

Assessment of Water Treatments to Control *Pythium myriotylum* in Tobacco Greenhouses

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Current Management Strategies

- Tray sanitation
 - Steaming
 - Disinfectant
- Water treatments
 - UV
 - Fungicide
 - Oxidate (Hydrogen Dioxide & Peroxyacetic Acid)
 - Terramaster (Etridiazole), oomycete-targeted



Any alternatives?

Chemical

- Elumin (ethaboxam): oomycete-targeted fungicide
- Ridomil Gold (mefenoxam): oomycete-targeted fungicide
- Cutrine-plus (copper ethanolamine complex): algaecide

Nonchemical

- Copper ions
- UV



*the most aggressive species
Pythium myriotylum*

Greenhouse Experiments

Mini float water system

- CRD w/ 5 reps
- Chemical water treatments
- Inoculated when roots extended to water (4 wk old)

Table 1. The treatments in mini-bay chemical trials.

Treatment	Application rate	Application time
Untreated control	NA	NA
Terramaster (Etridiazole)	1.00 fl oz/100 gal (0.3 ml/gal)	Once, 1hr before inoculation
Ridomil Gold (Mefenoxam)	2.5ml/100 gal (0.025 ml/gal)	Once, 1hr before inoculation
Elumin (Ethaboxam)	0.8 fl oz/100 gal (0.24 ml/gal)	Once, 1hr before inoculation
Citrine-Plus (Copper Ethanolamine Complex)	0.0072 ml/bay	Once, 1hr before inoculation



Greenhouse Experiments

Small float water system

- RCBD w/ 5 reps
- Nonchemical water treatments
- Inoculated at seeding



Table 2. Treatments in small-bay non-chemical trials.

Treatment	Application rate	Application time
Untreated control	NA	NA
Terramaster (Etridiazole)	1.00 fl oz/100 gal (0.3 ml/gal)	Once, 2 weeks after seeding
Copper ions	1.6 ppm	Before, 2 weeks and 4 weeks after seeding
Copper ions	0.8 ppm	Before, 2 weeks and 4 weeks after seeding
UV	Circulate 5 times, 6 gal/min	Before, 2 weeks and 4 weeks after seeding

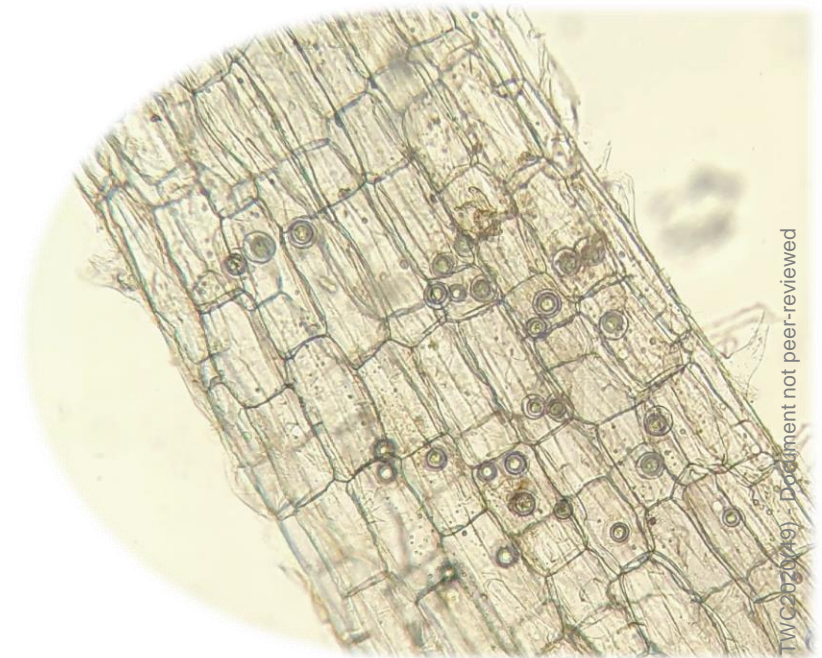
Evaluation: Good or Bad?

- Multiple data collection during the season: trend analysis
- Seedling counts → % Seed germination & seedling mortality incidence
- % Leaf chlorosis incidence
- % Stunting incidence
- % Root rot incidence and severity



Final assessment: end-point comparison

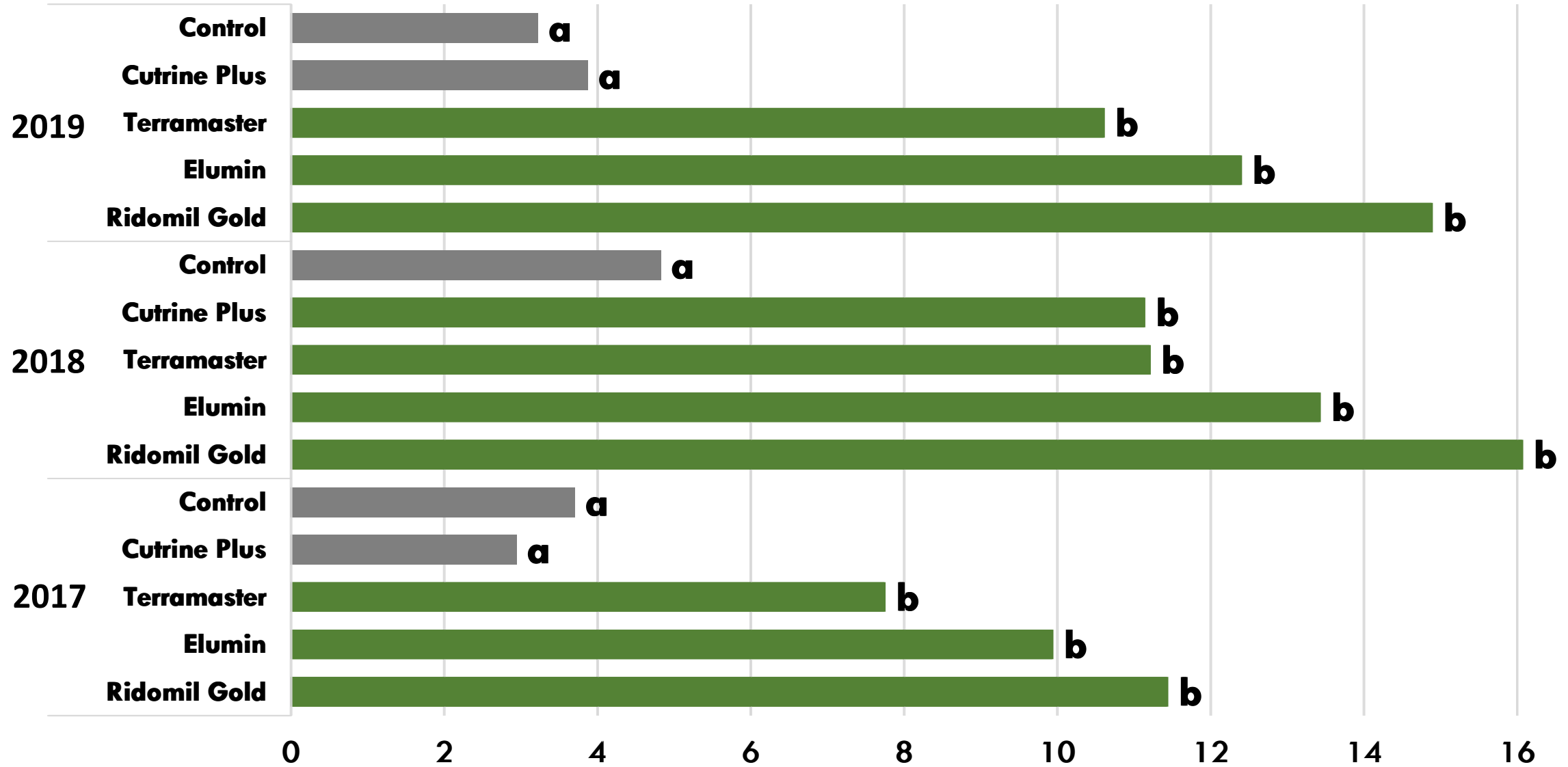
- % Root rot incidence & severity
- Root length
- Root weight
- Spore counts



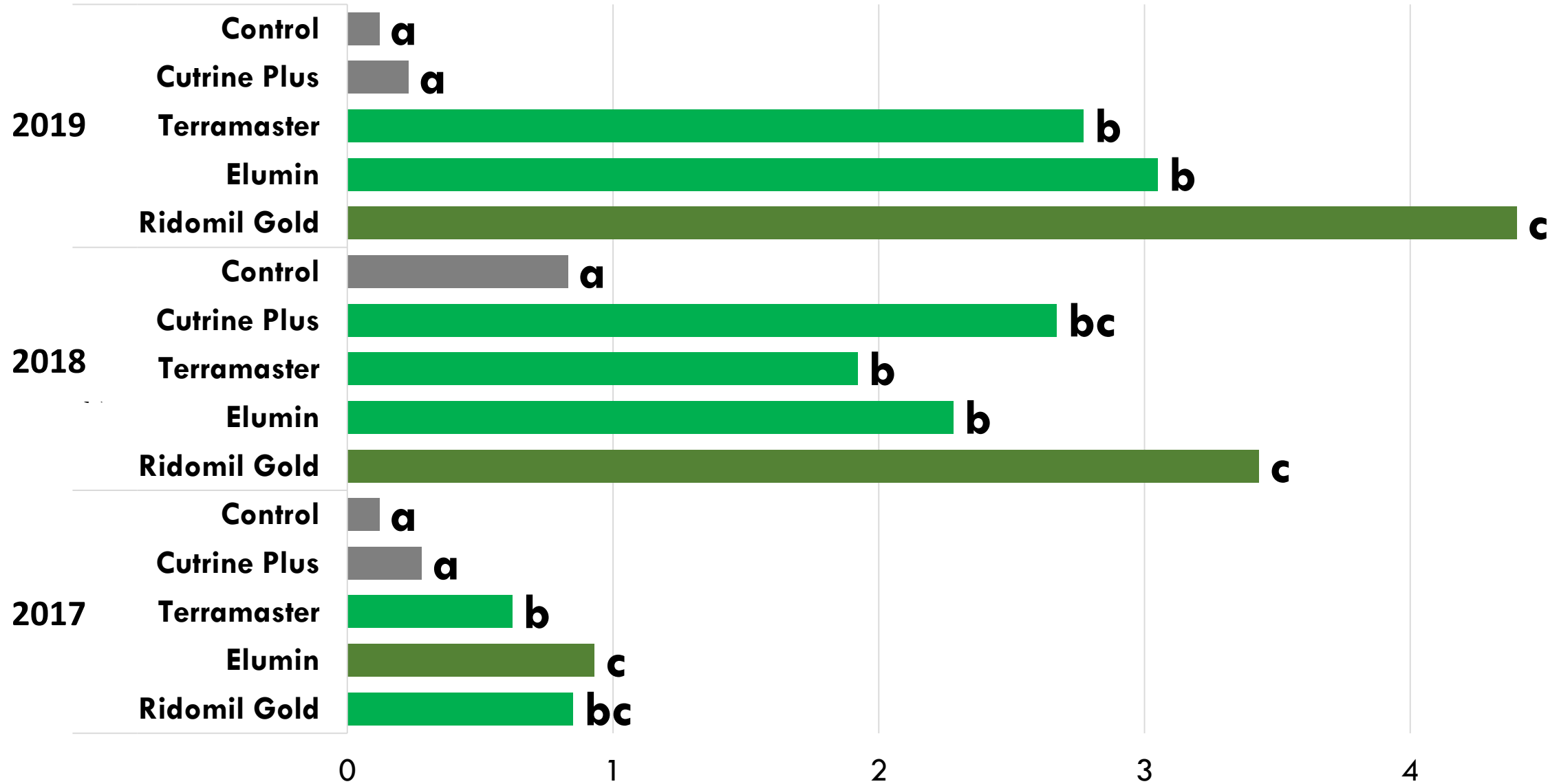


Effects of Chemical Water Treatments

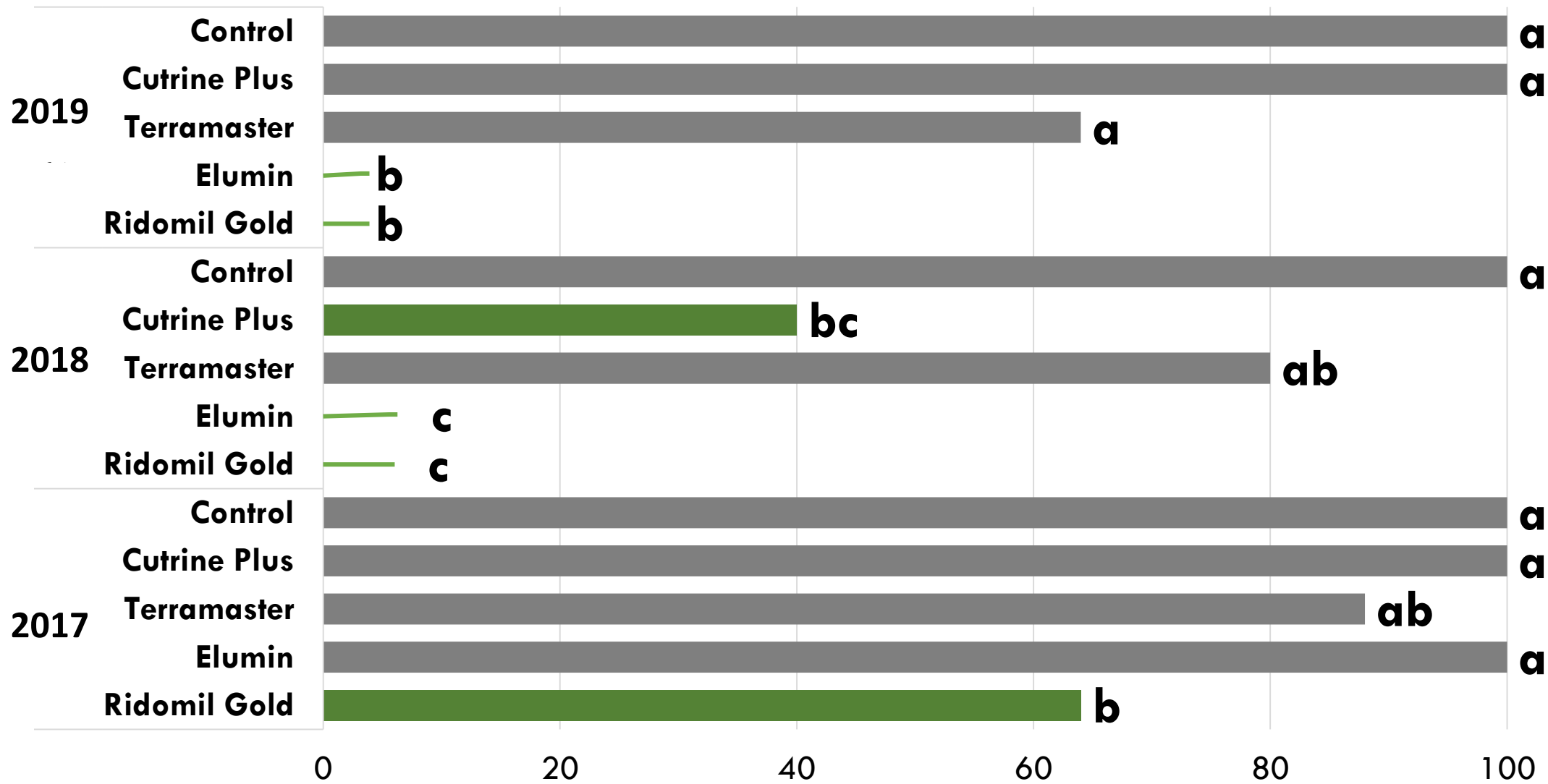
Effects of Chemical Water Treatments on Tobacco Seedling Root Length (cm)



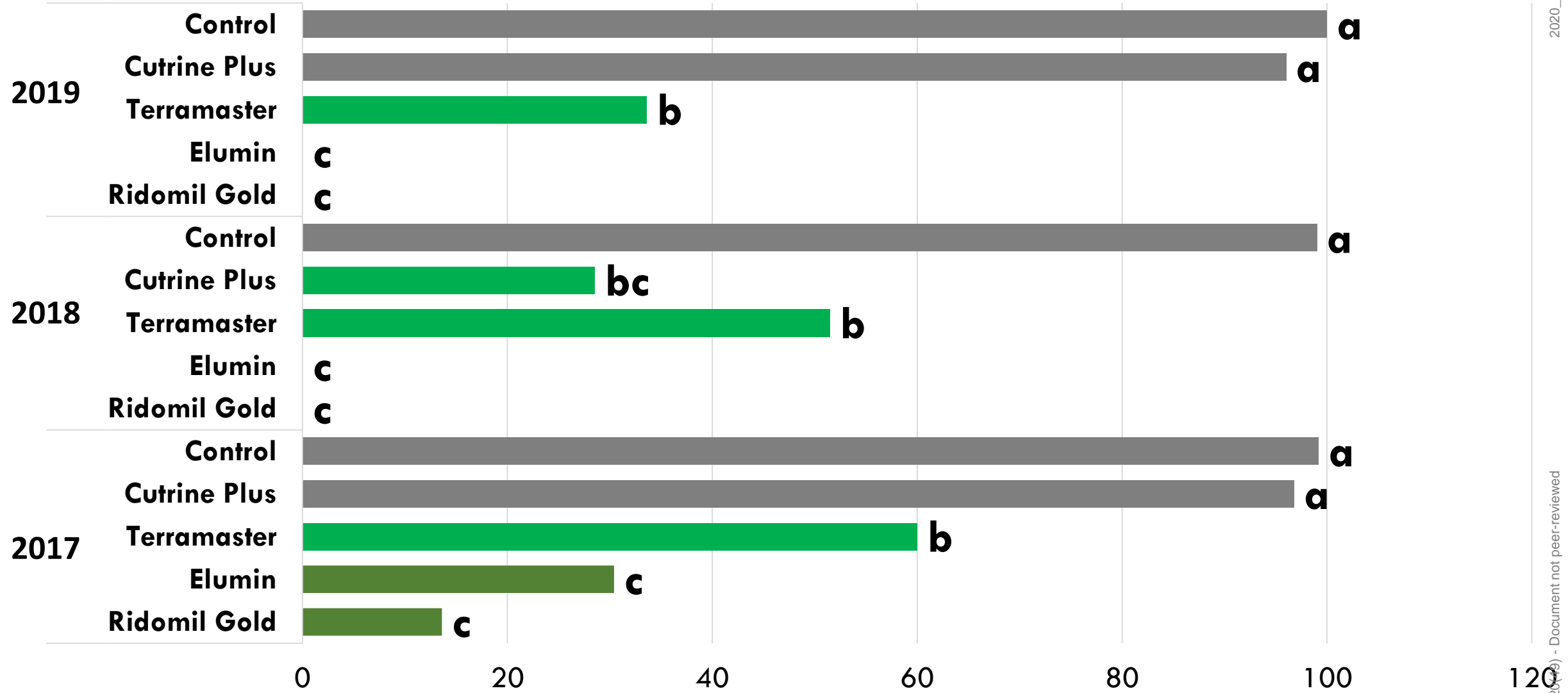
Effects of Chemical Water Treatments on Tobacco Seedling Root Weight (g)



Effects of Chemical Water Treatments on Tobacco Seedling Root Rot Incidence (%)



Effects of Chemical Water Treatments on Tobacco Seedling Root Rot Severity (%)





control

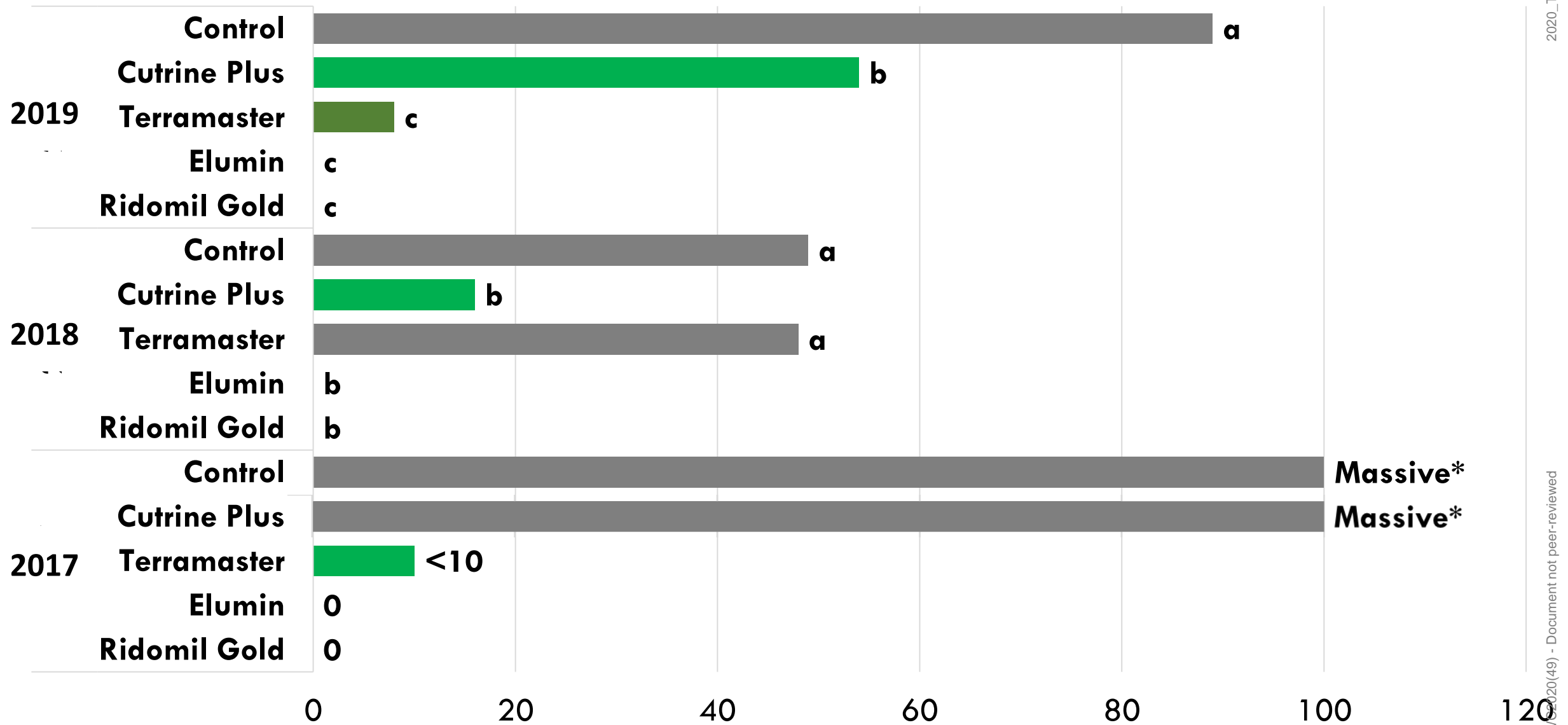
Cutrine plus

Terramaster

Elumin

Ridomil Gold

Effects of Chemical Water Treatments on The Number of Oospores in Tobacco Seedling Root Tissue





control



Citrine plus



Elumin



Ridomil Gold

Treatment effect change over time

Table 4. The treatment and time effects on TN 90 LC tobacco seedlings and root rot diseases in mini-bay chemical trials.

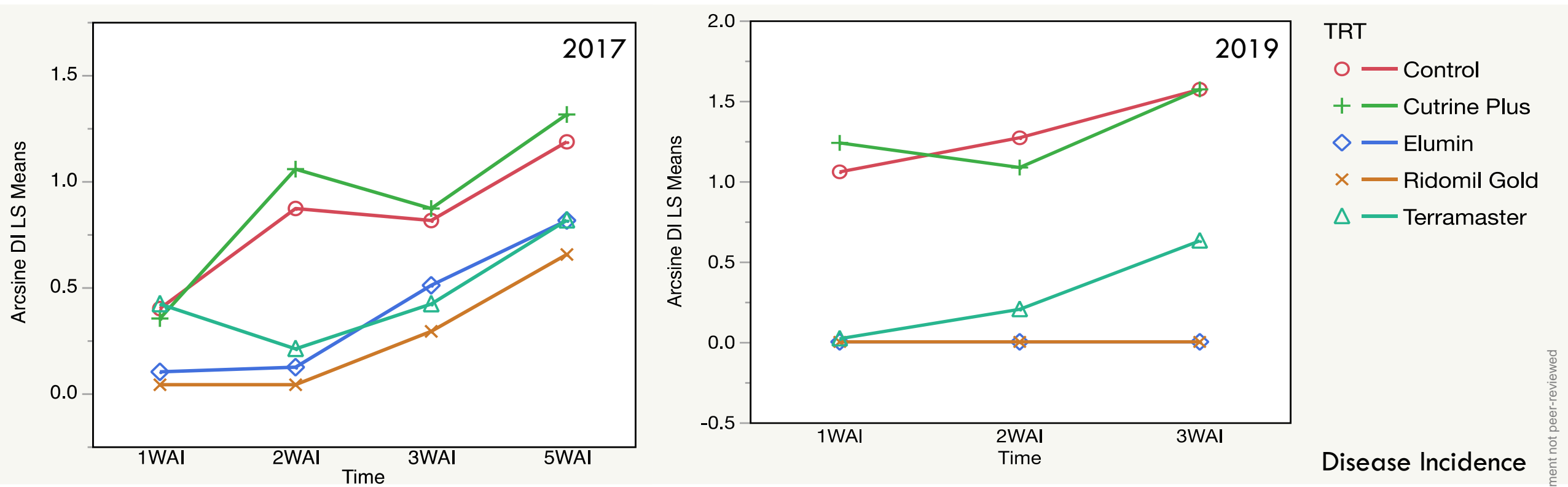
Year	Effects	Water roots root rot incidence (P value)	Water roots root rot severity (P value)	Root length (P value)	Plant height (P value)	Stunting incidence (P value)	Leaf chlorosis incidence (P value)	Mortality incidence (P value)
2017	TRT	< 0.0001*	< 0.0001*	< 0.0001*	< 0.0001*	0.0001*	< 0.0001*	0.1688
	Time	< 0.0001*	< 0.0001*	0.3842	< 0.0001*	0.4456	< 0.0001*	0.0033*
	TRT*Time	0.0081*	< 0.0001*	0.1225	< 0.0103*	0.8464	< 0.0001*	0.9170
2018	TRT	0.1929	0.1567	0.1157	0.0331*	0.6300	0.7628	0.0887
	Time	0.2957	0.9870	0.1153	< 0.0001*	0.0013*	< 0.0001*	0.0043*
	TRT*Time	0.6891	0.7543	0.9658	0.9075	0.8717	0.7240	0.1638
2019	TRT	< 0.0001*	< 0.0001*	< 0.0001*	< 0.0001*	0.0001*	< 0.0001*	0.0002*
	Time	0.0047*	0.0046*	0.5739	< 0.0001*	< 0.0001*	< 0.0001*	< 0.0001*
	TRT*Time	0.0571	0.0896	0.7375	0.0585	0.0001*	< 0.0001*	0.0023*

*indicated significant differences in repeated measures ANOVA, with P values less than 0.05.

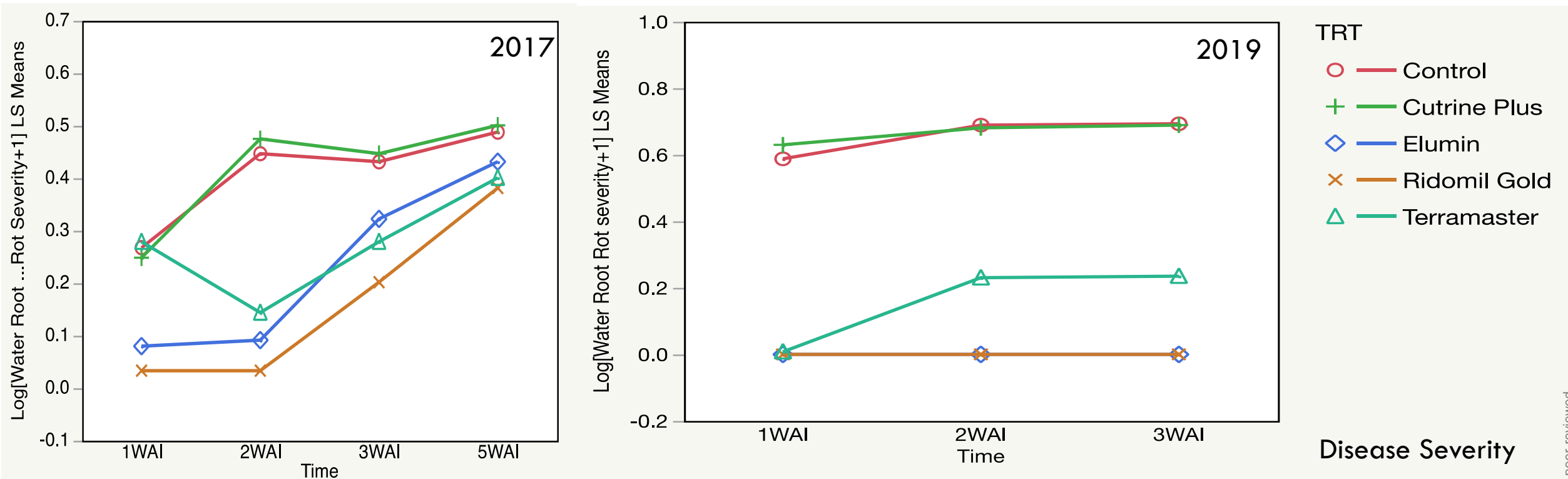
The root rot disease data were collected based on the appearances of water roots.

TRT
X
Time
Interaction_C
hemical

Trend Analysis_Chemical



Trend Analysis_Chemical

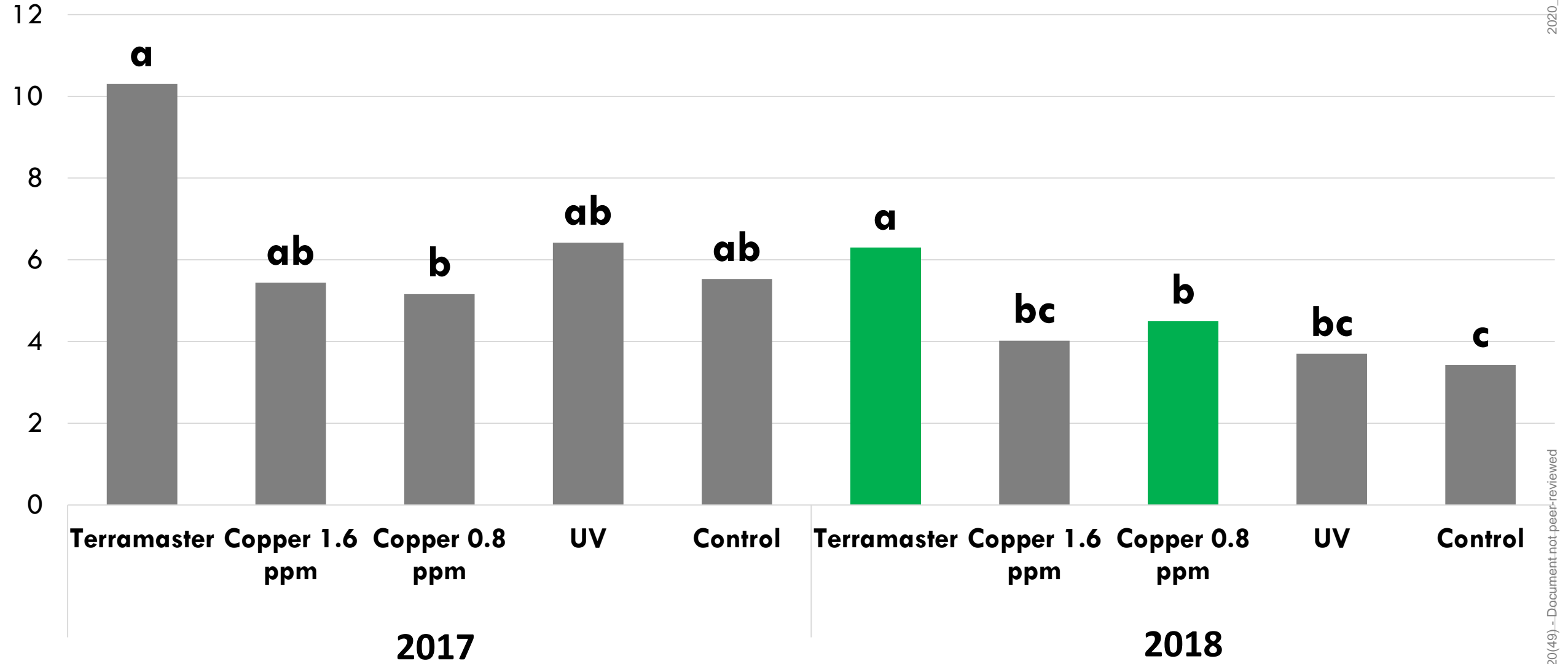


root rot, root length, plant height, leaf chlorosis. Mortality, kind of. Stunting, inconsistent.

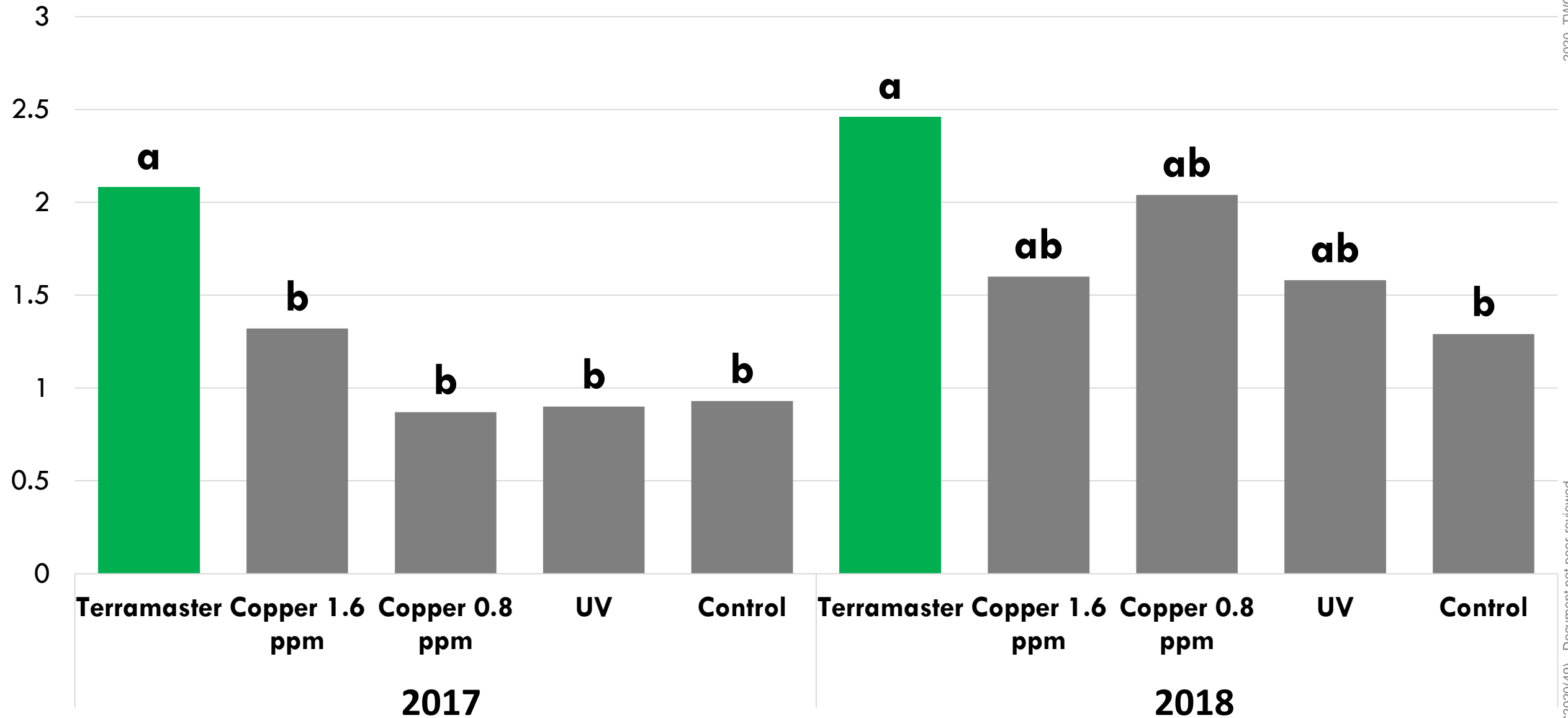
Effects of Nonchemical Water Treatments



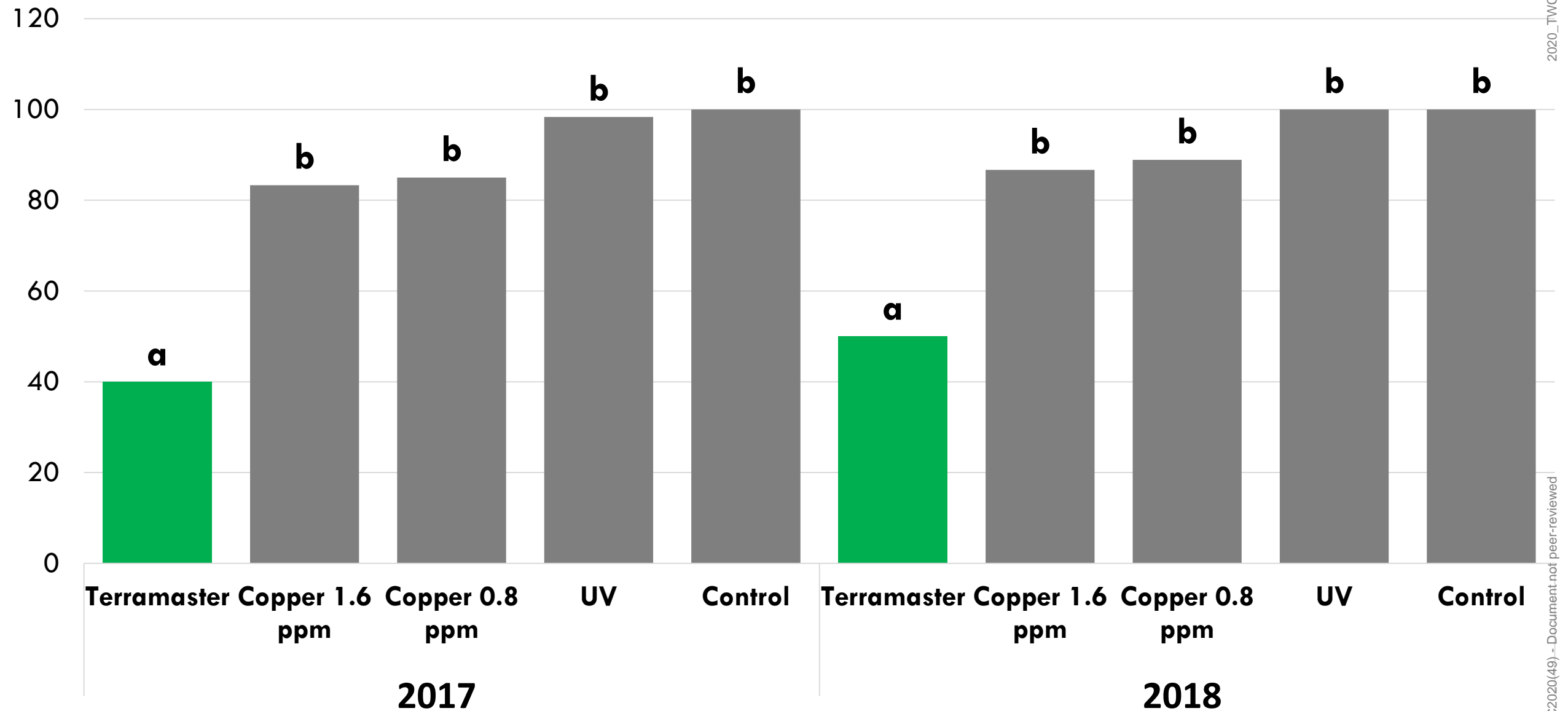
Effects of Copper ion and UV Treatments on Tobacco Seedling Root Length (cm)



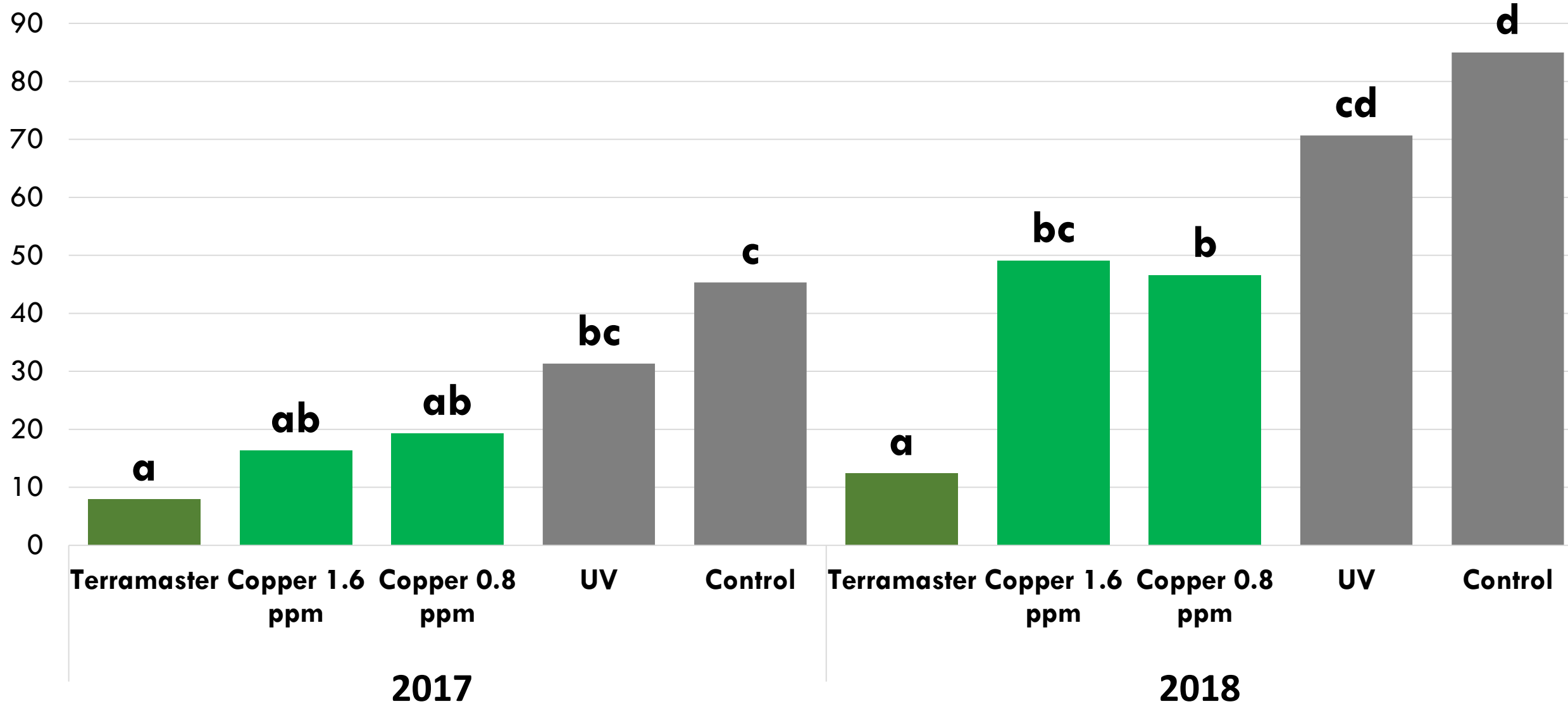
Effects of Copper ion and UV Treatments on Tobacco Seedling Root Weight (g)

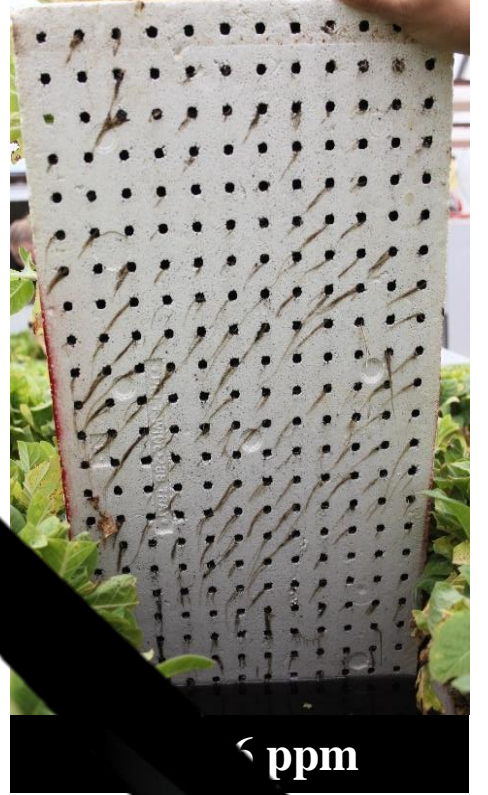
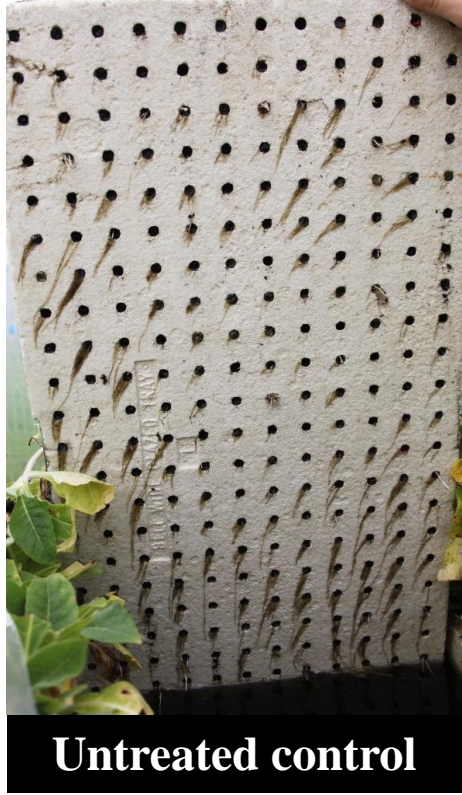


Effects of Copper ion and UV Treatments on *Pythium* Root Rot Incidence (%)

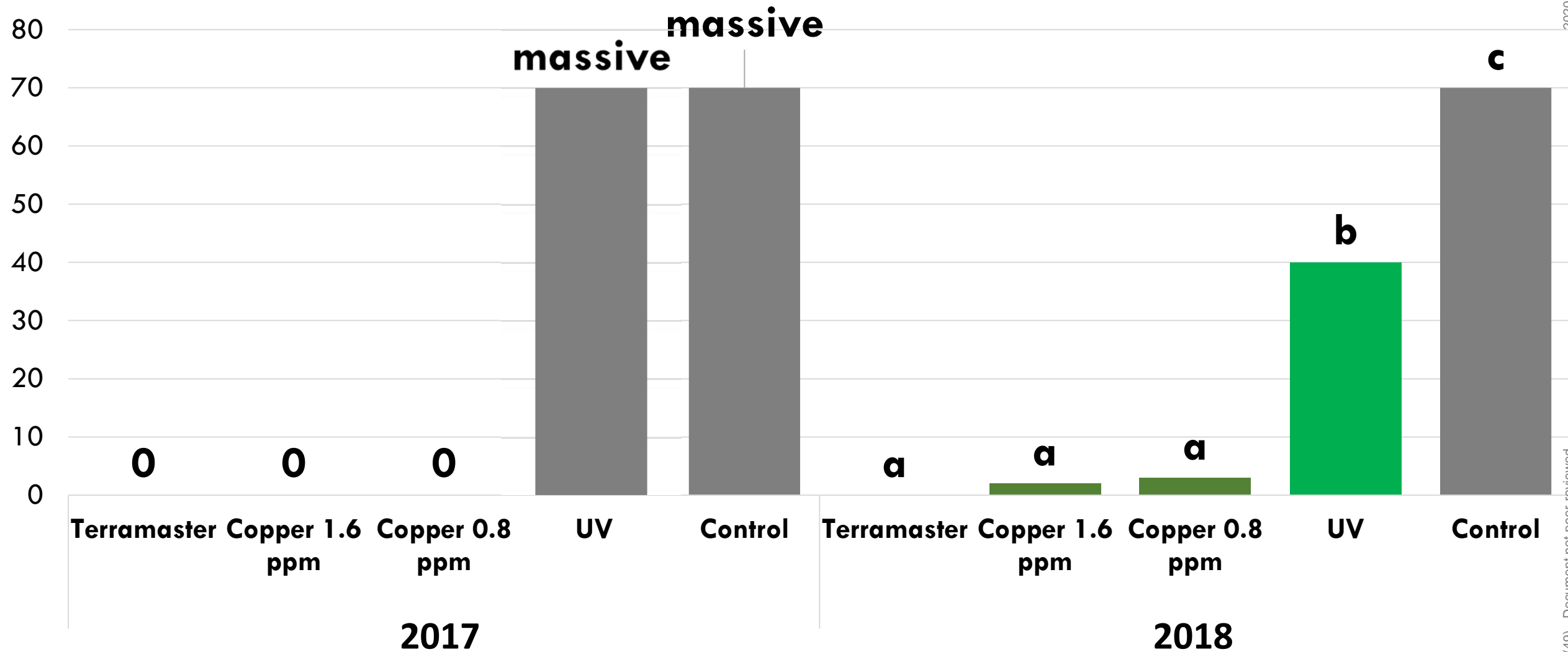


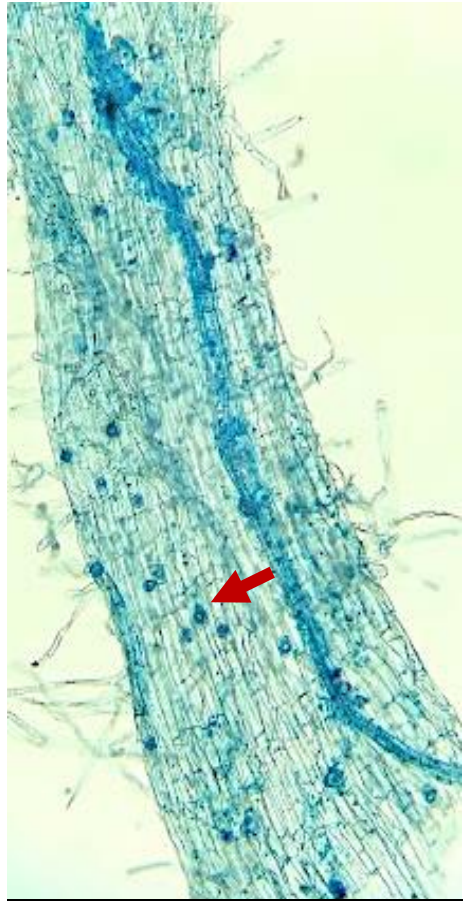
Effects of Copper ion and UV Treatments on *Pythium* Root Rot Severity (%)



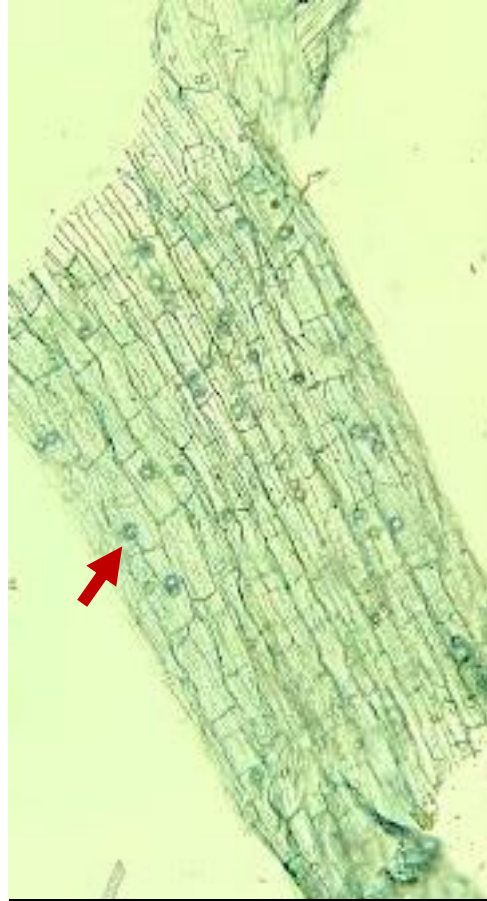


Effects of Copper ion and UV Treatments on Oospore count in 2-mm Root Tissue





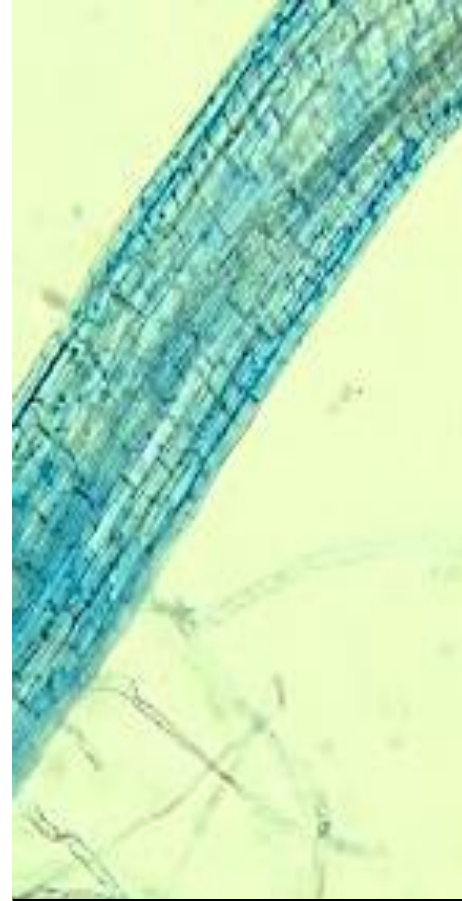
Untreated control



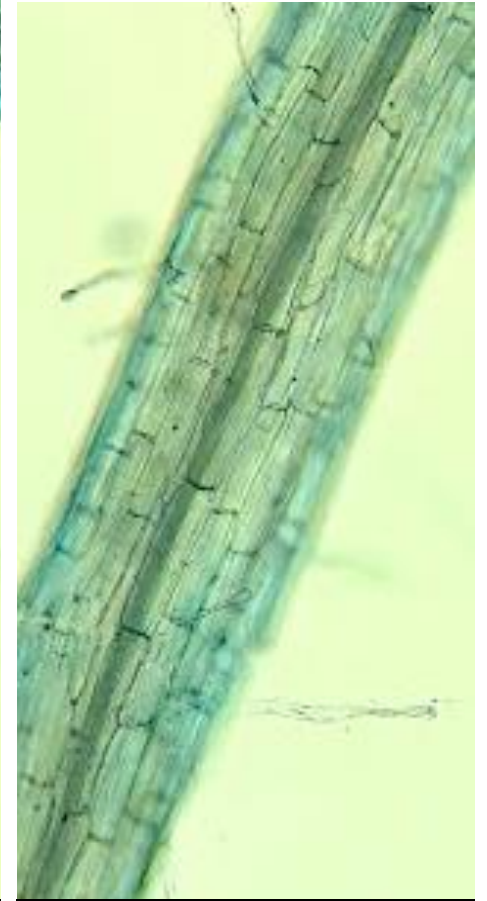
UV



Terramaster



Cu 0.8 ppm



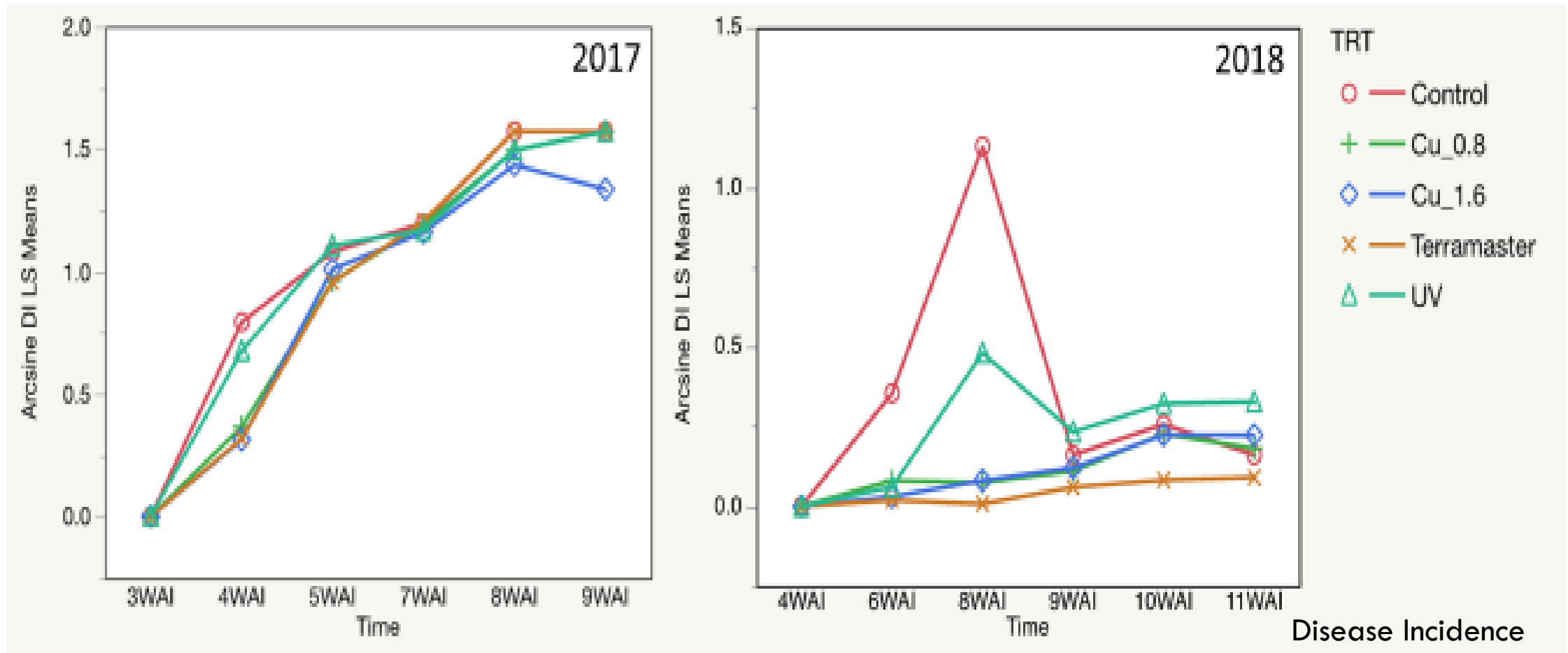
Cu 1.6 ppm

TRT X Time Interaction _Nonchemical

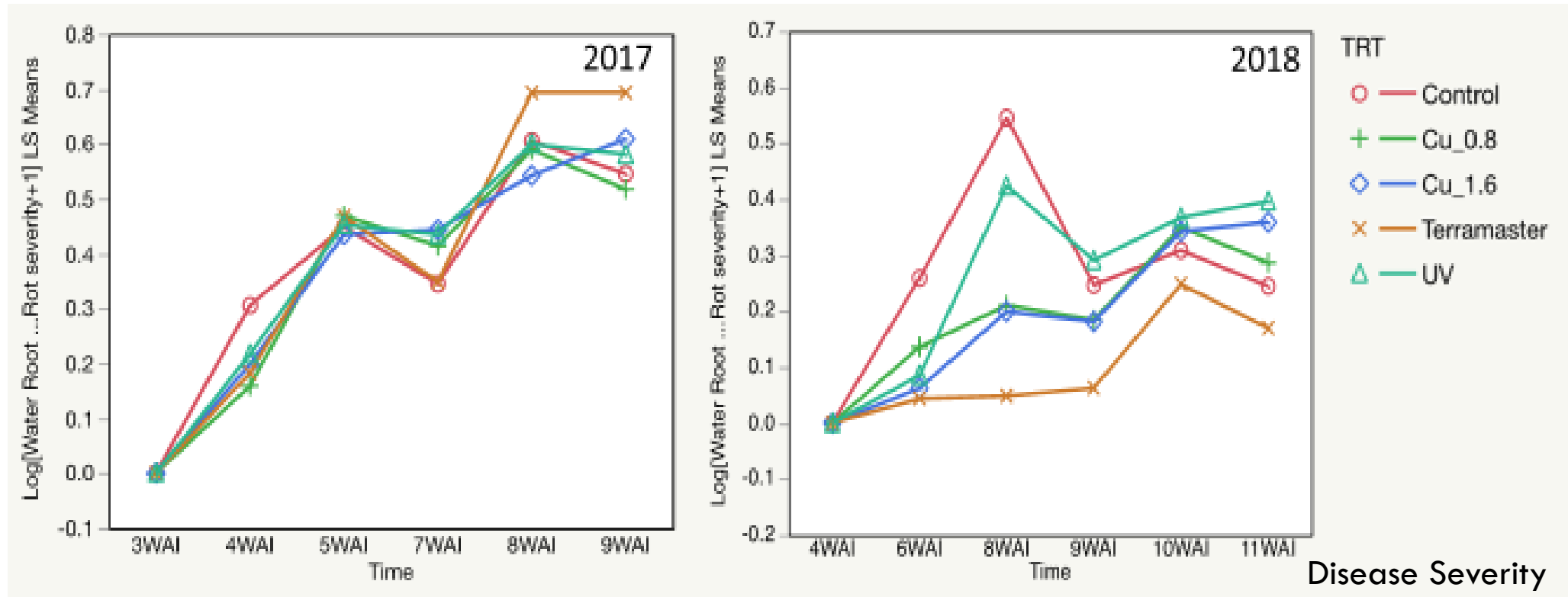
Table 13. The treatment and time effects on TN 90 LC tobacco seedlings and root rot diseases in small-bay trials.

Year	Effects	Water roots root rot incidence (P value)	Water roots root rot severity (P value)	Leaf chlorosis incidence (P value)	Stunting incidence (P value)	Mortality incidence (P value)	Non- germinating rate (P value)
	TRT	0.0290*	0.1193	0.8140	0.0268*	0.0900	0.4584
2017	Time	<0.0001*	<0.0001*	0.0001*	<0.0001*	0.0066*	<0.0001*
	TRT* Time	0.3817	<0.0001*	0.9205	0.4130	0.2298	0.3594
	TRT	<0.0001*	<0.0001*	0.0023*	0.0752	0.4060	0.2404
2018	Time	<0.0001*	<0.0001*	0.0004*	0.3711	<0.0001*	<0.0001*
	TRT* Time	<0.0001*	0.0002*	0.0256*	0.7682	0.3602	0.6790

Trend Analysis_Nonchemical



Trend Analysis_Nonchemical



No consistent trend

Summaries

Chemical

- Elumin (ethaboxam)

Less root rot, leaf chlorosis, stunting and plant death

- Ridomil Gold (mefenoxam)

Fewer spores in roots

- Cutrine-plus (copper ethanolamine complex)

Better root quality Wasn't as good as Etridiazole in NC state study

Higher rate?

Nonchemical

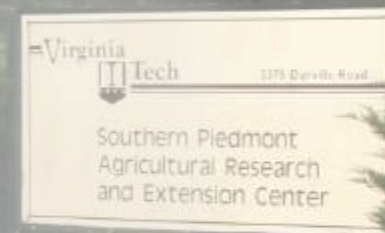
- Copper ions *Promising. New roots.*

- UV

May reduce the amount of spores

Acknowledgement

- **Altria, JTI, PMI & Virginia Tobacco Board**
- **Spencer, Noah, Laura, Molly, Tyler, Reed Lab, and other folks @ SPAREC**
- **Dr. Baudoin and other folks on campus**



Questions

○ Experiment Design

- [Mini floatwater system](#)
- [Small floatwater system](#)
- [Treatment application](#)
- [Treatment evaluation](#)

○ Water Treatments

- [Promising chemical treatments](#)
mefenoxam & ethaboxam
- [Promising nonchemical treatments](#)
Copper ion, UV?