Impact of Biological Seed Treatments on Plant and Soil Health

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Biological seed treatments had a strong effect at one site-year (+12% corn yield), but soil mechanisms remain unknown.

Background

- Chemical seed treatments (CST) are technology that has been used for millennia to:
  - ✓ Reduce plant disease
  - ✓ Pest and pathogen control
  - ✓ Improve overall seedling success and plant growth
- More currently some biological seed treatments (BST), especially when combined with chemical, are thought:
  - ✓ Same as CST above
  - ✓ Help improve nutrient availability and increase soil health
  - • *Study Objective: To determine effect of BST on soil and plants over multiple site-years.*
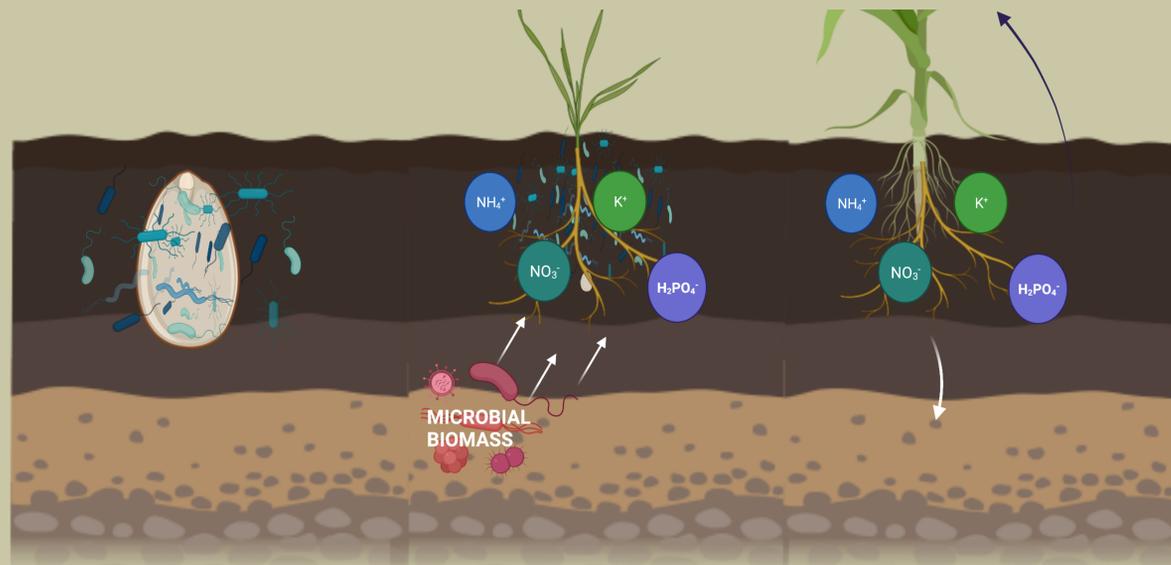
Methods

- 112-day hybrids: KSC6812 SS RIB & 6274SX
- Sampled bulk and rhizosphere soils
  - Shovel-n-Shake[2]
  - Bulk samples 0-15 cm
- Soil sample timing: V6, R1, R6 maize stages
- Soil samples only from Central, IA 2020 growing season and only BST*
- Soil Responses(X):
  - Microbial biomass carbon and nitrogen (MBC, MBN) via chloroform fumigation extractions[3]
  - Plant available nutrients: NH_4^+ and NO_3^- using 0.5M K_2SO_4 extraction[3], K^+ and P using Mehlich III extractions[4]
  - Rhizosphere Effect (RE_x) calculated

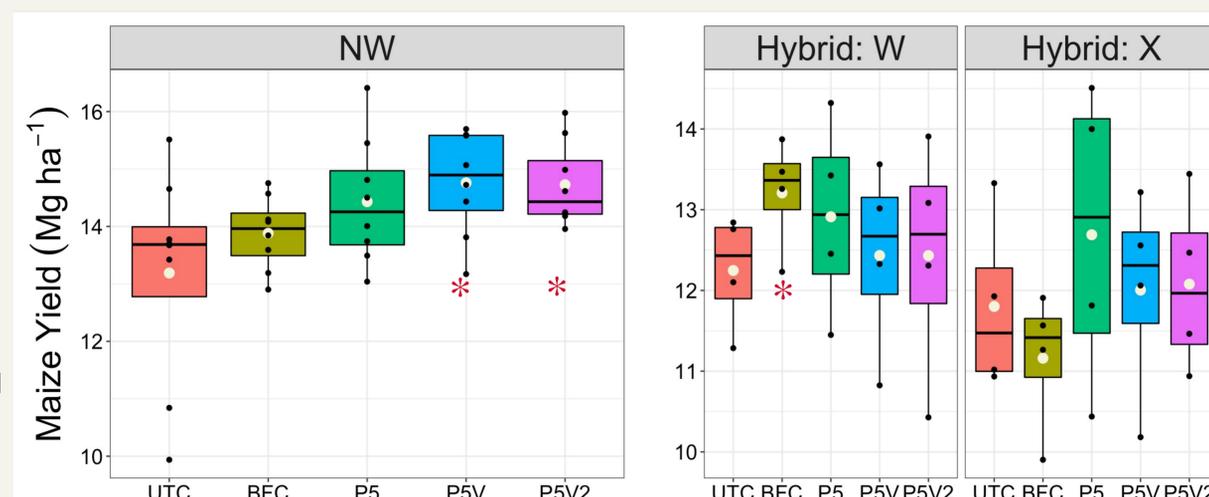| Treatments	
UTC	untreated control
BFC	base fungicidal control
P5	BF+ Poncho
P5V*	BF + Poncho Votivo
P5V2*	BF + Poncho Votivo + TWO.O

Results/Discussion

- See Figures and Tables to the right

Conclusion

- Variable soil responses
  - ✓ No consistent BST effect
  - ✓ Increasing and decreasing trends
- Main effect of seed treatment soil test P (BFC>UTC)
- BST had significant treatment x stage RE_x at V6

Soil Variable	Bulk	Rhz	RE_x
MBC	−	−	↓
MBC:MBN	↓	↑	↑

- We show evidence BST can increase yields sometimes and has effects on soils that we have yet to understand.
- Future studies should include more site-years with associated hybrids.

Photos show sampling rhizosphere soil at V2 stage using the Gobran and Clegg (1996) method.

$$RE_x = \frac{X_{Rhz} - X_{Bulk}}{X_{Bulk}} \times 100$$

3-way interaction ANOVA

Explanatory Variable	df	NH_4^+	NO_3^-	K^+	P	pH	MBC	MBN	Ratio
treatment	3	0.5689	0.7911	0.1043	0.0040	0.4939	0.9014	0.6287	0.7778
zone	1	0.6952	<.0001	<.0001	<.0001	<.0001	<.0001	0.0001	0.7742
stage	2	<.0001	<.0001	<.0001	0.1859	<.0001	0.0001	0.0525	0.1317
treatment x zone	3	0.9060	0.7055	0.2195	0.7562	0.5580	0.9658	0.5810	0.2072
treatment x stage	6	0.7560	0.9838	0.8171	0.8506	0.9948	0.7213	0.6947	0.8869
zone x stage	2	0.0034	0.0030	<.0001	0.7287	0.0001	0.0684	0.0006	0.3287
treatment x zone x stage	6	0.5242	0.3635	0.6599	0.9812	0.8098	0.1958	0.2842	0.1774

Rhizosphere Effect

Explanatory Variable	df	NH_4^+	NO_3^-	K^+	P	pH	MBC	MBN	Ratio
treatment	3	0.302	0.152	0.602	0.404	0.276	0.586	0.288	0.5824
stage	2	0.035	0.997	<.0001	0.361	<.0001	0.017	0.016	0.0007
treatment x stage	6	0.238	0.223	0.69	0.685	0.441	0.009	0.52	0.0131

Top table is 3-way interaction ANOVA with treatment, zone, and stage as fixed variables, lighter colors indicate statistical significance. Bottom table is 2-way interaction ANOVA for RE_X, equation used to calculate RE is to the left. Red outline highlights significant treatment and treatment interaction effects.

Maize grain yield (Mg ha^{-1}) for Northwest, IA in 2019 had a significant treatment effect (p-value= 0.042), and a 12% (*) increase in yield with P5V and PV2 average when compared to UTC (p-value=0.0032).

Maize grain yield (Mg ha^{-1}) for Central, Iowa in 2020 for hybrid W (middle panel) and hybrid X (right panel) where there was a significant seed treatment by hybrid affect (p = 0.06). When further analyzed, hybrid W had marginally significant treatment effect (p-value= 0.0774).

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