Pickling Cucumber

Where: Gallery Overlook (upper level) Room E & F
MI Recertification credits: 2 (1B, COMM CORE, PRIV CORE)
CCA Credits: PM(1.5) CM(0.5)
Moderator: Ben Phillips, Vegetable Extension Educator, MSU Extension, Saginaw, MI

9:00 am	How to Improve Weed Control in Your Cucumber Fields • Bernard Zandstra, Horticulture Dept., MSU
9:20 am	Cucumber Disease Control in 2017 • Mary Hausbeck, Plant, Soils and Microbial Sciences Dept., MSU
9:45 am	The North Carolina Pickling Cucumber Industry and Use of Parthenocarpic Fruiting Types • Jonathan Schultheis, Dept. Horticultural Science, North Carolina State University
10:15 am	Downy Mildew Resistant Pickling Cucumbers • Nischit Shetty, Seminis Seeds, Felda, FL
10:40 am	Auto-Steering and Precision Ag: What Can It Do for You? • Dennis Pennington, Plant, Soil, and Microbial Sciences Dept., MSU
11:00 am	Session Ends

How to Improve Weed Control in Your Cucumber Field

Bernard Zandstra
Michigan State University
2017 EXPO
Grand Rapids, MI
December 5, 2017

Cucumber Weed Control Experiment 2017

1. Field tilled	May 19
2. Field shallow tilled	May 31
3. Cucumber planted	June 1
4. Pre herbicides	June 2
5. Post Herbicides	June 27
6. Harvest	July 20 (50 days)

Objectives

1. Find safe use of Reflex on cucumber
2. Determine safety of bicyclopyrone on cucumber
3. Find a safe rate of Dual Magnum on cucumber

Results

1. Planting was delayed by wet, cool weather. There was a good flush of annual weeds, mainly BYGR and COLQ; also some CORW and RRPW.
2. Final tillage was 1 inch deep the day before planting. Most weeds were small and uprooted.
3. Very few weeds emerged after planting.
4. All herbicide treatments had almost complete weed control.

Cucumber Injury and Yield (1)

		Rate Lb ai/a	Rating 6/22	Rating 7/5	Kg/Plot 7/20
1.	Curbit Command	1.13 0.375	1.7	1.3	49
2.	Strategy	6 pt	1.7	1.7	53
3.	Curbit Reflex	0.75 0.125	2.3	2.7	47
4.	Curbit Command Reflex	0.75 0.25 0.125	2.7	2.7	50

Cucumber Injury and Yield (2)

		Rate Lb ai/a	Rating 6/22	Rating 7/5	Kg/Plot 7/20
5.	Curbit Command BIR	0.75 0.25 0.033	1.7	2.3	51
6.	Curbit Command BIR	0.75 0.25 0.045	2	2	56
7.	Curbit Command BIR	0.75 0.25 0.033 PO1	2	3.7	41*

MICHIGAN STATE UNIVERSITY

Cucumber Injury and Yield (3)

		Rate Lb ai/a	Rating 6/22	Rating 7/5	Kg/Plot 7/20
8.	Curbit Command Sandea	0.75 0.25 0.023	2.3	2.7	54
9.	Curbit Command Dual Magnum	0.75 0.25 0.3	3	3	50

MICHIGAN STATE UNIVERSITY

Cucumber Injury and Yield (4)

		Rate Lb ai/a	Rating 6/22	Rating 7/5	Kg/Plot 7/20
10.	Curbit Command Sandea	0.75 0.25 0.023 (PO1)	2	3.3	49
11.	Curbit Command Sandea BIR	0.75 0.25 0.023 (PO1) 0.023 (PO1)	1.3	3.3	48
12.	Untreated		1.7	2.3	48

MICHIGAN STATE UNIVERSITY

Cucumber Grade 2+3

		Rate Lb ai/a	Kg/Plot 7/21
1.	Curbit Command	1.13 0.375	37
2.	Strategy	6 pt	42
3.	Curbit Reflex	0.75 0.125	36
4.	Curbit Command Reflex	0.75 0.25 0.125	37

MICHIGAN STATE UNIVERSITY

Cucumber Grade 2+3

		Rate Lb ai/a	Kg/Plot 7/21
5.	Curbit Command BIR	0.75 0.25 0.033	41
6.	Curbit Command BIR	0.75 0.25 0.045	43
7.	Curbit Command BIR	0.75 0.25 0.033 PO1	32*
8.	Curbit Command Sandea	0.75 0.25 0.023	40

MICHIGAN STATE UNIVERSITY

Cucumber Grade 2+3

		Rate Lb ai/a	Kg/Plot 7/21
9.	Curbit Command Dual Magnum	0.75 0.25 0.3	39
10.	Curbit Command Sandea (PO1)	0.75 0.25 0.023	40
11.	Curbit Command Sandea (PO1) BIR (PO1)	0.75 0.25 0.023 0.023	38
12.	Untreated		39

MICHIGAN STATE UNIVERSITY

Summary

1. Reflex 0.125 lb (0.5 pt) was safe on cucumber.
2. Dual Magnum 0.3 lb (5 fl oz) was safe on cucumber.
3. BIR was safe Pre; BIR POST caused yield reduction
4. A second tillage before planting improved weed control.
5. There are no changes in cucumber herbicide recommendations for 2018.

MICHIGAN STATE UNIVERSITY

Processing Pepper Weed Control Banana and Jalapeno

1. Pre Transplant
2. Post broadcast
3. Post shielded

MICHIGAN STATE UNIVERSITY

Most Effective Treatments and Highest Yield

A.	Command	1 lb (2.7 pt)	PreTP
	Dual Magnum	0.95 lb (1pt)	PreTP
B.	Command	1 lb (2.7 pt)	PreTP
	Reflex	0.25 lb (1 pt)	PreTP
C.	Dual Magnum	0.95 lb (1 pt)	PreTP
	Command	1 lb (2.7 pt)	PreTP
	Sandea	0.023 lb (0.5 oz)	POST
	Select Max	0.12 lb (1 pt)	POST

MICHIGAN STATE UNIVERSITY

Postemergence Shielded & Directed Spray

- Rely 280 – glufosinate
- Gramoxone – paraquat
- Reglone – diquat

All treatments had good weed control, no crop injury, and acceptable yield

MICHIGAN STATE UNIVERSITY

Pepper Weed Control – Pre Transplant

Good Treatments

1. Dual Magnum + Command
2. Reflex + Command
3. Prowl H2O (heavier soil)
4. Treflan or Devrinol PPI

MICHIGAN STATE UNIVERSITY

Pepper Postemergence

1. Sandea – pigweed, nutsedge
2. Select or Poast – grasses
3. Gramoxone – shielded (RUP)

MICHIGAN STATE UNIVERSITY

Pepper Total Yield 2017 (kg)

	Treatment	Banana	Jalapeno
1.	Prowl H2O 1.4 lb	14.5	16.3
2.	Command 1 Dual Magnum 0.95	25.2	29.5
3.	Reflex 0.25 Command 1	25.2	25.2
4.	Dual Magnum 0.95 Command 1 Sandea 0.023 + Select 0.12 (Post)	22.8	26.1

MICHIGAN STATE UNIVERSITY

Acknowledgements

Pickle and pepper growers
Pickle and Pepper Research Committee (industry)
MSU Extension, AgBio Research
USDA NIFA; USDA IR4
Syngenta Crop Protection
Seminis Seeds
CPS, Gowan, Kumiai

Bernard Zandstra
Zandstra @msu.edu
517-353-6637

Cucumber Disease Control in 2017

Mary K. Hausbeck (517-355-4534) and Katie Goldenhar
Michigan State University, Department of Plant, Soil and Microbial Sciences

Cucurbit Downy Mildew (DM): DM causes severe leaf blight on cucurbit crops, including cucumber, melon, squash, and pumpkin. Incited by the fungal-like pathogen *Pseudoperonospora cubensis*, DM has occurred every growing season for Michigan cucumber growers since 2005. Michigan remains the top producer of pickling cucumbers in the U.S. and produced 236,700 tons valued at $47.3 million in 2016. Although DM can be especially damaging to cucumber and melons, squash and pumpkins may also become infected. The DM pathogen cannot overwinter in Michigan fields but can overwinter in greenhouses or production regions that do not experience a frost.

Over the last several years, some fungicides that used to be effective are no longer working well in Michigan. If DM is not effectively controlled, especially early in the cropping cycle, yield loss and misshapen fruit usually occur. Fungicides must be used preventively but it is difficult to know when the DM pathogen is threatening the crop and spraying must begin. Spore trapping has been used in Michigan for nearly ten years to detect an influx of DM sporangia into our production areas and alert the industry that disease is likely (www.veggies.msu.edu/downy-mildew-news, www.downymildew.msu.edu).

Replicated, controlled trials were conducted at the MSU Plant Pathology Farm in Lansing, MI to compare fungicides applied alone (Trial 1) and fungicide programs applied to susceptible and tolerant cucumber cultivars (Trial 2) for their ability to limit DM. Products tested are listed in Table 1. Foliar disease severity was rated on the Horsfall-Barratt scale (Table 2). DM was first observed on the MSU Plant Pathology Farm on 3 August on cucumber in a sentinel plot.

Table 1. List of fungicides tested in Michigan in 2017.

Product name	Active ingredient	FRAC[1]	Labeled
Bravo WeatherStik.....	chlorothalonil	M05	yes
Cueva	copper	M01	yes
Curzate	cymoxanil	27	yes
Elumin SC.....	ethaboxam	22	yes
Forum.....	dimethomorph	40	yes
Gavel.....	mancozeb/zoxamide	M03/22	yes
Koverall.....	mancozeb	M03	yes
Omega	fluazinam	29	supplemental
Orondis Opti SC.....	oxathiapiprolin(A)/chlorothalonil(B)	49/M05	yes
Orondis Ultra SC.....	oxathiapiprolin/mandipropamid	49/40	yes
Presidio	fluopicolide	43	yes
Previcur Flex.....	propamocarb	28	yes
Priaxor.....	fluxapyroxad/pyraclostrobin	7/11	no
Ranman SC	cyazofamid	21	yes
Revus.....	mandipropamid	40	yes
Tanos.....	famoxadone/cymoxanil	11/27	yes
Zampro SC.....	dimethomorph/amectoctradin	40/45	yes

[1]Numbers and letters are used to define the fungicide groups by their mode of action. M = multi-site inhibitors. Visit www.frac.info for more information about FRAC codes.

Table 2. Horsfall-Barratt scale of foliar disease severity.

Rated on a scale of 1 to 12, where 1=0% plant area diseased, 2=>0 to 3%, 3=>3 to 6%, 4=>6 to 12%, 5=>12 to 25%, 6=>25 to 50%, 7=>50 to 75%, 8=>75 to 87%, 9=>87 to 94%, 10=>94 to 97%, 11=>97 to <100%, 12=100 plant area diseased.

Trial 1. Evaluation of single fungicides for control of DM of cucumber.

The trial was established at the Plant Pathology Farm in Lansing, MI, on Capac loam soil, in a field previously planted for 2 years to soybeans. Plots were prepared as raised beds. Drip tape was established on each bed, and the beds were covered with black plastic. Single rows spaced 5.5 feet at center were sown with 'Vlaspik' cucumber on 14 July. Each treatment replicate was a 20-foot bed for each of four replicates with a 2-foot buffer between beds within a planting row. Treatments were arranged in a randomized complete block design. The plot was fertilized throughout the growing season with weekly applications of 20-20-20 via drip tape at 2.5 lb/A. Weeds were managed by hand and insects controlled with Admire Pro 8 fl oz applied through the drip 4 weeks after plant emergence. Foliar sprays were applied with a CO_2 backpack boom sprayer equipped with 2 then 3 (as the canopy grew) XR8003 flat-fan nozzles, operating at 50 psi, delivering 50 gal/A. Fungicide treatments were applied preventively prior to disease development at 7-day intervals on 2, 9, 18, 25 August; and 2, 9, 16 September. The Horsfall-Barratt scale (Table 2) was used to rate DM foliar severity on 18, 24, 31 August and 6, 11, 18, 26 September. The trial was harvested on 1, 12, 20 September, and total yield is reported.

On the first rating date of 8 August, the untreated control plants received a severity rating of 1.75 (2=>0-3% plant area diseased) (Table 3, Fig. 1). On 11 September, the untreated control was rated 8 (>75-87% plant area diseased). Orondis Opti SC had no disease and Orondis Ultra SC and Omega SC had disease <3%. Bravo WeatherStik SC, Koverall DG, Ranman SC, Zampro SC, Gavel DF and V-10208 SC were still effectively controlling disease (less than 12% diseased area). By 26 September, the untreated control plants were rated 10 (10=>94-97% plant area diseased), and Presidio SC, Previcur Flex SL, Revus SC, Tanos DF, Curzate DG, Forum SC and Priaxor SC received ratings of 8 (>75-87% plant area diseased) or higher. This information verifies that some fungicides that were previously relied upon by the Michigan pickling cucumber industry can no longer provide a significant level of control. For the final rating, three treatments received ratings ≤3.5 (4=>6-12% plant area diseased), and included Omega SC, Orondis Opti SC, and Orondis Ultra SC. All treatments except Revus SC significantly reduced AUDPC values compared with the untreated; Omega SC, Orondis Opti SC, and Orondis Ultra SC were significantly more effective than all other fungicides (Table 3, Fig. 1). Orondis Opti SC and Orondis Ultra SC produced the highest yields at 121.8 and 121.2 lb, respectively; products producing statistically similar yields included Omega SC, Bravo WeatherStik SC, Koverall DG, Ranman SC, Zampro SC, and Gavel DF (Table 3, Fig. 2).

In addition to the Orondis fungicides and Omega SC, Ranman SC, Zampro SC, Gavel DF, Koverall and Bravo WeatherStik SC proved to be helpful and are recommended for use in a DM program. Although there have been observations from other regions of the U.S. that Ranman SC may not be holding up against DM as in past years, this trial indicates that it remains an effective product and should be included in disease management programs in Michigan.

Table 3. Evaluation of single fungicides for control of DM of cucumber.

Treatment and rate/A	Foliar disease severity (Horsfall-Barratt scale)							
	8/18	8/24	8/31	9/6	9/11	9/18	9/26	10/3
Untreated control	1.8 a*	3.0 c	4.8 a	4.8 a-c	8.0 a	10.0 a	10.0 a	10.5 a
Bravo WeatherStik SC 2 pt	1.0 c	1.5 b-d	1.8 ef	3.0 d-f	3.3 bc	4.5 d	5.3 f	5.5 de
Koverall DG 2 lb	1.0 c	1.5 b-d	2.0 d-f	3.3 d-f	4.5 bc	5.5 d	5.8 ef	6.3 d
Cueva SC 2 qt	1.0 c	1.3 cd	3.5 bc	4.0 b-d	7.0 a	9.0 ab	7.8 cd	7.8 c
Presidio SC 0.25 pt	1.0 c	2.3 a-c	3.0 b-d	3.8 c-e	7.0 a	9.0 ab	8.3 bc	8.0 c
Previcur Flex SL 1.2 pt	1.0 c	2.3 a-c	4.0 ab	5.3 a	8.0 a	9.8 ab	8.5 bc	8.0 c
Ranman SC 0.17 pt	1.0 c	1.0 d	2.0 d-f	2.0 f-h	2.3 cd	4.8 d	5.0 f	4.3 ef
Zampro SC 0.88 pt	1.0 c	1.8 b-d	2.0 d-f	2.5 e-g	4.0 b	5.3 d	4.8 f	5.3 de
Gavel DF 2 lb	1.3 bc	1.3 cd	2.8 c-e	2.5 e-g	4.3 b	5.0 d	5.3 f	5.5 de
Tanos DF 0.5 lb	1.3 bc	1.3 cd	3.0 b-d	3.8 c-e	8.0 a	9.5 ab	9.0 ab	9.0 bc
Curzate DG 5 oz	1.3 bc	1.5 b-d	2.5 c-e	3.8 c-e	7.8 a	9.5 ab	9.0 ab	8.8 bc

Treatment and rate/A	Foliar disease severity (Horsfall-Barratt scale)							
	8/18	8/24	8/31	9/6	9/11	9/18	9/26	10/3
Omega SC 1 pt	1.0 c	1.0 d	1.0 f	1.5 gh	1.8 cd	1.8 e	3.3 g	3.0 fg
Revus SC 8 fl oz	1.5 ab	2.5 ab	4.0 ab	5.8 a	8.0 a	9.8 ab	10.0 a	10.0 ab
Forum SC 6 fl oz	1.0 c	1.8 b-d	2.5 c-e	4.0 b-d	7.3 a	9.0 ab	8.5 bc	8.8 bc
Orondis Opti SC 34.2 fl oz	1.0 c	1.0 d	1.0 f	1.0 h	1.0 d	1.0 e	3.0 g	3.5 fg
Orondis Ultra SC 9.64 fl oz	1.0 c	1.0 d	1.0 f	1.0 h	1.3 d	1.5 e	2.5 g	2.5 g
Elumin SC 8 fl oz	1.0 c	1.3 cd	2.3 de	2.5 e-g	4.5 b	7.8 c	6.8 de	6.0 de
Priaxor SC 8 fl oz	1.0 c	1.5 b-d	2.8 c-e	3.8 c-e	7.0 a	8.8 bc	8.8 bc	8.5 bc

Treatment and rate/A	AUDPC** for disease severity	Yield (lb)			
		9/1	9/12	9/20	Total yield
Untreated control	316.5 a*	23.9 b-d	14.2 ij	11.1 g	49.2 fg
Bravo WeatherStik SC 2 pt	152.5 ef	28.4 a-c	38.5 ab	50.8 ab	117.6 ab
Koverall DG 2 lb	176.9 de	29.4 ab	35.0 a-c	43.0 bc	107.3 ab
Cueva SC 2 qt	250.6 c	24.8 b-d	26.2 d-g	26.4 de	77.4 cd
Presidio SC 0.25 pt	257.1 c	25.4 a-d	27.6 c-f	28.5 d	81.4 c
Previcur Flex SL 1.2 pt	285.4 ab	21.4 d	19.6 g-i	17.8 e-g	58.8 d-g
Ranman SC 0.17 pt	135.0 f	26.6 a-d	33.7 a-d	48.3 a-c	108.5 ab
Zampro SC 0.88 pt	158.5 d-f	29.6 ab	36.6 ab	50.9 ab	117.1 ab
Gavel DF 2 lb	165.1 d-f	29.2 ab	40.1 a	49.0 a-c	118.3 ab
Tanos DF 0.5 lb	270.3 bc	24.7 b-d	15.9 ij	15.6 fg	56.2 e-g
Curzate DG 5 oz	266.3 c	26.9 a-d	17.9 h-j	19.1 d-g	63.9 c-f
Omega SC 1 pt	82.8 g	27.3 a-d	35.6 ab	49.2 a-c	112.1 ab
Revus SC 8 fl oz	309.5 ab	23.2 cd	10.5 j	9.9 g	43.6 g
Forum SC 6 fl oz	258.0 c	28.7 a-c	20.4 f-i	18.0 e-g	67.1 c-f
Orondis Opti SC 34.2 fl oz	69.8 g	26.1 a-d	39.5 a	56.2 a	121.8 a
Orondis Ultra SC 9.64 fl oz	67.8 g	24.1 b-d	40.8 a	56.3 a	121.2 a
Elumin SC 8 fl oz	196.3 d	31.1 a	30.9 b-e	39.5 c	101.5 b
Priaxor SC 8 fl oz	254.3 c	24.4 b-d	24.3 e-h	25.3 e-g	74.0 c-e

*Column means with a letter in common are not statistically different (LSD t Test; P=0.05).

**AUDPC=area under the disease progress curve.

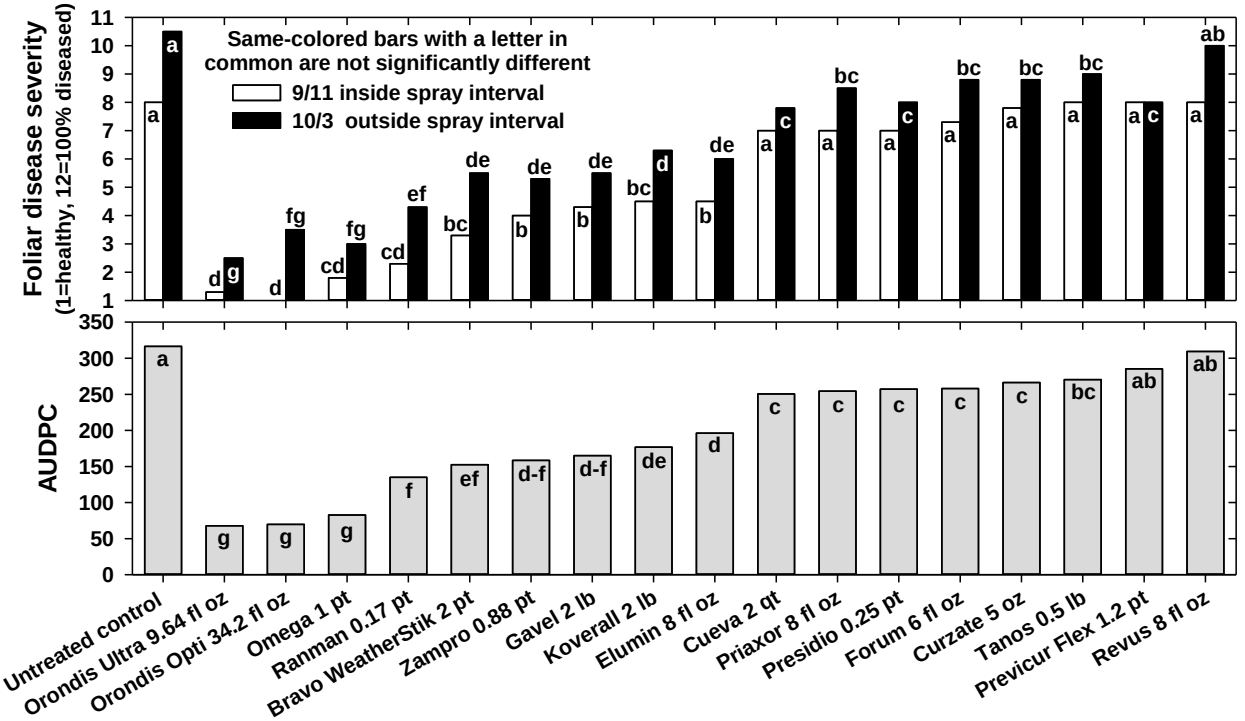


Fig. 1. Foliar disease severity (top) and AUDPC values (bottom) of cucumbers treated with fungicides (last spray applied 9/16.)

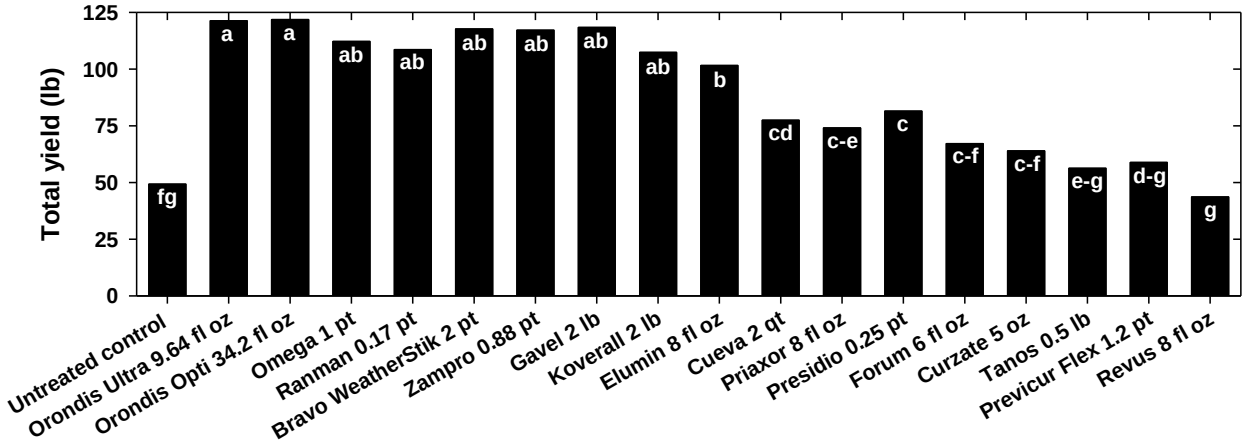


Fig. 2. Yield of cucumbers treated with fungicides for control of downy mildew.

Fig. 3. Symptoms of downy mildew on cucumbers treated at 7-day intervals with single fungicides.

Trial 2. Evaluation of cultivars and fungicides for control of DM of cucumber.

The trial was established at the MSU Plant Pathology Farm in Lansing, MI, on Capac loam soil in a field previously planted to cucumber. Planting plots were prepared as raised beds. Drip tape was established on each bed, and the beds were covered with black plastic. Single rows spaced 5.5 feet at center were seeded on 21 July with four cucumber cultivars developed by Seminis Vegetable Seeds, Inc: Vlaspik, Expedition, Citadel and Peacemaker. Vlaspik and Expedition are industry standard cultivars that are susceptible to DM. Citadel and Peacemaker show an intermediate level of resistance to Michigan's DM isolates. Each cultivar subplot was two 20-foot beds, repeated four times for each of three replicates with a 2-foot buffer between beds within a planting row. Treatments were arranged in a split plot randomized block design, with fungicide program being the main plot and cultivar being the subplot. The plot was fertilized throughout the growing season with weekly applications of 20-20-20 via drip tape at 2.5 lb/A. Weeds were removed by hand and insects controlled with Admire Pro 8 fl oz applied through the drip 4 weeks after plant emergence. Foliar fungicide sprays were applied to cucumber foliage before symptoms of DM were present with a CO_2 backpack boom sprayer, equipped with two then three (as the canopy grew) XR8003 flat-fan nozzles, operating at 50 psi, delivering 50 gal/A. Fungicide treatments were applied at 7-day intervals on 3, 10, 18, 25 August and 1, 9, 16 September. Cucumber leaves were evaluated for DM severity using the Horsfall-Barratt scale (Table 2) on 18, 24, 31 August and 6, 12, 18 and 26 September.

Data indicate that Citadel and Peacemaker were somewhat more resistant than the susceptible standards Vlaspik and Expedition (Table 4). The fungicide program that included Orondis Opti was very effective in this study. By the last rating date, all fungicide programs significantly limited foliar DM severity and AUDPC values on all cultivars compared with the untreated control. The Orondis program was more effective than the Bravo and Ranman programs for reducing foliar DM severity and AUDPC values for cultivars Vlaspik, Expedition and Citadel (Table 5). The fungicide programs significantly increased marketable yield for all cultivars compared with the untreated control (Table 5), with the exception of Peacemaker cucumbers treated with Bravo whose yield was similar to the untreated control.

Table 4. Evaluation of cucumber cultivars and fungicides for foliar severity of DM.

Treatment*	Foliar disease severity (Horsfall-Barratt scale)													
	Vlaspik							Expedition						
	8/18	8/24	8/31	9/6	9/12	9/18	9/26	8/18	8/24	8/31	9/6	9/12	9/18	9/26
Untreated control	1.7**	3.3 a	4.3 a	5.0 a	8.0 a	9.7 a	9.7 a	1.7	2.7 a	3.3 a	4.7 a	8.0 a	10.0 a	10.0 a
Bravo	1.0	2.0 b	1.7 b	2.0 b	4.0 b	4.7 b	5.7 b	1.0	2.0 ab	2.0 bc	3.0 b	3.7 b	4.3 b	5.7 b
Ranman + Bravo *alt* Previcur + Bravo *alt* Zampro + Bravo	1.0	2.0 b	2.3 b	2.0 b	3.3 b	3.7 c	5.3 b	1.0	2.0 ab	2.3 b	2.3 b	3.3 b	3.7 b	5.3 b
Orondis Opti *alt* Ranman + Bravo *alt* Previcur + Bravo	1.0	1.7 b	1.7 b	1.7 b	1.3 c	2.0 d	4.0 c	1.0	1.3 b	1.3 c	1.3 c	1.7 c	2.0 c	3.7 c
Treatment*	**Citadel**							**Peacemaker**						
	8/18	**8/24**	**8/31**	**9/6**	**9/12**	**9/18**	**9/26**	**8/18**	**8/24**	**8/31**	**9/6**	**9/12**	**9/18**	**9/26**
Untreated control	1.0**	3.0 a	3.0 a	4.3 a	8.0 a	9.0 a	8.7 a	1.0	2.7 a	2.7 a	4.0 a	7.0 a	8.3 a	8.0 a
Bravo	1.0	2.0 b	2.0 b	2.0 b	2.7 b	3.0 b	4.7 b	1.0	1.7 bc	1.7 bc	2.0 b	2.0 b	2.3 b	4.3 b
Ranman + Bravo *alt* Previcur + Bravo *alt* Zampro + Bravo	1.0	2.0 b	2.0 b	2.0 b	2.3 b	2.7 b	5.0 b	1.0	2.0 ab	2.0 ab	2.0 b	2.0 b	2.3 b	4.3 b
Orondis Opti *alt* Ranman + Bravo *alt* Previcur + Bravo	1.0	1.7 b	1.3 c	1.3 b	1.0 c	1.0 c	2.7 c	1.0	1.0 c	1.0 c	1.0 c	1.0 c	1.3 b	3.0 b

*Products were applied at these rates/A: Bravo WeatherStik SC 2 pt, Ranman SC 2.7 fl oz, Previcur Flex SL 1.2 pt, Zampro SC 14 fl oz, Orondis Opti SC 2.14 pt. *alt*=alternate.

xColumn means with a letter in common or with no letter are not significantly different (LSD t Test; P=0.05).

Table 5. Area under the disease progress curve (AUDPC) and marketable yield.

Treatment[z]	AUDPC[y] for disease severity				Marketable yield (bu/A)			
	Vlaspik	Expedition	Citadel	Peacemaker	Vlaspik	Expedition	Citadel	Peacemaker
Untreated control	1765 a[x]	1655 a	1540 a	1290 a	113.6 b	91.4 b	168.7 b	261.3 b
Bravo	402 b	335 b	172 b	112 b	306.4 a	316.6 a	347.3 a	331.2 ab
Ranman + Bravo *alt* Previcur + Bravo *alt* Zampro + Bravo	249 b	255 b	189 b	118 b	372.4 a	335.1 a	355.1 a	364.7 a
Orondis Opti *alt* Ranman + Bravo *alt* Previcur + Bravo	68 c	61 c	27 c	23 b	321.4 a	362.3 a	313.5 a	371.9 a

[z]Products were applied at these rates/A: Bravo WeatherStik SC 2 pt, Ranman SC 2.7 fl oz, Previcur Flex SL 1.2 pt, [y]Zampro SC 14 fl oz, Orondis Opti SC 2.14 pt. *alt*=alternate.
AUDPC=area under the disease progress curve.
[x]Column means with a letter in common or with no letter are not significantly different (LSD t Test; *P*=0.05).

This material is based upon work that is supported by Pickle Packers International, Inc. and the National Institute of Food and Agriculture, U.S. Department of Agriculture, under award number 2016-68004-24931. Any opinions, findings, conclusions, or recommendations expressed in this publication are those of the author(s) and do not necessarily reflect the view of the U.S. Department of Agriculture.

United States Department of Agriculture
National Institute of Food and Agriculture

The North Carolina Pickling Industry and Use of Parthenocarpic Fruiting Types

Jonathan R. Schultheis
North Carolina State University
Department of Horticultural Science
2721 Founders Drive, 264 Kilgore
Raleigh, NC 27695-7609
Jonathan_schultheis@ncsu.edu

The acreage dedicated to the production of pickling cucumbers in North Carolina (NC) has changed dramatically over the last 20 plus years. In 1994, the pickling acreage in NC was about 25,500 acres, which was similar to the acreage produced in Michigan (MI) of 24,500 acres. In 2006, MI produced 33,000 thousand acres, while NC produced 16,000 acres. In 2012, acreage of production and cash receipts for the NC picking cucumber industry were 6,400 acres and $12.3 million, while MI produced 29,700 acres valued at $37.2 million. Since 2012, acreage in NC has remained around 7,500 while acreage in MI has remained relatively stable near 30,000.

North Carolina differs from most pickling cucumber production areas in the country as the majority of its production acreage is hand harvested multiple times rather than as a one time destructive machine harvest. Approximately 90% of NC acreage is hand harvested as labor is in place for intensively managed tobacco and sweetpotato crops which were valued at over $1.5 billion in NC in 2016. Most production acreage of pickling cucumbers utilizes a blend of a standard seeded predominately female cucumber cultivar (~90%) that is blended with a monoecious seeded pollenizer cultivar (~10%) that provides sufficient pollen for good pollination and fruit set.

Use of parthenocarpic cucumbers were originally used in Europe where pollination was a challenge due to cool, wet growing conditions that could inhibit fruit set, quality and yields. The first genetically parthenocarpic cucumbers were available in the 1960s. Parthenocarpy means the plant can form and set fruits without pollination or fertilization. Advantages in using parthencarpic cultivars are that the fruits that are set are seedless and that pollinators (bees) are not needed for fruit set to occur. The later helps to reduce production costs involved with purchase of bumble bee hives or the rental of one to three honey bee hives per acre. Early studies showed a yield advantage with parthenocarpic cucumbers; however, fruits were softer and more subject to bloating than non-parthenocarpic types. More recently, there has been increased interest in the use of parthenocarpic cucumber cultivars for field production of pickling cucumbers as fruit quality has been improved.

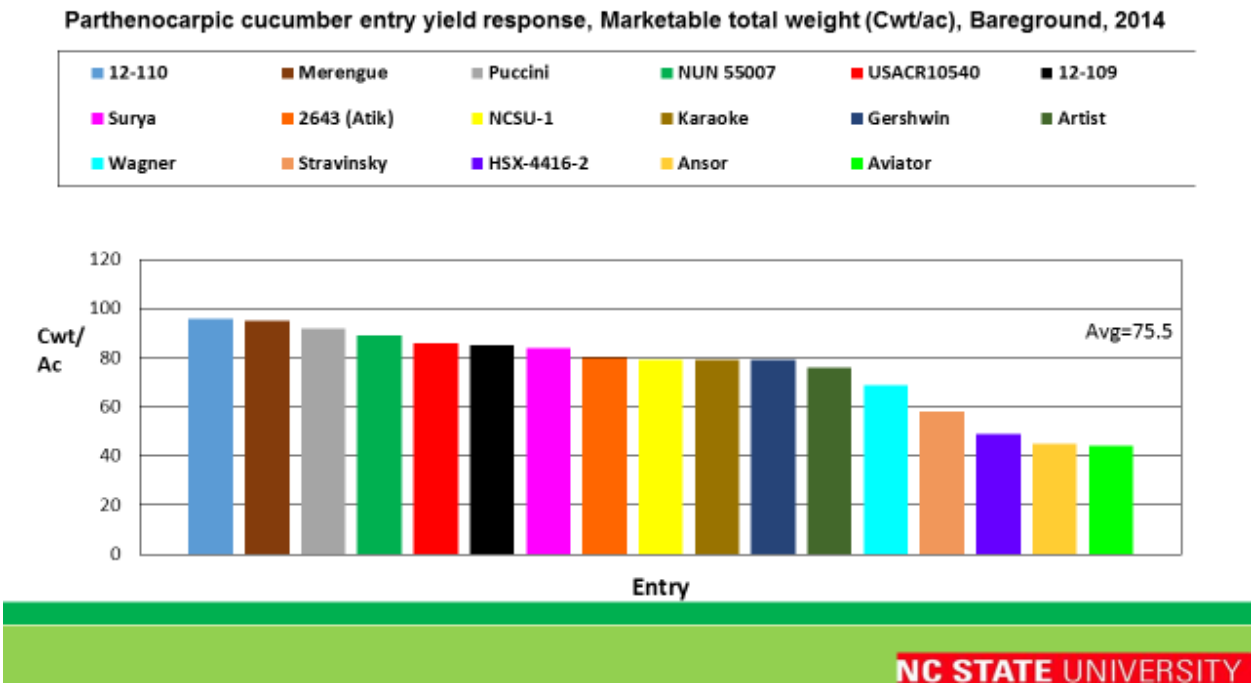
Although parthenocarpic cucumbers have increased yield potential, parthenocarpic seeds (~$12/1000) are most costly than non-parthenocarpic cucumbers (~$3/1000). For once-over mechanical harvest, approximately 2 to 3 times more seeds are planted than with multiple hand harvest. In NC, planting densities average between 50 to 60 thousand seeds per acre for mechanical harvest compared with 25 thousand seeds per acre for multiple harvest. Plant populations will vary depending on cultivar and environment, and divergent plant populations that result in greatest yields have been reported in various

research studies; these have ranged from 60,000 to 300,000 plants per acre. The economics of seed cost, especially with the more costly parthencarpic than non-parthenocarpic seed needs to be considered. Several studies in NC were conducted to evaluate yields and dollar returns when varying parthenocarpic seed densities in pickling cucumber field production.

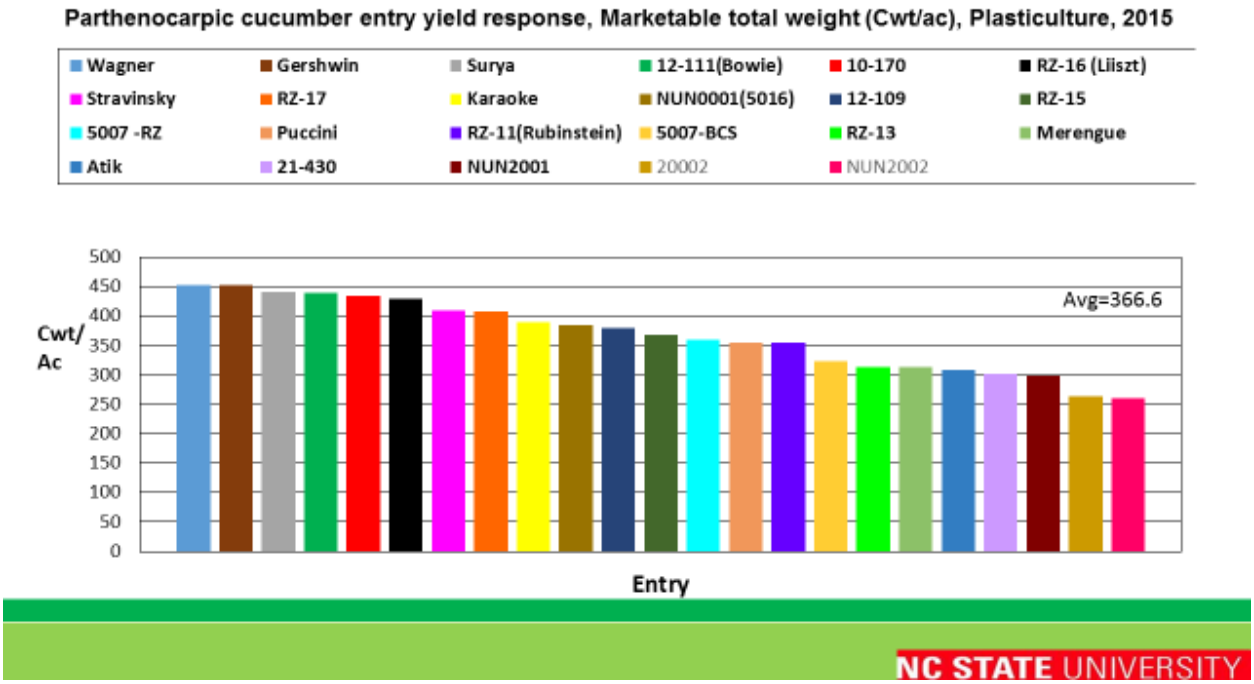
Densities of cultivars Puccini and Meringue parthenocarpic seeds were varied from 12,500 plants per acre to 175,000 plants per acre to determine how this affected yields. Production of plants at a given plant population was also measured by determining the percentage plants that produced at least one marketable fruit per plant. The influence of density and harvest timing on yield and dollar return per acre will also be discussed.

Several cultivars and advanced lines of parthenocarpic cucumbers for field production were evaluated in 2014 and 2015. Seventeen pickling cucumber entries were evaluated and grown on bare ground in 2014 and 23 entries were grown on plastic mulch with drip fertigation and evaluated in 2015. Both studies were multiple harvest studies. There were eight harvests in the spring 2014 planting, and eight and six harvests in the 2015 spring and fall plantings, respectively.

In 2014, some of the highest yielding entries that exceeded 80 cwt per acre were 12-110 (status unknown), Merengue, Puccini, NUN 55007, USAACR 10540 (status unknown), 12-109 (discontinued), and Surya (see graph below). Entries that had moderate yields in this study (68 to 79 cwt/acre) were 2943 (Atik), NCSU-01, Karaoke, Gerswhin, Artist, and Wagner, while the lowest yielding entries in this study (44 to 57 cwt/acre) were Stravinsky, HSX 4416-2 (status unknown), Ansor and Aviator. Yields were very low in large part due to foliage burn after the first harvest with a surfactant added to the herbicide.



In 2015, the yield average was much higher (366.6 cwt/acre) than in 2014 (75.5 cwt/acre). Entries that exceeded 400 marketable cwt per acre were; Wagner, Gerswhin, Surya, 12-111 (Bowie), 10-170 (status unknown), RZ-16 (Liszt), Stravinsky, and RZ-17 (see graph below). Entries that yielded marketable fruit between 350 cwt/acre and 400 cwt/acre included; Karaoke, NUN0001, 12-109 (discontinued), RZ-15 (dropped), NUN 5007 (seed sourced from Rijk Zwaan), Puccini and RZ-11 (Rubinstein), while entries that yielded between marketable yields between 300 to 350 cwt/acre included 5007 (seed sourced from Bayer Crop Science), RZ-18, Meringue, Atik, and 21-340 (status unknown). The lowest yielding entries, below 300 cwt/acre were NUN2001, 20002 (dropped), and NUN2002 (dropped).



Interests and use of parthenocarpic pickling cucumbers in the industry for field production continues to increase. High potential yields are fueling this interest and the advantage of producing fruit set without bees is an advantage. Rijk Zwaan, Bayer Crops Science, and Bejo seed companies are focusing many of their pickling cucumber breeding efforts on developing cultivars that will serve the US industry. Monsanto has an active parthenocarpic breeding program but is presently not focused on the US pickling cucumber industry. Continued research is needed to manage production strategies that are economical with regards to seed planting density, consistency in production across environments, and fruit quality that meets processor needs.

Downy Mildew Resistant Cucumbers

Great Lakes Expo 2017

Nischit Shetty
Monsanto Vegetable Seeds

Downy Mildew Resistant Pickling Cucumbers

Nischit Shetty
Monsanto Vegetable Seeds

Seminis

Downy Mildew

- Caused by *Pseudopernospora cubensis* L.
- Serious fungal disease on cucumbers worldwide
- Resistance *dm-1* first described in 1954 was incorporated into most commercial hybrids
- Resistance broken by new strain in US in 2004
- Spores move by wind and storms
- Within 10 days of spore appearance entire fields can be lost
- Current management is through fungicide program

Seminis

Why Genetic Resistance

DEFENSE

- Convenient
- Sustainable
- Environmentally friendly
- Low fungicide residue
- Longer window to react to outbreak of the disease
- Additional tool along with conventional fungicides to fight the disease
- Peace of mind

Seminis

MSU Trials – East Lansing 2015

Commercial Hybrid

DEFENSE Hybrid

Seminis

Seminis

DEFENSE™

Provides:

Improved Downy Mildew Protection

- Stronger resistance to Downy mildew has been introduced to select pickle hybrids through conventional breeding

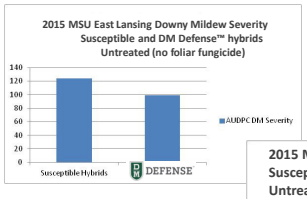
Flexible Fungicide Spray Program

- DM Defense™ hybrids provide growers the potential for a more flexible spray schedule as a result of Downy mildew resistance

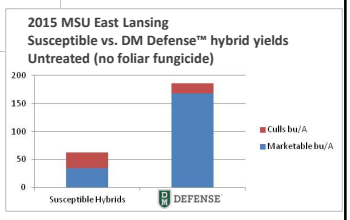
Excellent Yield and Quality Potential

- Products sold under the DM Defense™ brand will possess the same yield and quality potential that customers have grown to expect from Seminis®.

Seminis



Michigan Trials.



DEFENSE

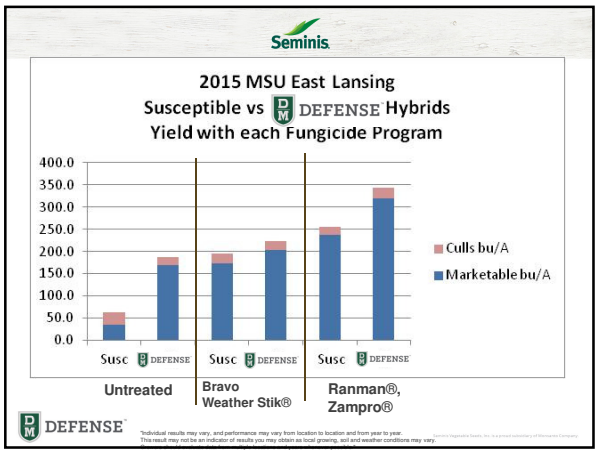
"Individual results may vary, and performance may vary from location to location and from year to year. This result may not be an indicator of results you may obtain as local growing, soil and weather conditions may vary. Growers should evaluate data from multiple locations and years whenever possible."

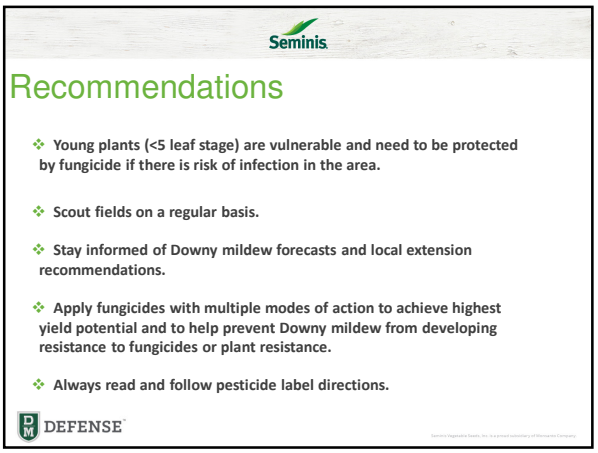
http://www.seminis-us.com/resources/agronomic-spotlights/managing-downy-mildew-in-cucumbers/

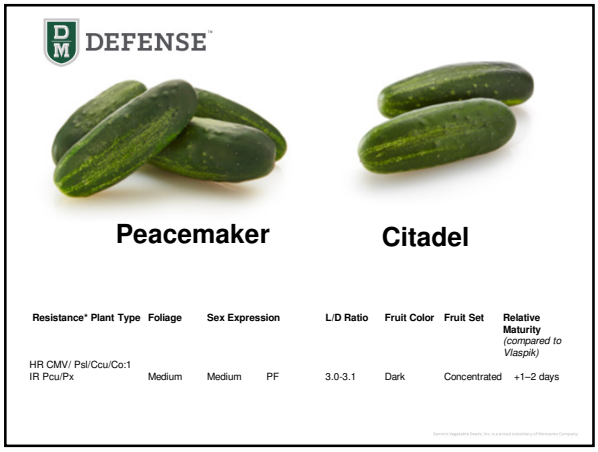
Downy Mildew Resistant Cucumbers

Great Lakes Expo 2017

Nischit Shetty
Monsanto Vegetable Seeds







SV4719CS

SV4719CS is an early Gynoecious slicer that yields attractive dark green color fruits with uniform fruit size in about 56 days. It has a moderately vigorous vine. SV4719CS fruits are about 8 inches long, hold their uniform, dark green color well and are cylindrical and blocky in shape.

Hybrid: SV4719CS
Relative Days to Maturity (DS): 56
Flower Habit: GY
Plant: Moderately Vigorous
Fruit Shape: Cylindrical, blocky
Fruit Size: 8 x 2.25 in.; 23 x 6 cm
Fruit Skin: Uniform, dark green
Disease Resistance: Psl, Co, Ccu (R); CMV, Px and Pcu (IR)
Features: IR to Pcu, Early to harvest, high yields with good fruit color.

Seminis grow forward

http://www.seminis-us.com/resources/agronomic-spotlights/managing-downy-mildew-in-cucumbers/

Auto-Steering and Precision Ag: What Can It Do For You?

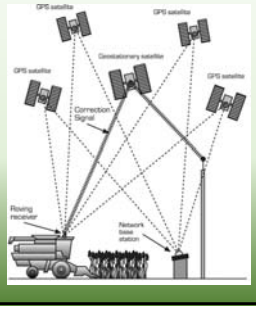
Dennis Pennington
Wheat Extension Specialist
Michigan State University

MICHIGAN STATE UNIVERSITY | Extension

Topics

- How GPS works
- Benefits
- What's available
- Capabilities
- Cost
- Application of technology

How does GPS work?



- Yield monitoring
- Yield mapping
- Variable rate fertilizer
- Weed mapping
- Variable spraying
- Topography and boundaries
- Salinity mapping
- Guidance systems
- Records and analyses

Satellite Corrections

The Wide Area Augmentation System (**WAAS**) is an air navigation aid developed by the Federal Aviation Administration (p... ...ctor Raytheon Company) to augment the Global Positioning Syste... (GPS)... the goal of improving its accuracy, integrity, and availability. (<...

Continuously Operated Refe... ...nce ...tio...

Benefits of Auto-Steer

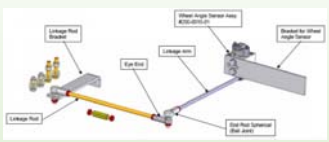
- Improved efficiency
- Reduced driver fatigue
- Able to watch equipment
- Reduce overlap (nutrients & spray)
- Tillage accuracy

7% overlap ✖ 1500 acres = 105 acres

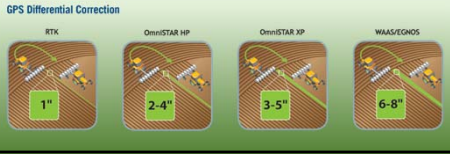
Matt Darr – IA State University - http://www.extension.iastate.edu/CropNews/2012/0224darr.htm

What's Available?

Fully Integrated Systems



Capabilities



Cost

Steering wheel systems:

Accuracy	Cost
6-8" (WAAS)	$7200
2"	$10,200
<1" (RTK)	$13,200

Fully integrated systems:

Accuracy	Cost
6-8" (WAAS)	$9500
2"	$11,500
<1" (RTK)	$14,500

Application of the Technology

- Tillage

105 acres × $15/ acre = $1575

Variable Rate Application

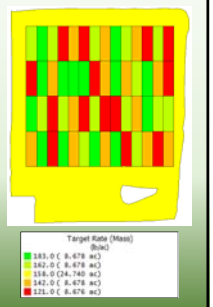
Precision Planting

Precision Spraying

Application of the Technology

- Harvesting
- On Farm Research Plots
- Other





Questions?

Dennis Pennington
pennin34@msu.edu
@pennin34
Cell: 269-832-0497

Olivet FFA Corn Maze
Olivet, MI 2017

Drones

- Agriculture is the single largest use of drones currently
- Used for:
  1. Scouting
  2. Identifying trouble spots
  3. Background information used for VRT
- Flight and guidance systems; camera, lenses and sensors; wireless; remote control; smart phone/tablet

Drones

- Types of images:

Drones

Rules and regulations:

- Must fly under 400 feet
- Drone must be in line of sight of operator
- Remain clear of aircraft operations (no fly zones around airports)
- Do not fly near sensitive infrastructure properties such as power stations, water treatment facilities, correctional facilities, roadways, government facilities, etc.
- Protect the privacy rights of others
- Register your drone ($5 fee)
- May need COA (certificate of authorization)