



The Effect of Nitrogen Fertilization on Yield and Quality of Bell Peppers

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and

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and the CA Pepper Improvement Foundation.

Bell Peppers are grown for fresh and processing markets in CA. Some growers use poles and black plastic mulched beds with drip irrigation and harvest several times per season ...



Others grow without mulch or support for a once or twice over harvest.

**Some growers still use furrow irrigation,
but majority use subsurface drip irrigation and
apply liquid nitrogen fertilizer through the drip system.**



GOALS and OBJECTIVES:

Evaluate effect of N applied through drip irrigation on:

- **Pepper yield and quality at harvest**
- **Postharvest quality**

Rationale:



Nitrogen Best Management Practices may need updating.

No study in recent years has studied the relationship between N fertilizer and pepper harvest and postharvest quality, when grown under drip irrigation.



Fertilizer FIELD STUDIES 2009 and 2010

- **San Joaquin Valley, Westside Fresno County, UC Research Center**
- **Transplanted Bell Peppers at 9-10” spacing**
- **5 Nitrogen Rates – Preplant 11-52-0 + CAN 17 through the drip**
- **RCBD, Four 40-inch beds per plot x 60’row - Data collected from middle 2 beds; 4 Replicates**

METHODS



5 N Rates: lbs/A
(CAN 17 applied thru drip)

75

150

225

300

375

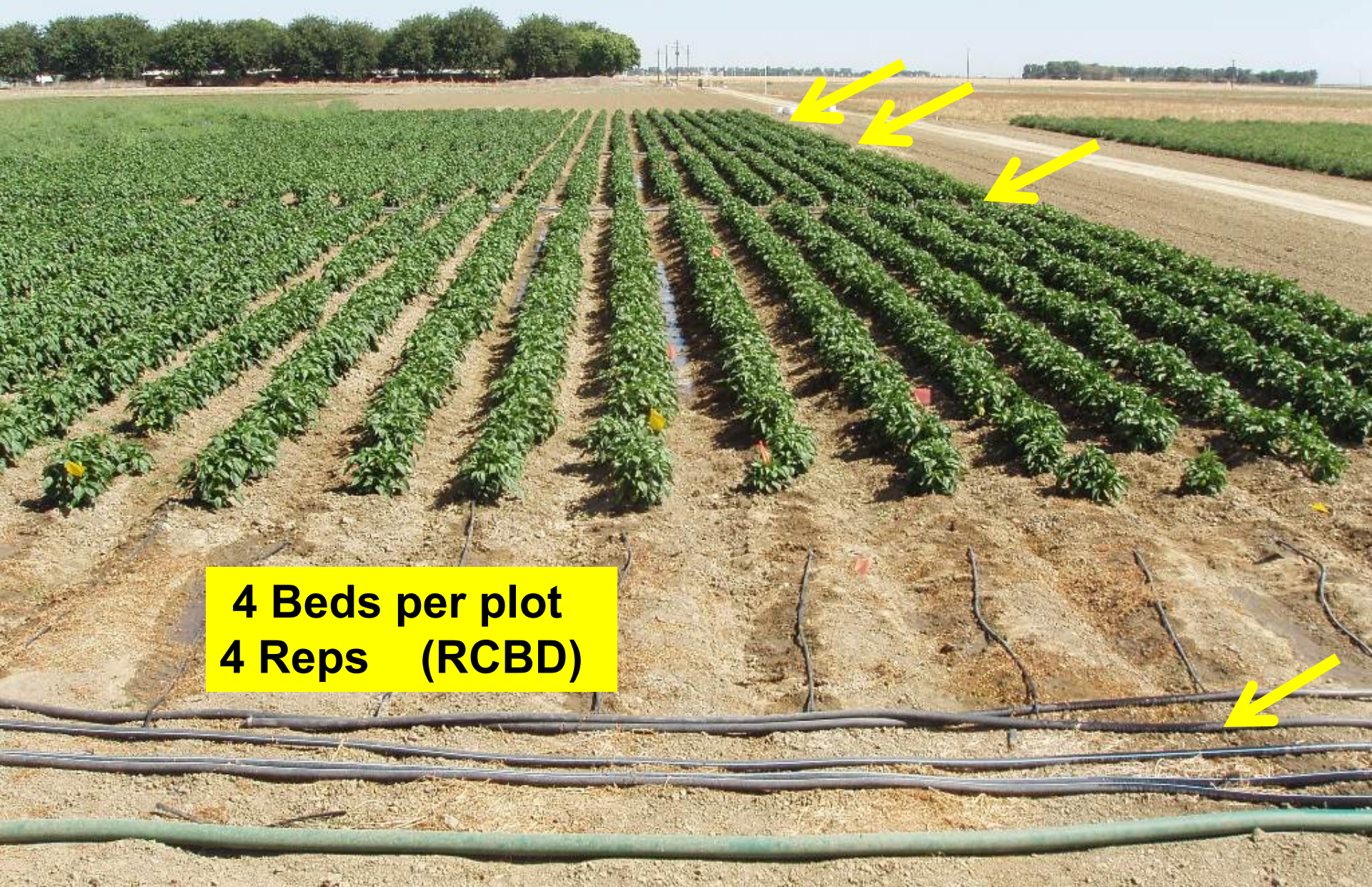


Flexflo Peristaltic injection pumps

METHODS



METHODS



4 Beds per plot
4 Reps (RCBD)

Methods & Measurements

2009

Plant: Mar 25

Variety: Jupiter

Harvest:

July 21 (120 days)

MG and Red fruit

2010

Plant: May 18

Variety: Baron

Harvest:

Aug 10 (81 days) MG fruit only

Aug 31 (110 days) MG and Red

BOTH YEARS

Preplant soil test

Whole leaf tissue analysis

3 times / season

Whole plant biomass sample at
harvest time only

MEASUREMENTS



15' row x 1 40-inch bed

**Destructive Harvest
YIELD**

Size Grades

Maturity

**Quality (culls, sunburn,
BER)**

MEASUREMENTS



Harvest #1 Mature Green Peppers sampled and analyzed in Postharvest Lab

Measurements: 2nd harvest: Mature Green & Red



High N Plot



Low N Plot



Postharvest Handling of Peppers:

- Minimum of 30 fruit/treatment x 4 replicates harvested
- Placed in plastic bags, bags put in plastic trays, then transported in an air-conditioned van to the Lab.
- Fruit held at 45 degrees, covered with plastic sheets to prevent weight loss
- Evaluations completed within 2 days of harvest.

PARAMETERS MEASURED:

- Fruit wet weight
- Dry weight
- Color (external)
- Wall Thickness
- Firmness (3 ways)
- Bruise susceptibility
- Cracking susceptibility

Postharvest Evaluations

Color measurement (Reflectance color meter)



REPORTING COLOR VALUES

Lightness or Darkness: L^*

Saturation, Vividness:

$$\text{Chroma} = (a^{*2} + b^{*2})^{1/2}$$

Color:

$$\text{Hue} = \tan^{-1} (b^*/a^*)$$

Hue values 115-125 for **green** peppers

Hue values 30-40 for **red** peppers

Postharvest Evaluations

Firmness measurements

Firmness using texture analyzer (control speed of compression)

For peppers use 25mm flat disc as shown in photo and compress peppers 5mm



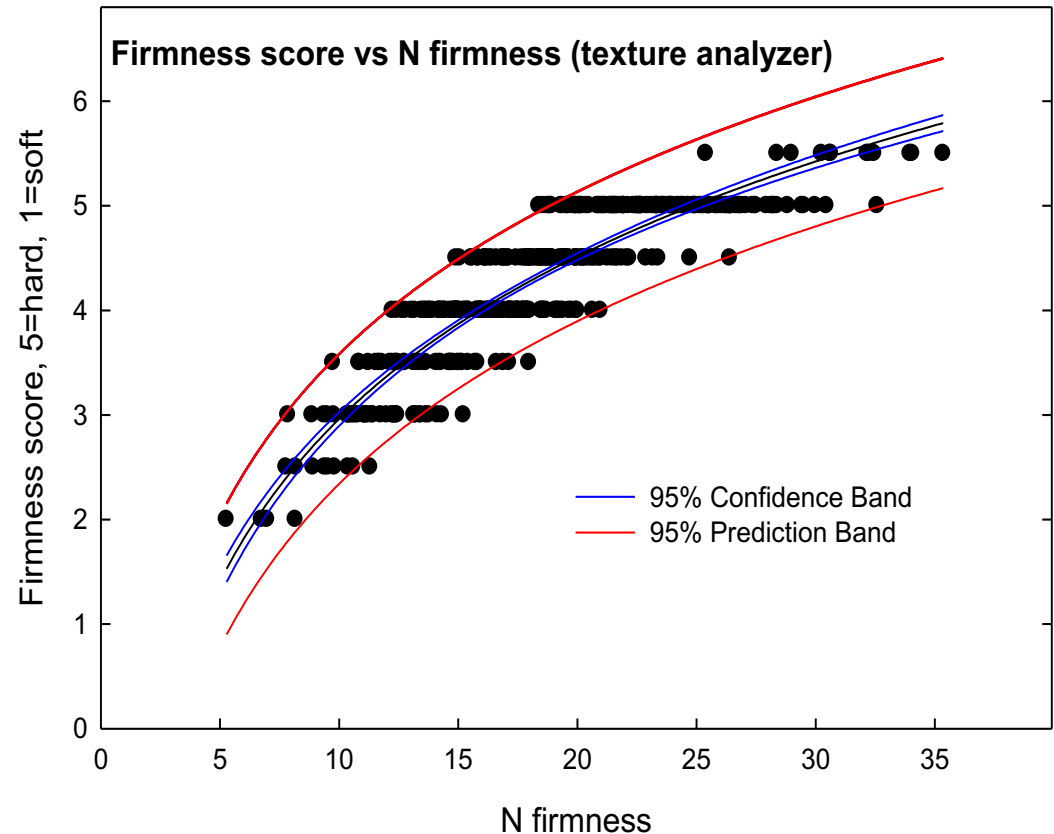
Report data as

Force to compress; 1 Newton = 9.81 kg-force = 4.5 lb-force

Postharvest Evaluations

Subjective Firmness Assessment using Hand Compression is correlated to texture analyzer results

Firmness Class	Score	Approximate Force to compress (N)
Hard	>5	>30
Very firm	5	25
Firm	4	18
Moderately firm	3	12
Moderately soft	2	10
Soft	1	<10



Postharvest Evaluations

Bruise Damage

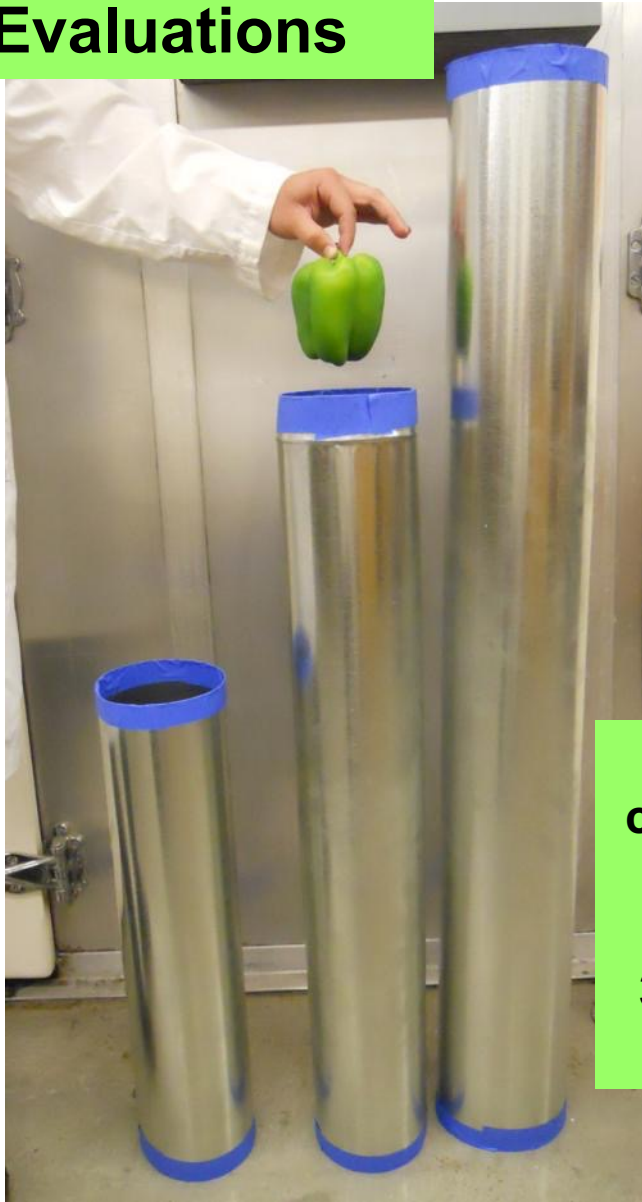


Assess damage immediately and after 5 days at 45°F using a subjective score of 1 to 5 where 1= no visible bruise, 2= slight, 3= moderate, 4= moderately severe and 5=severe.

Stainless steel ball dropped through tubes onto peppers from 1, 2 or 3 feet

Postharvest Evaluations

Cracking Susceptibility



Peppers scored for visible cracking at the blossom end.

Score 1= none, 2= slight, 3= moderate, 4= moderately severe and 5= severe.



Peppers dropped onto blossom end from heights of 1, 2 or 3 feet

Postharvest Evaluations



Rings from equator for:
Pericarp thickness
% dry weight

Dried ground sample can be used
for sugars or other components

Field Results - 2009

Field Expt Table 2: Effect of Nitrogen Rates on Pepper Leaf Tissue Samples and Plant Biomass

N lbs/A	% Total N Whole Leaf Samples			Biomass at Harvest (wet weights) Average of 5 plants (lbs)		
	5-Jun	24-Jun	17-Jul	Total Plant	Fruit	Leaf/Stem
75	4.23 c	5.02 c	4.20 c	3.60 bc	2.63 bc	0.94 c
150	4.51 bc	5.55 b	4.68 b	3.92 abc	2.77 ab	1.12 bc
225	4.72 ab	5.63 b	5.21 a	4.50 a	3.15 a	1.34 a
300	4.94 a	5.85 ab	5.32 a	4.24 abc	2.88 ab	1.32 ab
375	4.94 a	6.01 a	5.60 a	3.45 c	2.25 c	1.15 abc
Pr>Treat	0.808	0.131	0.599	0.048	0.048	0.008
Pr>Block	0.007	0.001	0.001	0.006	0.002	0.193
CV%	5.3	4.2	5.2	12.2	14.2	11.6
LSD (0.05)	0.38	0.37	0.40	0.74	0.60	0.21

Field Results - 2009

Field ExptTable 3: Effect of N-Rates on Pepper Yield, Fruit Size, Maturity, Culls

N lbs/A	Bell Pepper Yield Tons/Acre					Harvest date = July 23, 2009				
	Small	Med	Large	X-L	Culls	Total Yield	ALL Greens	All Reds	Mkt Yield*	
75	1.8	3.0	5.8	4.7	5.1 a	19.7	5.6	9.1	12.8 c	
150	1.4	5.5	6.7	5.0	4.0 ab	21.6	7.9	9.7	16.2 ab	
225	1.1	4.2	7.7	6.2	2.4 c	21.3	8.0	11.0	17.9 a	
300	1.4	5.4	5.9	4.9	2.9 bc	20.5	7.8	9.8	16.2 ab	
375	1.4	3.9	6.7	6.1	3.3 bc	18.9	5.9	9.7	14.2 bc	
Pr>Treat	0.472	0.132	0.343	0.329	0.013	0.579	0.153	0.478	0.090	
Pr>Block	0.010	0.885	0.008	0.014	0.184	0.001	0.000	0.029	0.001	
CV%	35.4	32.5	20.3	23.6	26.6	12.6	24.1	14.7	15.7	
LSD (0.05)	NS	NS	NS	NS	1.4	NS	NS	NS		
LSD (0.10)*									3.3	

* Market Yield = Med, Large, X-L Fruit

Field Results - 2010

Field Expt Table 3: Effect of N-Rates on Pepper Yield, Fruit Size, Maturity, Culls

BOTH PICKS

N lbs/A	Bell Pepper Yield Tons/Acre				Harvest date = August 10 & 31, 2010				
	SMALL	MED	LARGE	X-L	Culls	Total Yield	ALL Greens	All Reds	Mkt Yield*
75	1.6	4.6	9.2	1.5	4.4	26.2	16.9	4.9	21.8
150	1.0	2.9	10.5	2.7	3.4	25.9	17.2	5.3	22.5
225	1.3	4.1	10.0	2.1	3.4	26.4	17.5	5.6	23.1
300	1.8	4.1	8.6	3.0	4.0	27.3	17.5	5.9	23.4
375	1.7	4.9	9.6	2.1	3.0	27.0	18.2	5.3	23.6
Pr>Treat	0.62	0.18	0.79	0.84	0.50	0.22	0.99	0.77	0.95
Pr>Block	0.71	0.83	0.21	0.45	0.45	0.99	0.21	0.04	0.08
CV%	52.1	26.1	23.3	84.9	32.2	16.0	20.0	21.4	16.5
LSD (0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS

* Market Yield = Med, Large, X-L Fruit

Postharvest Results 2009

Postharvest Table 1. Pericarp thickness and % dry weight

Color stage	N Lbs/A	dry weight %	Pericarp thickness, mm
GREEN	75	7.81	4.74
	150	7.88	4.45
	225	7.80	4.73
	300	7.71	4.52
	375	7.55	4.63
RED	75	8.89	6.00
	150	8.86	5.55
	225	9.47	5.96
	300	9.52	5.74
	375	9.25	5.96
	Ave Green	7.75	4.62
	Ave Red	9.20	5.84
	LSD.05	0.44	0.27

Postharvest Results 2009

Postharvest Table 2. Fruit harvested at the **Mature-Green** stage.

N Lbs/A	Fruit wt. g	Firmness score 5=hard, 1=soft	Firmness measurement N	Color, Hue value
75	144.4	4.7	21.1	119.9
150	146.2	4.9	22.6	122.7
225	161.0	4.4	21.0	121.1
300	204.1	4.7	22.5	121.3
375	174.4	4.6	21.2	122.4
Average	166.0	4.7	21.7	121.5
LSD.05	14.4	0.2	ns	1.5

Postharvest Table 3. Fruit harvested at the **Red** stage.

N Lbs/A	Fruit wt. g	Firmness score 5=hard, 1=soft	Firmness measurement N	Color, Hue value
75	177.2	3.4	13.4	36.9
150	198.6	4.1	17.1	37.0
225	194.1	3.8	16.0	35.1
300	163.4	4.2	16.4	35.7
375	209.8	3.7	14.4	34.3
Average	188.8	3.8	15.5	35.8
LSD.05	15.6	0.3	1.6	1.8

Postharvest Results 2010 (preliminary)

Table 1. 2010 Harvest 1 Mature Green peppers

N treatment, lbs	Fruit wt. g	dry weight %	Pericarp thickness, mm
75	150.8	7.11	4.83
150	153.3	6.55	4.84
225	158.4	6.68	5.01
300	165.6	6.59	4.87
375	163.9	6.80	5.14
Average	158.3	6.74	4.94
LSD.05	10.3	0.10	0.20

Table 2. 2010 Harvest 1 Mature Green peppers

N Lbs/A	Firmness score 5=hard, 1=soft	Firmness measurement, N	Color, Hue value
75	4.85	27.65	120.6
150	4.79	28.17	120.5
225	4.94	29.53	120.4
300	4.86	29.94	120.6
375	4.88	30.45	120.3
Average	4.87	29.11	120.5
LSD.05	0.12	ns	ns

Postharvest Results 2010 (preliminary)

Table 3. 2010 Harvest 1 **Mature Green** peppers

N lbs/A	% weight loss (5 days at 7.5°C)	Bruise Index	Crack Susceptibility Index
75	1.08	2.79	4.46
150	1.08	2.79	4.42
225	1.07	2.65	4.46
300	1.08	2.56	4.27
375	1.04	2.77	4.62
Average	1.07	2.71	4.44
LSD.05	ns	ns	ns

So where are we?

University of California
Agriculture and Natural Resources



**Inconclusive
Results:**

**MORE DATA
Needed.**



**This is a work
in progress.**

THANK YOU

**This research is supported by the CA Pepper Commission
and the CA Pepper Improvement Foundation.**