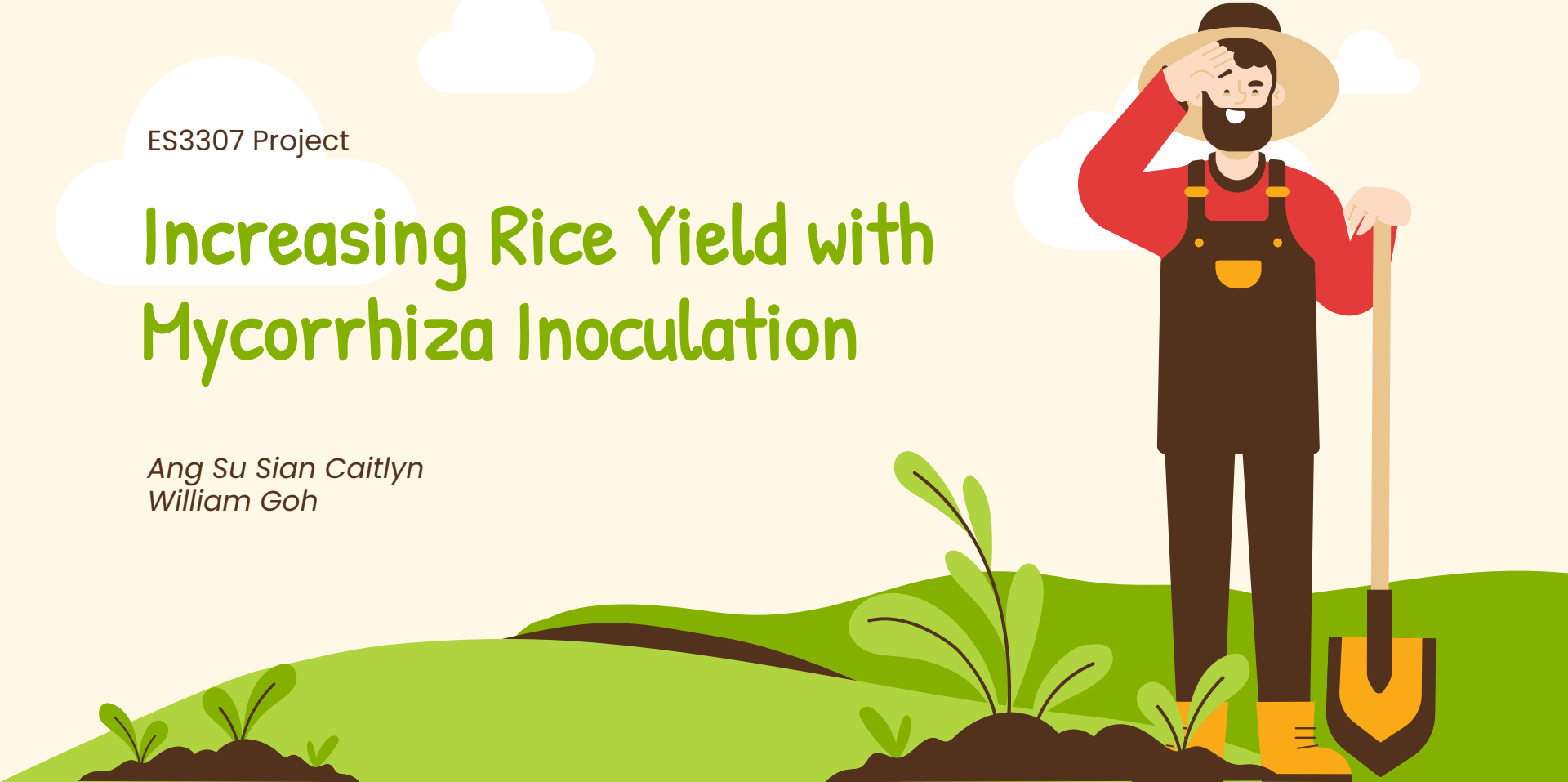
ES3307 Project

Increasing Rice Yield with Mycorrhiza Inoculation

Ang Su Sian Caitlyn
William Goh



1

Background & Hypothesis

Background

Need for food security

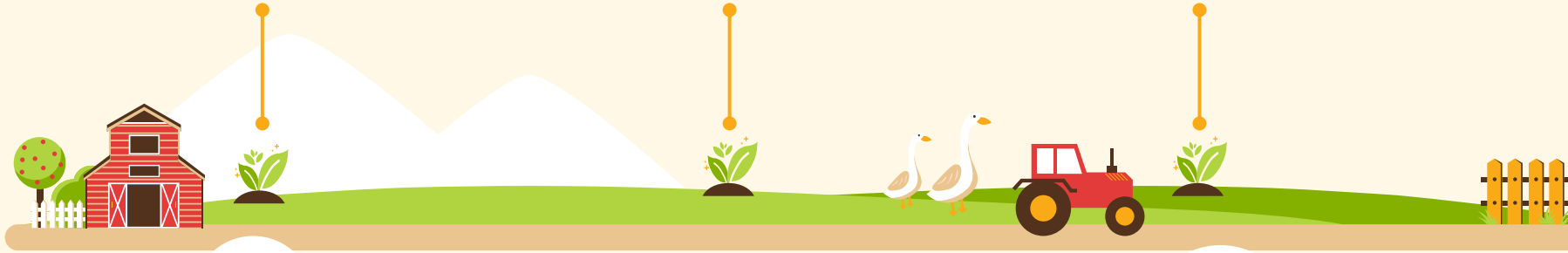
Growing population
Climate change
Loss of fertile land

Why Rice?

(*Oryza sativa*) Indica variety
Staple for Asia and SEA

Why SEA?

Tropical regions with depleted soils



Our goal

We want to explore other ways of improving soil health for maximising yield

Traditionally: Intensive use of fertilizers (N & P)

AMF can benefit Rice Crops

Demonstrated yield benefits

Studies shown **some** AMF benefit **some** crop growth through nutrient efficiency or water stress tolerance

Knowledge gaps

Conflicting reports of yield outcomes with different AMF-crop pairs, different conditions

Research Question

To find out if Mycorrhiza inoculation could improve *Oryza sativa* crop yield under nutrient depleted conditions

2

Experimental Design

Variables

MASS

Grain mass per plant, as a measure of yield (kg)

AMF

3

AMF inoculation by species 1, 2 or no inoculation as control

Funneliformis mosseae, *F. geosporus*, *Claroideoglomus claroideum*, *Glomus microaggregatum*, and *Rhizophagus irregularis*

NIT

2

Nitrogen level (normal vs depleted)

PHOS

2

Phosphate level (normal vs depleted)

Cross-factored Orthogonal Treatment Combinations

No AMF Normal nitrogen Normal phosphate	AMF 1 Normal nitrogen Normal phosphate	AMF 2 Normal nitrogen Normal phosphate
No AMF Lowered nitrogen Normal phosphate	AMF 1 Lowered nitrogen Normal phosphate	AMF 2 Lowered nitrogen Normal phosphate
No AMF Normal nitrogen Lowered phosphate	AMF 1 Normal nitrogen Lowered phosphate	AMF 2 Normal nitrogen Lowered phosphate
No AMF Lowered nitrogen Lowered phosphate	AMF 1 Lowered nitrogen Lowered phosphate	AMF 2 Lowered nitrogen Lowered phosphate

Variables

120 Replicates

12 Combination

3 Variables cross-factored

10 Replicates (pots)

One pot is one replicate

3 Seeds per pot

Take average mass of rice yield

Controlled variables

Soil type

Sterilized soil for no AMF control as a baseline

Water regime

Standardised

Positioning of pots

Randomised

Environmental factors

Sunlight, temperature, etc

Fertilizer application

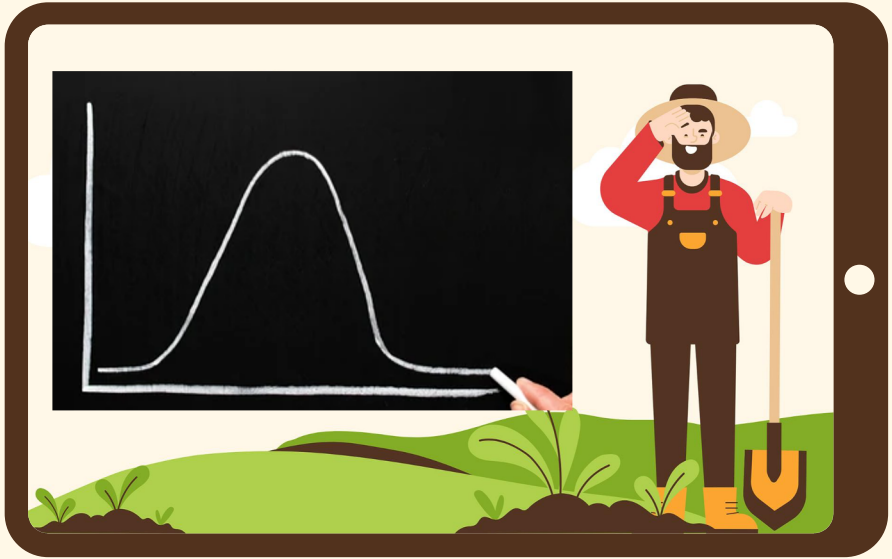
Slow-release pellets of same mass

3

Results & Model Fitting

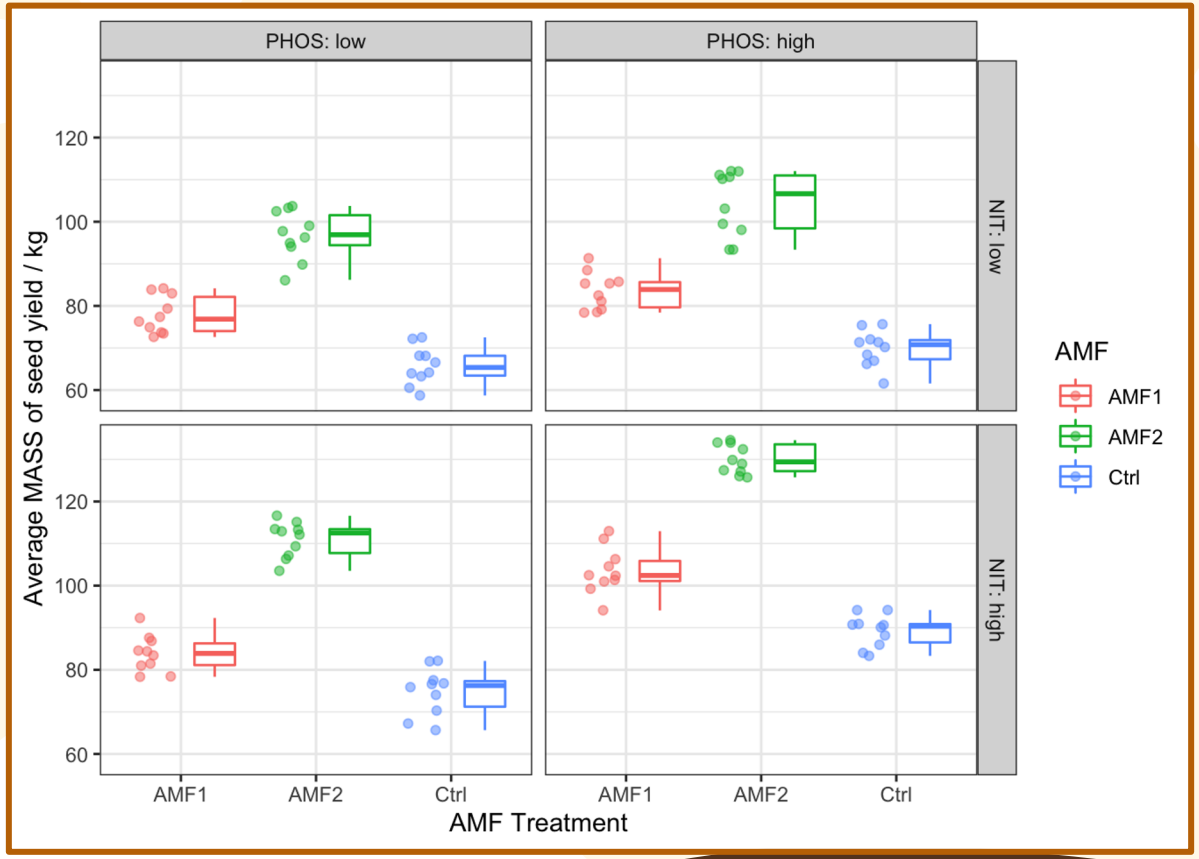
Stepwise p-value method

Dataset Generation



Random sampling from a normal distribution around expected means

Raw Data


PHOS: low
PHOS: high
NIT: low
NIT: high
Average MASS of seed yield / kg
120
100
80
60
AMF1
AMF2
Ctrl
AMF Treatment
AMF
AMF1
AMF2
Ctrl

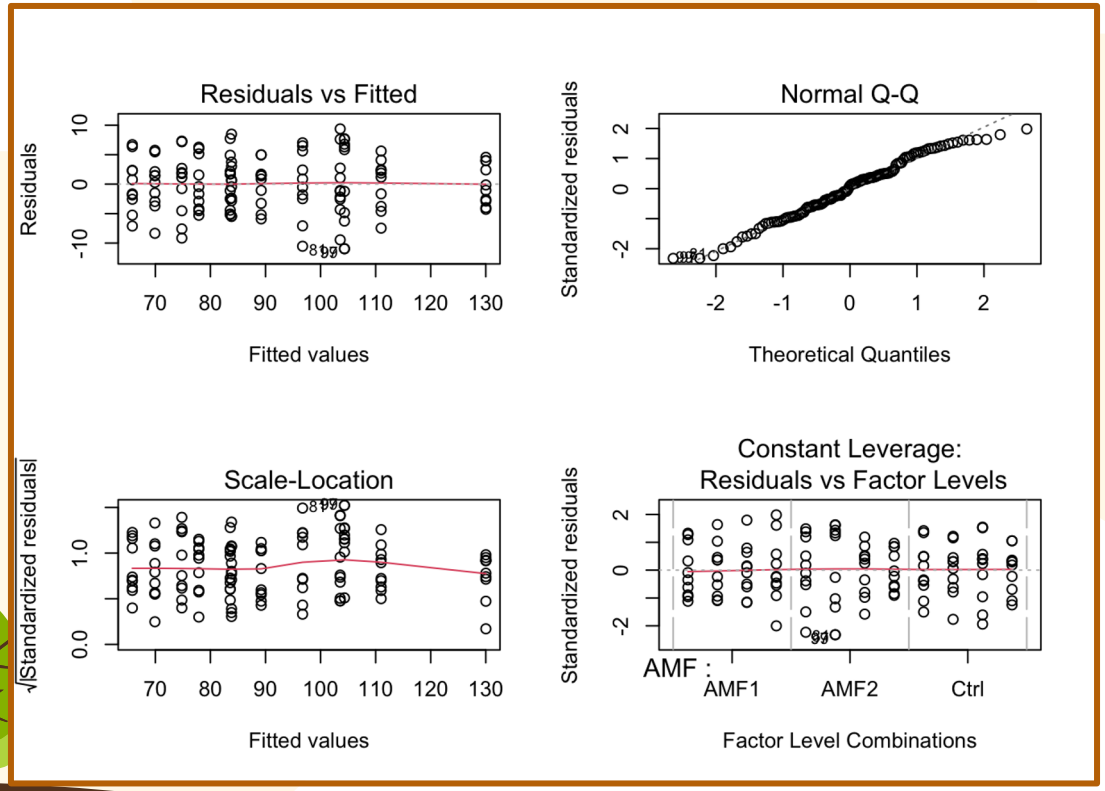
Model 1

MASS ~ AMF * NIT * PHOS

All interactions

Model 1

MASS ~ AMF * NIT * PHOS



Model 1

MASS ~ AMF * NIT * PHOS

	Sum Sq	Df	F value	Pr(>F)
AMF	26124.06501	2	526.7422887	0.0000000
NIT	7384.47645	1	297.7879608	0.0000000
PHOS	4149.05031	1	167.3154813	0.0000000
AMF:NIT	281.95489	2	5.6850862	0.0044927
AMF:PHOS	95.90008	2	1.9336436	0.1495943
NIT:PHOS	1065.51235	1	42.9680765	0.0000000
AMF:NIT:PHOS	18.26894	2	0.3683585	0.6927350
Residuals	2678.15883	108	NA	NA

Model 2

MASS ~ AMF + NIT + PHOS + AMF:NIT + AMF:PHOS + NIT:PHOS

Dropped 3-way interaction term

Model 1 vs Model 2

Res.Df	RSS	Df	Sum of Sq	F	Pr(>F)
108	2678.159	NA	NA	NA	NA
110	2696.428	-2	-18.26894	0.3683585	0.692735

Model 2

MASS ~ AMF + NIT + PHOS + AMF:NIT + AMF:PHOS + NIT:PHOS

	Sum Sq	Df	F value	Pr(>F)
AMF	26124.06501	2	532.861883	0.0000000
NIT	7384.47645	1	301.247606	0.0000000
PHOS	4149.05031	1	169.259321	0.0000000
AMF:NIT	281.95489	2	5.751135	0.0042117
AMF:PHOS	95.90008	2	1.956108	0.1462955
NIT:PHOS	1065.51235	1	43.467272	0.0000000
Residuals	2696.42776	110	NA	NA

Model 3

MASS ~ AMF + NIT + PHOS + AMF:NIT + NIT:PHOS

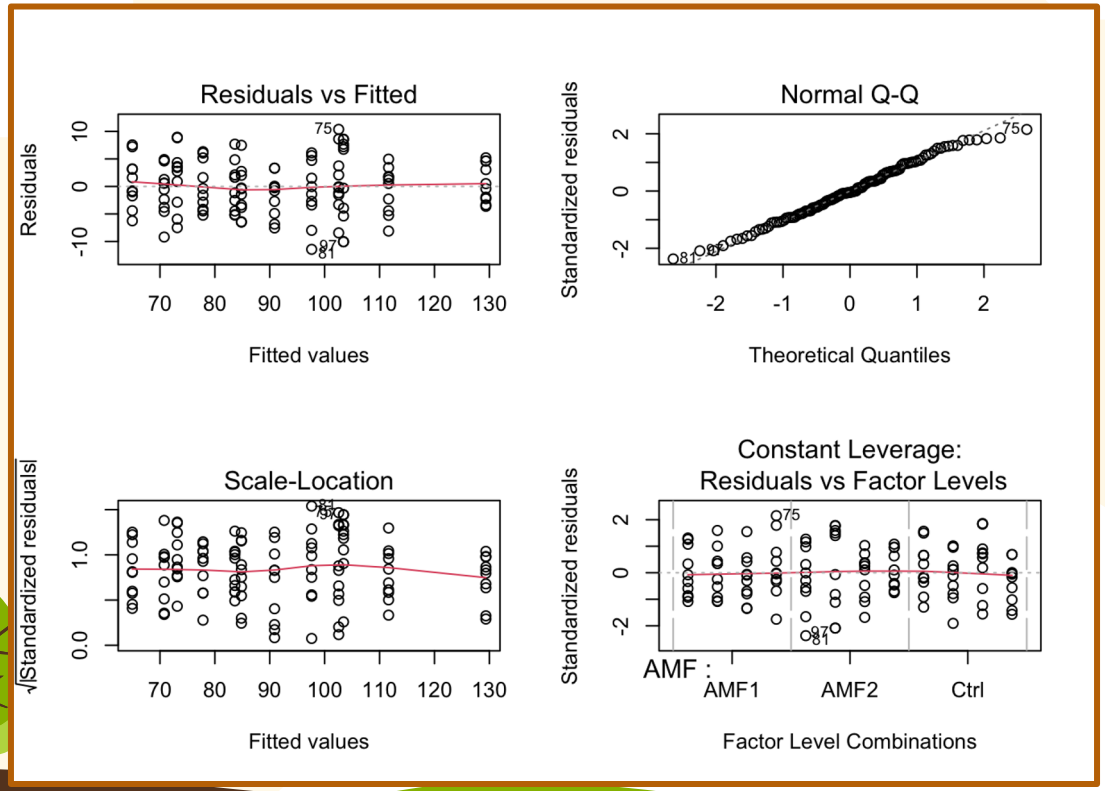
Dropped AMF:PHOS interaction term

Model 2 vs Model 3

Res.Df	RSS	Df	Sum of Sq	F	Pr(>F)
110	2696.428	NA	NA	NA	NA
112	2792.328	-2	-95.90008	1.956108	0.1462955

Model 3

MASS ~ AMF + NIT + PHOS + AMF:NIT + NIT:PHOS



4

Analysis and Inference

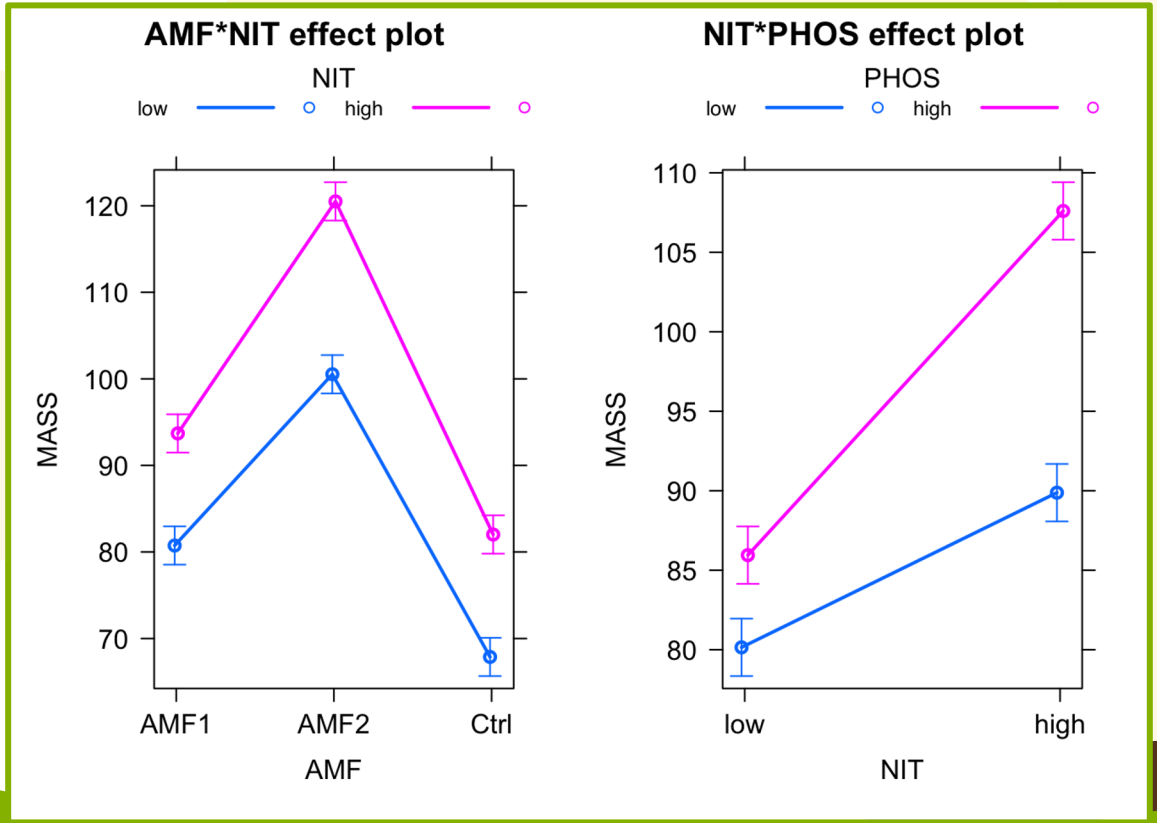
Using Model 3

Model 3

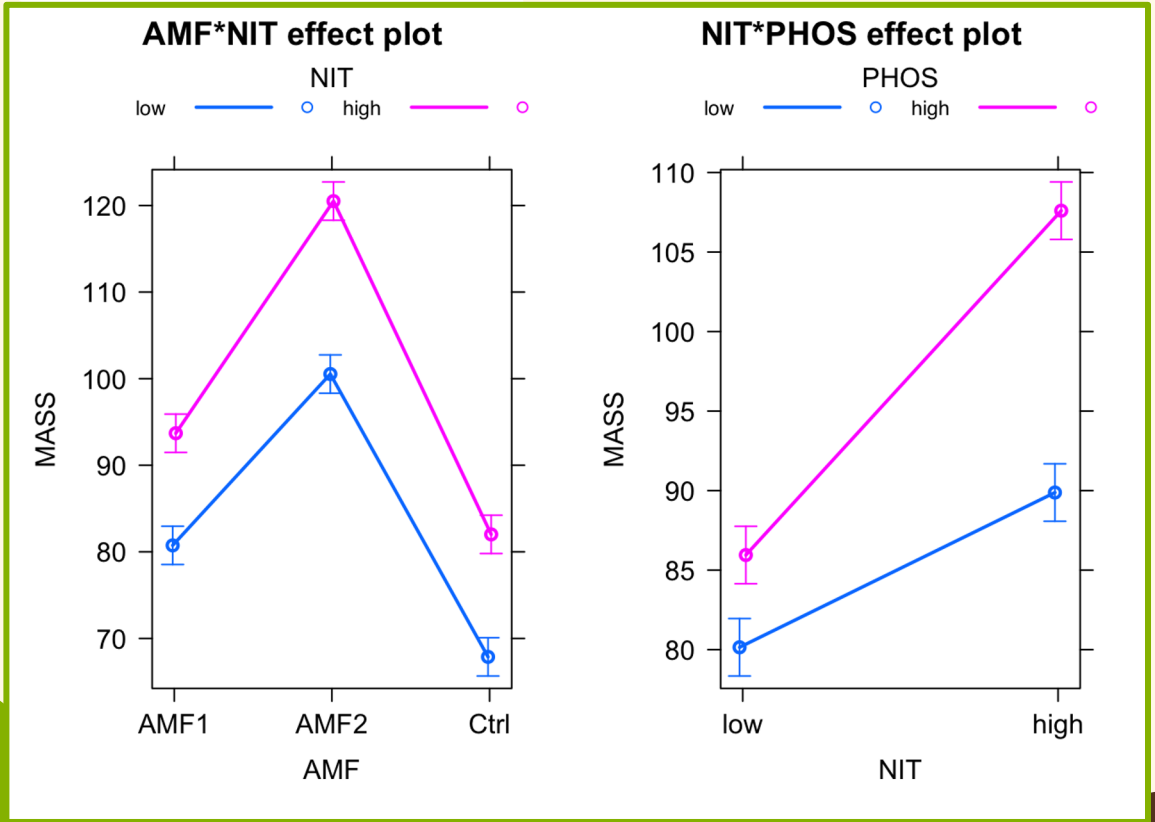
MASS ~ AMF + NIT + PHOS + AMF:NIT + NIT:PHOS

	Sum Sq	Df	F value	Pr(>F)
AMF	26124.0650	2	523.916861	0.0000000
NIT	7384.4764	1	296.190636	0.0000000
PHOS	4149.0503	1	166.418007	0.0000000
AMF:NIT	281.9549	2	5.654592	0.0045758
NIT:PHOS	1065.5123	1	42.737597	0.0000000
Residuals	2792.3278	112	NA	NA

Interaction Plots



Interaction Plots

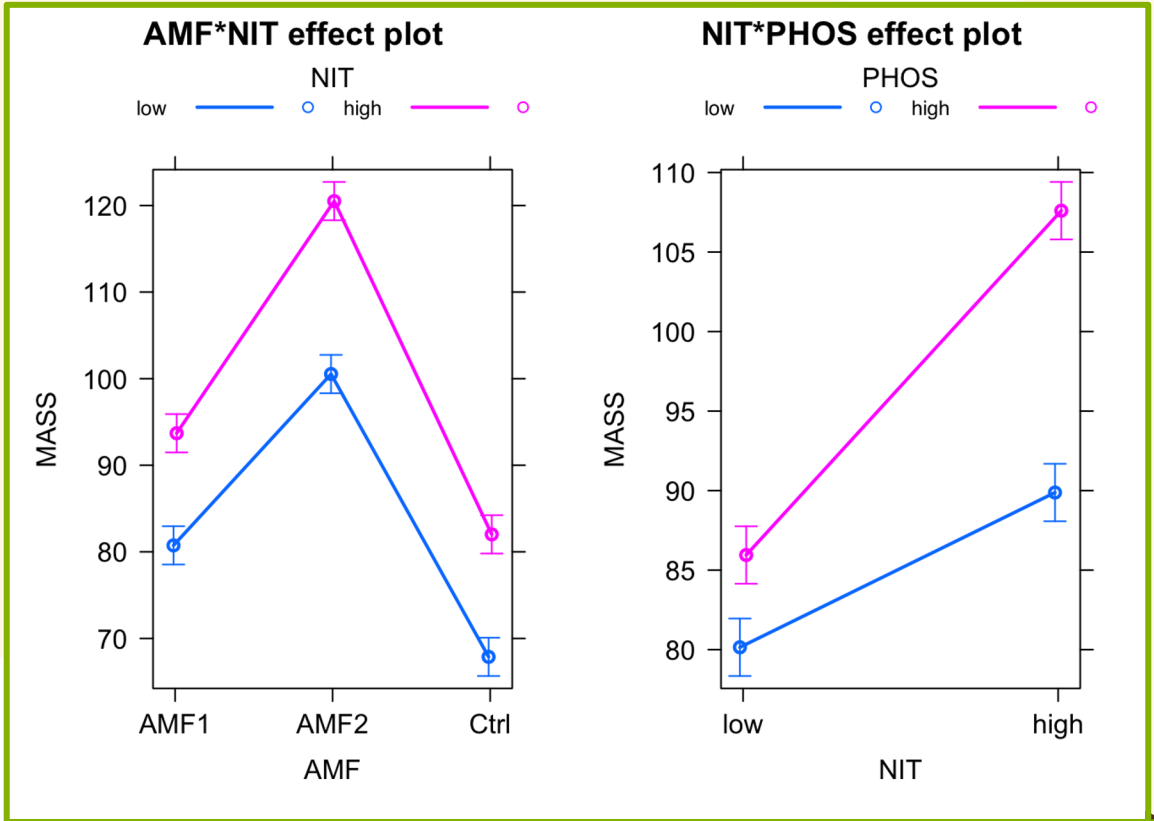


NIT + PHOS interacts synergistically to increase MASS to a greater extent than if only one were high

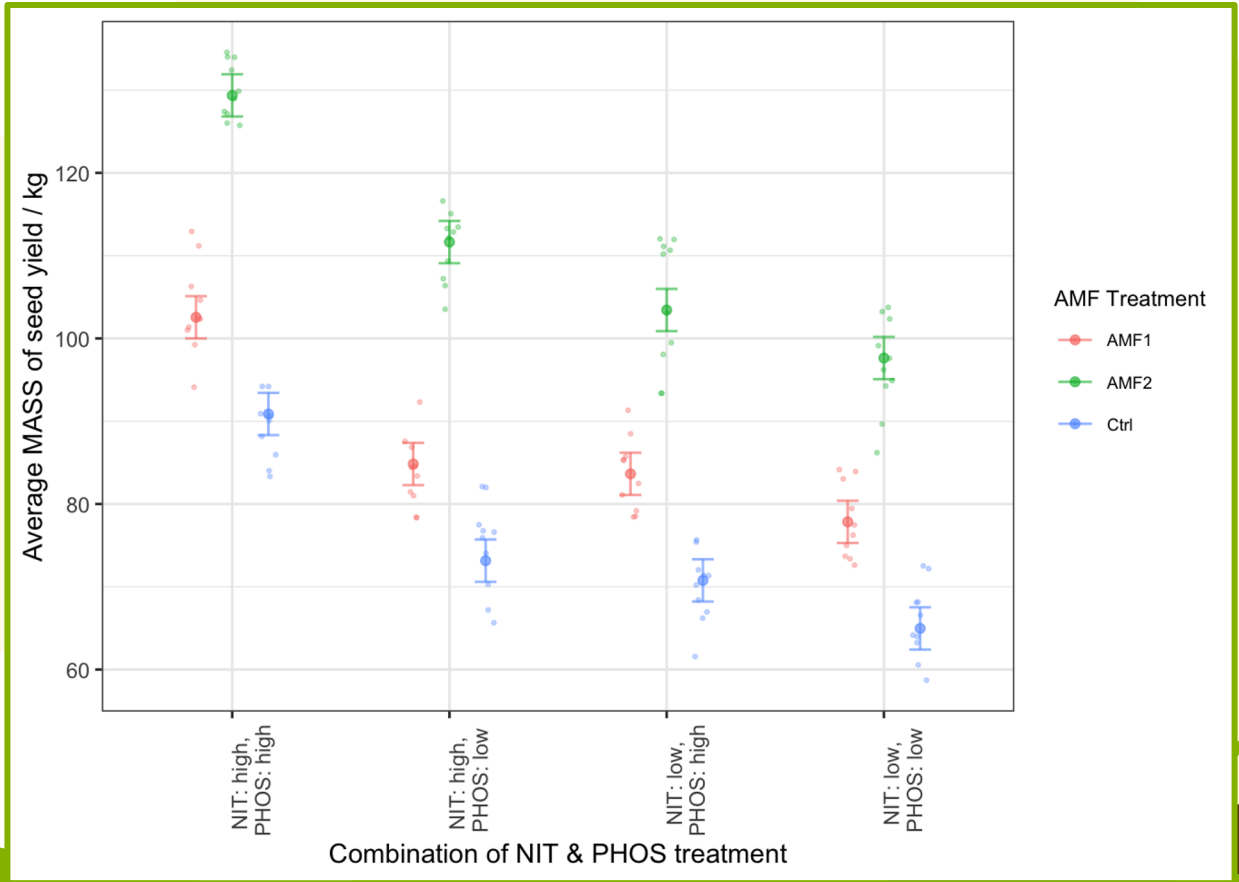
Interaction Plots

AMF-NIT interaction does not appear as dramatic

In general, AMF 2 can increase MASS to a greater extent than AMF 1



Effect Size Plot

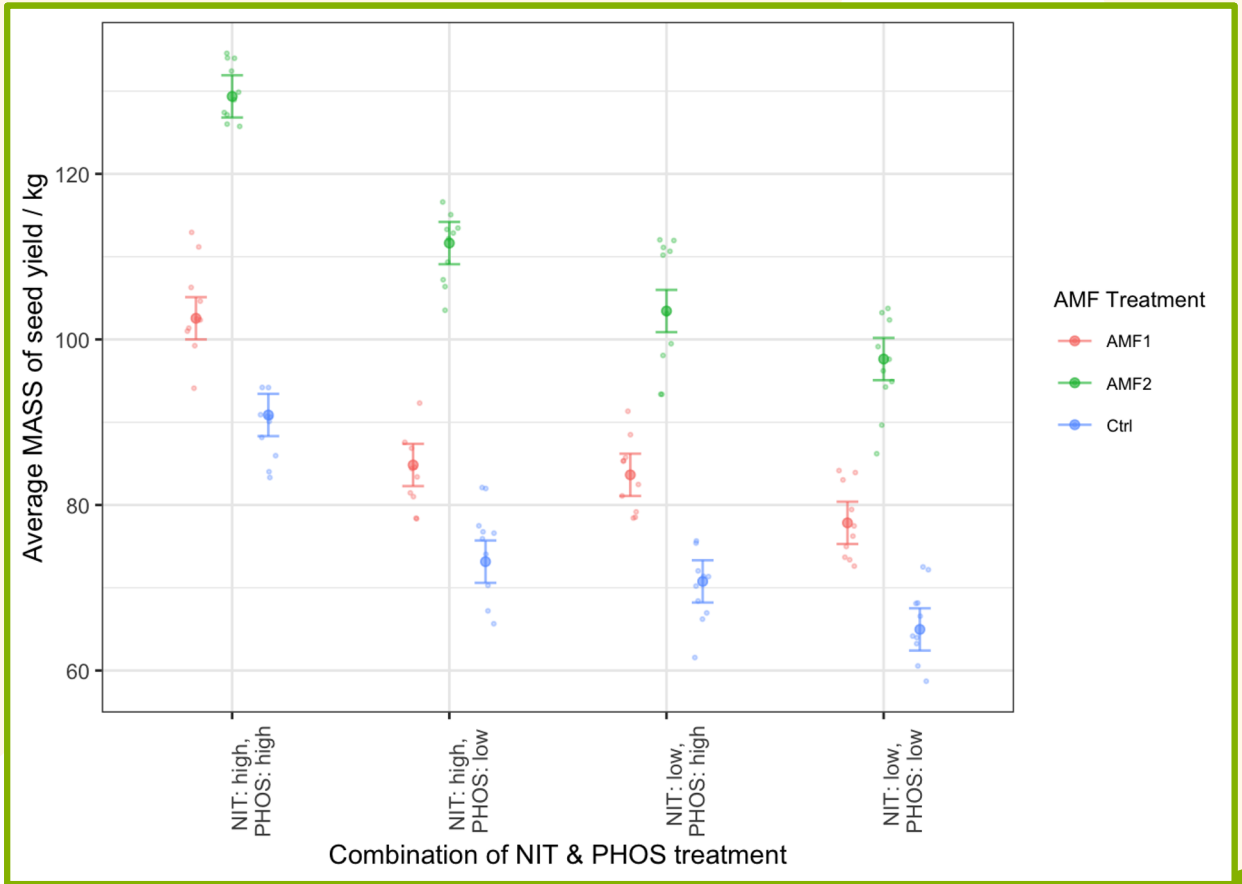


Effect Size Plot

AMF 2 > AMF 1 > Control

Synergistic effect of NIT + PHOS

AMF can increase MASS further



Thank You