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# A comparison of gradient table, field, and paper towel germination tests of melon (*Cucumis melo* L.) seeds

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# Other research projects in my laboratory

- Plant genetic resistance and seed treatments to control, watermelon fruit blotch disease (*Acidovorax citrulli*) of cucurbits.
- Using active and passive solar systems to heat low tunnels for season extension of small fruit and vegetable production.
- Improving stand establishment of vegetable soybean using biological seed treatments.

# Objectives for my research talk today:

- More realistic germination testing that better predicts field emergence.
- Find alternative procedures to paper towel tests which use a lot of paper towels.
- Evaluate the potential of LabField<sub>TM</sub> table (thermogradient table with soil) for greater use in seed testing.
- Comparison of diverse (*Cucumis melo* L.) genotypes.

# Cantaloupe (*Cucumis melo* L., netted melon)

## Cultivars

- 1 'Minnesota Midget'
  - 2 'Charentais'
  - 3 'Hale's Best Jumbo'
  - 4 'Edisto'
  - 5 'Athena'
- all cultivars were purchased from Eden Brothers Seed Company, 2099 Brevard Rd. Arden, NC 28704 USA



# Germination tests compared:

- Field planting, 2.5 cm deep, clay-loam soil, watered daily, avg. soil temp. 26.3°C. date planted 28 June 2020. emergence counted twice daily.
- AOSA Paper towel germination test (similar to ISTA): alternating 20-30°C, dark, conducted on four germination paper towels one dry, three wet, first count 4 days final count 10 days.
- LabField<sub>TM</sub> (thermogradient table with gussets) filled with Promix Potting Soil and adjusted to 4 temperatures 12.5, 17.5, 25.0, 31.0°C, hand-watered daily, emergence counted twice daily.

# Statistical Procedures

- Paper towel germination testing included three replications of 50 seeds each in an incubator. Data were collected on root lengths after 4 days and germination percentages after 10 days.
- Field and gradient table plantings included three replications of 20 seeds each in a randomized complete block design. Emergence was counted twice daily. MTG was calculated using the summation equation (summation of the seeds that germinated each period times the hours after planting divided by the total number of seeds that germinated to yield and average time in hours).
- ANOVA was performed on log transformed time data and sqrt arcsine transformed percentage data using the computer program R. MTG was not calculated for treatments that had less than 25% germination because an insufficient portion of the population was sampled. Mean separation was by Tukey's Honest Significant Difference test

# Field germination test





# AOSA standard paper towel test (similar to ISTA testing procedures)



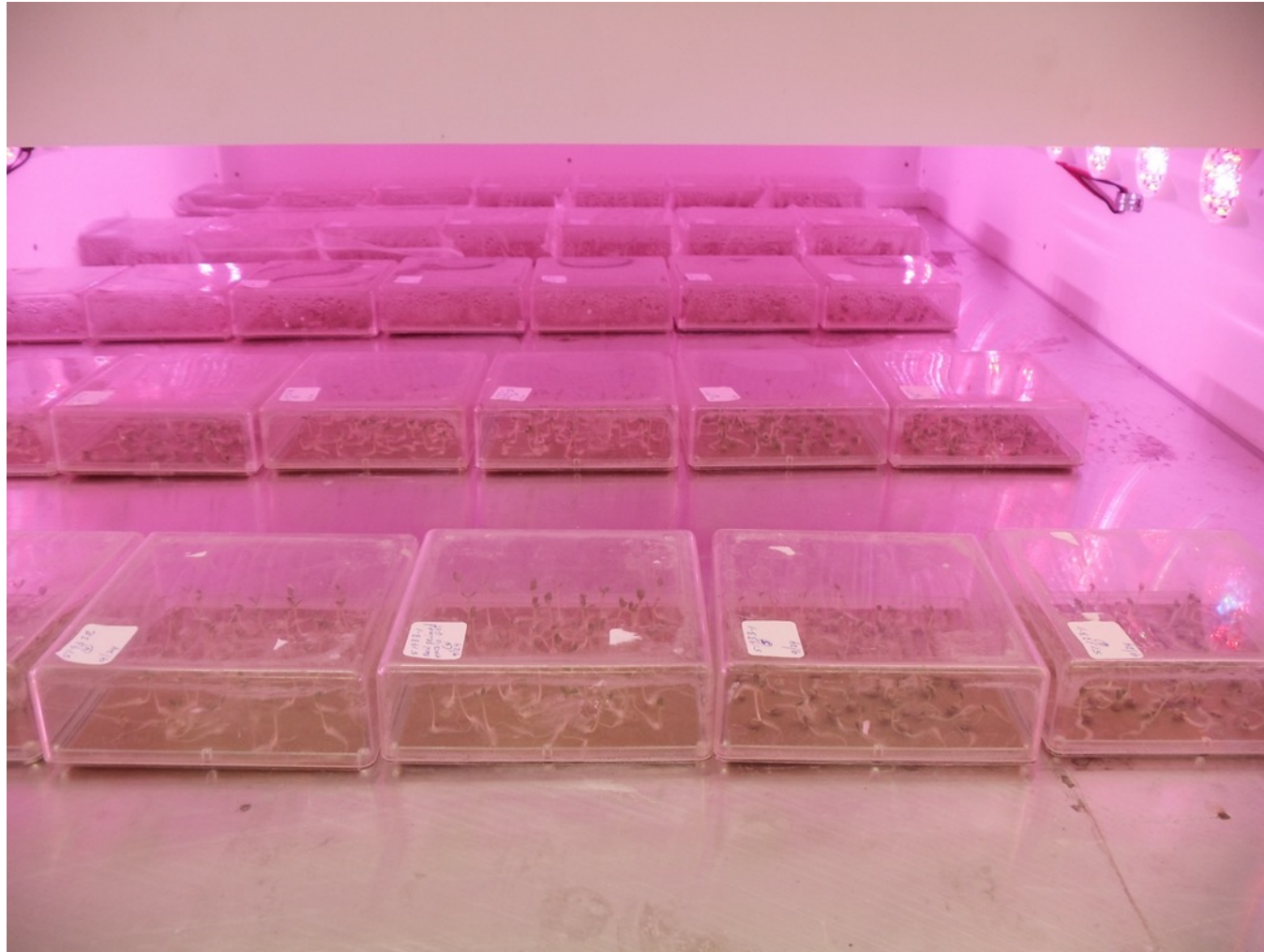
Four-day root lengths and final germination percentages were recorded for this test.



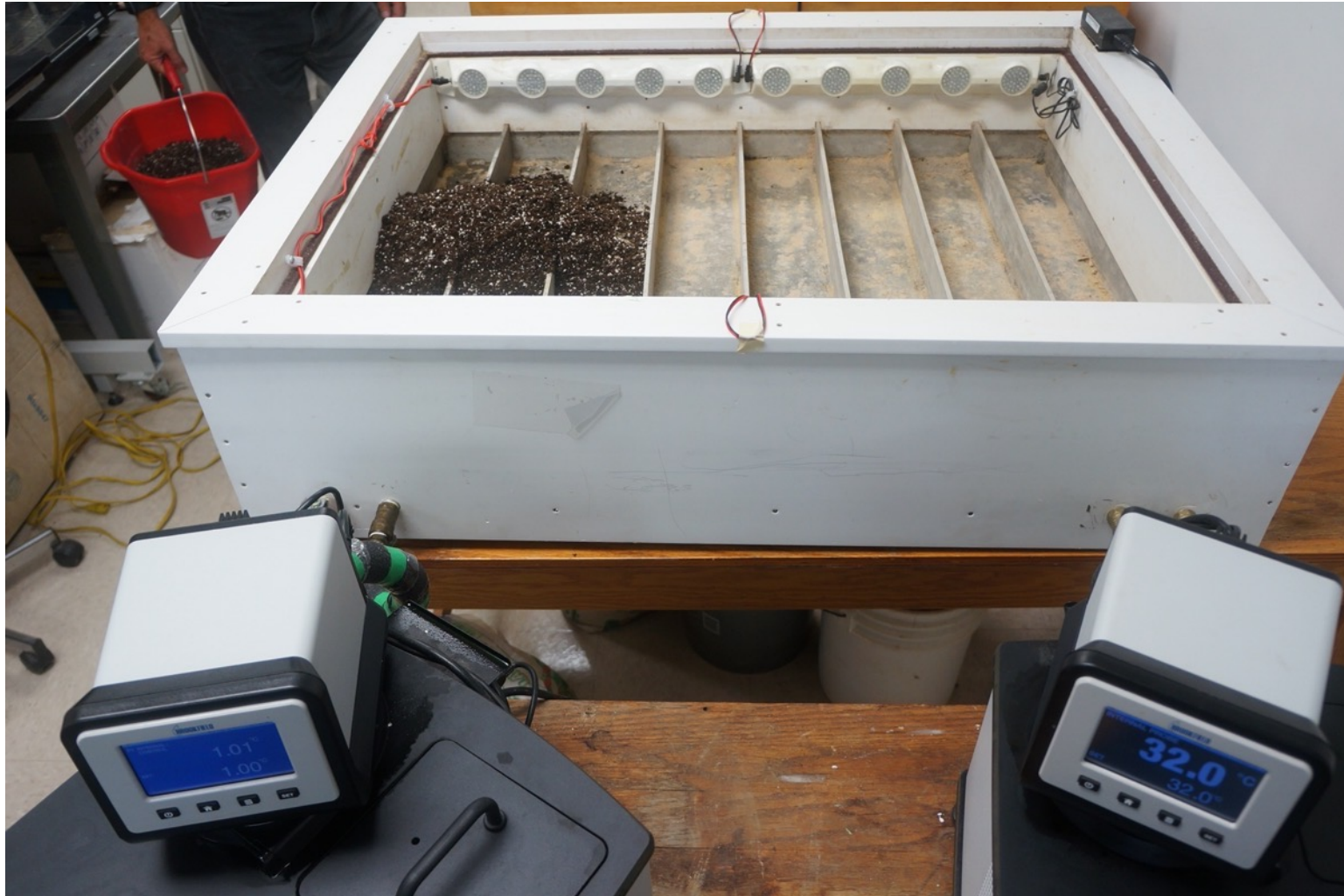
Thermogradient tables have been used to test seed germination for many years. Oregon State Seed Lab.



# Classic thermogradient system using plastic boxes for germination



# LabField<sub>TM</sub> Design (thermogradiant table with gussets)



# LabField<sub>TM</sub> Thermogradient with Soil



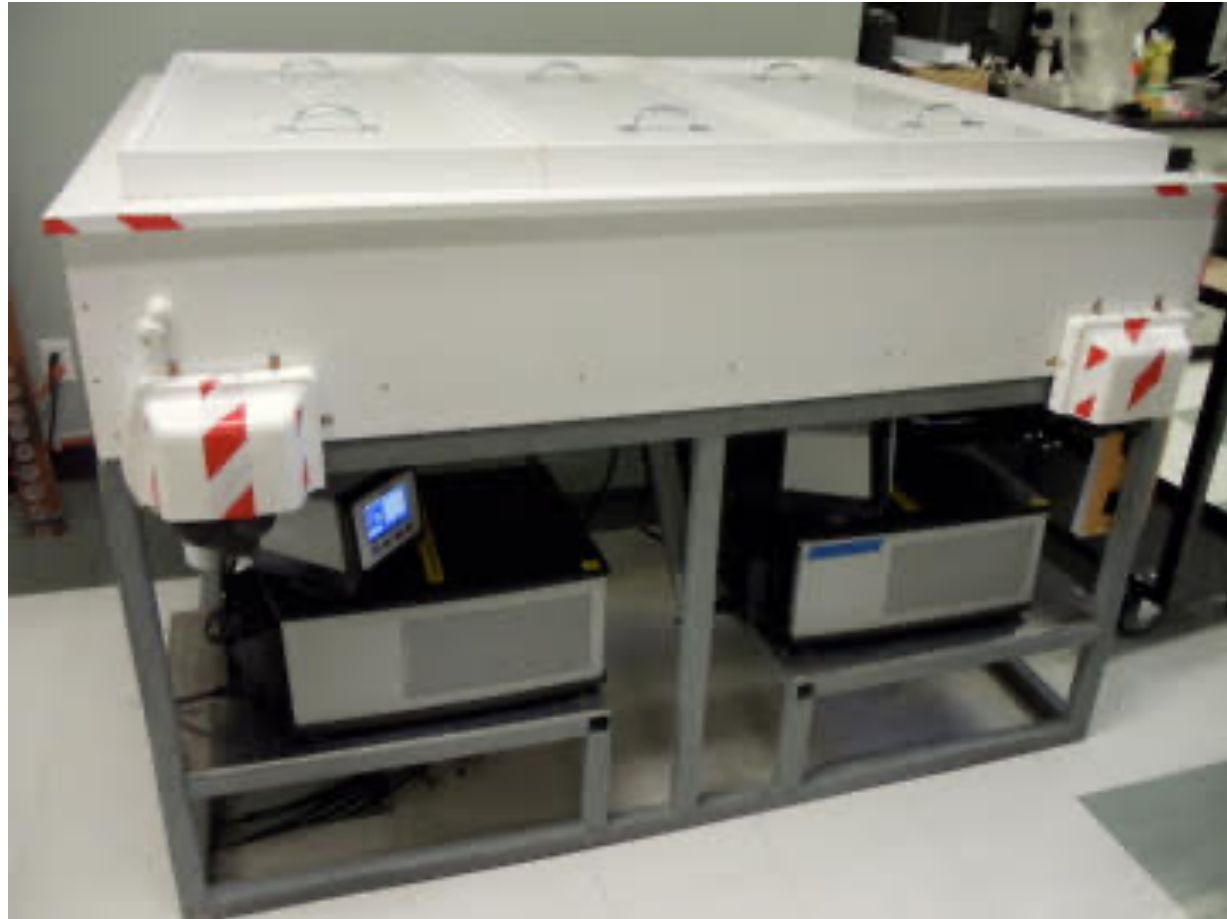
Each channel represents a different experimental soil temperature. We can see effects of cold soil (right) on emergence



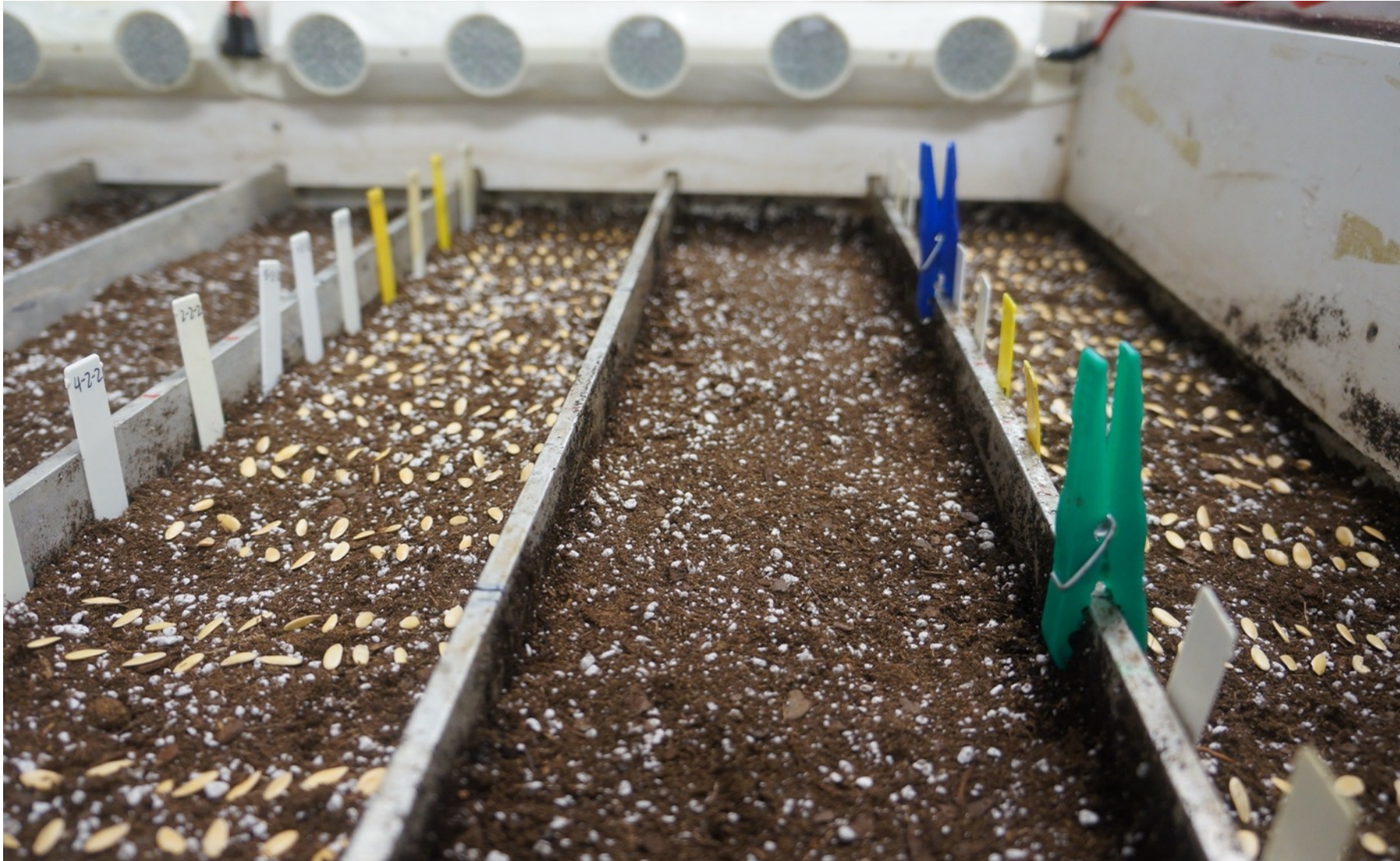
# TableField™ Laboratory Platform For Testing Soil Properties at Different Temperatures



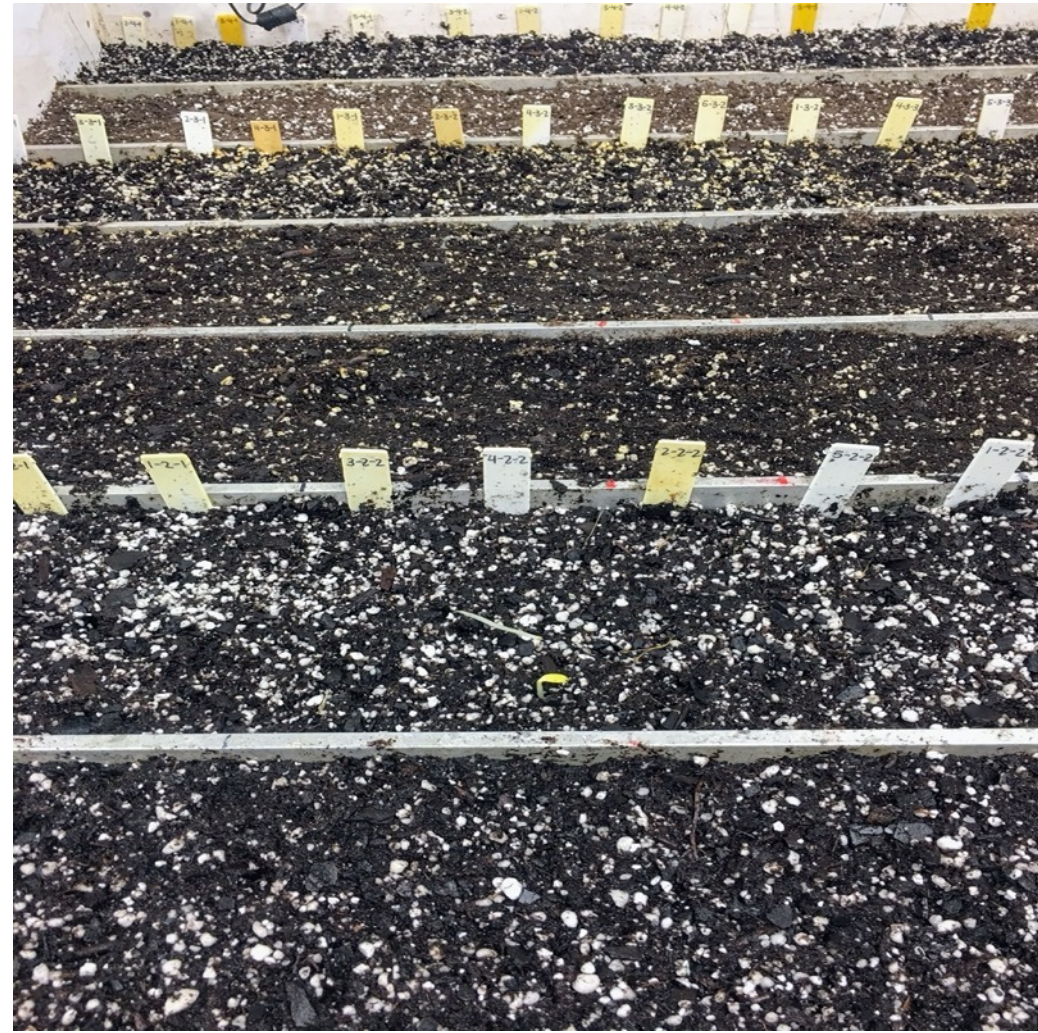




# LabField<sub>TM</sub> Experiment. Seed placement prior to covering



Tags marked randomized replications of 20 seeds each covered with 2.5 cm of soil



Soil at the warm end dried faster than at the cold end. Lanes at the warm end were hand watered daily. The table had an drainage system to remove excess water.



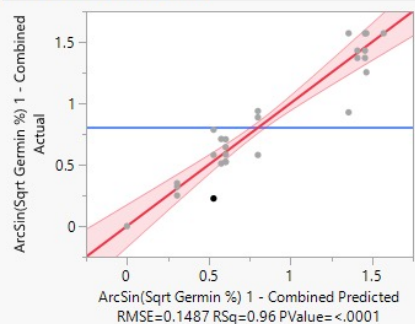
# Soil temperature measurement at seed depth



Response ArcSin(Sqrt Germin %) 1 - Combined

Whole Model

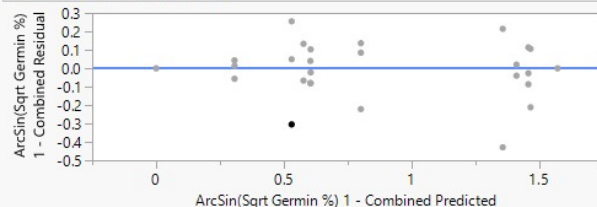
Actual by Predicted Plot



Effect Summary

Source	LogWorth	PValue
1 - Treatment	15.601	0.00000
1 - Cultivar	14.593	0.00000
1 - Cultivar*1 - Treatment	4.474	0.00003

Residual by Predicted Plot



Summary of Fit

RSquare	0.956662
RSquare Adj	0.936438
Root Mean Square Error	0.148737
Mean of Response	0.806095
Observations (or Sum Wgts)	45

AICc	BIC
-10.6148	-1.13674

Analysis of Variance

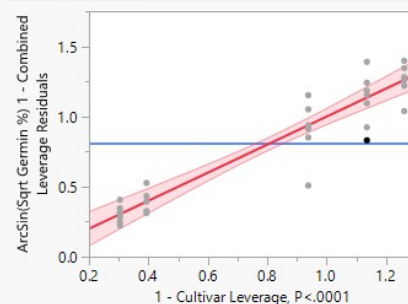
Source	DF	Sum of Squares	Mean Square	F Ratio
Model	14	14.650398	1.04646	47.3025
Error	30	0.663680	0.02212	Prob > F
C. Total	44	15.314077		<.0001*

Effect Tests

Source	Nparm	DF	Sum of Squares	F Ratio	Prob > F
1 - Cultivar	4	4	6.7934210	76.7699	<.0001*
1 - Treatment	2	2	6.6149064	149.5052	<.0001*
1 - Cultivar*1 - Treatment	8	8	1.2420701	7.0181	<.0001*

1 - Cultivar

Leverage Plot



Least Squares Means Table

Level	Sq Mean	Std Error	Mean
Athena	1.1350422	0.04957896	1.13504
Chartenais	1.2606500	0.04957896	1.26065
Edisto	0.3934001	0.04957896	0.39340
Hales Best Jumbo	0.9376542	0.04957896	0.93765
Minnesota Midget	0.3037275	0.04957896	0.30373

LSMeans Differences Tukey HSD

α= 0.050 Q= 2.90061

LSMean[i]	LSMean[j]				
	Athena	Chartenais	Edisto	Hales Best Jumbo	Minnesota Midget
Athena	0	-0.1256	0.74164	0.19739	0.83131
	0	0.07012	0.07012	0.07012	0.07012
		0	-0.329	0.53827	-0.006
			0	0.07777	0.94502
				0	0.40076
Chartenais	0.12561	0	0.86725	0.323	0.95692
	0.07012	0	0.07012	0.07012	0.07012
	-0.0778	0	0.66387	0.11962	0.75355
	0.32898	0	1.07063	0.52637	1.1603
Edisto	-0.7416	-0.8672	0	-0.5443	0.08967
	0.07012	0.07012	0	0.07012	0.07012
	-0.945	-1.0706	0	-0.7476	-0.1137
	-0.5383	-0.6639	0	-0.3409	0.29305
Hales Best Jumbo	-0.1974	-0.323	0.54425	0	0.63393
	0.07012	0.07012	0.07012	0	0.07012
	-0.4008	-0.5264	0.34088	0	0.43055
	0.00599	-0.1196	0.74763	0	0.8373
Minnesota Midget	-0.8313	-0.9569	-0.0897	-0.6339	0
	0.07012	0.07012	0.07012	0.07012	0
	-1.0347	-1.1603	-0.293	-0.8373	0
	-0.6279	-0.7535	0.1137	-0.4305	0

Least Squares Means Table

Level		Sq Mean
Chartenais	A	1.2606500
Athena	A B	1.1350422
Hales Best Jumbo	B	0.9376542
Edisto	C	0.3934001
Minnesota Midget	C	0.3037275

Levels not connected by same letter are significantly different.

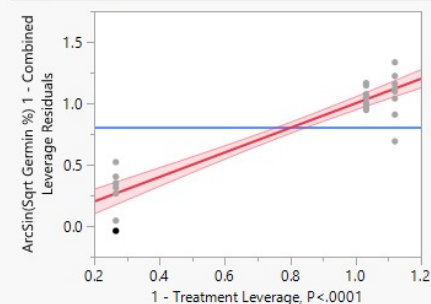
Power Details

Test 1 - Cultivar

Power	α	σ	δ	Number	Power
0.0500	0.148737	0.388542	45	1.0000	

1 - Treatment

Leverage Plot



Least Squares Means Table

Level	Sq Mean	Std Error	Mean
Field	1.1200169	0.03840370	1.12002
Paper Towel	1.0320000	0.03840370	1.03200
Temperature 1	0.2662675	0.03840370	0.26627

LSMeans Differences Tukey HSD

α= 0.050 Q= 2.46534

LSMean[i]	LSMean[j]		
	Field	Paper Towel	Temperature 1
Mean[i]-Mean[j]			
Std Err Dif			
Lower CL Dif			
Upper CL Dif			
Field	0	0.08802	0.85375
	0	0.05431	0.05431
	0	-0.0459	0.71985
	0	0.22191	0.98764
Paper Towel	-0.088	0	0.76573
	0.05431	0	0.05431
	-0.2219	0	0.63184
	0.04588	0	0.89963
Temperature 1	-0.8537	-0.7657	0
	0.05431	0.05431	0
	-0.9876	-0.8996	0
	-0.7199	-0.6318	0

Least Squares Means Table

Level		Sq Mean
Field	A	1.1200169
Paper Towel	A	1.0320000
Temperature 1	B	0.2662675

Levels not connected by same letter are significantly different.

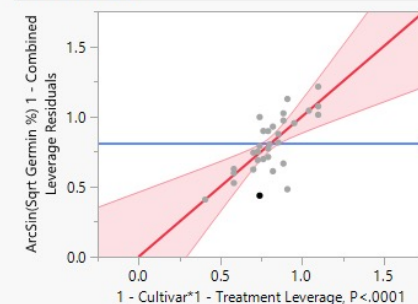
Power Details

Test 1 - Treatment

Power	α	σ	δ	Number	Power
0.0500	0.148737	0.383403	45	1.0000	

1 - Cultivar\*1 - Treatment

Leverage Plot



Power Details

Test 1 - Cultivar\*1 - Treatment

Power	α	σ	δ	Number	Power
0.0500	0.148737	0.166137	45	0.9996	

# Table 1. Germination Percentages Among the Three Tests

Cultivar	Field	Gradient Table (12.5/17.5/25/31°C)	Paper Towel <sup>1</sup>
<b>Germination/Emergence (%)</b>			
<b>Minnesota Midget</b>	56.7a	0/0/10a/21.7a	21.3a*
<b>Chartenais</b>	100.0b	51.7/48.3b/96.7b/86.7b	98.0b
<b>Hales Best Jumbo</b>	93.3c	0/10.0c/83.3b/93.3b	100.0b
<b>Edisto</b>	56.7a	0/13.3c/25.0d/35.0a	54.0c
<b>Athena</b>	98.3b	28.3/75.0a/93.3b/98.3b	99.3b

<sup>1</sup>Includes normal and abnormal seedlings.

\*F-test showed significant differences P<0.01 within each test among cultivars. Letters show mean differences LSD<sub>0.05</sub>.

# Table 2. Mean Times to Germination Among the Three Tests

Cultivar	Field	Gradient Table (12.5/17.5/25/31°C)	Paper Towel
		Mean Time to Germination (Days)	4-Day Root Length (cm)
Minnesota Midget	12.9a*	-/-/-/-#	0.7a
Charthenais	3.4b	34.0/16.1/4.6/2.6	5.5b
Hales Best Jumbo	4.1b	-/-/5.7/5.4	5.7b
Edisto	9.9c	-/-/11.5/8.9	1.7c
Athena	4.4b	37.3/16.1/3.6/1.5	4.7b

\*F-test showed significant differences  $P < 0.01$  within each test among cultivars. Letters show mean differences  $LSD_{0.05}$ .

#No MTG values were calculated when percentages were  $> 25\%$  since an insufficient number of the population are represented to characterize the speed of germination.



# Conclusions - 1

- Even though seeds were purchased new from a commercial supplier, there were major differences in seed quality. Both 'Edisto' and 'Minnesota Midget' failed to germinate to minimum standards of the US Federal Seed Law across all our tests.
- Paper towel tests reliably predicted field emergence. This was possibly do to planting seeds in warm soil during the summer when soil and test temperatures were similar.
- LabField<sub>TM</sub> tended to under estimate field emergence, especially at 25°C and below.
- LabField<sub>TM</sub> provided more information about performance at temperatures other than optimum which could help predict performance at suboptimum temperatures.

# Conclusions - 2

- Both 'Edisto' and 'Minnesota Midget' germinated more slowly than other cultivars, a sign that they were further along the death curve.
- Seeds germinated more slowly with decreasing temperatures on the LabField<sub>TM</sub> table which may be helpful for predicting emergence in cold soils and identifying cultivars and seed lots that perform well under cold conditions such as 'Chartenais' and 'Athena'.
- 'Hale's Best Jumbo' performed well at warm temperatures but not at cold temperatures suggesting variation in base temperature may exist among these cultivars.
- Four-day root lengths had value predicting germination performance and yielded results as an inverse of mean time to germination data.

# Thank you!

- Are there any questions?
- If you prefer, you can email questions to me at:  
welbaum@vt.edu