Strategies for Germinating Lettuce with Drip Irrigation

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California Lettuce Research Board

Why germinate lettuce using drip irrigation?

- ✓Eliminate use of sprinklers
- ✓Reduce production costs?
- ✓Save water?
- ✓Reduce food safety risks?

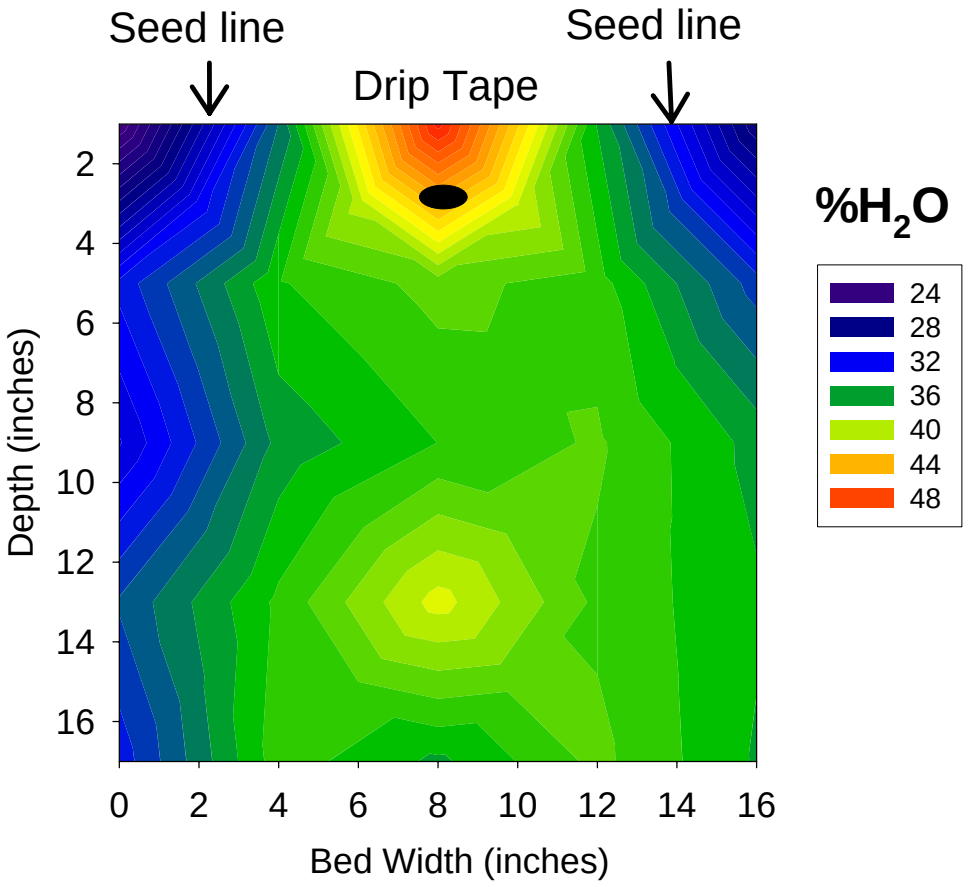
Central Coast Water Quality Impairments:

- bacterial pathogens
- nutrients (P and N)
- sediments
- pesticides
- salts

Potential Limitations to Drip Germination

- **Lateral Movement of Moisture**
- **Water Use**
- **Nitrate leaching**
- **Weed Control**

Soil Moisture Distribution Around Buried Tape



Tape Discharge Rate = 0.34 gal/min/100 ft
Tape depth = 2.5 inches
Bulk Density = 0.86 g/cc,
Soil = Clay

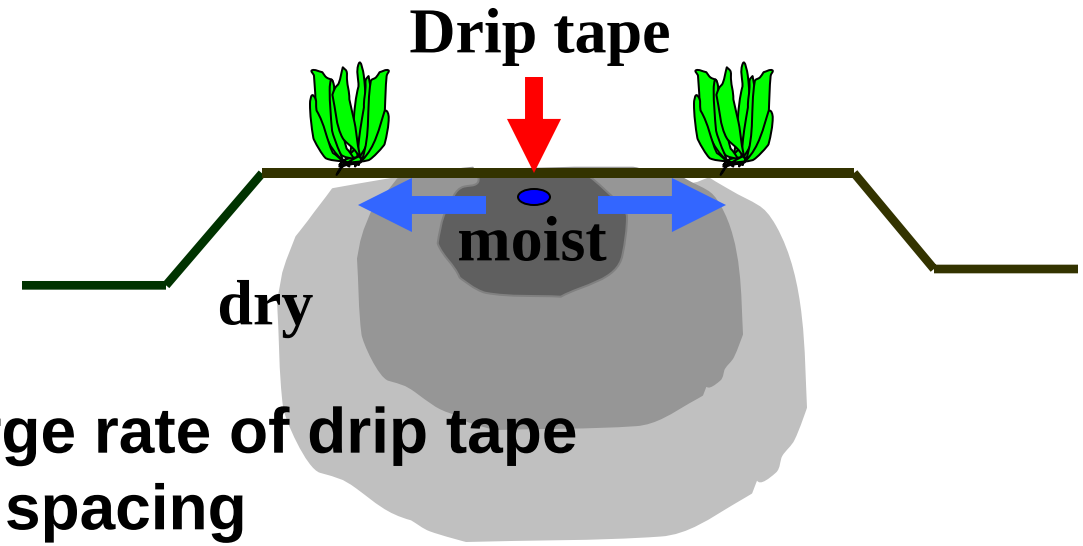
Objectives

1. Evaluate strategies for enhancing lateral movement of moisture around drip tape and maximizing germination
2. Compare water use and nitrate leaching between drip and sprinkler germination
3. Evaluate weed control under drip germination (Fennimore and Smith)

Field Trials

- Hartnell 2005: 2 Replicated Field Trials 2005
  - Chemical strategies to improve lateral movement
- Hartnell 2006: Replicated Field Trial
  - Cultural strategies to increase lateral movement
- USDA Spence Farm 2006: Replicated Field Trial
  - Weed control and comparison of sprinkler and drip
- 5 Commercial Field Sites 2006
  - Compare water use, germination, and nitrate leaching between sprinkler and drip

Strategies for Enhancing Lateral Movement of Water and Germination



- Discharge rate of drip tape
- Emitter spacing
- Depth of drip tape
- Bed Compaction (rolling)
- Aggregate size (mulching)
- Seed depth

Erosion Control Polymer

Soilfloc™ 300E

ENVIRONMENTALLY SAFE

SOILFLOC® 300E is a water-soluble, linear polyacrylamide (PAM) that is designed for use in agriculture for erosion control, infiltration enhancement and dust abatement. SOILFLOC® 300E flocculates suspended, fine, soil particles and settles them. SOILFLOC® 300E improves water infiltration, reduces the hardening of soils, and reduces soil loss.

Usage	Application Rates
Sprinkler Irrigation	Apply 2.5-8 lb./acre (maximum of 10 ppm)
Furrow Irrigation	Apply at a rate of 2.5-8 lb./acre (maximum of 10 ppm)

Directions for Use/Application

Sprinkler Irrigation:

1. SOILFLOC® 300E must be added in the first drop of water to reach the field.
2. Start irrigation water
3. Inject SOILFLOC® 300E downstream of sand filters.
4. Provide backflow protection for chemical pump.
5. Discontinue application of SOILFLOC® 300E prior to turning off irrigation water.
6. Apply in every other or every third irrigation cycle or when water becomes cloudy.

Furrow Irrigation:

1. SOILFLOC® 300E must be added in the first drop of water to reach the field.
2. Drip SOILFLOC® 300E upstream of the field being treated (into head ditch or irrigation canal)
3. Drip SOILFLOC® 300E into water slowly, never dump large quantities at once into water.
4. Apply in every other or every third irrigation cycle or when water becomes cloudy.

Storage and Handling Directions:
Keep in a cool, dry area
Keep out of direct sunlight
Keep out of the reach of children
Avoid contact with eyes or skin
Caution: spilled materials are slippery when wet

Contains 37% anionic polyacrylamide
Safe for use in food crops
NONPLANT FOOD INGREDIENT
Net Weight 450 lb./204.54 kg.

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1390 N. Manzanita St.
Orange, CA 92867
Toll Free: (877) 771-6041
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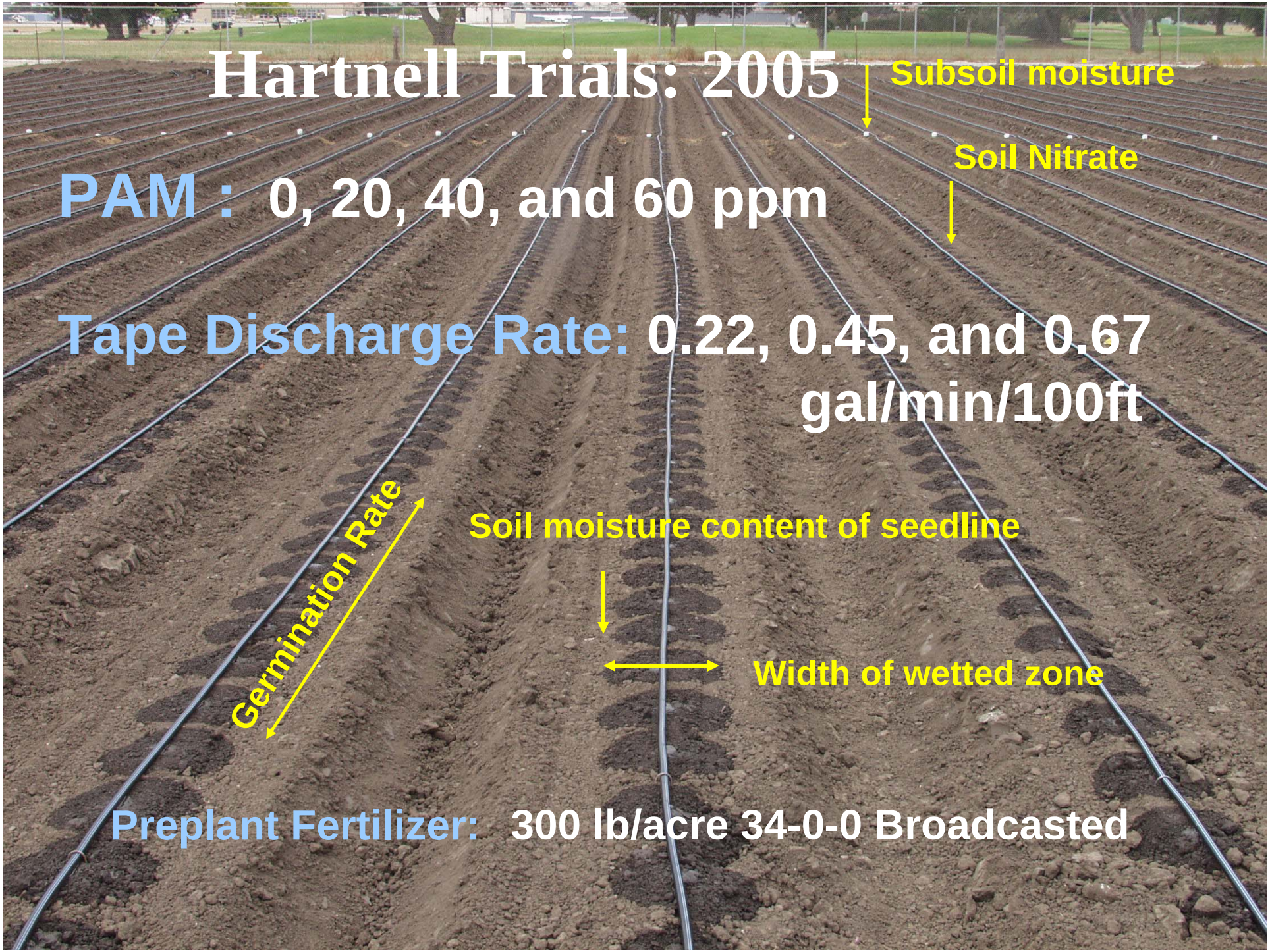

Hartnell Trials: 2005
Subsoil moisture
Soil Nitrate
PAM : 0, 20, 40, and 60 ppm
Tape Discharge Rate: 0.22, 0.45, and 0.67 gal/min/100ft
Germination Rate
Soil moisture content of seedline
Width of wetted zone
Preplant Fertilizer: 300 lb/acre 34-0-0 Broadcasted

Applied Water used in Drip Germination Trials

Trial 1

Date	Tape Discharge Rate 0.22 gpm/100 ft	0.45 gpm/100 ft	0.67 gpm/100 ft
	--------Applied Water (inches) ----------		
12-May	0.33	0.68	1.01
16-May	0.23	0.48	0.71
18-May	0.18	0.37	0.55
Total	0.75	1.52	2.27

Trial 2

Date	Tape Discharge Rate 0.22 gpm/100 ft	0.45 gpm/100 ft	0.67 gpm/100 ft
	---- Applied Water (inches) ----------		
8-Jun	0.23	0.47	0.69
10-Jun	0.12	0.24	0.35
13-Jun	0.15	0.31	0.46
15-Jun	0.14	0.28	0.42
17-Jun	0.21	0.43	0.64
Total	0.84	1.72	2.57

Diameter of Wetted Area on Surface of Bed (PAM and tape discharge rate effects)

Trial 1

	Tape Discharge Rate (gal/min/100ft)			
PAM	0.22	0.45	0.67	Average
(ppm)	---------- wetted width (inches)----------			
0	14.3	15.8	19.2	16.5
20	13.1	16.6	19.3	16.3
40	12.5	15.6	23.0	17.0
60	13.4	17.4	19.1	16.7
Average	13.3	16.4	20.2	
LSD.05	NS	NS	NS	

Trial 2

	Tape Discharge Rate (gal/min/100ft)			
PAM	0.22	0.45	0.67	Average
(ppm)	---------- wetted width (inches)----------			
0	11.3	13.9	15.8	13.7
20	11.7	13.4	15.2	13.4
40	11.8	14.4	15.5	13.9
60	12.0	14.1	15.8	13.9
Average	11.7	13.9	15.6	
LSD.05	NS	NS	NS	

= statistically different

Tape Discharge Rate Effects on Lateral Movement of Moisture

0.67 gal/min/100ft

0.45 gal/min/100ft

0.22 gal/min/100ft

Gravimetric Water Content of Bed Surface (Tape discharge rate effects)

Trial 1

Tape Discharge Rate	Gravimetric Soil Moisture seedline	shoulder
(gpm/100 ft)	------ % moisture -------	
0.22	13.3	9.4
0.45	16.9	14.9

Trial 2

Tape Discharge	Gravimetric Soil Moisture seedline	shoulder
(gpm/100 ft)	------ % moisture -------	
0.22	12.5	5.8
0.45	16.0	10.9

= statistically different

Germination Rate
(Tape discharge rate and PAM effects)

Trial 1

	Tape Discharge Rate (gal/min/100ft)			
PAM	0.22	0.45	0.67	Average
(ppm)	--------- germination (plants/10 ft) ---------			
0	39.7	54.2	57.5	50.5
20	46.7	62.7	59.9	56.4
40	45.8	51.6	54.5	50.7
60	35.0	54.8	52.1	47.3
Average	41.8	55.8	56.0	
LSD.05	NS	NS	NS	

= statistically different

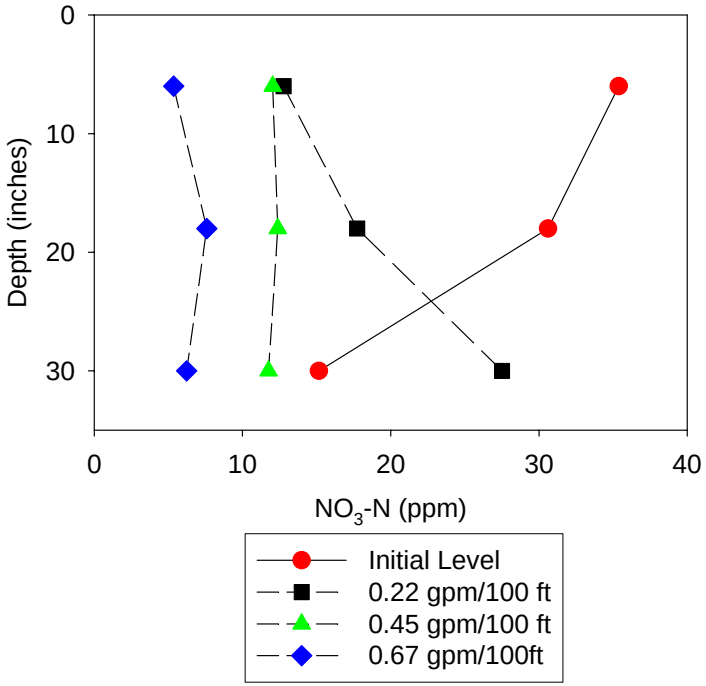
Trial 2

	Tape Discharge Rate (gal/min/100ft)			
PAM	0.22	0.45	0.67	Average
(ppm)	--------- germination (plants/10 ft) ---------			
0	14.7	46.4	56.9	39.4
20	11.9	42.7	54.7	36.4
40	14.6	50.3	54.9	39.9
60	14.9	54.2	54.5	41.2
Average	14.0	48.4	55.2	
LSD.05	NS	NS	NS	

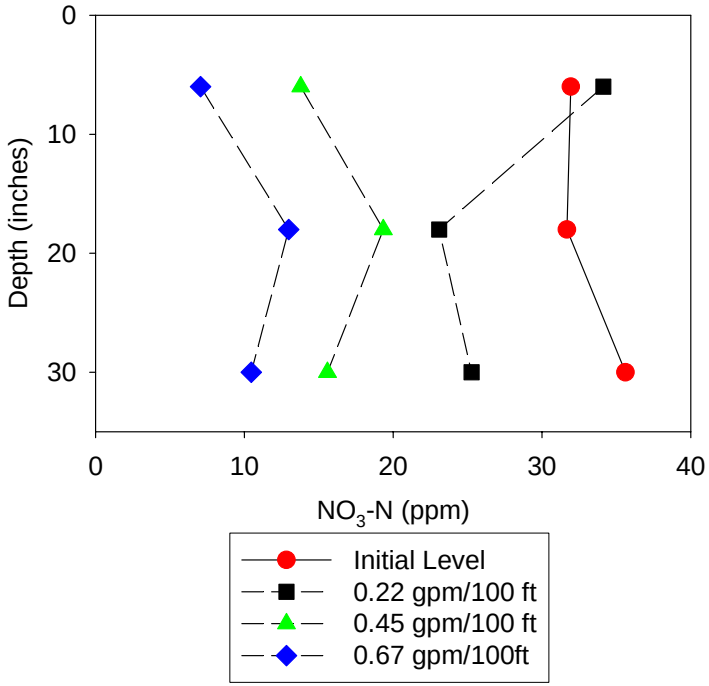
= statistically different

Residual Nitrate of Soil Profile
(Effect of Tape Discharge Rate)

Trial 1

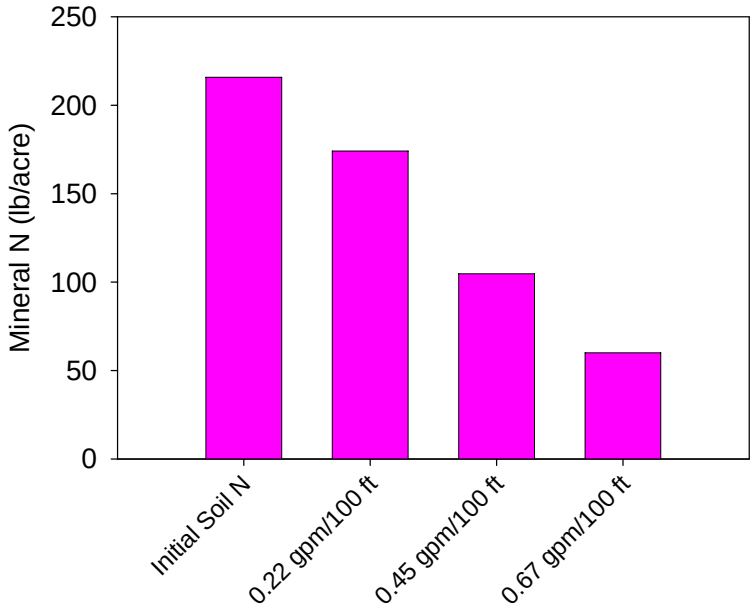


Trial 2

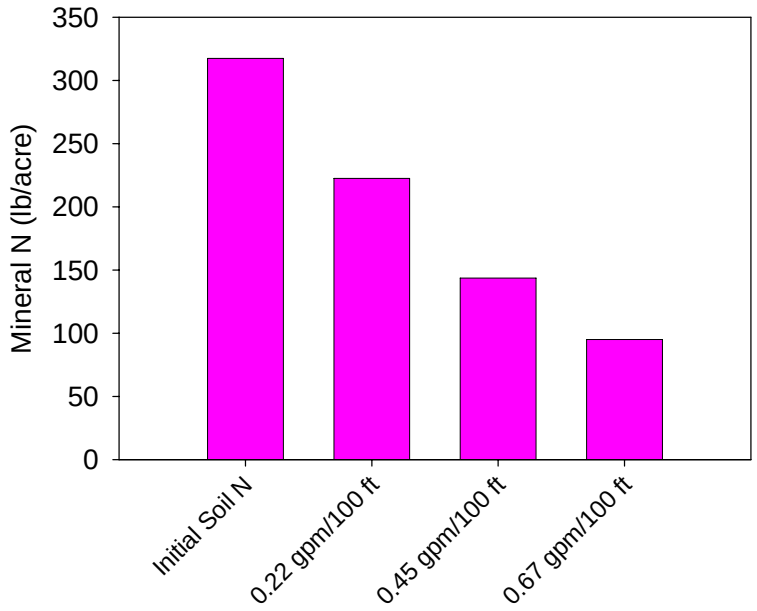


Residual Nitrogen
(Effect of Tape Discharge Rate)

Trial 1



Trial 2



Hartnell Field Trial 2006 (Cultural Strategies)

- ✓ **Tape discharge: 0.3 and 0.5 gpm/100ft**
- ✓ **Emitter spacing: 8 and 12 inches**
- ✓ **Tape depth: 1.8 and 3.1 inches**
- ✓ **Beds rolled: weighted and unweighted**


TORO
Count on it.
Aqua Traxx

Applied Water at Hartnell Drip Germination Trial (June 2006)

Date	Cumulative Applied H_2O
	inches
6/6/2006	0.75
6/8/2006	1.13
6/10/2006	1.50
6/12/2006	1.88

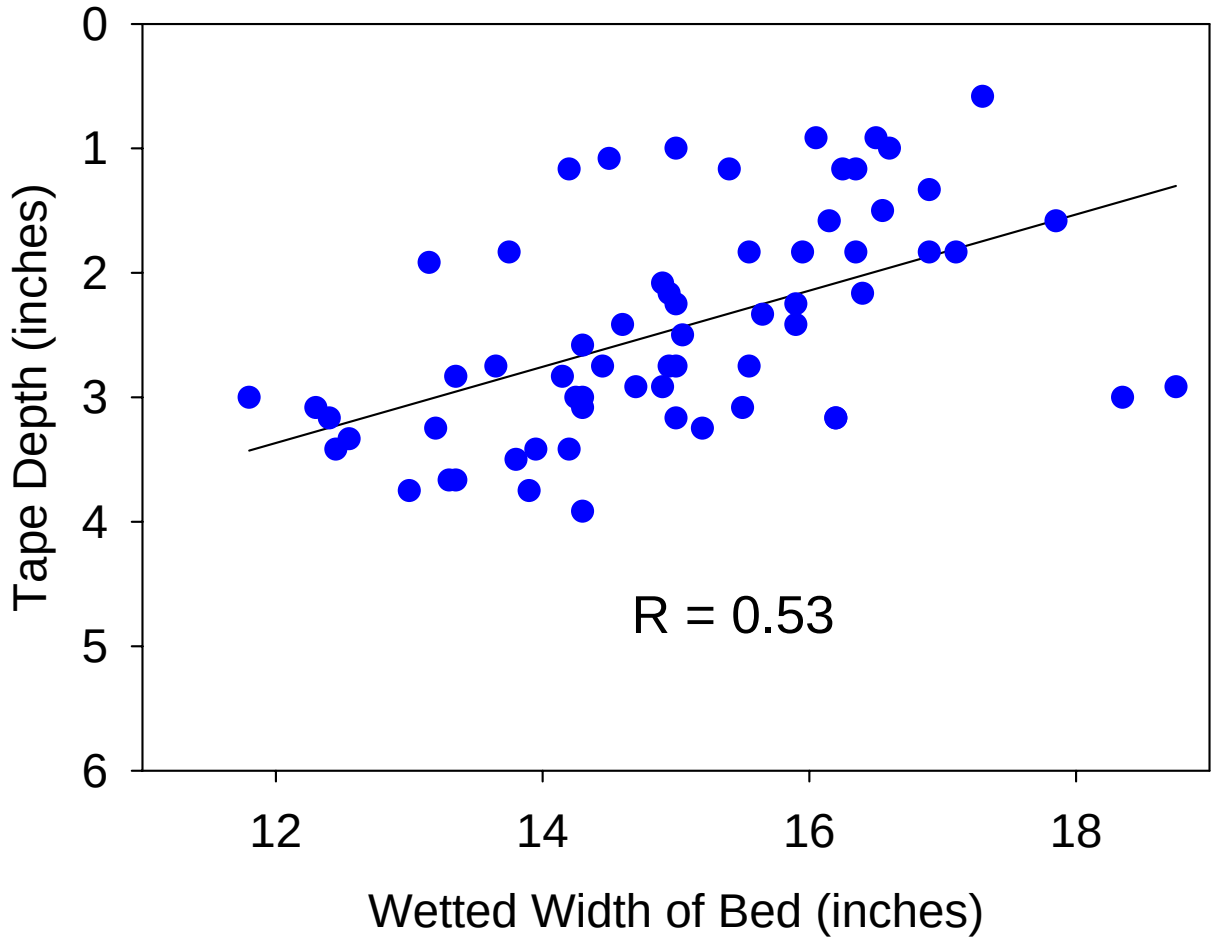
Effects of Tape Depth and Emitter Spacing on Germination and Water Movement

Treatment Description	Gravimetric Moisture[x]	Wetted Width[x]	Germination 11-Jun	Germination 13-Jun
	g/cc	inches	plants/10 ft	
---------- Depth ----------				
shallow (1.8 inches)	16.3	15.7	49.4	58.2
deep (3.1 inches)	15.0	14.3	44.6	57.5
F-test	0.056	0.027	NS[y]	NS
---------- Spacing ----------				
8 inches	15.8	14.9	48.0	59.8
12 inches	15.4	15.1	46.0	55.9
F-test	0.079	NS	NS	NS

[x] 1st irrigation, 6/06/2006

[y] not statistically signficant

Tape Depth *vs* Wetted Width of Bed



Effects of Tape Discharge Rate and Bed Rolling on Germination and Water Movement

Treatment Description	Gravimetric Moisture[x]	Wetted Width[x]	Germination 11-Jun	Germination 13-Jun
	g/cc	inches	plants/10 ft	
---------- Tape Discharge Rate ----------				
0.3 gpm/100 ft	16.0	15.0	47.7	57.3
0.5 gpm/100 ft	15.3	15.1	46.3	58.4
F-test	0.003	NS[y]	NS	NS
---------- Rolling ----------				
1X	15.4	14.7	46.5	56.2
2X[z]	15.9	15.3	47.5	59.5
F-test	0.041	0.084	NS	NS

[x] 1st irrigation, 6/06/2006

[y] not statistically signficant

[z] 1st rolling was unweighted, 2nd rolling was weighted with water.

USDA Spence Trial 2006

Drip vs Sprinklers

- ✓ Beds Mulched
- ✓ Tape discharge = 0.5 gpm/100ft
- ✓ Emitter spacing = 8 inches
- ✓ Tape depth = surface, 2.5 inches
- ✓ Beds rolled

Water Use and Germination
Spence Drip Trial
(August 2006)

	Applied Water (inches)[x]	Wetted Width (inches)	Initial Germination Count (plants/10 ft)	2nd Germination Count (plants/10 ft)
Drip-surface	3.08	16.81	54.0	53.2
Drip-buried	3.08	16.20	54.0	52.3
Sprinkler	3.24	--	26.7	44.3

[x] 8/22/06 - 8/30/06

Commercial Field Trials

(Unreplicated split-field trials)

Site Summary of Commercial Drip Fields

Site	Type	bed width	emitter spacing	tape discharge rate	tape depth		bulk density (0-3 inches)
					average	S.D.	
		----- inches ----		gpm/100 ft	----- inches ----		g/cc
1	head	40	12	0.53	2.62	0.39	1.13
2	head	40	12	0.34	3.36	0.41	1.03
3	romaine	80	12	0.32	3.22	0.40	0.97
4	romaine	40	8	0.34	2.50[x]	--	0.90
5	romaine	40	8	0.34	2.50[x]	--	1.09

[x] estimated depth

Water Applied for Germination

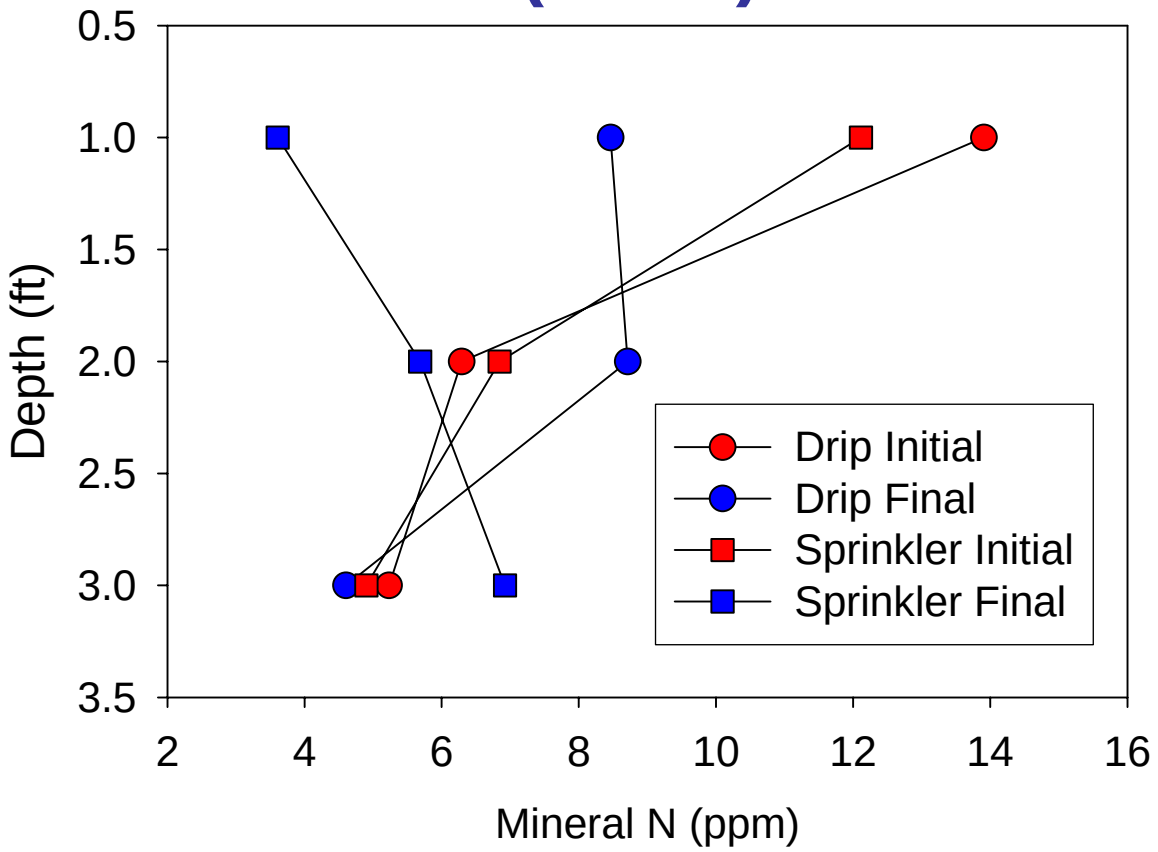
	Sprinkler		Drip	
Site	area	applied water	area	applied water
	acres	inches	acres	inches
1	7.9	7.1	7.8	8.1
2	6.1	7.1	5.8	3.6
3	7.3	4.6	7.5	8.3
4	3.8	5.9	4.0	5.0
5	5.9	6.0	2.4	1.5
Average		6.2		5.3

Germination Rate of Sprinkler and Drip Irrigated Fields

	Sprinkler		Drip	
Site	Average	S.D.	Average	S.D
	---------- plants/10ft ----------			
1	42.0	4.9	46.8	2.7
2	27.8	6.3	44.3	4.3
3	36.0	3.7	28.8	16.5
4[x]	12.1	1.1	10.6	1.8
5[x]	11.0	1.8	11.7	1.2

[x] planted to stand density of 12 plants per 10 ft

Mineral N in Soil Profile During Germination (site 3)



Mineral N loss of Drip and Sprinkler Germinated Fields (0-3 ft)

	Sprinkler		Drip	
Site	**NO3-N**	**Mineral-N**	**NO3-N**	**Mineral-N**
	---------- % loss ----------			
1	45.9	48.8	81.9	77.0
2	12.8	21.5	5.4	-1.3
3	30.4	32.0	17.7	14.3
4	71.3	76.8	-20.4	-20.0
Average	40.1	44.8	21.1	17.5

2006 Commercial Field Trials: RomaineYield

Trial 4

Treatment	plant weight untrimmed	plant weight trimmed	biomass yield	marketable yield	
	--- lb/plant ---		------- tons/acre --------		boxes/acre[x]
subsurface drip	1.32	0.85	14.1	9.2	458
surface drip	1.32	0.86	14.3	9.3	466
sprinkler	1.13	0.81	13.9	9.9	495

[x] 40 lbs/box

Trial 5

Treatment	plant weight untrimmed	plant weight trimmed	biomass yield	marketable yield	
	--- lb/plant ---		------- tons/acre --------		boxes/acre[x]
subsurface drip	1.03	0.56	13.7	7.1	354
sprinkler	0.92	0.55	12.0	7.3	364

[x] 40 lbs/box

2006 Commercial Field Trials: Plant Stand at Harvest

Trial 4

Treatment	total plants	diseased plants	marketable plants
	------- plants/acre -------		
subsurface drip	26718	5265	21453
surface drip	25933	4448	21486
sprinkler	28517	3892	24625

Trial 5

Treatment	total plants	diseased plants	marketable plants
	------- plants/acre -------		
subsurface drip	27405	2616	24789
sprinkler	27797	1275	26522

Summary of Commerical Trials

- ✓ Water use was similar for drip and sprinkler irrigation
- ✓ Nitrate losses were similar for drip and sprinkler irrigation
- ✓ Germination rates were similar for sprinkler and drip irrigation

Best Practices for Drip Germination

- ✓ Mulch Beds
- ✓ Shallow placement of tape (2-3 inches)
- ✓ Medium flow tape and 8 inch emitter spacing
- ✓ Drip system must have a high application uniformity
- ✓ Compact beds with a weighted roller
- ✓ Plant slightly deeper

Thank You!