



Extension



Extension

Chemigation and Fertigation



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- <https://www.canr.msu.edu/irrigation/>
- <https://engineering.purdue.edu/ABE/Engagement/Irrigation>
- <http://www.egr.msu.edu/bae/water/>

1

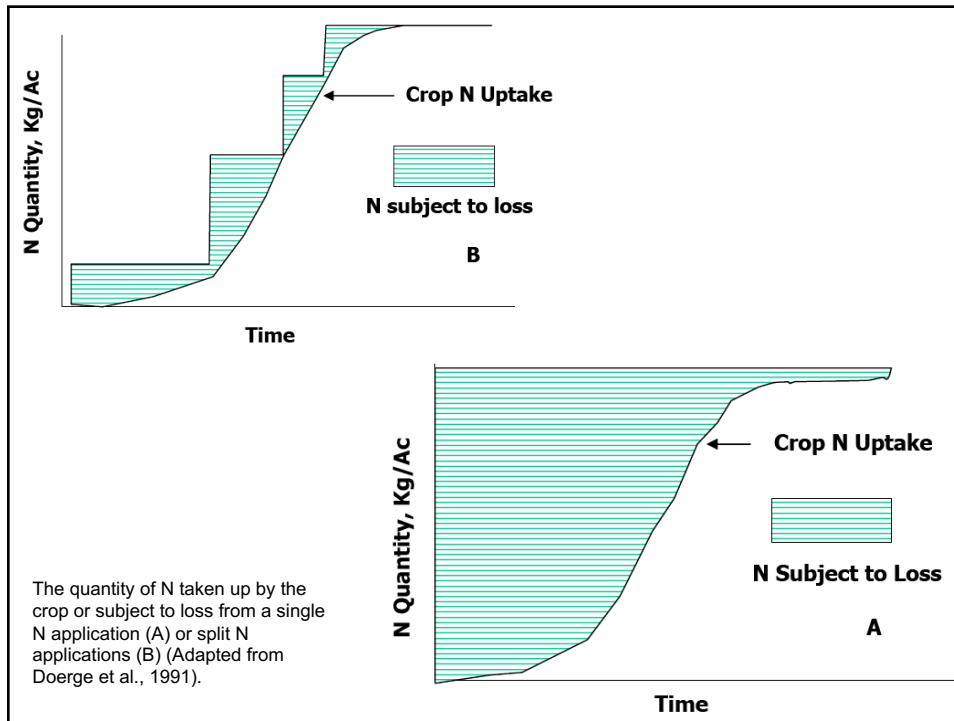
Chemigation – Application of pesticide via irrigation water.

Fertigation – Application of fertilizer via irrigation water.



Water-up –water in, germination of seed, incorporation of fertilizer and herbicides

2



3

Example N plan :
 200 bu/acre irrigated commercial corn

Expected yield goal 200 bu/acre resulting in 220 lb. N recommendation

35 lbs. in starter at planting
 135 lbs. as sidedress
 50 lbs fertigation, 2 week prior to tassel

50 lbs. in starter at planting
 70 lbs. as sidedress
 100 lbs fertigation, 2 week prior to tassel

50 lbs. in starter at planting
 70 lbs. sidedress or fertigation, knee high
 50 lbs. fertigation, waste high
 50 lbs. fertigation, 2 week prior to tassel

50 lbs. in starter at planting
 75 lbs. fertigation, knee high
 75 lbs. fertigation, 2 week prior to tassel
 20 lbs. fertigation, at tassel

4

Rescue Nitrogen Applications

Fertigation with small irrigation application requires very large injection systems.

10 gallon 28% =31lbs. N

450 gph =1 acres"/hour , 900 gph =2 acres"/hour

Required injection pump to achieve a 31 lbs. N in given application

Pump capacity 450 gph Application	Required Injection Pump capacity	Pump capacity 900 gph Application	Required Injection Pump capacity
1"	10 gph	1"	20 gph
3/4"	15 gph	3/4"	30 gph
1/2"	20 gph	1/2"	40 gph
1/4"	40 gph	1/4"	80 gph

In a wet year dribbling / flying on rescue N followed by rain or 0.2" irrigation is best management practice for many

5

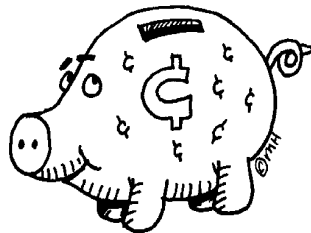
Think of your soil as a bank

avoid fertigation application that can not be held in the existing root zone

Water holding capacity:
The soil (bank) can hold only a given volume of water before it allows it to pass lower down.

Rooting depth:
The plant can only get water to the depth of it's roots.

Soil type :
Heavier soil can hold more water / foot of depth than light soils



Intake rate:
Water applied faster than the soil intake rate is lost.

Deletion:
Plants can pull out only 30 – 60% of the water

Water lost from the bottom of the profile can wash out (leach) water soluble nutrients and pesticides.

6

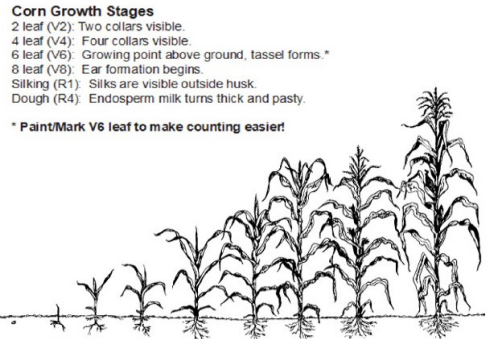
Estimate crop water use since last root zone filling rain to find max fertigation amount.

Example: Week of tasseling, 85° degree days 5 days since last major rain = 1" max application

Average water use for CORN in inches/day –adapted From * Irrigation Scheduling Checkbook Method, Jerry Wright, University of Minnesota, 2002

Temperature	Week after emergence																	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
50-59	.01	.02	.03	.04	.05	.06	.08	.09	.09	.10	.10	.10	.09	.07	.06	.05	.04	.03
60-69	.02	.03	.04	.06	.08	.09	.11	.12	.13	.15	.14	.14	.13	.11	.09	.07	.06	.04
70-79	.03	.04	.05	.07	.10	.12	.15	.16	.17	.19	.19	.18	.17	.14	.11	.09	.07	.05
80-89	.03	.05	.07	.09	.13	.15	.18	.20	.22	.24	.23	.22	.21	.17	.14	.11	.09	.06
90-99	.04	.06	.08	.11	.15	.18	.21	.24	.26	.28	.27	.26	.25	.20	.17	.13	.11	.07
Corn growth stages		3 leaf			8 leaf			1 st tassel	silk		blister kernel		early dent	dent				

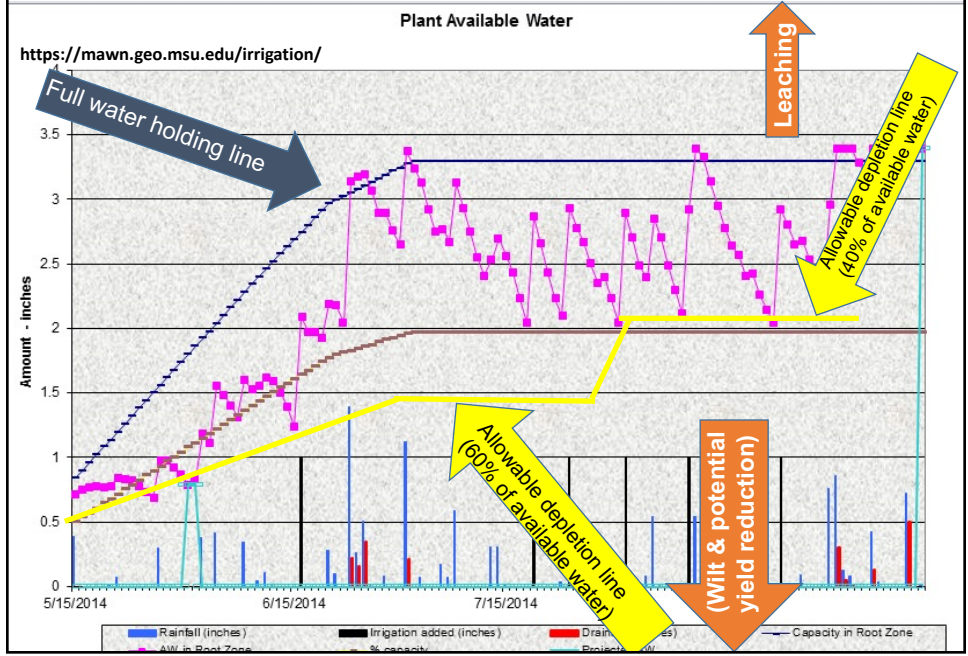
Crop Stage	K	Rooting Depth	% Growing Season
V2	0.2	6	10
V4	0.20	10	15
V6	0.39	15	20
V8	0.56	20	27
V10	0.76	23	34
V12	1.0	26	50
V14	1.1	28	55
V16-VT	1.2	30	60
Silking	1.2	30	65
Blister	1.2	30	70
Dough	1.2	30	75
Begin Dent	1.2	30	80
Full Dent	1.0	30	85
Black Layer	0.66	30	90
Full Maturity	0.11	30	100



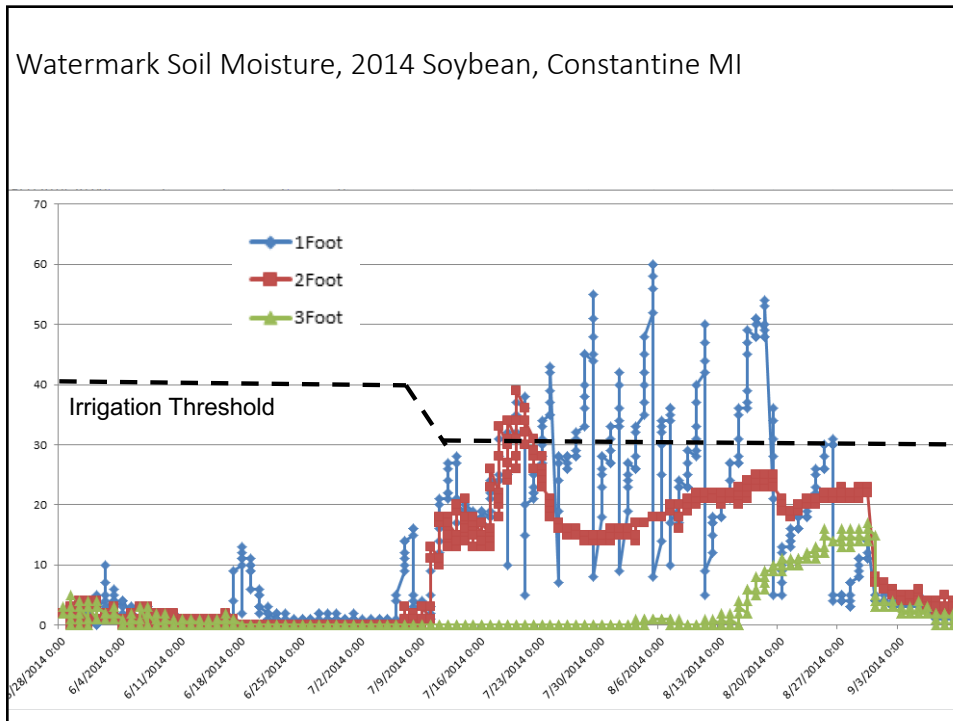
It is the policy of Purdue University Cooperative Extension Service that all persons

7

MSU Excel Irrigation Schedule Checkbook Method - Mendon 2014



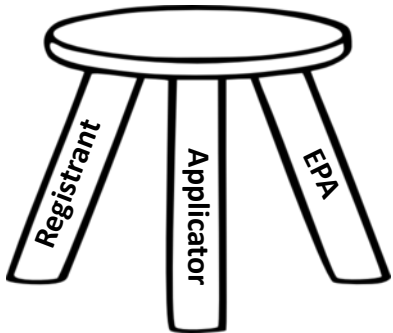
8



9

Chemigation Label

Chemigation label provide specific mixing, application and safety precautions.



Federal pesticide laws require products applied through irrigation systems to have a federal chemigation label.

Used within the direction of the label, the product is safe and effective.

Fertilizer solution – Growers responsibility – well code

- 28% most common – 27%+S used when Sulfur is needed
- Go with proven products or let the neighbor try it first

10

Headline AMP®

Fungicide

For use in disease control and plant health in corn and sugarcane

Active Ingredients:

pyraclostrobin*: (carbamic acid, [2-[[[1-(4-chlorophenyl)-1H-pyrazol-3-yl]oxy]methyl]phenyl]methoxy-,methyl ester)	13.64%
metconazole**: 5-[4-chlorophenyl(methyl)-2,2-dimethyl-1-(1H-1,2,4-triazol-1-yl)methyl]cyclopentanol	5.14%
Other Ingredients:	81.22%
Total:	100.00%

*Equivalent to 1.22 pounds of pyraclostrobin per gallon.
**Equivalent to 0.46 pound of metconazole per gallon.

EPA Reg. No. 7969-291

EPA Est. No.

**KEEP OUT OF REACH OF CHILDREN
WARNING/AVISO**

Si usted no entiende la etiqueta, busque a alguien para que se la explique a usted en detalle. (If you do not understand this label, find someone to explain it to you in detail.)

See inside for complete **First Aid, Precautionary Statements, Directions For Use, Conditions of Sale and Warranty,** and state-specific crop and/or use site restrictions.

In case of an emergency endangering life or property involving this product, call day or night 1-800-832-HELP (4357).

Net Contents:

BASF Corporation
26 Davis Drive, Research Triangle Park, NC 27709

<http://www.cdms.net/ldat/ld9A/M004.pdf>

PROPICONAZOLE GROUP 3 FUNGICIDE | BENZODIOLUPPI GROUP 1 FUNGICIDE | AZOXYSTROBIN GROUP 11 FUNGICIDE | FILL HERE TO OPEN ▶



Trivapro®

Fungicide

syngenta.

Active Ingredients:	
Diazoxinilflogryl*	2.9%
Azoxystrobin**	10.5%
Propiconazole***	11.9%
Other Ingredients:	74.7%
Total:	100.0%

*CAS No. 1072957-71-1
**CAS No. 131850-33-8
***CAS No. 69307-90-1

Trivapro Fungicide is formulated as a suspo-emulsion and contains 0.25 lb of benzoxinilflogryl, 0.32 lb of azoxystrobin, and 1.04 lb of propiconazole active ingredients per gallon.

**KEEP OUT OF REACH OF CHILDREN.
WARNING/AVISO**

Si usted no entiende la etiqueta, busque a alguien para que se la explique a usted en detalle. (If you do not understand this label, find someone to explain it to you in detail.)

See additional precautionary statements and directions for use inside booklet.

See **First Aid** statement inside booklet and on container label.

EPA Reg. No. 100-1613
EPA Est. 100-NE-001

SCP 1613A-L1E-0219

4107409

2.5 gallons
Net Contents

<https://www.syngenta-us.com/current-label/trivapro>

11

Traveler Fertiligation – Limit to 1/3 of the total fertilizer application for the season
Few fungicides labels allow use with travelers

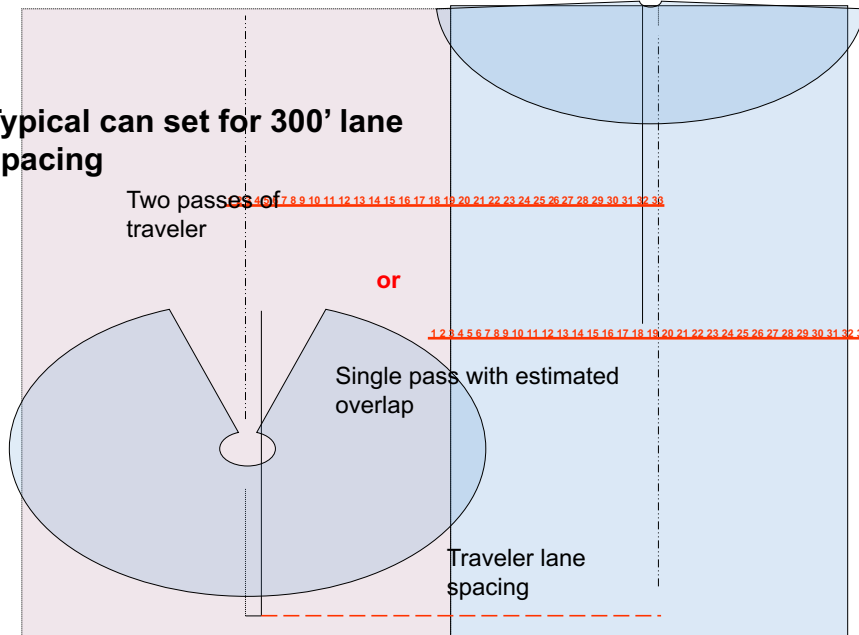
Typical can set for 300' lane spacing

Two passes of traveler

or

Single pass with estimated overlap

Traveler lane spacing



12

Use Directions For Sprinkler Irrigation Applications, con't

DO NOT exceed 1/2 inch (13,577 gallons) per acre. In stationary or non-continuous moving systems, inject the product/water mixture in the last 15 to 30 minutes of each set allowing sufficient time for all of the required pesticide to be applied by all the sprinkler heads and applying the labeled rate per acre for that crop. (Headline AMP label)

- In general, best performance via irrigation is 0.1 to 0.25 inches of water per acre. Center-Pivot Irrigation (Trivapro label)

Is the pesticide effective if it is on the soil surface or in the ground?

Corn at tassel will hold 0.07" in the foliage, 0.10 in foliage and soil surface



13

Is the pivot capable of the needed application?

Dealer Name : HOPKINS FARM SE Serial No. or B No. : S029524	GROSS APPLICATION (INCHES)	MAIN PANEL TIMER (PERCENT)	REVOLUTION TIME (HOURS)
Last Tower Tire Size : 14.8 x 24	0.17	100.0	6.2
Last Tower Motor Speed : 43.0	0.17	100.0	6.2
Feet per Minute @ 100% : 10.20	0.20	83.5	7.4
Flowrate : 500	0.30	55.7	11.2
Pivot Pressure : 31	0.40	41.8	14.9
% of Pivot Revolution : 100%	0.50	33.4	18.6
Length to Last Tower : 606	0.60	27.8	22.3
Total System Length : 651	0.70	23.9	26.1
Range of End Gun : 105	0.80	20.9	29.8
Total Length w/Endgun : 756	0.90	18.6	33.5
Date: 04/09/13	1.00	16.7	37.2
	1.10	15.2	41.0
	1.20	13.9	44.7
	1.30	12.8	48.4
	1.40	11.9	52.1
	1.50	11.1	55.8
	1.60	10.4	59.6
	1.70	9.8	63.3
	1.80	9.3	67.0
	1.90	8.8	70.7
	2.00	8.4	74.5

FieldBoss & FieldVision Inputs:
500 gpm
373 min
756 ft

GROWSMART
#11034

This chart is an estimate of the performance of your Zimmatic center pivot system.

System Length	System Serial #	System Gallonage
655 ft.	394-1414	500 @ .35
Water Applied	.109 IN / .70.0 MM	.5 IN / 15.0 MM
Timer Setting	100%	29 23 19
Add 20% if 50 Hz.		38 48 57
Hours To Apply	11 19 29	38 48 57
TIRE SIZE	14.8 x 24	Gear Ratio 60:1
Last Tower 'S' tower SAC		End Gun Model 5P1100

It is estimated that corn at tassel will hold 0.07" of water in the foliage.

Another 0.03" is held by the soil surface.

Resulting in 0.10" of water from each application never making it to the root zone.

Small application (0.07" - 0.14") are good for pesticide application, but not for Nitrogen application.

14

Coverage and Concentration

Headline Amp Product, 14.4 oz./acre	gal/acre water	% Headline Amp
Aerial Application minimum	5	2.25000
Common Ground Application	20	0.56250
0.07" chemigation	1901	0.00592
0.15" chemigation	4073	0.00276
0.25" chemigation	6789	0.00166
0.5" chemigation	13,577	0.00083

15

Use Directions For Sprinkler Irrigation Applications, continued...

DO NOT apply when wind speed favors drift beyond the area intended for treatment. (Trivapro label)

Off target application are violation of label, Michigan Irrigation GAAMP, and Indiana /Michigan Pesticide regulations



16

Use Directions For Sprinkler Irrigation Applications, continued...

Crop injury, lack of effectiveness, or illegal pesticide residues in the crop can result from non-uniform distribution of treated water. Thorough coverage of foliage is required for good control. (Headline AMP label)

Restrictions: (1) Use only with drive systems which provide uniform water distribution. (2) **Do not use end guns** when chemigating Trivapro Fungicide through center pivot systems because of non-uniform application. (Trivapro label)



17



Uniform Application

Inspect and Repair

Equipment First



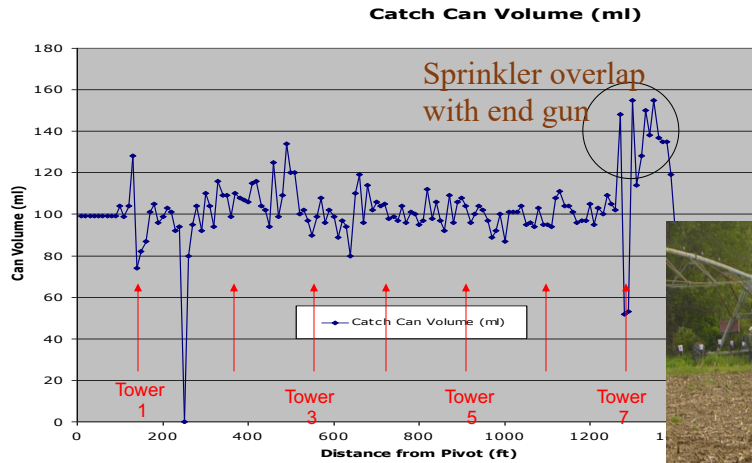





About a 20 x over application

18

Uniform Water application essential for uniform fertigation/chemigation



<https://www.canr.msu.edu/irrigation/index#presentations>

19

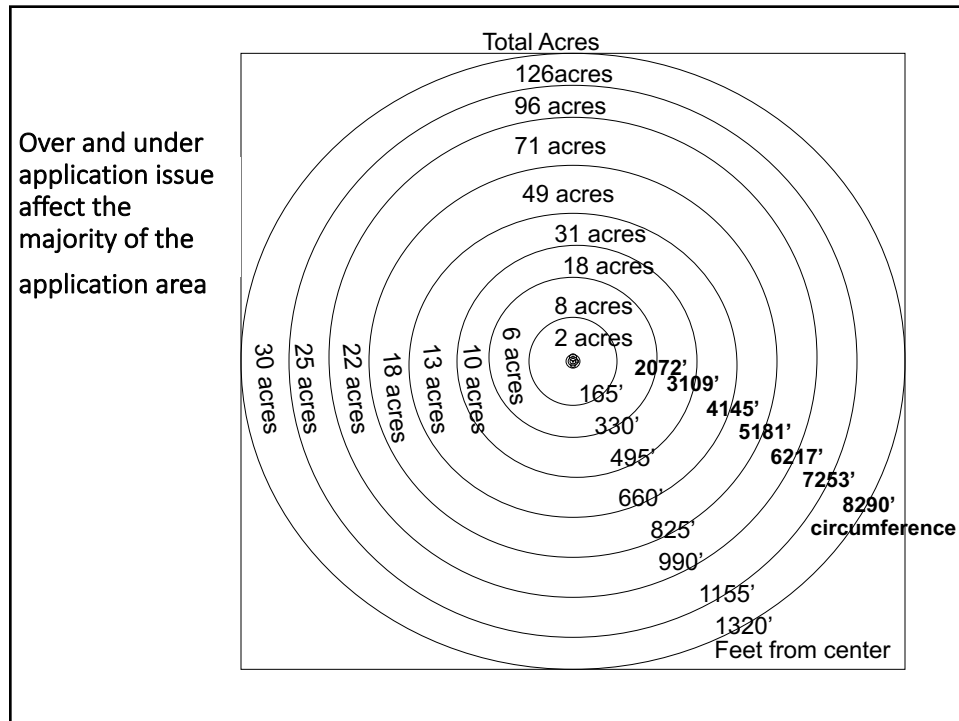
Most system apply within 85% of the expected application

MSU Extension Irrigation System Evaluation Tool, 1-23-07												
2	Farm Name	[Redacted] Farm										
3												
4	System Identification	Cornering Arm System on	[Redacted] Farm-Behind House									
5		Cornering Arm Extended										
6	System Settings											
7	Application rate (in)	0.5			Wind speed (mph)	4 mph						
8	Percent timer Setting (%)	19			Wind Condition (variable or steady)	steady						
9	Operating Pressure (psi)											
10	Rate of application calculator											
11												
12	Time from start to end of application at highest rate section of system (min.)				22							
13	Rate of application for the highest rate section of system (minute /one inch)				48.00				Inches/Hour	1.25		
14	Length of evaluation area (ft)	1340			Average Application (cm)					1.164		
15	Catch Can Spacing Distance (ft)	10			Average Application (in)					0.46		
16					Average catch, collected only (ml)					88.95		
17	number of cans data collected from	129			70% average catch can (ml)					59.94		
18	number of cans set	134			Evaluation area, full circle (acres)					122.82		
19					catch can opening area (sq cm)					76.977		
20	Diameter of catch can (cm)	9.9			catch can opening area (sq in)					11.767		
21												
22												
23	catch can number	Distance from center point	catch volume in ml	Data adjustment	Comments	Water volume (cm)	Water volume (in)	% applied of average	Deviation from average (%)	Area covered per catch can (acres)	Area covered per catch can (% of total)	Weighted Deviation
25	1	10		88.95		1.156	0.455	99.26%	-0.74%	0.01623	0.01%	0.0001
26	2	20		88.95		1.156	0.455	99.26%	-0.74%	0.02685	0.02%	0.0002
27	3	30		88.95		1.156	0.455	99.26%	-0.74%	0.04327	0.04%	0.0003
28	4	40		88.95		1.156	0.455	99.26%	-0.74%	0.05770	0.05%	0.0005
29	5	50		88.95		1.156	0.455	99.26%	-0.74%	0.07212	0.06%	0.0006
30	6	60		88.95		1.156	0.455	99.26%	-0.74%	0.08655	0.07%	0.0007
31	7	70	125	0.00		1.624	0.639	139.48%	39.48%	0.10097	0.08%	0.0011
32	8	80	75	0.00		0.974	0.384	83.69%	-16.31%	0.11539	0.09%	0.0008
33	9	90	115	0.00		1.494	0.588	128.32%	28.32%	0.12982	0.11%	0.0014
34	10	100	105	0.00		1.364	0.537	117.16%	17.16%	0.14474	0.12%	0.0014

Application is 4% under expectation

Page 1

20



21

Greatest improvement needed

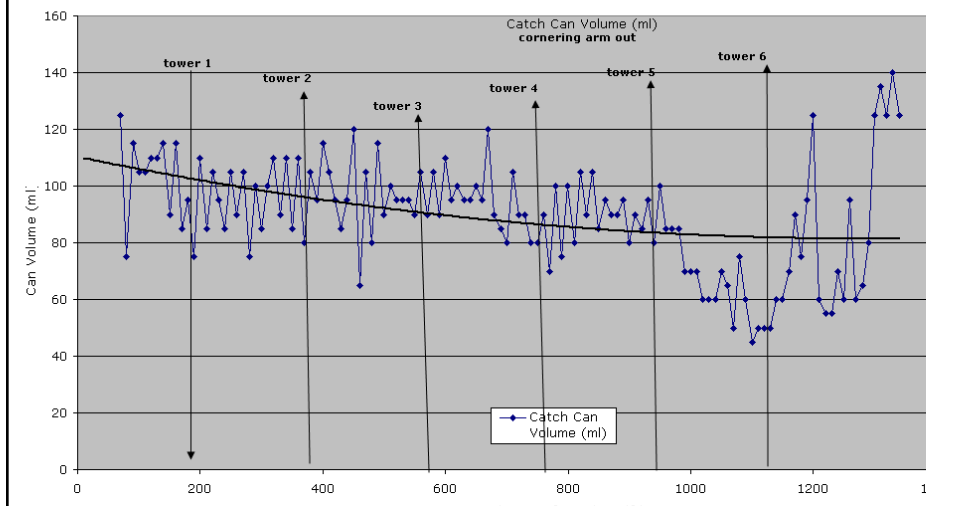
- End gun stop adjustment
- Water supply over or under design
- End gun orifice, too little or too much
- Wrong sprinkler or tip
- Leaks, plugs and no turn sprinklers

22

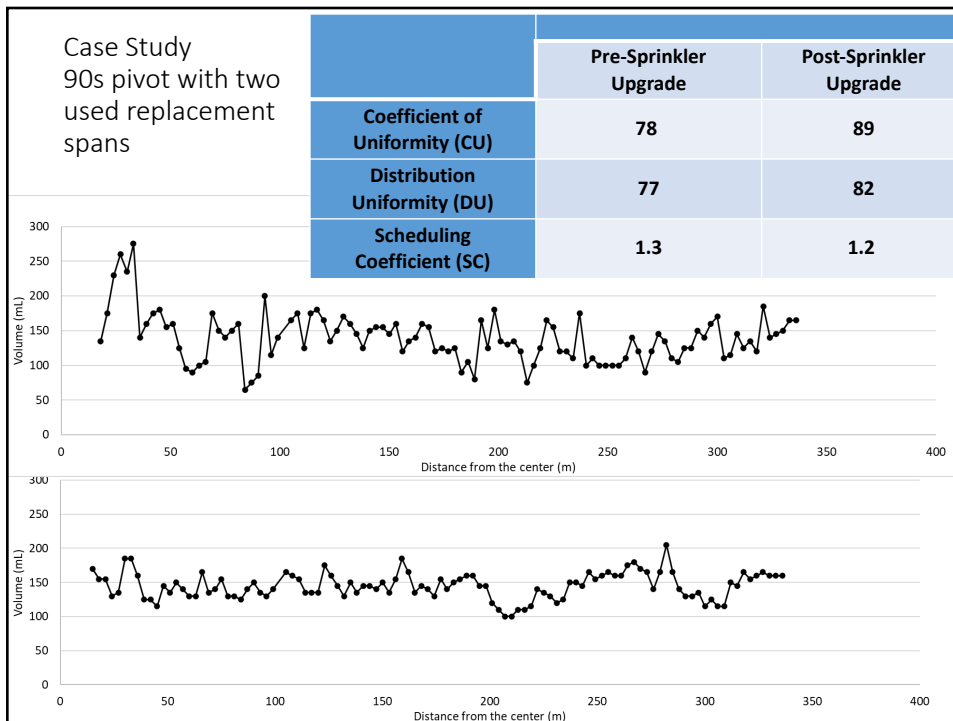
Water supply over or under design

supply over design yield tail up, supply under design yield tail down

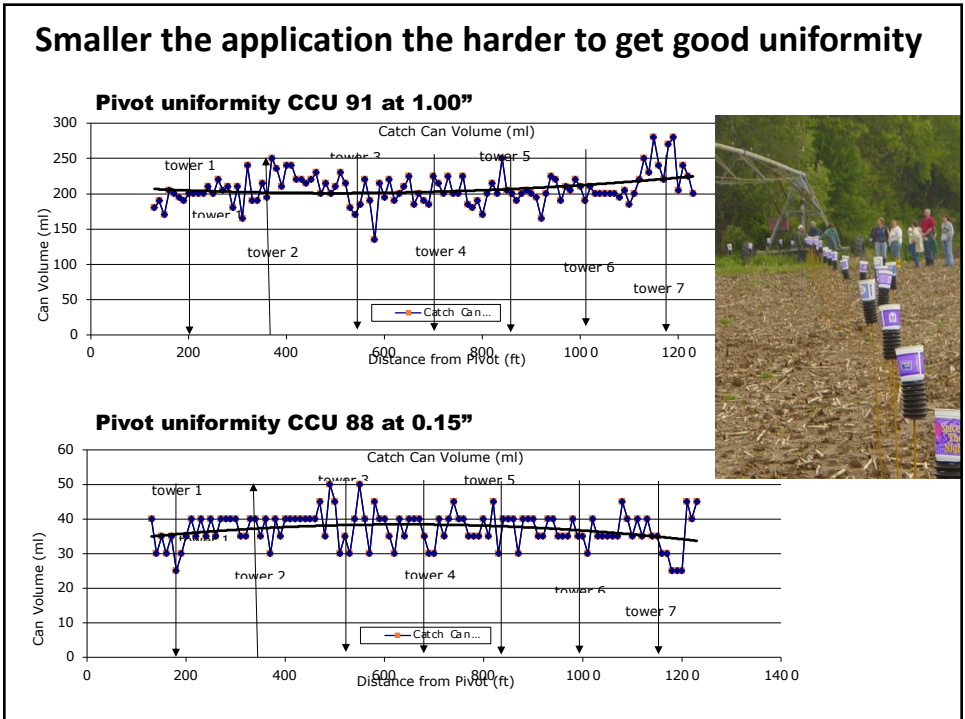
Example of Water supply under volume for sprinkler design



23



24



25

Irrigation System Uniformity

- Most systems are designed to have 90% or better uniformity
- Changes in **volume** and **pressure** from design parameters will cause reduction in uniformity
- Some sprinklers can perform well over a large change in pressure over others
- Multiple overlaps tends to reduce potential problems

26

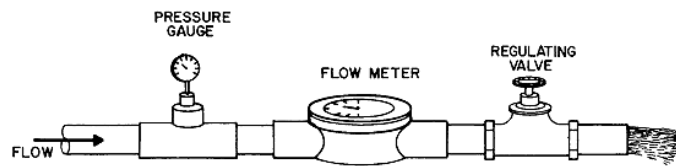
Measure Pressure:

- at pivot point and last sprinkler
- If pressure differ from chart specification > 10%, measure flow



27

Measure flow at desired pressure prior to ordering sprinkler package



Poor performance:



Ask dealer to measure flow at peak water use season and compare to design parameters.



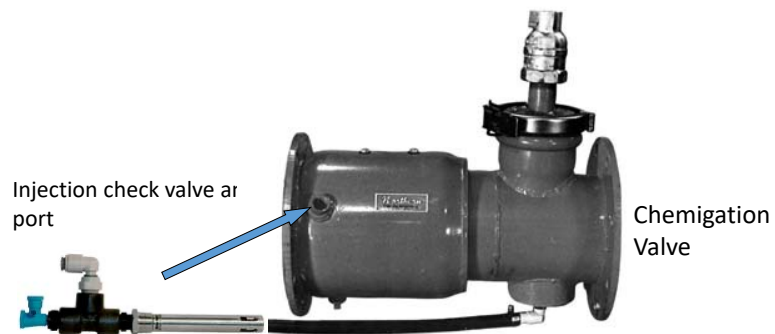
28

Suggested Minimum Performance to Chemigation/Fertigation

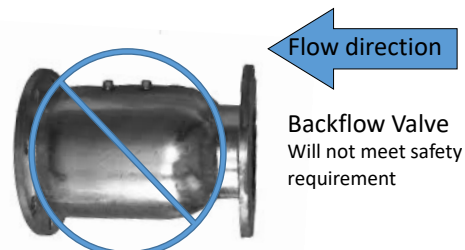
- System uniformity evaluation 85% or greater
-----or at a minimum-----
- Pivot point and last sprinkler pressure within 10% of sprinkler package specifications
- Required backflow protection in place and functional
- No major leaks or repair needed
- No major runoff issues
- No 2X or greater over application areas
- Interlock shut off system in place and functional

29

- The system must contain a functional check valve, vacuum-relief valve, and low-pressure drain appropriately located on the irrigation pipeline to prevent water-source contamination from backflow.



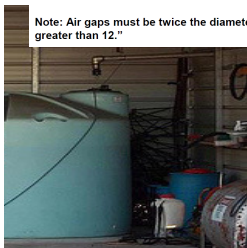
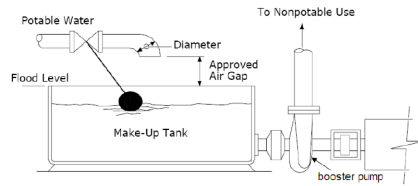
- The pesticide injection pipeline must contain a functional, automatic, quick-closing check valve to prevent the flow of fluid back toward the injection pump.



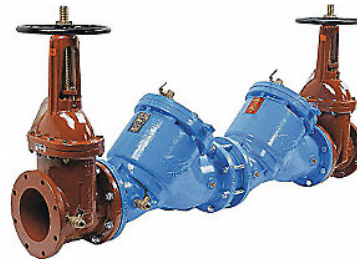
30

A few of the additional requirements if irrigation water supply is a public water supply

- **DO NOT** connect an irrigation system (Including greenhouse systems) used for pesticide application to a public water system unless the pesticide label-prescribed safety devices for public water systems are in place. (Headline AMP label)

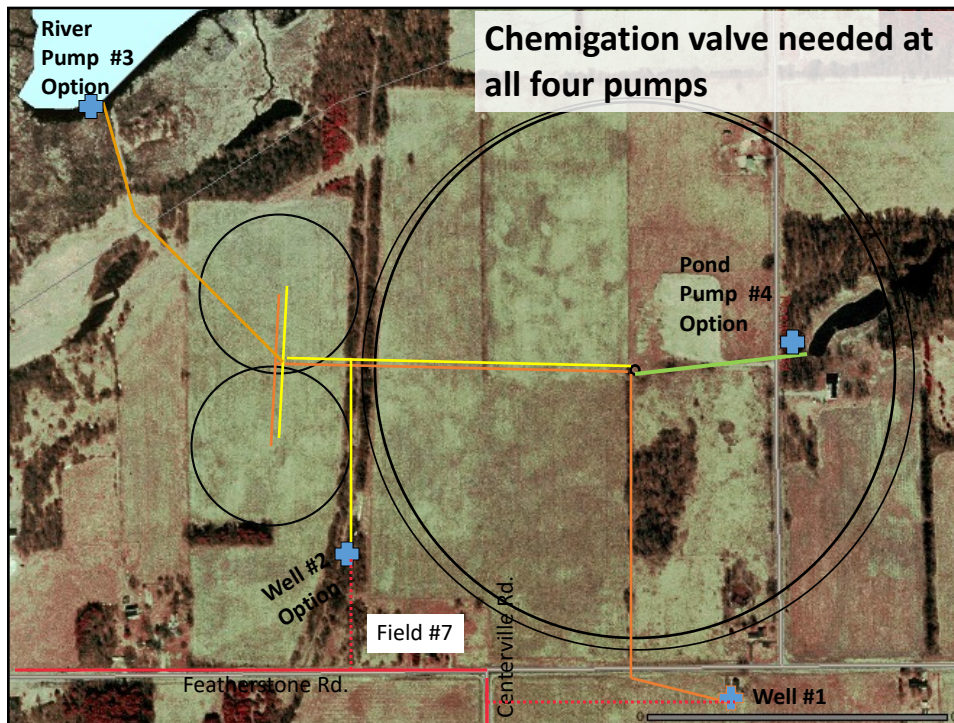


Note: Air gaps must be twice the diameter of the inlet pipe, at least 1", but no greater than 12."



reduced-pressure zone, back-flow preventer (RPZ) or a reservoir tank the diameter filled by a pipe from public water supply with a air gap twice size of fill pipe.

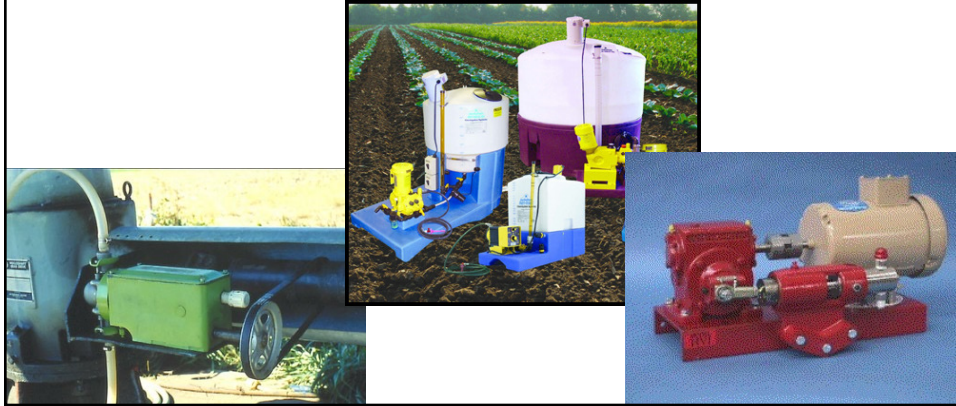
31



32

Positive displacement injection pump

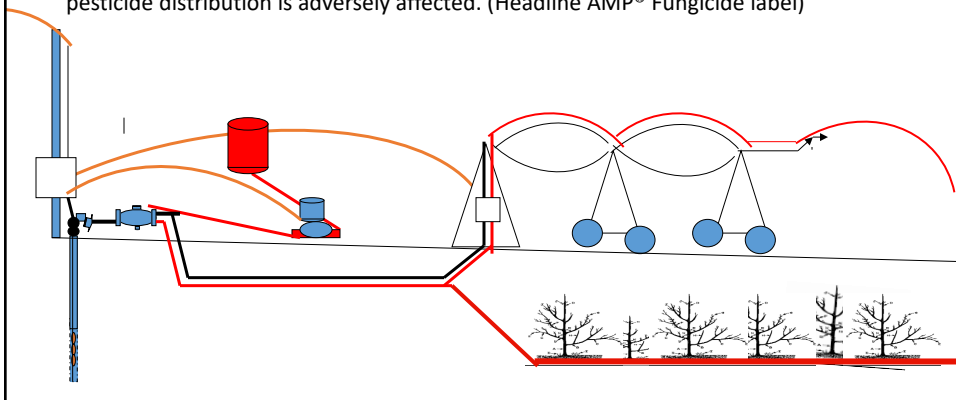
- Systems must use a metering pump, such as a positive displacement injection pump (e.g. diaphragm pump), effectively designed and constructed of materials that are compatible with pesticides and capable of being fitted with a system interlock. (Headline AMP® Fungicide label)



33

Safety Interlock - Pivot movement, water pump and injection pump need to be interlocked so if any one of them stops, all are shut down.

- The system must contain functional interlocking controls to automatically shut off the pesticide-injection pump when the water pump motor stops.
- The irrigation line or water pump must include a functional pressure switch that will stop the water pump motor when the water pressure decreases to the point where pesticide distribution is adversely affected. (Headline AMP® Fungicide label)



34

Chemigation / Fertigation Calibration

- If you have questions about calibration, you should contact state extension service specialists, equipment manufacturers or other experts. (Headline AMP® Fungicide label)

Example:

160 acres – 20 dry acres = 140 acres, pivot can cover the area in 12.5 hour at 100% move (0.15”)

12 oz./acre required x 140 acres = 1680 oz.
1680 oz. = 13.125 gal

Mix 13.125 gal of fungicide with enough water to make 140 gal. of solution

12.5 hours period * 60 minutes = 750 min.

1680 oz. / 750 minutes = 2.24 oz./min.

Adjust pump to deliver 2.24 oz./minute
(a little over 1 gal./hr.)



35

- A person knowledgeable with the chemigation system and responsible for its operation, or under supervision of the responsible person, shall shut the system down and make necessary adjustments should the need arise.

(Headline AMP® Fungicide label)

Monitor for calculation errors or system malfunctions.

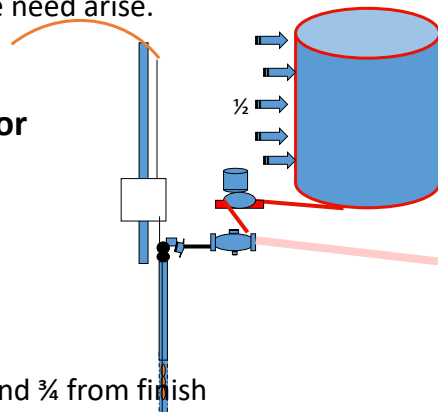
- Shut-downs
- Backflows
- Hose burst

Mark the supply tank level at start

Mark the supply tank level at $\frac{1}{4}$, $\frac{1}{2}$, and $\frac{3}{4}$ from finish

Monitor and adjust if needed, calculate and record the actual applied amount for future decisions.

Backflow situation.... Pump, Pump, Pump as soon as possible.



36

Shut down, flush

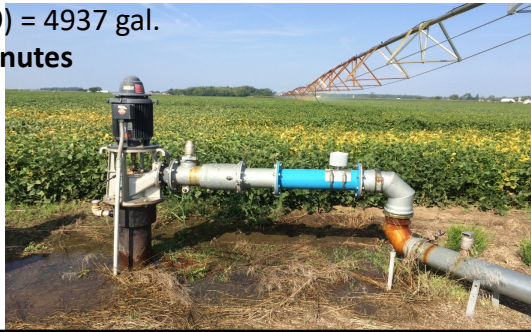
- Allow sufficient time for pesticide to be flushed through all lines and all nozzles before turning off irrigation water. (Headline AMP® Fungicide label)

Example: pumping time flush system

I have 1000' of 8" pipe between my injection point and my 1300' center pivot with 6 3/8" pipe. Water supply to pivot is 800 gpm.

$(10 \times 261 \text{ gallons}) + (13 \times 179) = 4937 \text{ gal.}$
 $4937 \text{ gal.} / 800 \text{ gpm} = \mathbf{6.2 \text{ Minutes}}$

100' of given pipe size pump capacity			
6 inch	6 3/8 inch	8 inch	12 Inch
147 gal.	179 gal.	261 gal.	588 gal.



37



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Potential

Lyndon Kelley

MSU Extension / Purdue University Irrigation Management Agent

St. Joseph Co. MSU Extension, 612 E. Main St., Centreville, MI 49032

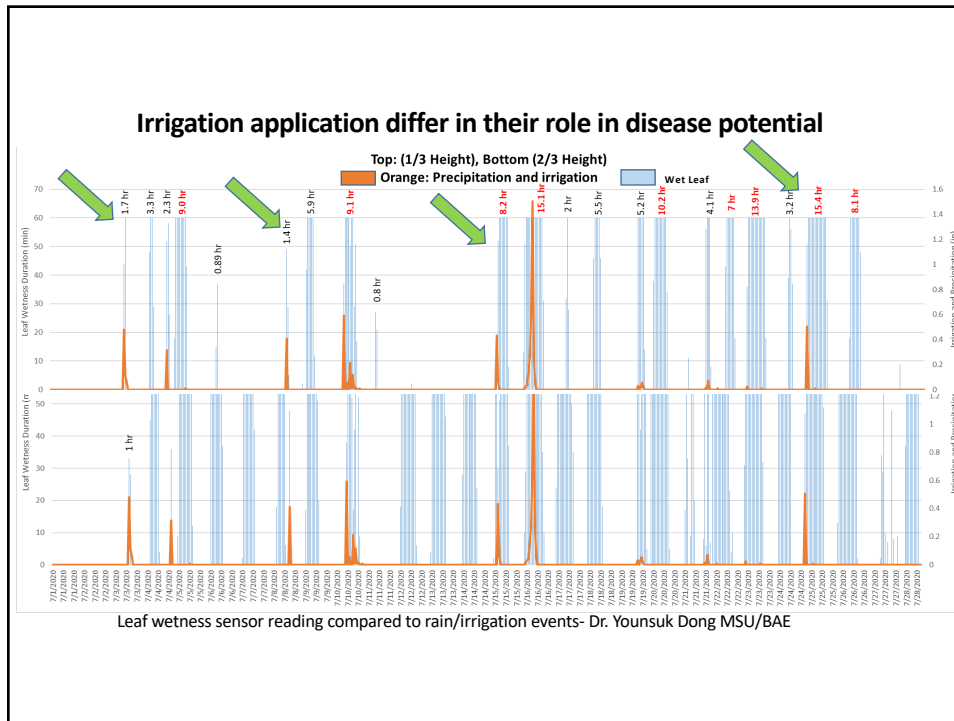
cell 269-535-0343, kelleyl@MSU.EDU, 269-467-5511

<https://www.canr.msu.edu/irrigation/>


<https://engineering.purdue.edu/ABE/Engagement/Irrigation>

<http://www.eqr.msu.edu/bae/water/>

38



39



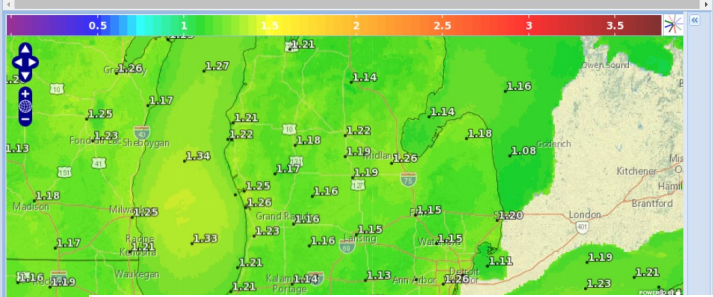
NATIONAL WEATHER SERVICE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

<https://www.weather.gov/abr/etforecasts>
<https://enviroweather.msu.edu/rpetalert.php>

Graphical Forecasts
Weather.gov - National Digital Forecast Database Graphical Forecasts

National Digital Forecast Database Display

National (CONUS) Total Weekly FRET (in) Ending Aug 5, 8 PM EDT



FRET – expected rainfall x Kc corn 115% x 110 % for evaporative loss = needed application
(1.20 – no rain x 1.15) x 110% = 1.65”

Total Weekly FRET (in)
Through Wed Aug 5 2020, 8 PM EDT
Issued: Jul 30 at 8 AM EDT

Irrigation scheduling:

Irrigate only when you can increase yield and quality, or reduce risk

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National (CONUS) Alaska Hawaii Guam Puerto Rico Tropical Atlantic Tropical Pacific

40

Large Irrigation Application Volumes Deliver More Effective Water To Crop with Less Wetting

- A typical **Corn or Soybean** crop will use 6.3” of water in August, average August rainfall is 3.2” in SW Michigan resulting in a 3.1” of needed irrigation
- Evaporation varies greatly by canopy, crop residue and soil type
- First 0.05-0.12” of each overhead application will evaporate from soil surface and crop canopy
- Given: 0.08” evaporative loss, 3.1” irrigation need

Evaporative Loss , Effective water and number of wetting events			
Based on 3” of irrigation, 0.10” evaporation / application			
	Water evaporated from crop canopy & soil surface	Effective water available for crop transpiration	Number of irrigation wetting events
Three applications of 1.0”	0.3”	2.7”	3
Six applications of 0.5”	0.5”	2.5”	6
Twelve applications of 0.25”	1.2”	1.8”	12

41



42