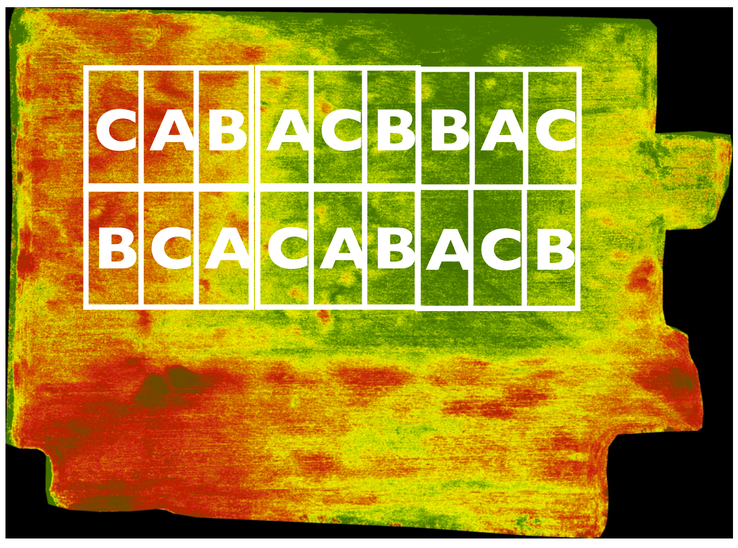
More confidence in Treatment:Block interactions

Less power for main effects

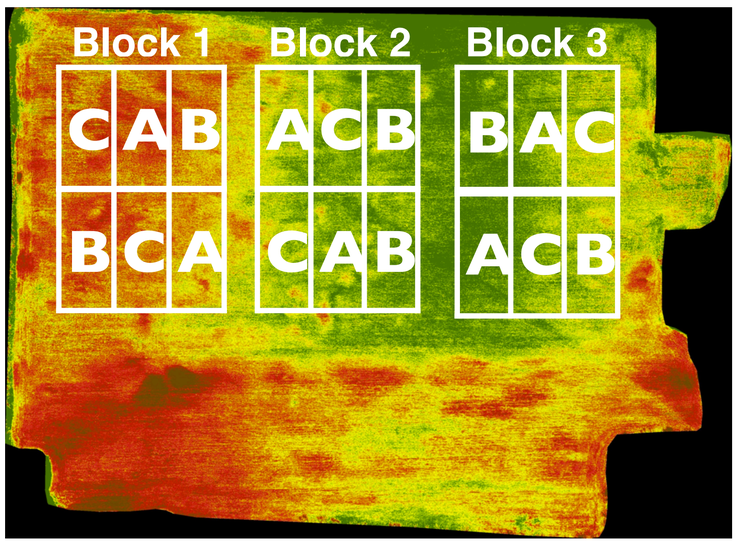
Higher DF

Less similar EU (higher s^2)

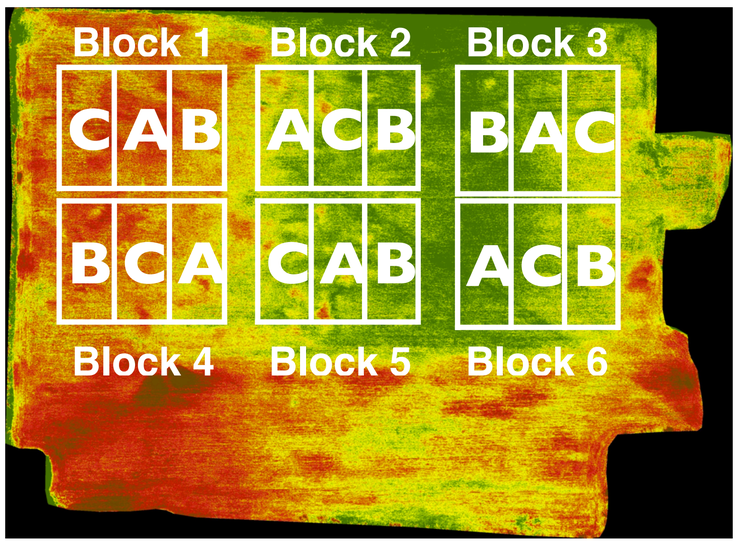
Optimal number of blocks



No Blocks



3 Blocks



6 Blocks

Recommendations:

Don’t block unless you can identify **clusters** of EU

More (small) blocks are best for studying **main effects**

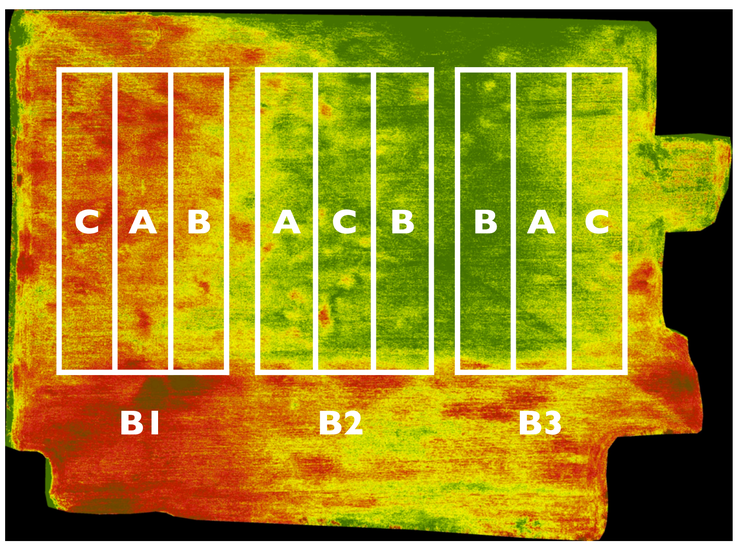
But, blocks should be representative of your target population

Only do replication of treatments within blocks if:

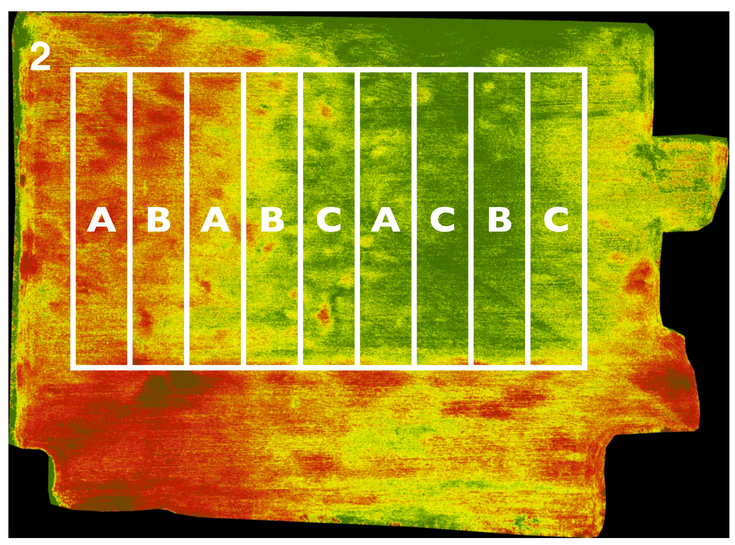
1) You want to know if treatment effects vary in your population

2) It’s not feasible to do smaller blocks that “make sense”

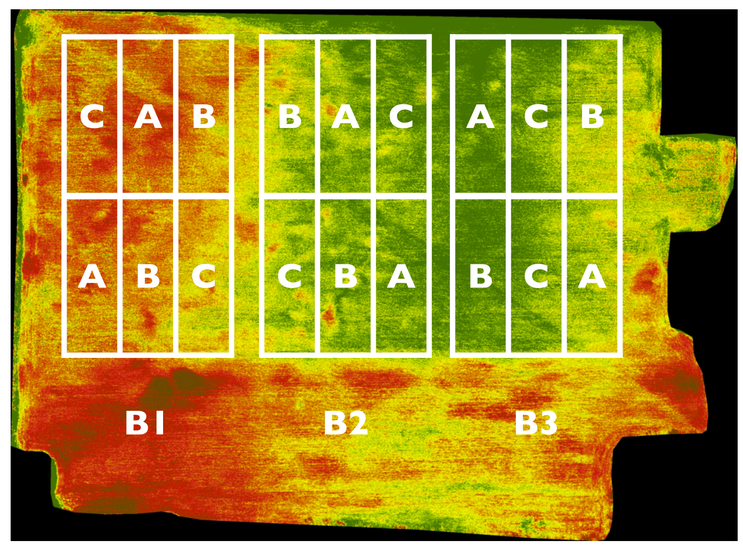
Recommending Designs



RCBD



CRD



RCBD with Reps

Which design would you use to make an Insecticide recommendation to **this farmer** (in this field)?

Reps are overkill, replicate plots within blocks are sub-samples; not-interspersed

Say the farmer could target regions within a field? Which would you use?

RCBD with reps is necessary (more like a factorial)

What design would you use to make a recommendation in a new field?

RCBD with Fields as blocks to estimate **main effect** of insecticide across all fields

Factorial with Fields as moderator to estimate **specific effects** in **certain types of fields**