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New Jersey Agricultural
Experiment Station

Precision Irrigation in the Orchard

Hemant Gohil, Ph.D.

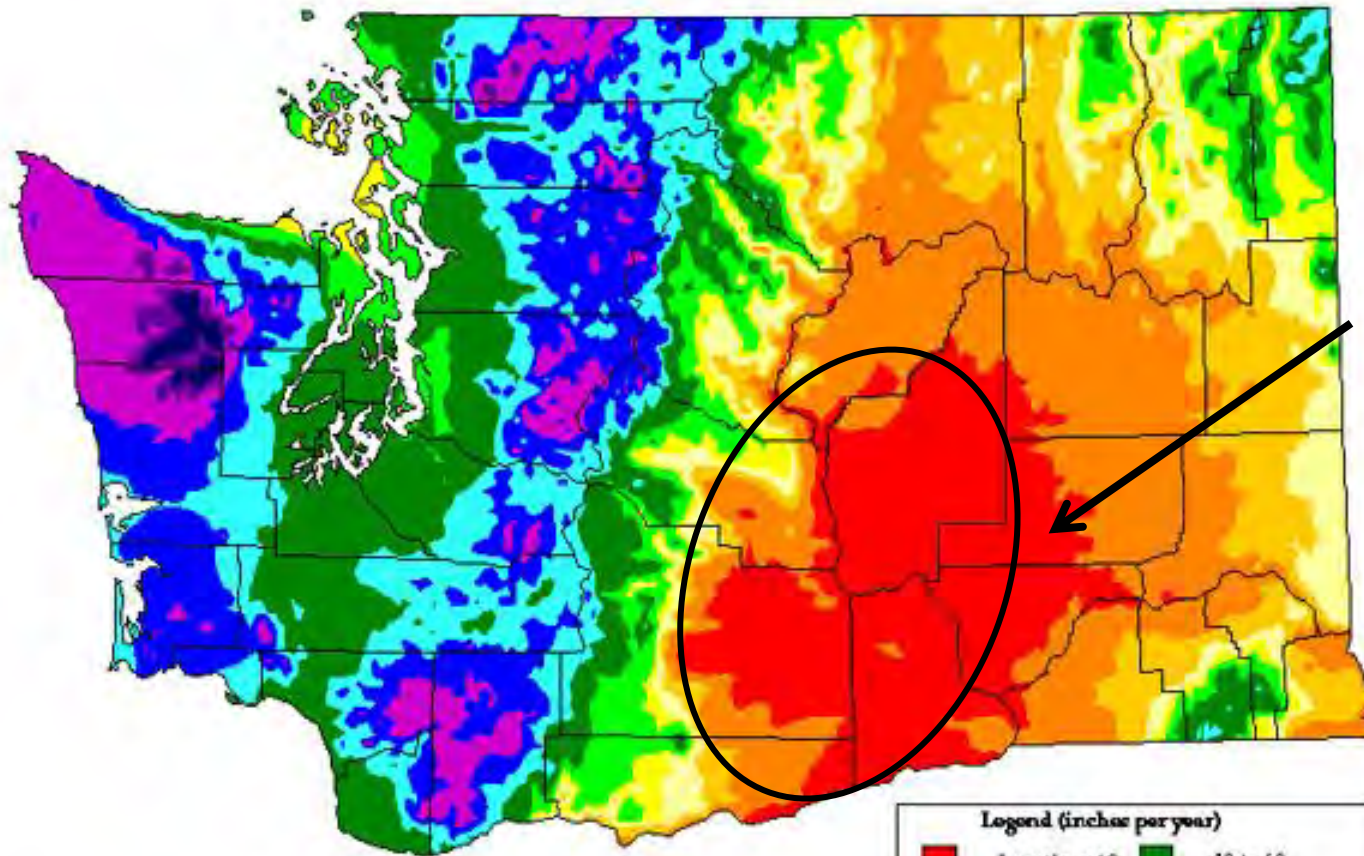
Gloucester County Agricultural Agent

Co-operative Extension of Rutgers University

Great Lake Expo, Grand Rapids, MI, Dec 3-5



Annual precipitation in Washington State

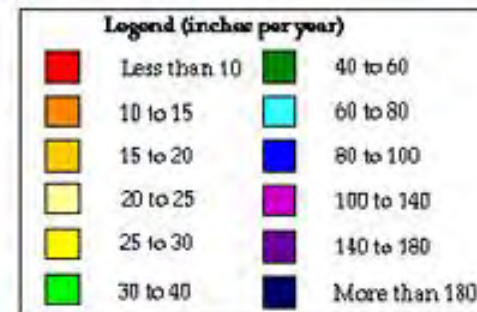


The largest and premium quality apple growing region

Average Annual Precipitation

Washington

Period: 1961-1990 Units: inches



Why Precision Irrigation?

- Greater wood structure during the early years.
- Less water during fruit development means smaller fruits and Loss in fruit size is irreversible.
(> 160 g in apple and peaches).
- Bitter pit in apple was observed more in poorly irrigated orchards in very dry year.
- Over-irrigation is expensive and may not help reduce bitter-pit

Precision Irrigation = Irrigation at right time, in right amount and right rate of application.

When to Irrigate
(depends on water stress)



How much to Irrigate
(soil type, irrigation system, age of tree)



How long to Irrigate
(irrigation system and soil type)

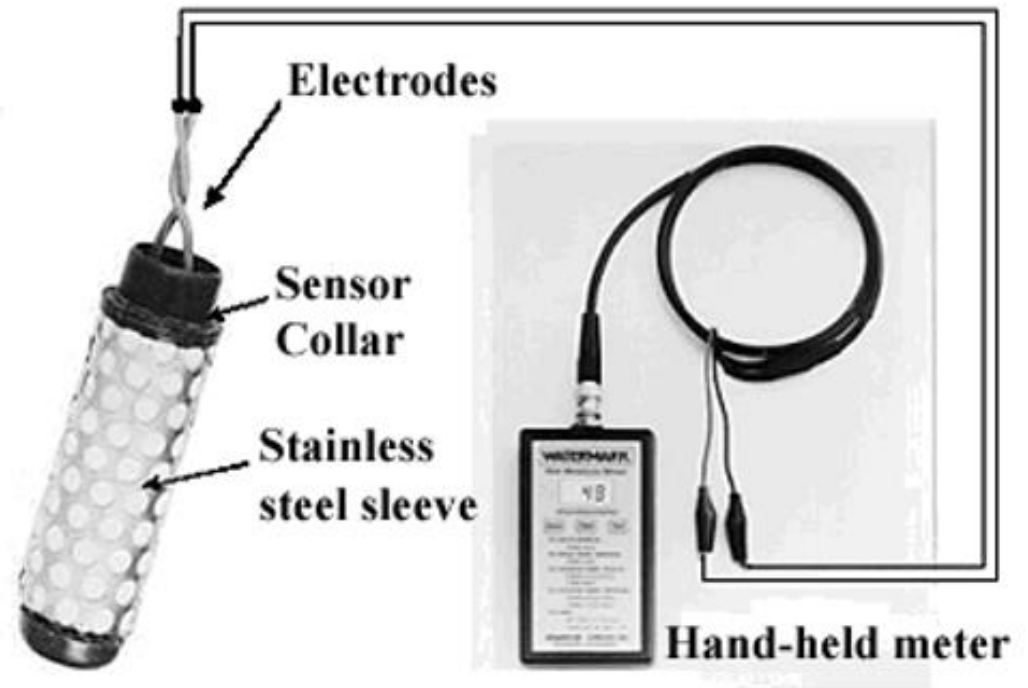
Approaches to estimate water stress

- Feel and appearance based
- Soil based (e.g. Tensiometer, resistance)
- Plant based (e.g. Pressure chamber)
- Irrigation model based (e.g. NEWA)

Soil Tensiometer.



Electrical resistance blocks





Use advanced soil sensors



newer Tensiometer
with data logger

Soil sensor reading and their meaning

Reading (centibars)	Soil water status	Interpretation
0-10 *Cbr	Saturated	No Stress. Water should be drained.
10-20 Cbr	Field capacity	No Stress. No Irrigation needed.
30-70 Cbr	Limited	Mild-moderate stress. Irrigate depending on soil type.
>70 Cbr	Too dry soil	High-severe stress. Irrigate to Field Capacity.

Begin Irrigation at 50% moisture depletion

Soil Type	Approx. centibars reading at 50% moisture depletion
Sand	20 Cbar
Loamy Sand	25 Cbar
Sandy Loam	40 Cbar
Loam	65 Cbar
Silt Loam	90 Cbar

How Much to irrigate?

Example of estimated water required per day during the dry spell.

	Age	Daily Water requirement Gallons/Tree	Trees/acre	Daily water requirement GPA
Traditional	Mature	30 - 45	109	3270 - 4950
	4	20 - 30		2180 - 3270
	3	10 - 20		1090 - 2180
	2	7 - 10		763 - 1090
	1	2 - 4		218 - 436
High-density	Mature	10 - 12	605	6050 - 7260
	4	8 - 10		4840 - 6050
	3	6 - 7		3630 - 4235
	2	2 - 3		1210 - 1815
	1	1 - 2		605 - 1210

The water use is amazingly similar among tree fruit species – Uni. of California ANR

* number of emitters/sprinklers per tree

Daily irrigation requirement/acre = water requirement/tree x number of trees/acre

Cornell Apple ET Model

State:

Weather station:

Select Date:

Apple ET Model for Elk Township

Change green tip date or tree density and click "Calculate" to recalculate results. Changing "Age of Orchard" will automatically recalculate table.

Green tip date	In row spacing	Between row spacing	Trees per acre	Age of orchard	Water balance
3/1/2016	20 feet	20 feet	109	Mature ▾	

Apple Evapotranspiration Model Results

Date	Orchard ET (gallons)		Rainfall		Irrigation	Water Balance (gallons/acre)	
	per tree	per acre	inches	gallons/acre	gallons/acre	Daily	Cumulative
Jul 5	21.8	2381	0.12	2281	0	-100	-100
Jul 6	43.5	4743	0.00	0	0	-4743	-4843
Jul 7	36.9	4026	0.00	0	0	-4026	-8869
Jul 8	37.1	4049	0.00	0	0	-4049	-12918
Jul 9	7.0	759	0.04	760	0	1	-12917
Jul 10	22.3	2433	0.00	0	0	-2433	-15350
Jul 11	37.9	4128	0.00	0	0	-4128	-19479
Jul 12	39.0	4256	0.00	0	0	-4256	-23734

How long to irrigate?

Determine the pump capacity for the orchard block.

Table 1: Determining the pump capacities for a drip irrigation orchard- examples

A	B	C	D	E	F	G	H
Spacing	Trees/acre	Emitters/tree	Emitter flow rate	Discharge/tree	Discharge/acre	Pump Capacity	3-acre block
ft x ft			gph	gph	gph	gpm	gpm
				C x D	B x E	F/60	3 x G
20 x 20	109	4	1	4	436	7	22
20 x 20	109	4	2	8	871	15	44
6 x 12	605	2	1	2	1210	20	61
6 x 12	605	2	2	4	2420	40	121

B = Trees/Acre = 43560 sq. ft./sq. ft. spacing per tree

E = Discharge/tree, gph = (emitters/tree) x (emitter flow rate)

F = Discharge/acre, gph = (Trees/acre) x (discharge/tree)

G = Pump capacity/acre, **gpm** = (discharge/acre)/60

How long to irrigate?

Table 2: Determining the pump capacity for a sprinkler irrigation orchard - examples

A	B	C	D	E	F	G	H
Spacing	Trees/Acre	Sprinklers/tree	Sprinkler Flow rate	Discharge/Tree	Discharge/Acre	Pump Capacity	3-acre block
ft x ft			gph	gph	gph	gpm	gpm
				C x D	B x E	F/60	3 x G
20 x 20	109	1	10	10	1089	18	55
20 x 20	109	1	5	5	545	9	27
6 x 12	605	1	10	10	6050	101	302
6 x 12	605	1	5	5	3025	50	151

B = Trees/Acre = 43560 sq. ft./ sq. ft. spacing per tree

E = Discharge/tree, gph = (sprinklers/tree) x (sprinkler flow rate)

F = Discharge/acre, gph = (Trees/acre) x (discharge/tree)

G = Pump capacity/acre, **gpm** = (discharge/acre)/60

How long to irrigate?

Table 3: Example of duration of irrigation per day during the dry spell in the orchard

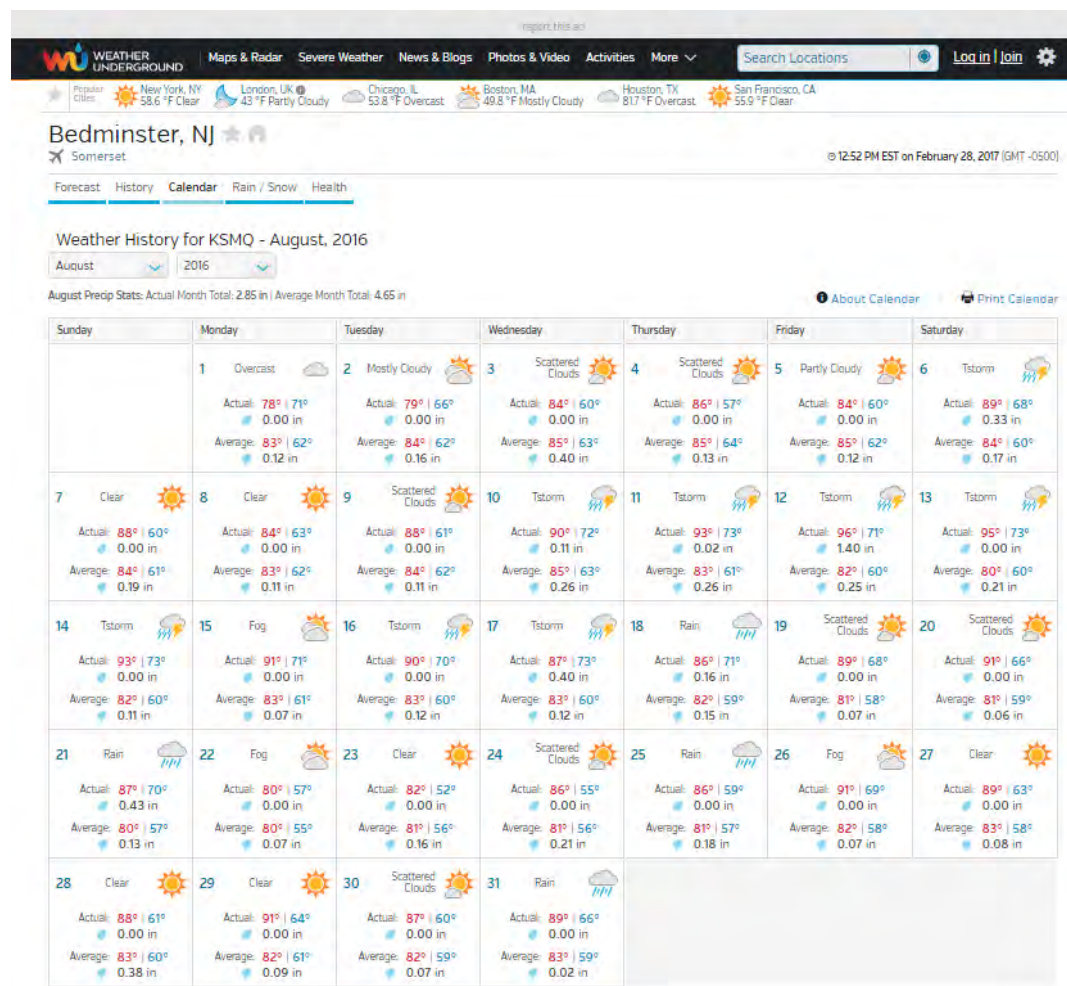
	Age	Water requirement Gallons/Tree	Trees/acre	Daily water requirement GPA	Hours of irrigation (required GPA/discharge)		
					Drip	Sprinkler	
					1 GPH x 4*	2 GPH x 4	10 GPH x 1
Traditional	Mature	30 - 45 G	109	3270 - 4950	8 - 10	4 - 5	3 - 4
	4	20 - 30 G		2180 - 3270	5 - 8	3 - 4	2 - 3
	3	10 - 20 G		1090 - 2180	3 - 5	2 - 3	2 - 1
	2	7 - 10 G		763 - 1090	2 - 3	1 - 2	0.5 - 1
	1	2 - 4 G		218 - 436	1 - 2	0.5 - 1	0.3 - 0.5
					1 GPH x 2	2 GPH x 2	5 GPH x 1
High-density	Mature	10 - 12 G	605	6050 - 7260	5 - 6	3 - 4	2 - 3
	4	8 - 10 G		4840 - 6050	4 - 5	2 - 3	1.5 - 2
	3	6 - 7 G		3630 - 4235	3 - 4	1 - 2	1 - 1.5
	2	2 - 3 G		1210 - 1815	1 - 2	0.5 - 1	0.5
	1	1 - 2 G		605 - 1210	0.5 - 1	0.5	0.5

* number of emitters/sprinklers per tree

Daily irrigation requirement/acre = water requirement/tree x number of trees/acre

Hours of irrigation = Daily water requirement, GPA/ discharge rate, GPA

How often? – once a week during early growing season and twice a week during summer



Follow soil moisture conservation practices in dry/drought season

- Fertilize lightly
- Shoot thin heavily
- Reduce weed growth and active cover crop
- Check the efficiency of irrigation systems

Thank You!

Good luck for the year 2019!!

Hemant Gohil, Ph.D.

*Gloucester County Agricultural Agent
Co-operative Extension of Rutgers University*

Ph: 856-244-8029

Gohil@njaes.rutgers.edu