the Southern Region small fruit consortium

2005 Agent Training on Methyl Bromide Alternatives

February 23, 2005

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Alternatives to consider on your Strawberry farm

Telone-C35
Metam Sodium
Telone-C35+Metam Sodium (heavy weed pressure)
Chloropicrin + Metam Sodium or Herbicides

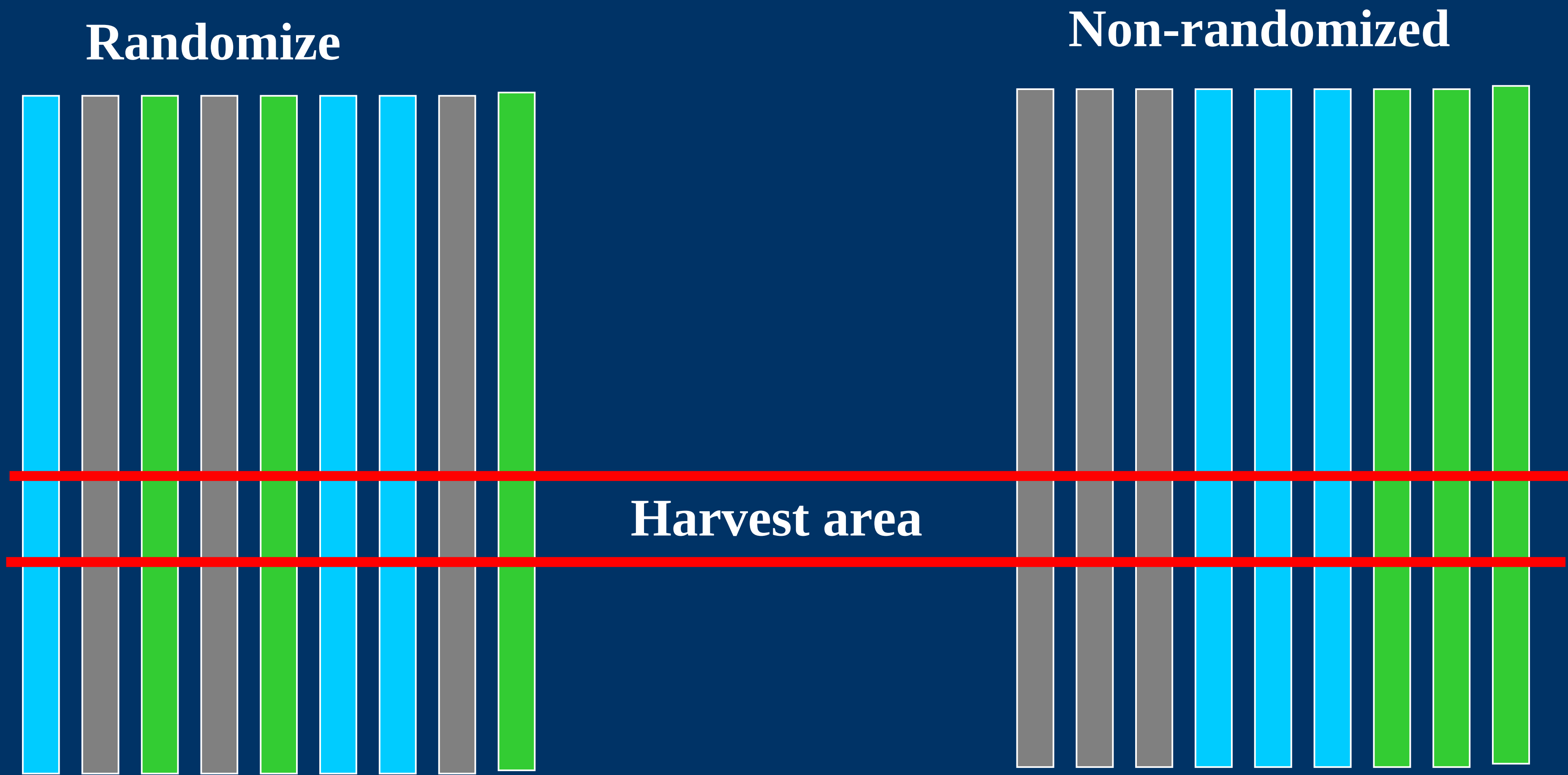
InLine (=EC formulation of Telone-C35)

(metam sodium = Vapam, Sectagon, Meta-CLR)

DOING AN ON-FARM TRIAL

For example: 3 treatments

Prefer non-fumigated row(s) – do you need to fumigate?



2005 ON-FARM-TRIALS

Site 1: North Carolina (Jones Co.)

Cooperators: Mark Seitz – Agent; Larry Ipock - Grower

Design: 200 foot rows, 30 inch beds, 60 inch row spacing; Randomization with 3 reps.

Treatments: MB, Telone-C35, Chloropicrin 99%


JOHN DEERE
2640


MB 67/33
T-C35
Chloropic 100%
MB
Chloropic 100%
T-C35

2005 ON-FARM-TRIALS

Site 2: Watkinsville, GA

Cooperators: **Dr. Phil Brannen – Plant Pathologist, James Washington - Grower**

Design: **500 foot rows, 32 inch beds, 60 inch row spacing; Randomization with 4 reps.**

Treatments: **MB, Telone–C35 + Vapam HL**


650

HOWARD
Rotavator HN

Telone/Vapam
MB 67/33
Telone/Vapam

2005 ON-FARM-TRIALS

Site 3: Virginia Beach, VA

Cooperators: Cal Schiemann-Agent, G.W. (Wink) Henley-Grower

Design: 290 foot rows, 26 inch beds, 60 inch row spacing; Randomization with 4 reps.

Treatments: MB, Telone –C35, Chloropicrin 99%


4B
15B
10
4D
1A
12D
23
4D
2A
29
2A
15D
30
Control

Data Recording Form

Rep	Trt. #	Plant Source	Bed Width	Crown Number	Crown dry wt (g)	Leaf area	Leaf dry weight (g)	Root dry weight (g)	Percent root rot serverity	Percent root hair rating
A	1	Telone-C35 + Vapam HL	17.0 gal/A + 37.5 gal/A							
A	2	Methyl Bromide 67:33	200.0 lb/A							
B	1	Telone-C35 + Vapam HL	17.0 gal/A + 37.5 gal/A							
B	2	Methyl Bromide 67:33	200.0 lb/A							
C	1	Telone-C35 + Vapam HL	17.0 gal/A + 37.5 gal/A							
C	2	Methyl Bromide 67:33	200.0 lb/A							
D	2	Methyl Bromide 67:33	200.0 lb/A							
D	1	Telone-C35 + Vapam HL	17.0 gal/A + 37.5 gal/A							

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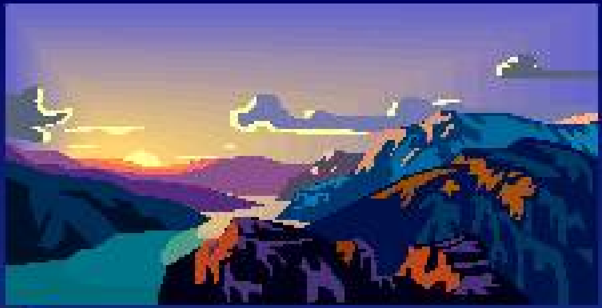


Alternatives to Methyl Bromide: Pest Management Considerations

J.W. Noling
University of Florida, IFAS,
North Carolina State CES Agent Training
Raleigh, North Carolina
February 23, 2005

General IPM Considerations
Principal Pests - Soil

Disease

Bacterial Wilt
Southern Blight
Fusarium Wilt
Verticillium Wilt
Pythium sp.
Rhizoctonia sp.
Fusarium Crown & Root Rot

Nematode

Root-knot
Sting
Reniform
Others

Arthropod

Wireworm
Mole Crickets
Cutworms
Others

Weeds

Nutsedges
Nightshades
Many Others

To Replace MBR requires an Integrated Chemical Approach

Summary of the effectiveness of various soil fumigants for nematode, soilborne disease, and weed control

FUMIGANT	NEMATODE	DISEASE	WEED
1)Methyl bromide	Excellent	Excellent	Good to excellent
2) Chloropicrin	None to Poor	Excellent	None-Poor
3) Enzone	None - Some	None - Some	None - Some
4) MetamSodium	Erratic	Erratic	Erratic
5) Basamid	Erratic	Erratic	Erratic
6) Telone II	Good to Excellent	None to Poor	Poor
7) Telone C17	Good to Excellent	Good	Poor
8) Telone C35	Good to Excellent	Good to excellent	Poor
9) Potassium N-Methydithiocarbamate (Kpam)	Erratic??	Erratic??	Erratic??
Noling Efficacy Scale-Not to be construed as Gospel			

LEACHING or SOIL RESIDENCE TIME AS A SOURCE OF INCONSISTENCY and as CONTAMINANTS OF GROUNDWATER

ALDICARB

1982-New York, Wisconsin
1984-Florida
1985-Wisc, NY, FL
1986-Mi, IND, AR, NC, Virg, Wash, Wisc, MA
1988-Florida
1990-New York

PHENAMIPHOS

1988-Georgia
1989-Georgia
1990-Georgia, Hawaii
1994- Hawaii
1995-Florida

ETHOPROP

1988-California
1990- New York
1991-Florida

CARBOFURAN

1989-N. Dakota,Maryland
1990-Montana
1994-Maryland

TERBOFOS

1989-North Dakota
1991-Florida

1,3-D

1990-Calif.

MBr

1983-California

Source:Barbash, J.E. and E. A. Resek. 1996. Pesticides in Groundwater, distribution, trends, and governing Factors. Ann Arbor Press. Chesea Mich. 347 p.

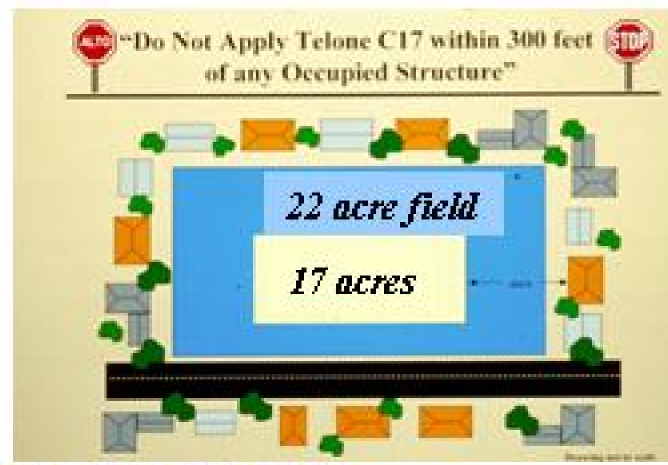
CHANGES - 1,3-D REGULATORY CONSTRAINTS :

- PERSONAL PROTECTIVE EQUIPMENT for PRE BED Applications w/ Yetter System –

"SAFETY GLASSES"

Otherwise, Chemical Resistant Gloves, Boots, Half-Face Respirator

- TREATMENT BUFFER ZONES

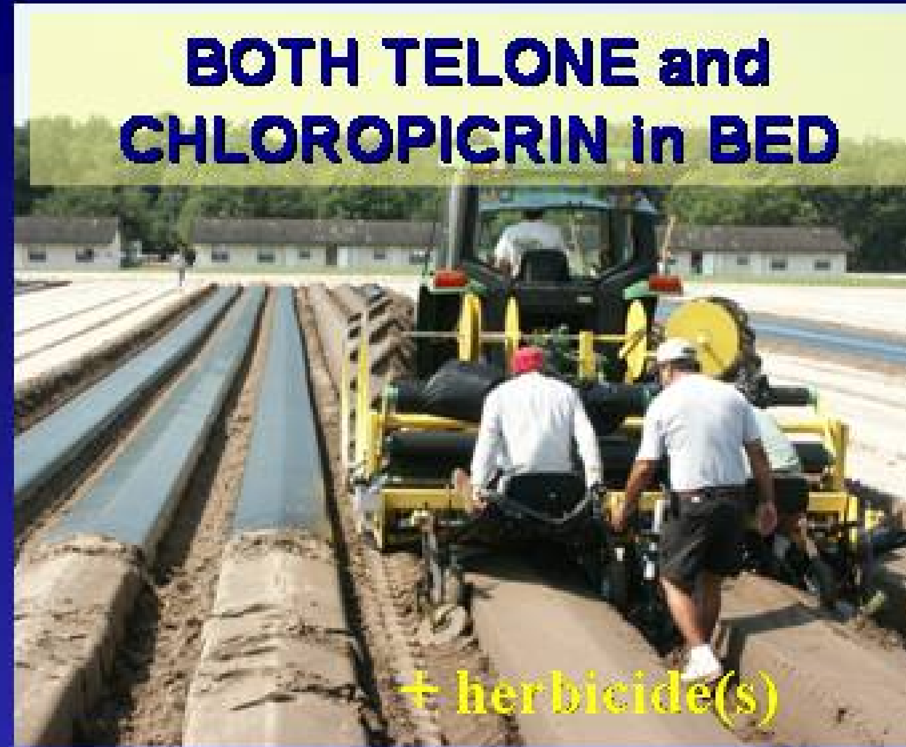


"100 ft of WELL or OCCUPIED STRUCTURE"

- 5 Day Re-Entry Period, not areas over Karst, other hydrology…

INTEGRATION of CHEMICALS

TELONE (1,3-D) – nematode
CHLOROPICRIN - disease
and
COMPLIMENTARY
HERBICIDE(S)



Followed by:

Fig. 8. Summary of tomato yields with various alternative chemical and nonchemical treatments relative to yields obtained with methyl bromide (expressed as a proportion) in six USDA sponsored small research plot trials Spring 1998 - Spring 2001.

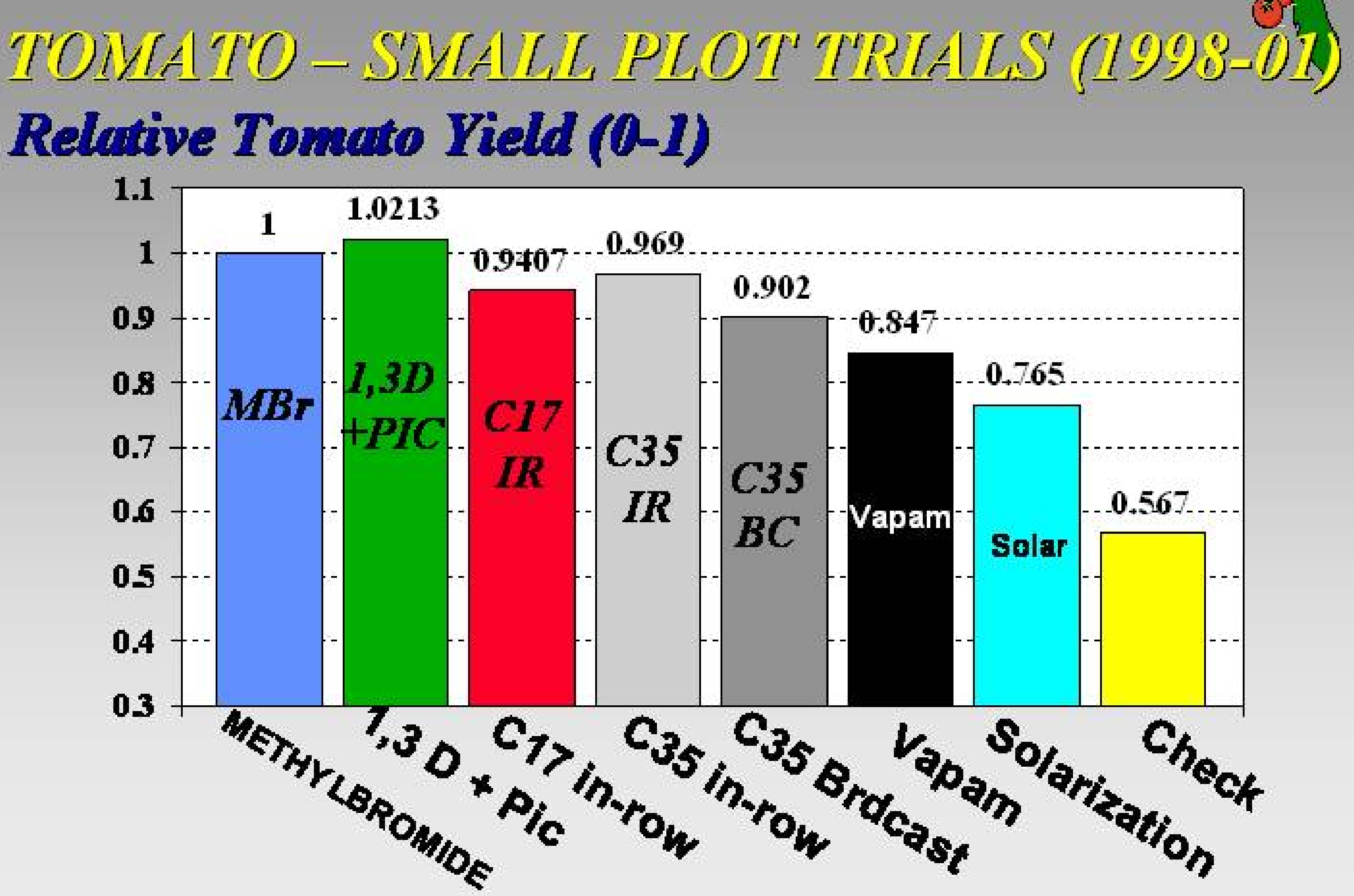
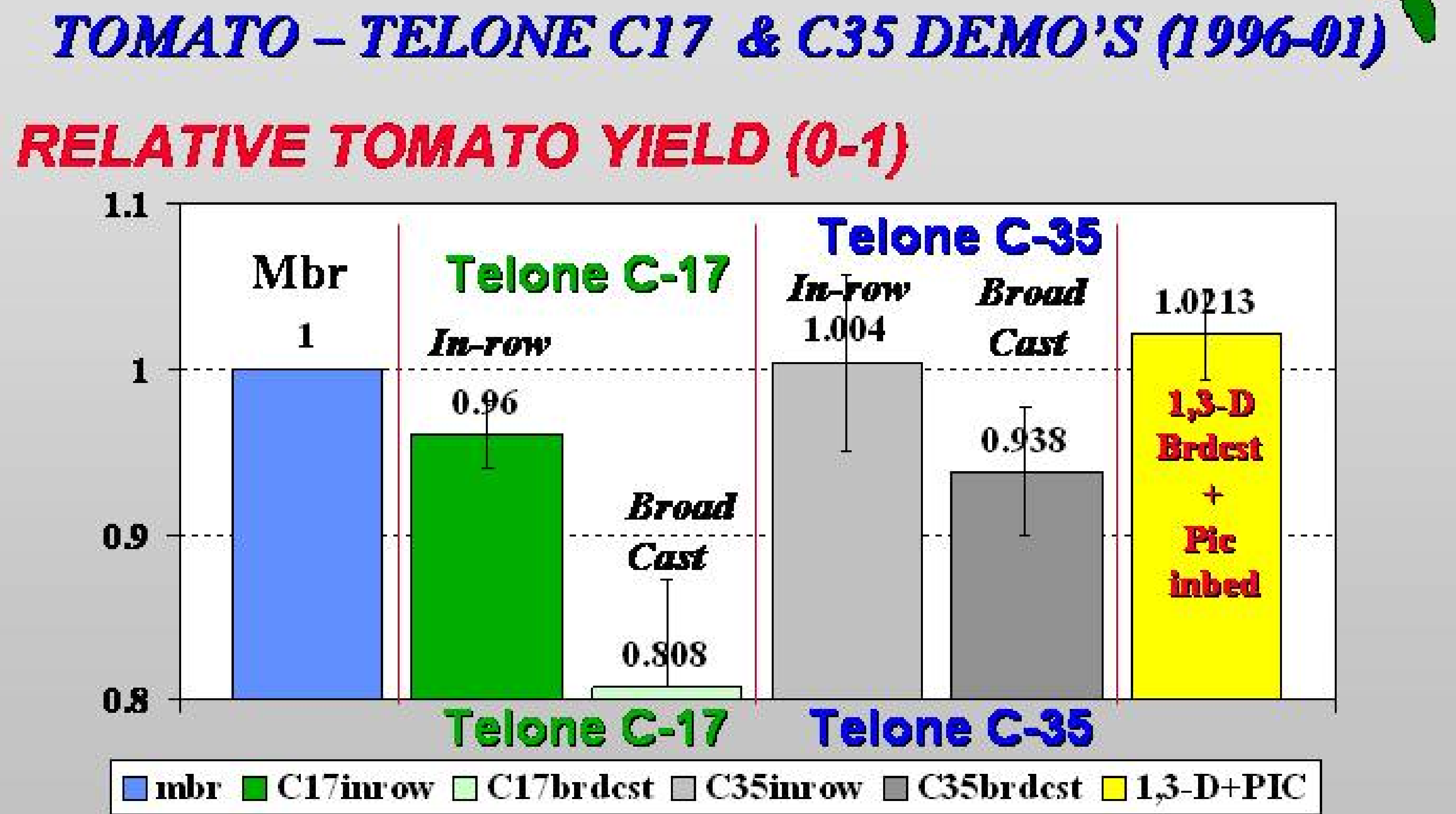


Fig. 4. Summary of tomato yields with Telone C17 or Telone C35 fumigant treatment relative to yields obtained with methyl bromide (expressed as a proportion) in six USDA sponsored large scale field demonstration trials conducted Spring 1996 - Spring 200



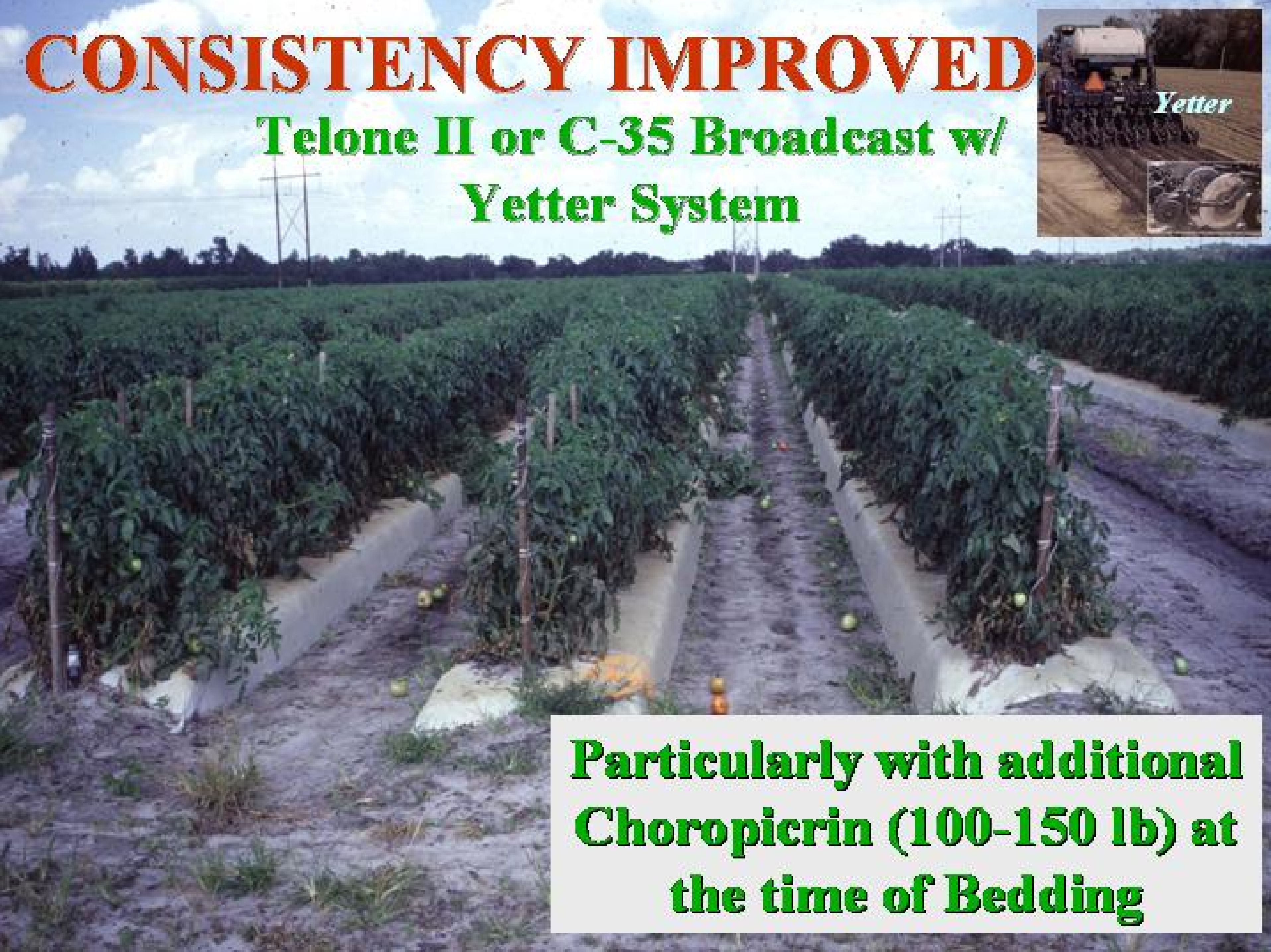
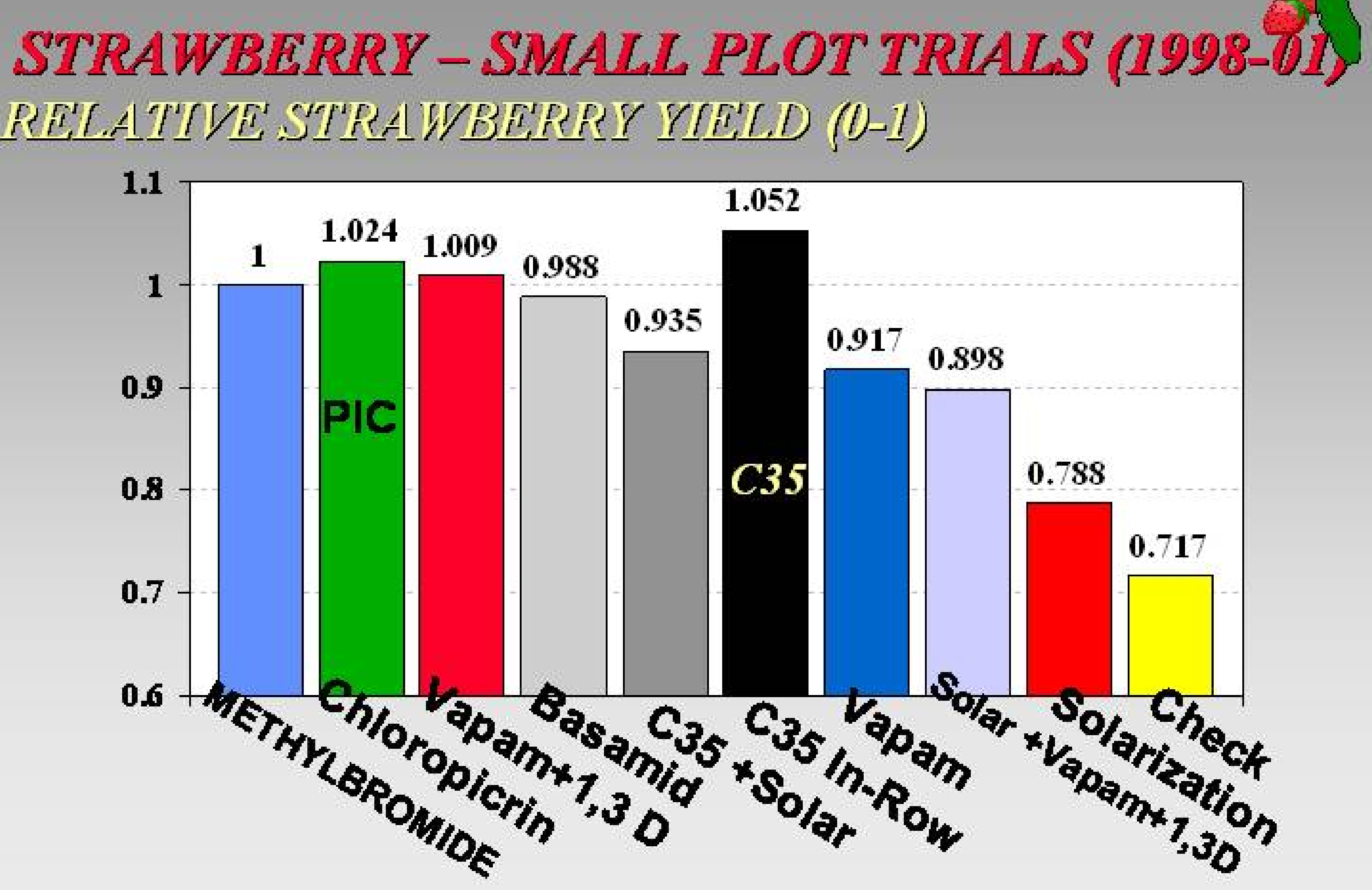
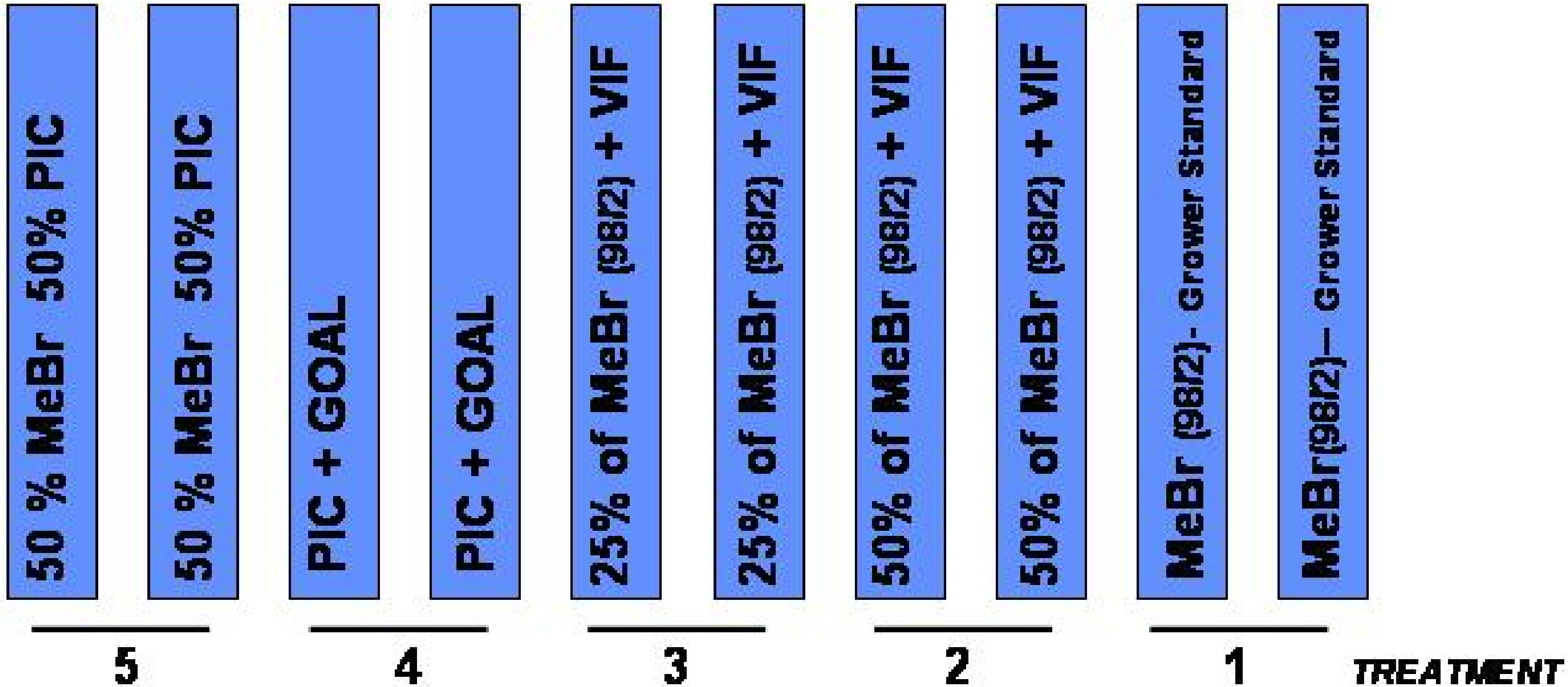

CONSISTENCY IMPROVED
Telone II or C-35 Broadcast w/
Yetter System
Yetter
Particularly with additional
Choropicrin (100-150 lb) at
the time of Bedding

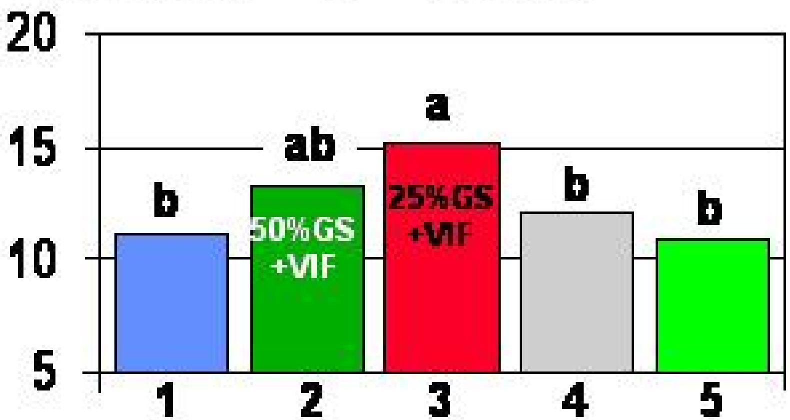
Fig. 9. Summary of strawberry yields with various alternative chemical and nonchemical treatments relative to yields obtained with methyl bromide (expressed as a proportion) in eight USDA sponsored small research plot trials Spring 1998 - Spring 2001.



BASIC REPLICATED -2 row -UNITS – CARL GROOMS FIELD TRIAL- FALL 2004



% Plants < 12" diameter



% of Row w / Dense Nutsedge

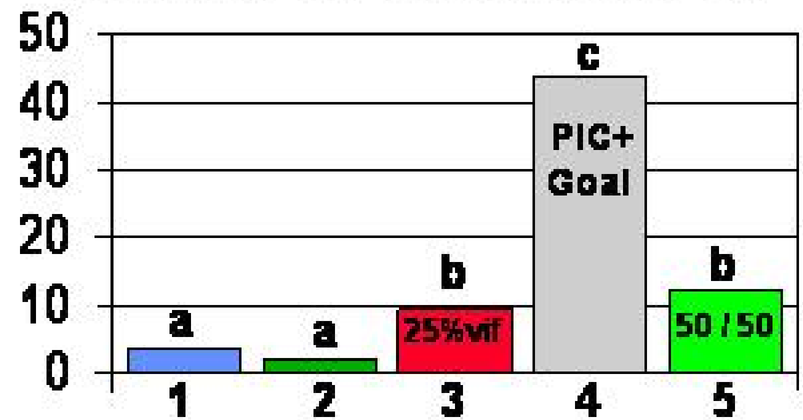
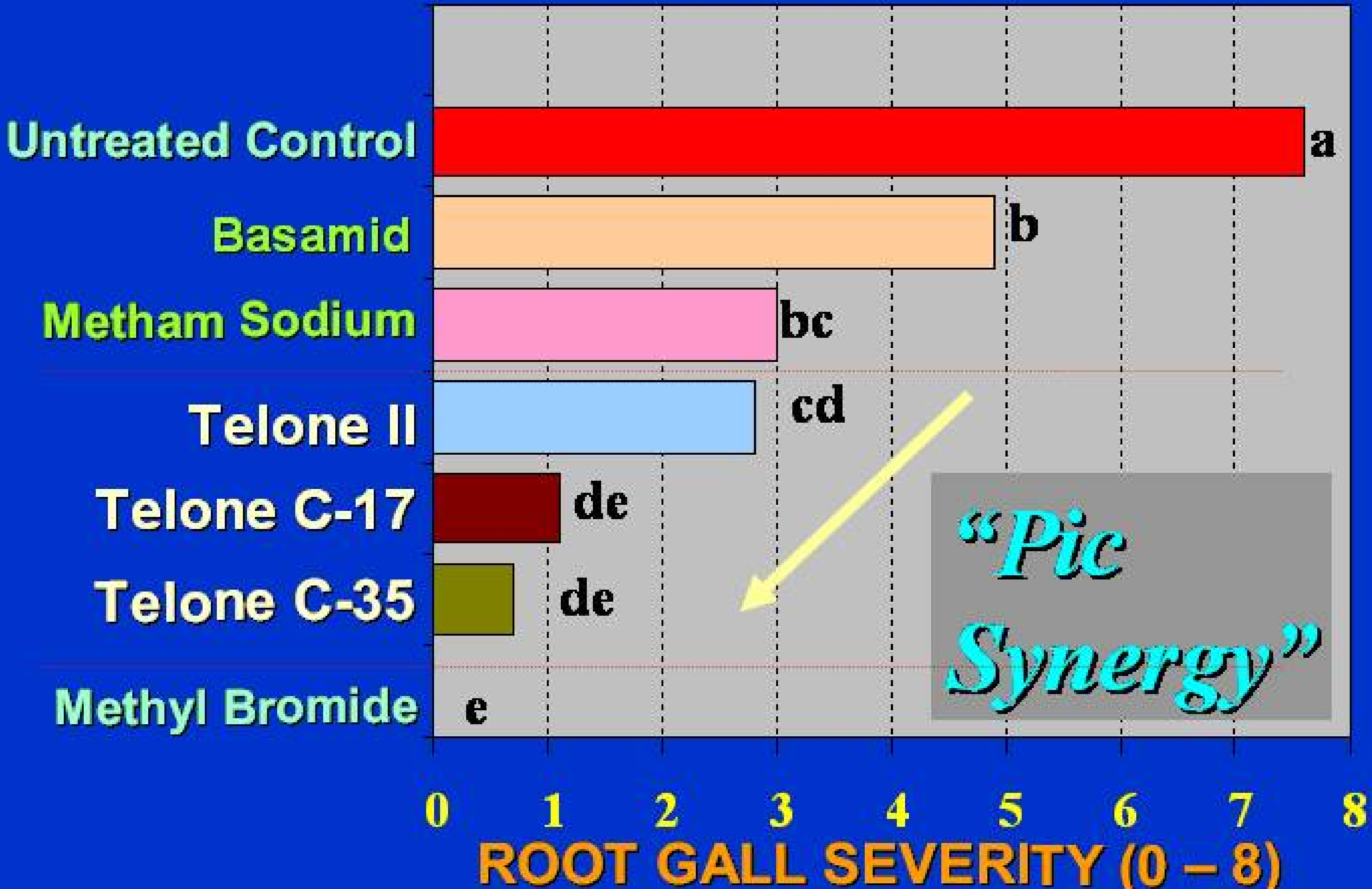
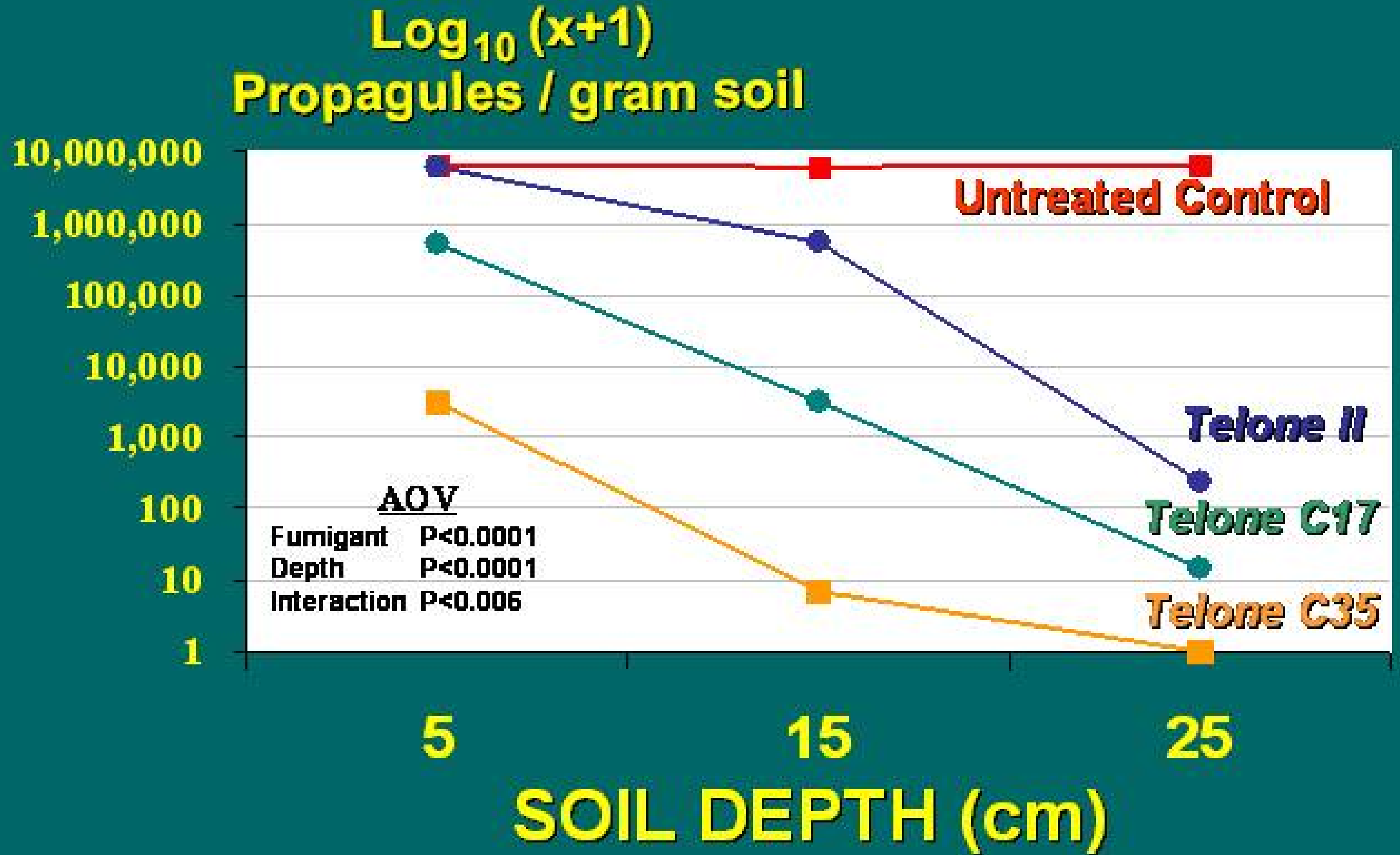


Fig. Influence of fumigant on tomato root gall severity. Spring 2000

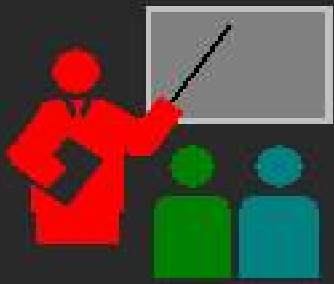


Other studies have documented similar results for weed efficacy.

Figure 5. Effect of fumigant treatment on survival of *Fusarium oxysporum f.sp. lycopersici* Race 3 at three soil depths in field microplots, CREC, Lake Alfred, FL. Spring 2000.



General Conclusions



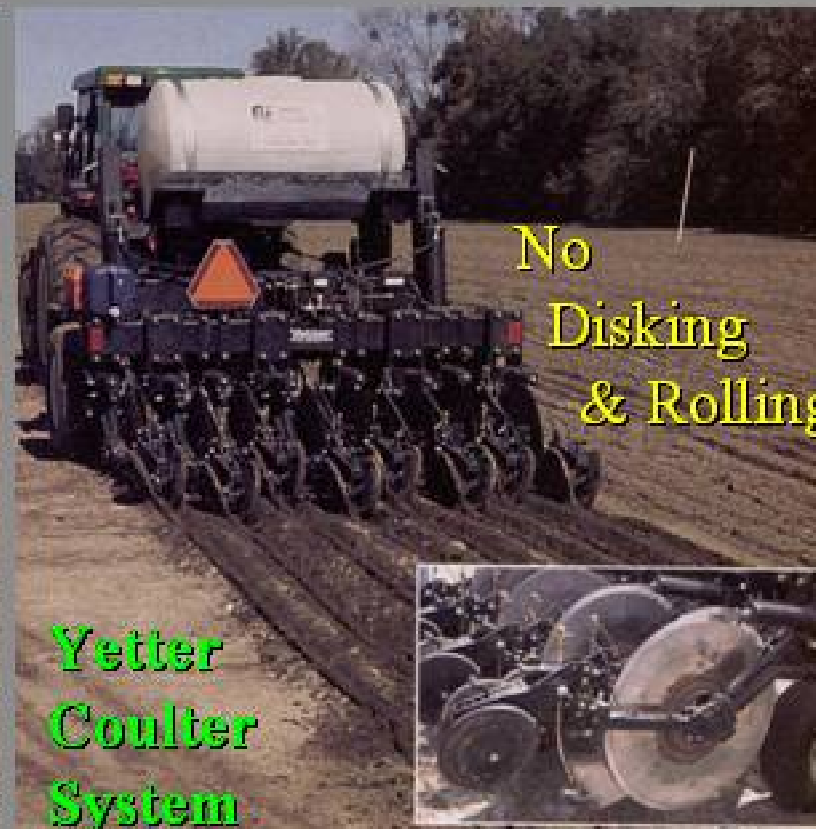
TELONE + CHLOROPICRIN

- 1,3-D poorly herbicidal & fungicidal in activity
- Broadspectrum activity synergized by Chloropicrin
- Telone C-35 ‘next best’ Alternative to MBr

2

INTEGRATION of NEW FUMIGANT APPLICATION TECHNOLOGY

OLD SYSTEM → ***PRESENTLY***



<u>Less in Air, More in SOIL</u>

IMPROVED CONSISTENCY

INTEGRATING NEW PLASTIC MULCH TECHNOLOGY

Fumigant Rate & Emission Reductions with VIF

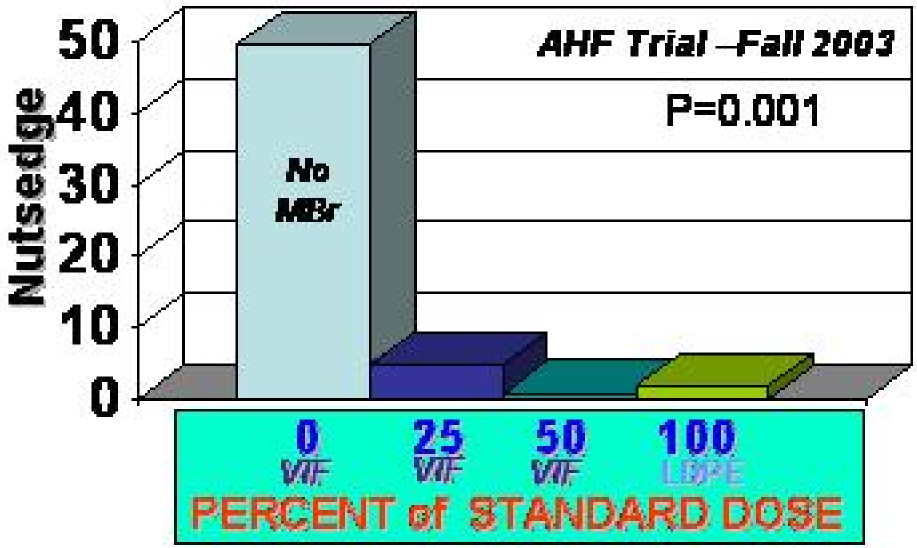
(mandatory CUE requirement?)

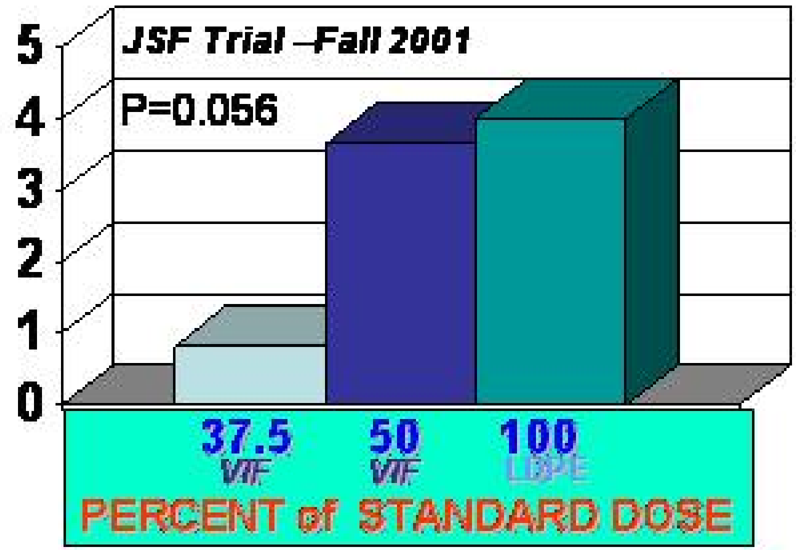
18 VIF Trials

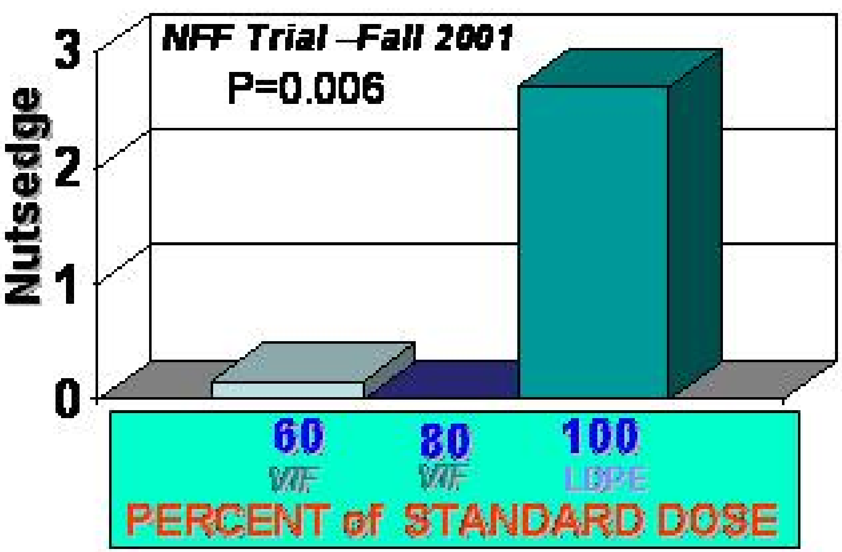
- No Major Differences

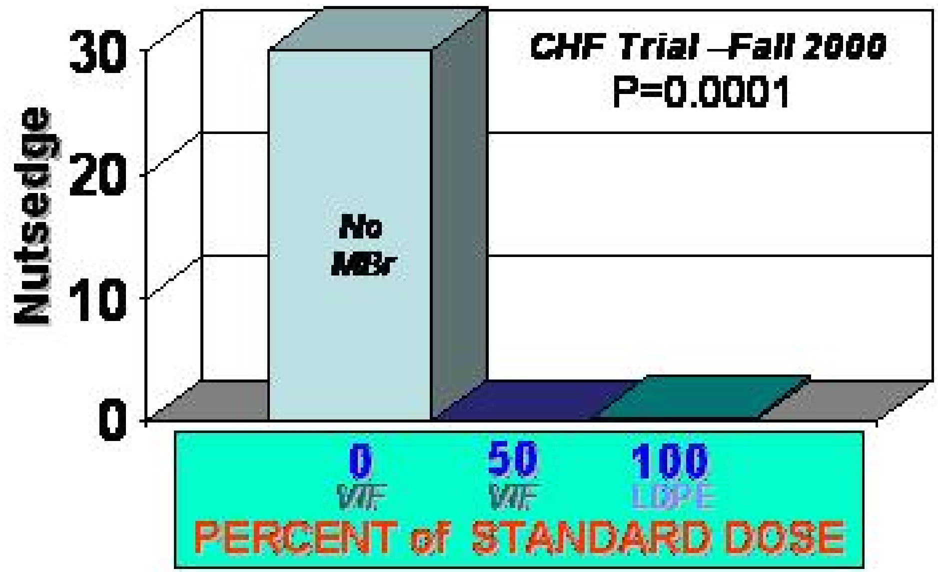
Weed Control Observed even when rates reduced as much as 50%

WEED DENSITY / 15 m row









VIF
Not Easy
to Lay!!!
Can be a SLOW GO!
VIF
VIF
Splitting & Zippering ?
rolls up 3"
Can't be Cut!
VIF
Appearance ?
SEPT 24, 2004
VIF

INSTALLATION DELAYS:

- 8 of 18 Demonstration sites during 2000-2004 reported plastic laying problems. Tractor speeds reduced to 2-3 mph.

Fall Trials	Film	Installation Speed (mph)	Installation Speed (mph)	Grower Film
Artesian 2004	IPM	3.6	4.8	Metalized
Grooms 2004	Greek	1.6	4.9	Pliant 1mil
Young 2004	IPM	1.2*	4.8	Pliant 1mil
Herndon 2004	Klerk	2.0	4.3	Pliant 1mil
Dover 2004	IPM	2.3	5.1	Pliant 1mil

*This site, like unreported others, encountered extreme, unresolved difficulties such as press wheel slippage, curling of the film, defective spooling, and two row machines.

Some Metalized mulches used for Thrips, Whitefly, and Virus Disease Management have Virtually Impermeable Film Qualities, are cheaper, USA produced, and are easier to lay. HOWEVER……

"ALL METALIZED MULCHES DO NOT APPEAR TO BE CREATED EQUAL"

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GENERAL CONCLUSIONS

- *VIF maintained treatment efficacy*
-
- *Obvious limits to Rate Reductions*
-
- *Difficulties remain for speedy installation*
-
- *Patience & Problem Solving Attitude*

- *Metalized Mulches ?*

INTEGRATING IRRIGATION with IPM

CHEMIGATION "BED WETTING" RESEARCH

Principal Objective:

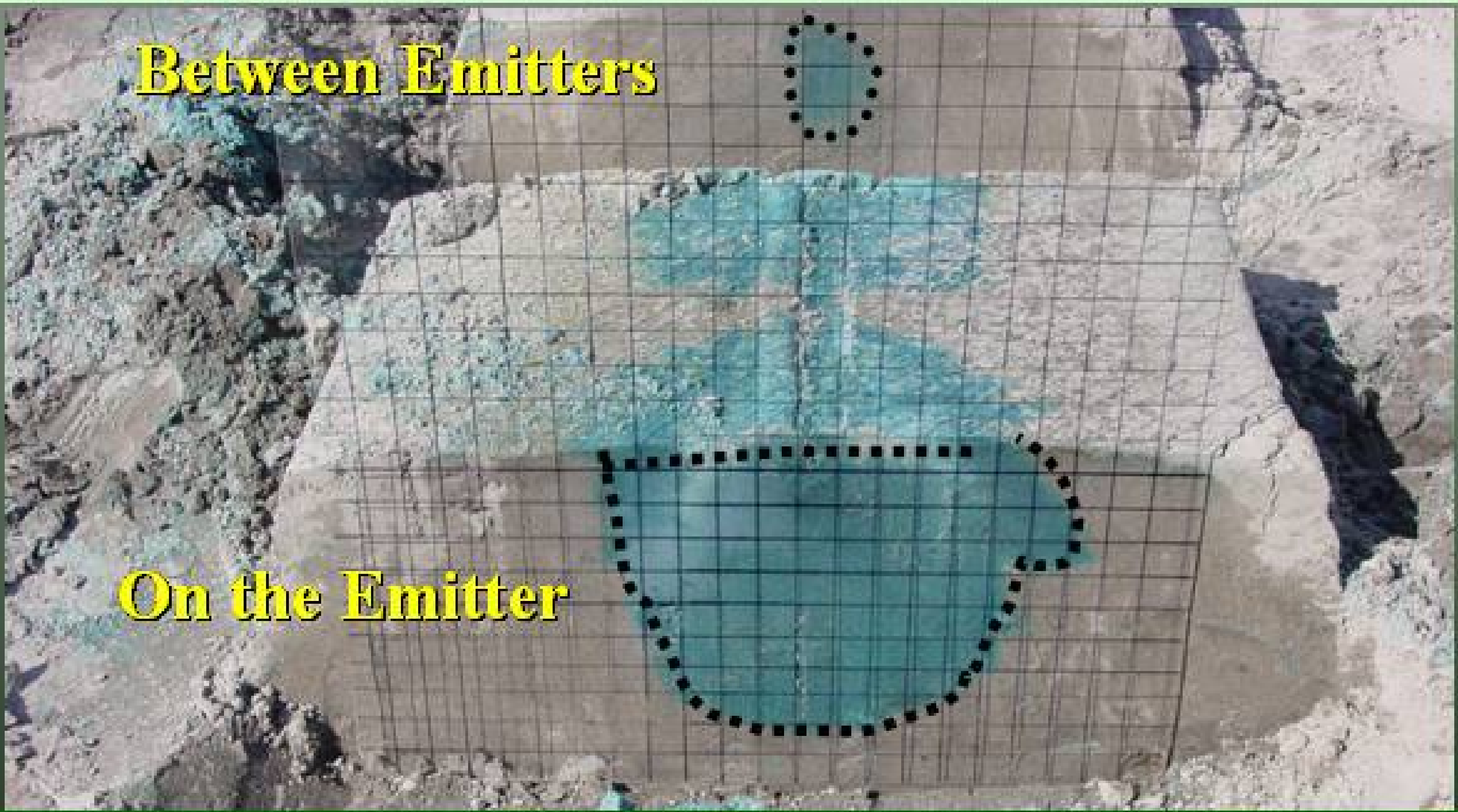
Characterize movement and resultant spatial distribution of a chemigated, water soluble blue dye in soil

Variables Examined:

Injection Period, Tube Numbers, Flow Rates, Emitter Spacings, Soil Compaction, Pulsing , Adjuvants, others…

MAXIMIZING CHEMIGATIONAL EFFICACY

GRID EVALUATION METHOD FOR MEASURING WIDTH, DEPTH, AND AREA OF DRIP WATER MOVEMENT

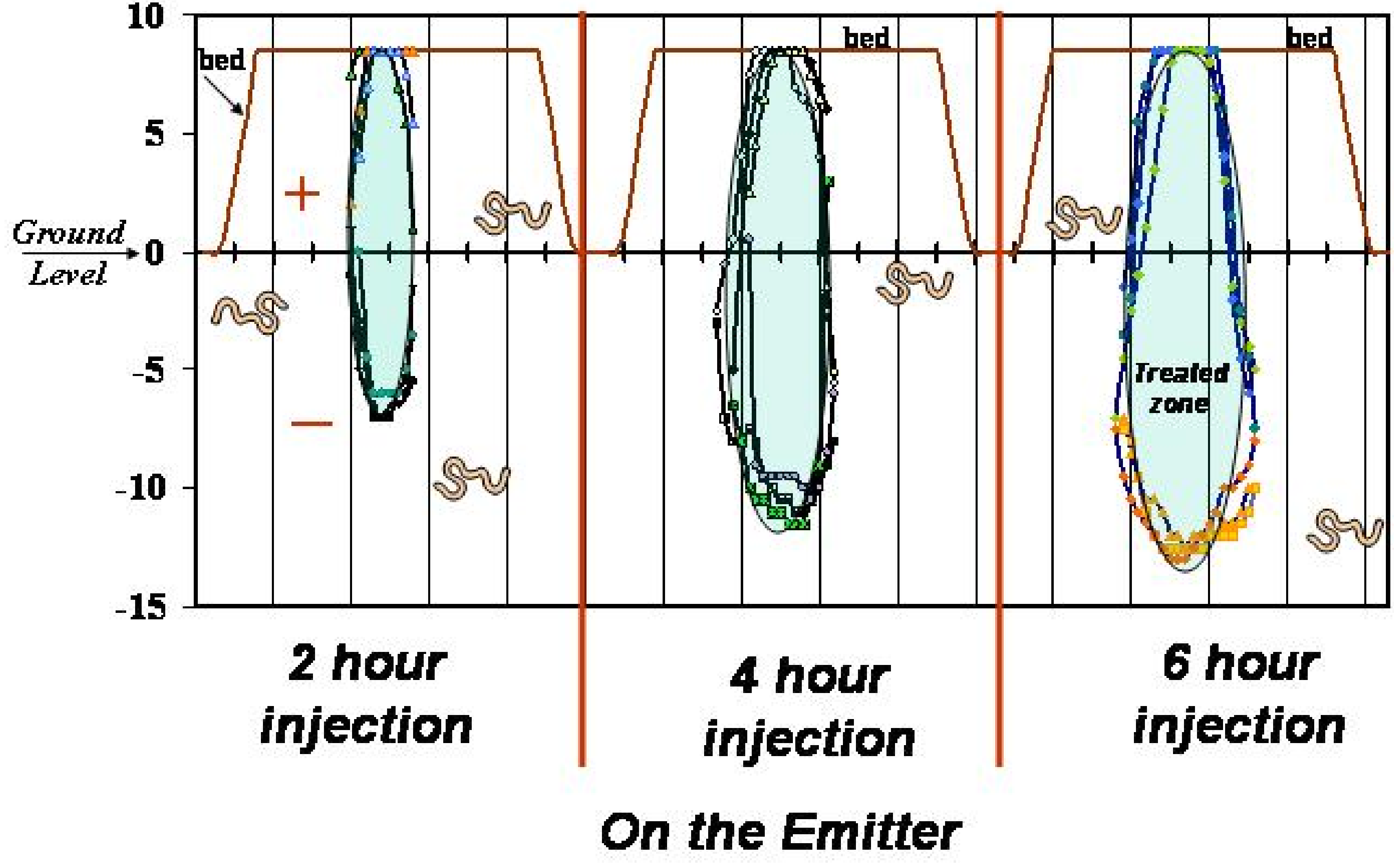


Mapped grid coordinates were then entered into the computer to analyze size of treated or dye stained areas relative to Bed Size, Run Time, Water Volume, Tape Number, and other treatment regimes.

General Result : Much of previous chemigation research evaluated suboptimal irrigation regimes

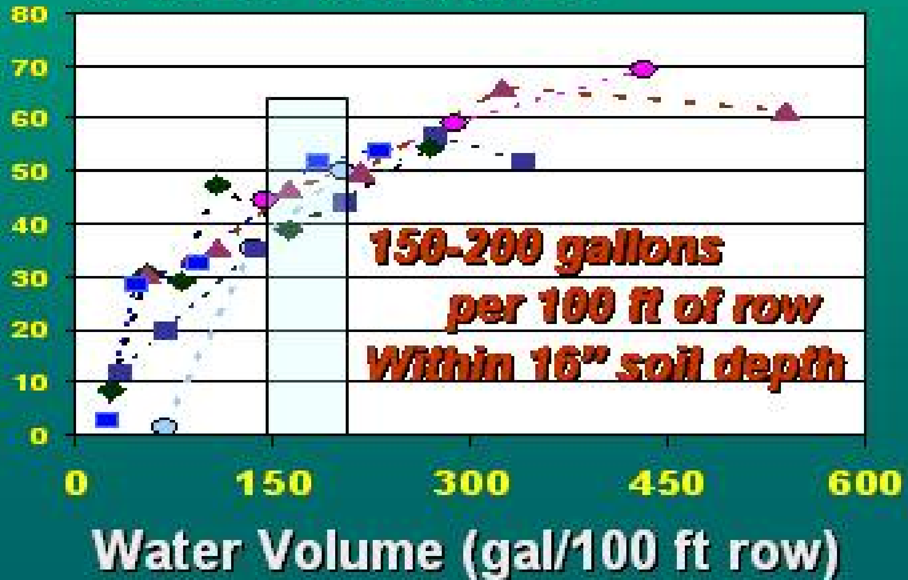
Treatment: 2 hr Chemical Injection Period

CHEMIGATION RESEARCH RESULT: SOME SITES CANNOT BE EFFECTIVELY TREATED



INTEGRATING IRRIGATION & PEST MANAGEMENT

% BED TREATED



General Results: "BED WETTING" RESEARCH

- *In no treatment did bed shoulders or other substantive areas receive treatment.* Max. Bed: 50-60%

"As an Alternative Strategy to Methyl Bromide"

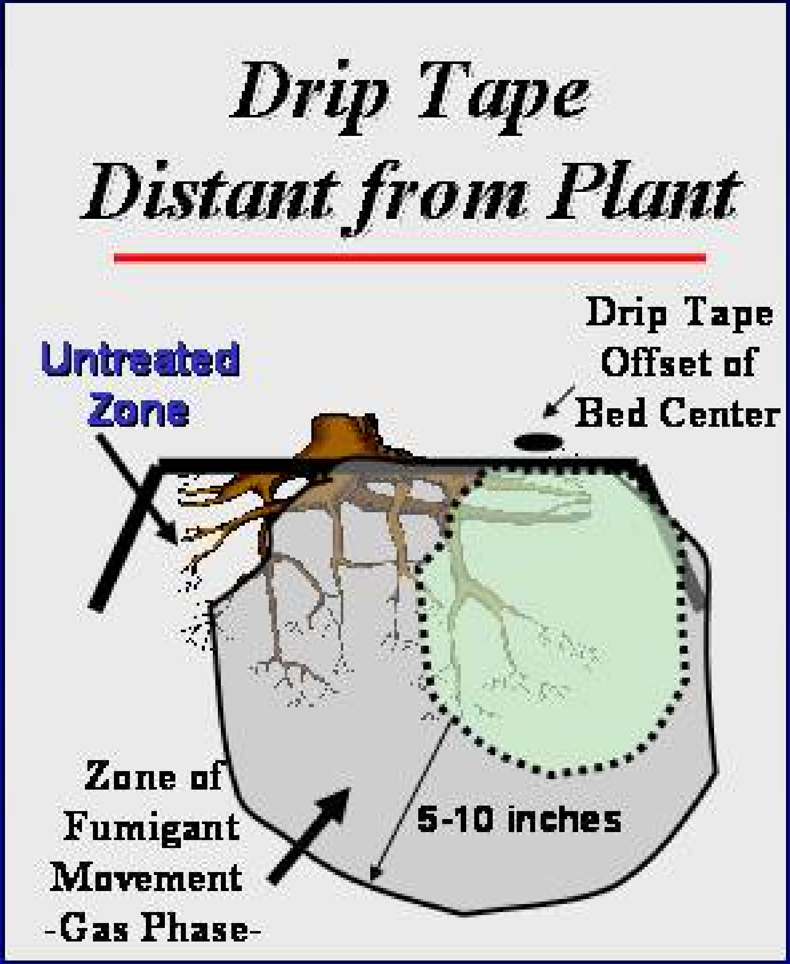
- *At least two drip tubes per bed will be required to achieve complete bed coverage of a chemigated compound*
- *Growers should consider their own on-farm, independent evaluations*

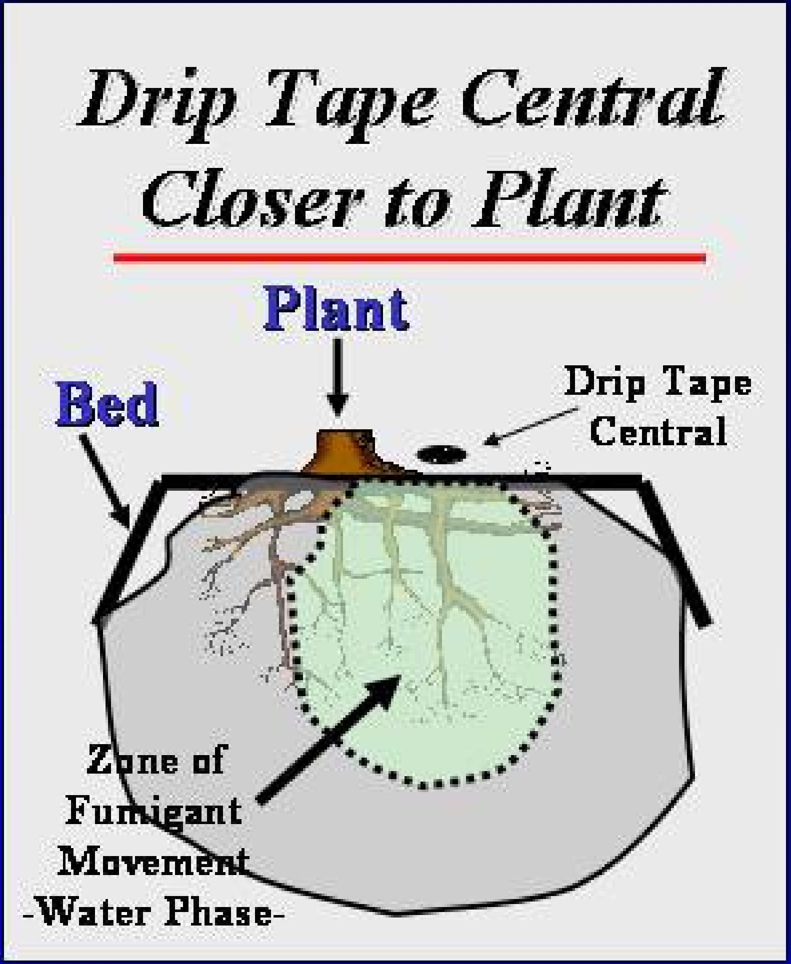
Xsectional View Top View Xsectional View

SITE S: Metham Sodium (60 gal/a) and Telone EC (12 gal/a) applied continuously in 4 hr run time for post harvest crop destruction/nematode control. Bradenton, FL

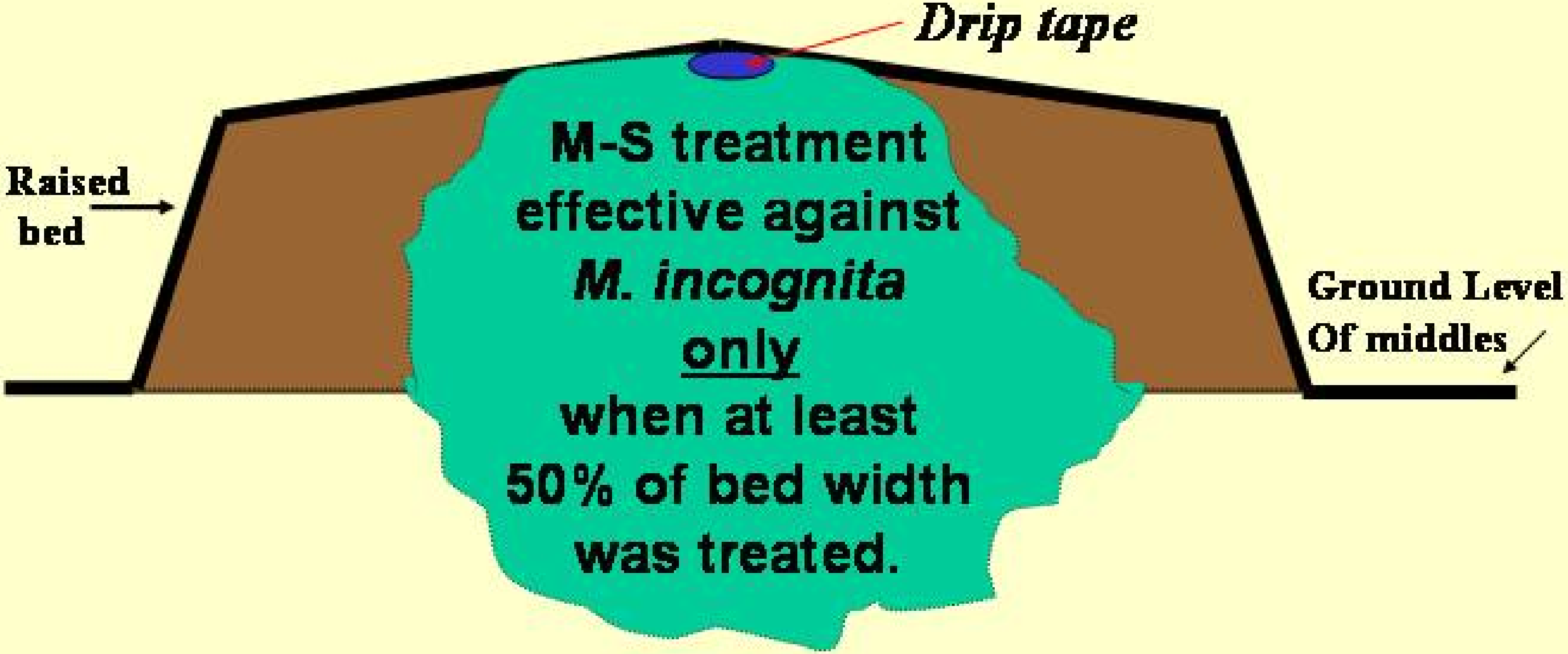
EARLY CROP DESTRUCTION / DOUBLE CROPPING

Importance of Central Drip Tape Placement and Adequate Line Pressure To Maximize Bed Coverage with Chemigated products





Effects of Metam-Sodium Applied by Drip Irrigation

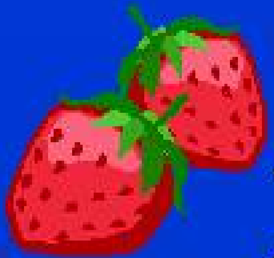


Roberts et al., 1988. Plant Disease 72:213-217

CROP RESCUE

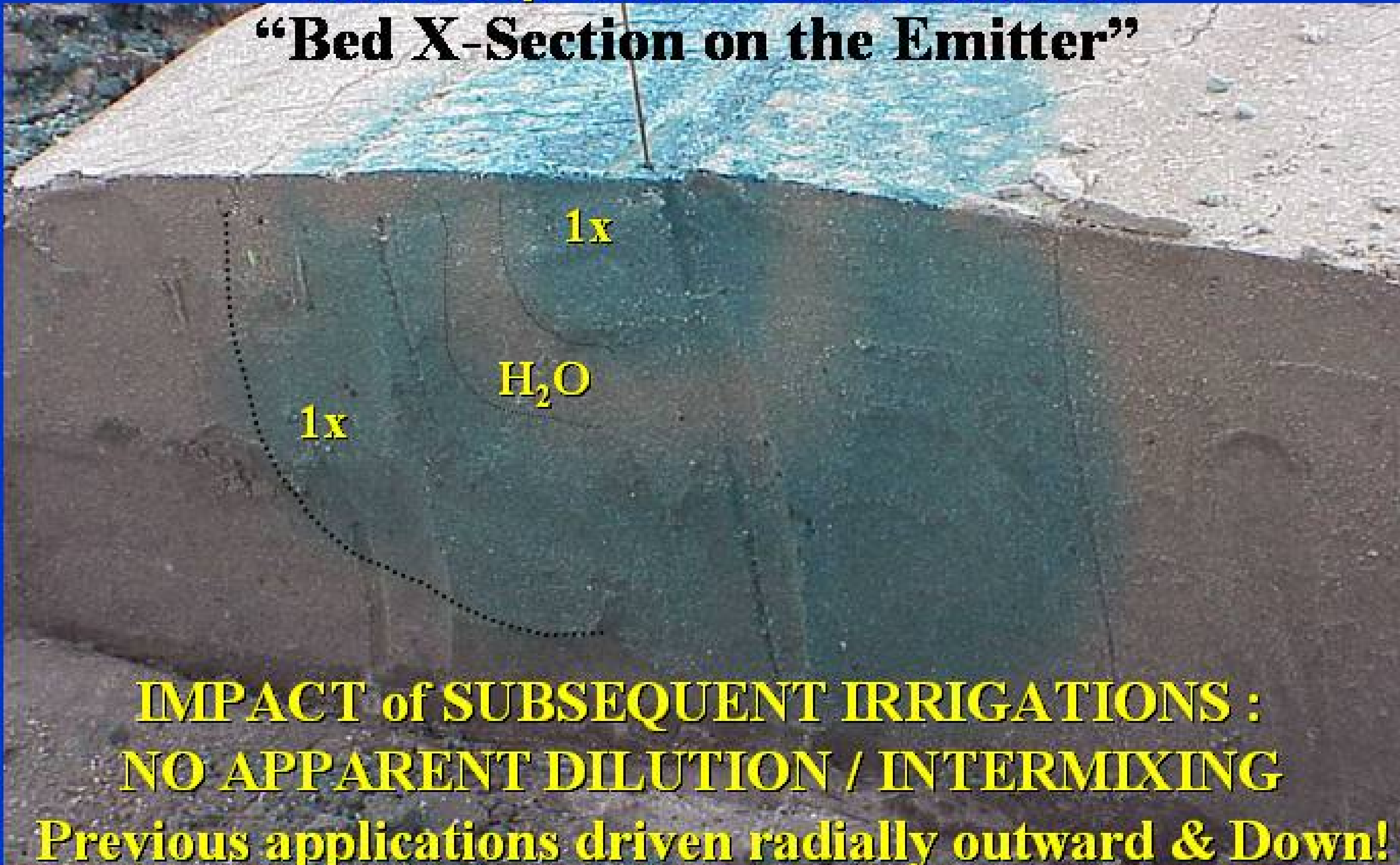
- Nematode Induced Problems Often Develop during Primary and or Secondary Crops which follow

NONFUMIGANT NEMATICIDES → CROP RESCUE



"THE REALITY: THERE ARE VERY FEW, AND FOR MANY CROPS, NO POST PLANT NEMATODE MANAGEMENT OPTIONS"

Effect of Pulsing on Resultant Dye and Drip Water Distribution



Effect of a 30 min. Line Flush on Resultant Dye and Drip Water Distribution

"Bed X-Sections on the Emitter"

Is it any wonder we have difficulties obtaining Efficacy when Little or no dilution or intermixing occurs, and Water Fronts move radially outward & Down!

Noling et.al., 2001

NEMATOSTATIC ACTIVITY
'the stupor effect'

CONCENTRATIONS (ppm) Required to Affect Stages of *Meloidogyne* Life Cycle

Product	Hatch	Migration	Development
Aldicarb	>8	>2	>4
Fenamiphos	>2	>2	>4
Ethoprop	>2	>4	>4

McLeod and Khair, 1974

Bottom Line:

To be effective as Nematostats: Must Maintain Toxic Concentration

Most Nonfumigant Nematicides Function:

DELAYING THE TIME OF ARRIVAL

ALDICARB	OXAMYL
PHENAMIPHOS	ETHOPROP

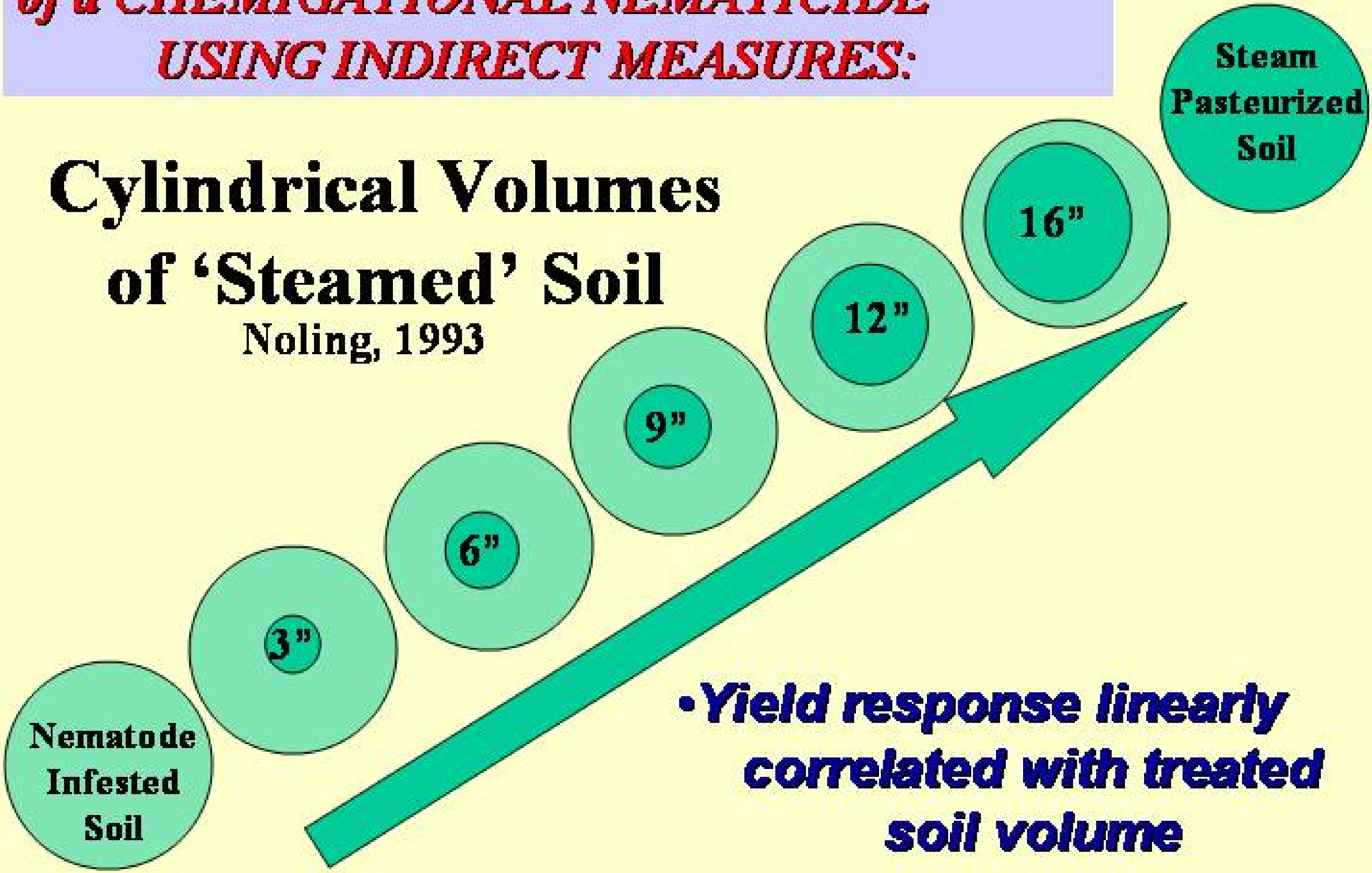
MOST OTHER NONFUMIGANTS

30 DAYS OF REPRIEVE…is usually enough to achieve desired yield response, HOWEVER, final harvest population levels of nematodes Is oftentimes higher in nonfumigant treated areas.

SIMULATING THE IMPACT & DISPERSION of a CHEMIGATIONAL NEMATICIDE USING INDIRECT MEASURES:

Cylindrical Volumes of 'Steamed' Soil

Noling, 1993



- ***Yield response linearly correlated with treated soil volume***

CHEMIGATION

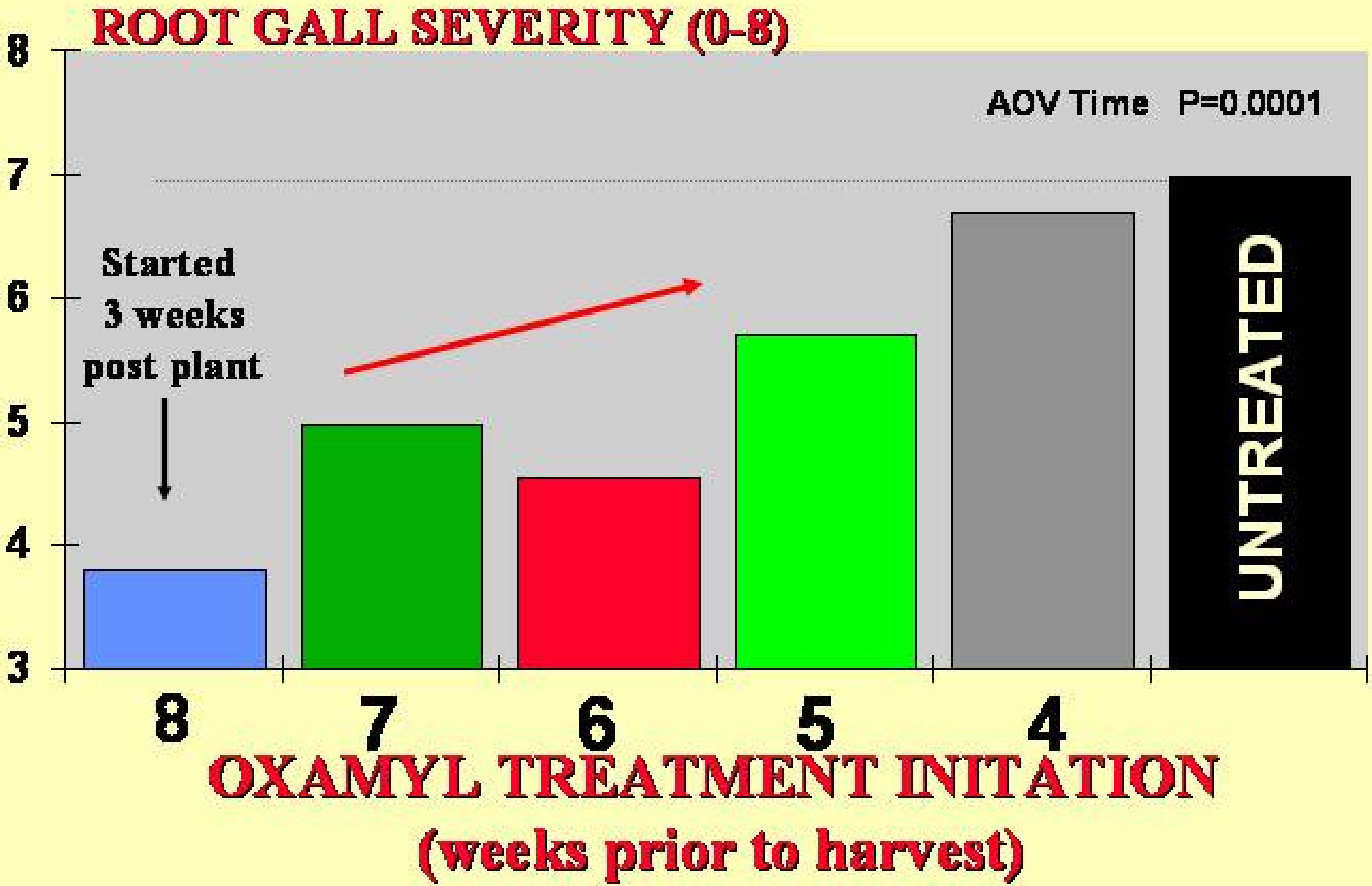
What Does the Literature Say:

- MOST WATER SOLUBLE NEMATICIDES LOSE THEIR EFFECTIVENESS BETWEEN 2ND AND 4th WEEK AFTER APPLICATION

- SPLIT better than SINGLE APPLICATIONS
  ie., 6X better than 3X, 3X better than 1X

Time of Discovery / Postplant Treatment Initiation

"Is it ever to late to initiate treatment"



Noling, 1998 *"Sooner weekly treatments initiated the better"*

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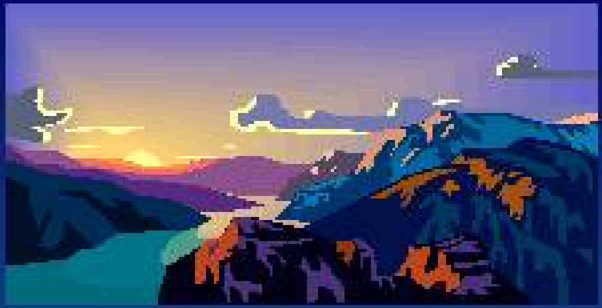
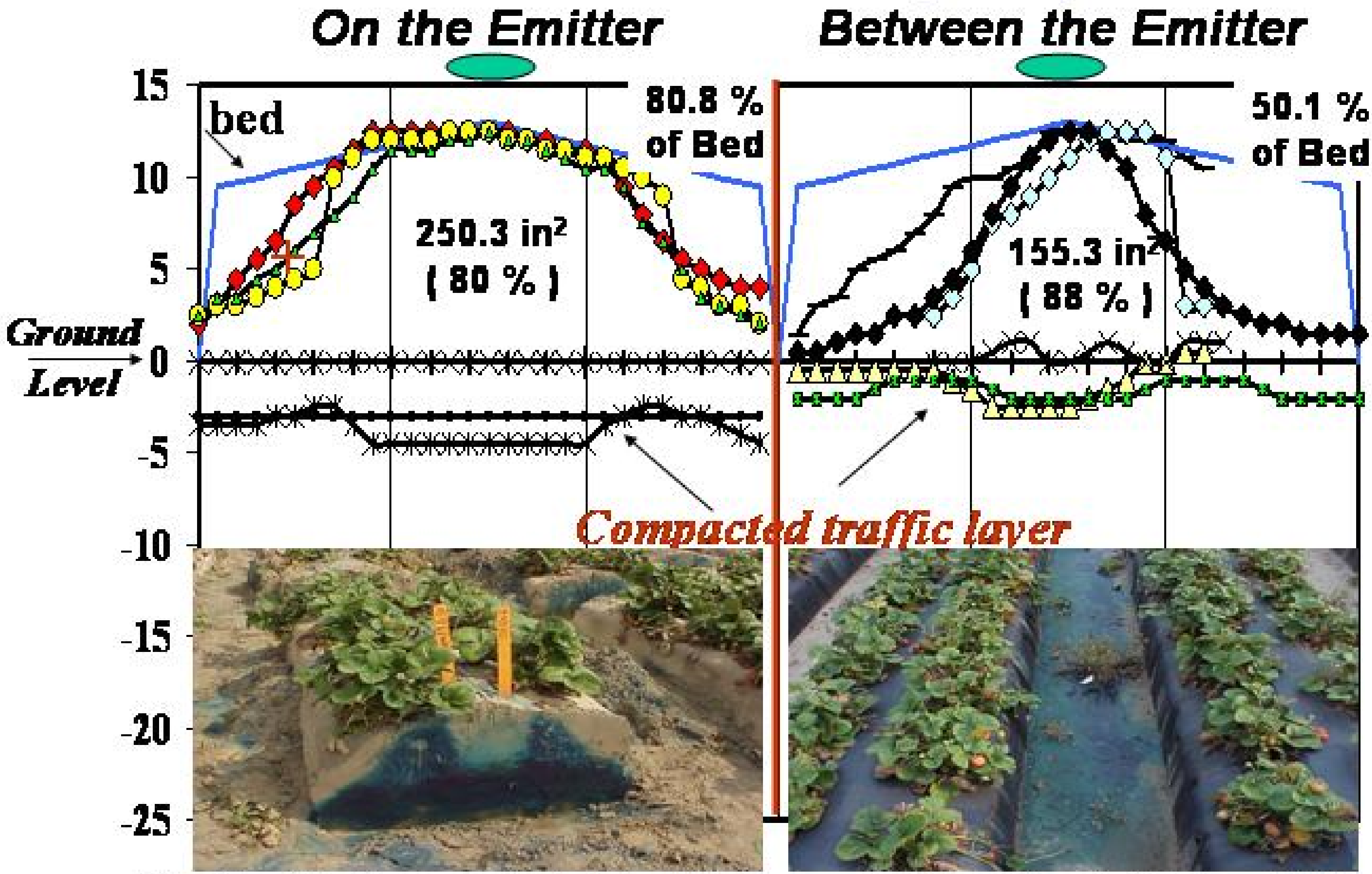


Integration of New CULTURAL PRACTICES

Influence of Soil Compaction On Diffusion of Fumigants

Soil Compaction Layer as Barrier to Water Infiltration

Cross Sectional Views (inches)



The dye hit the compacted traffic layer and then flooded into middles

EXPERIMENTAL DESIGN

LAND PREPARATION:

+ With CHISEL PLOW
- WITHOUT CHISEL PLOW

CHEMICAL TREATMENTS

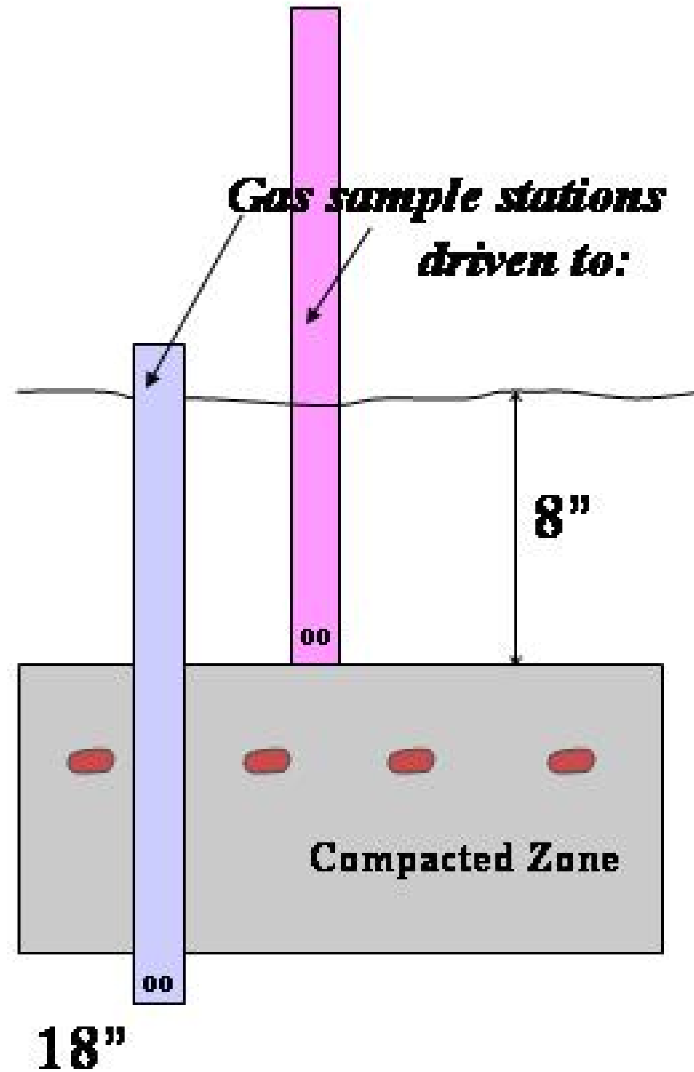
In-Row Methyl Bromide (350 lb/a)
In-Row Telone II (18 gal/a)
Broadcast Telone II (18 gal/a)

MEASURED SOIL GAS CONC.(8 &18")

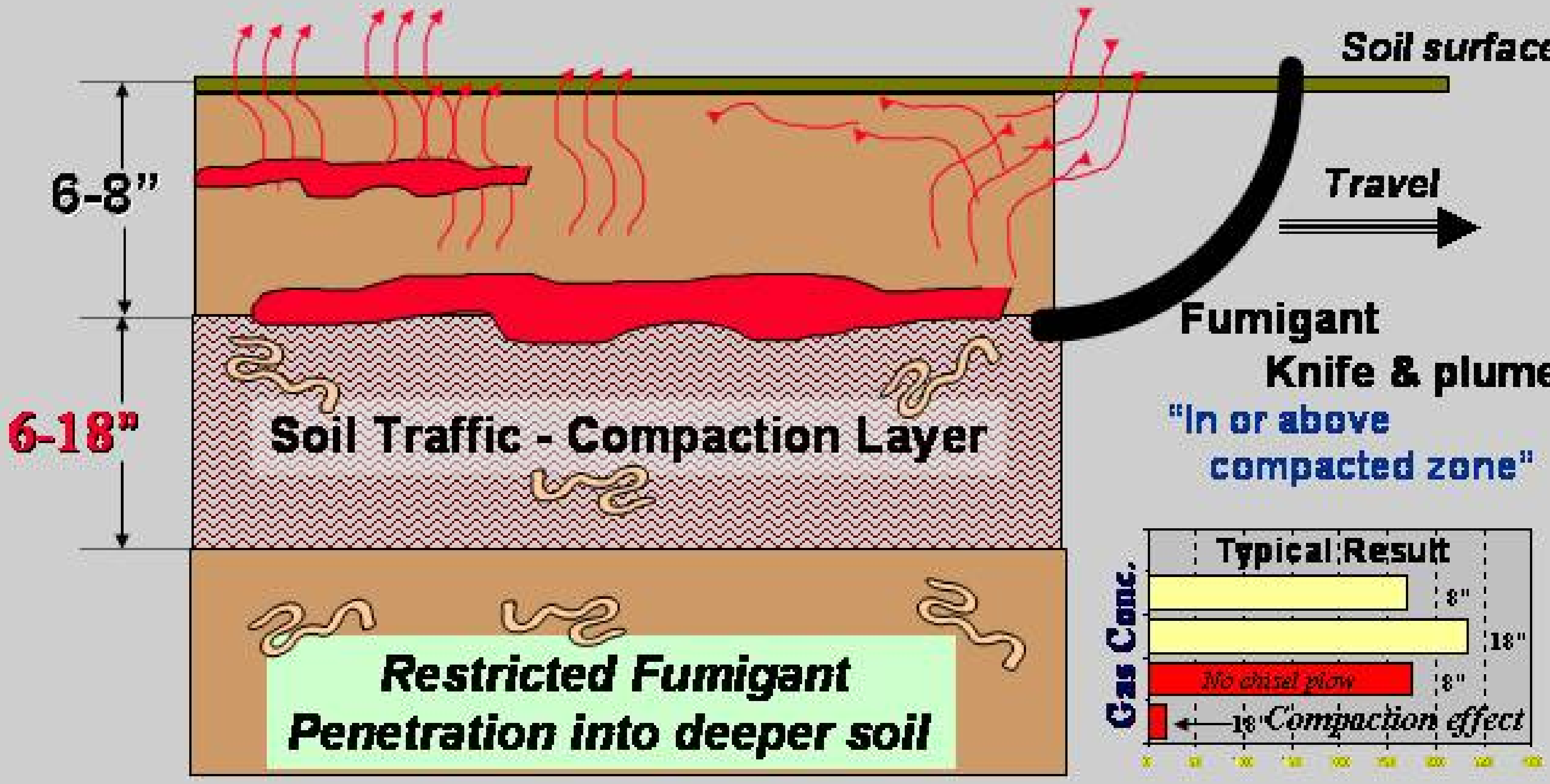
6 Reps / Trtmt

MEASURED GAS CONCENTRATIONS– 2 SOIL DEPTHS

Gas Concentrations
Measured with
GasTek Model GV-100
Vacuum Pump
using either
No. 132 HA (1,3-D)
No. 136H (MBr)
Detector Tubes



- *Soil Compaction Layer in Fields Everywhere*
- ***SEVERELY RESTRICTED FUMIGANT MOVEMENT***



- **Possible Cause of Treatment Inconsistency !**

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GENERAL CONCLUSIONS

- Unless destroyed by CHISEL PLOWING before injection, the presence of a soil compaction layer RESTRICTED downward diffusion of Telone (1,3-d) (and possibly MBr)

- To Maximize Distribution, Efficacy, & Consistency, MUST Chisel Plow Soil before Telone injection , particularly BROADCAST APPLICATIONS

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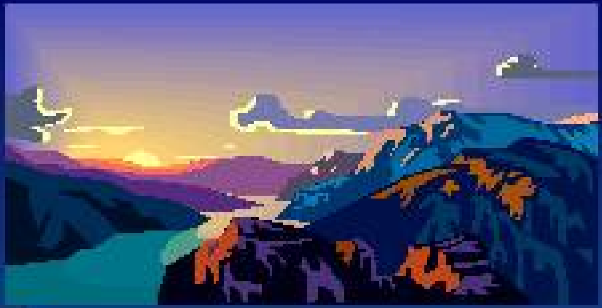


The Importance and Interaction of Weeds for Nematode Management

Working Hypothesis:

Weed density and diversity to increase in the Post Methyl Bromide Era

Florida Weed / Nematode Host Survey

OBJECTIVES:

Characterize weed host status to species of *Meloidogyne* and field Impacts to population growth

PROCEDURE

- Nematode Infested Fields Identified
- Plant Roots Carefully Excavated
  & Returned to Lab (nonrandom sampling)
- Roots Stained to Locate Egg masses
- Egg Masses per gram root Indexed

EGG MASS INDEX / g root

0	0	None
1	< 10	Light
2	11- 50	Moderate
3	51- 100	Heavy
4	> 100	Very Heavy

Figure 1. Heavy galling of pigweed roots by root knot nematode, Melodigyne spp.

Fig.2. Heavy galling of black nightshade by root knot nematode, Melodigyne spp.

Figure 3. Heavy galling of purslane roots by root knot nematode, Melodigyne spp.

Table 2. Results of Field Survey Demonstrating the Capacity of Different Weeds to Support Root-Knot Nematode Reproduction

Weed Species:	Reproductive Index (range)
● Pigweed	Heavy – Very Heavy
● Purslane	Very Heavy
● Nightshade	Few –Very Heavy
● Eclipta	Moderate - Heavy
Ragweed	None - Few
● Clover	Very Heavy
● Sesbania	Very Heavy
● Sand Vetch	Very Heavy
● Goosegrass	Few-Very Heavy
Crabgrass	None - Few
● Carolina Geranium	Very Heavy
● Cutleaf Primrose	Moderate
Gnaphalium	Moderate
Cudweed	None - Few
Yellow Nutsedge	Few

● Key Florida Species (Weed Density x Index)

Figure 4. -WEED MANAGEMENT-ROW MIDDLES-

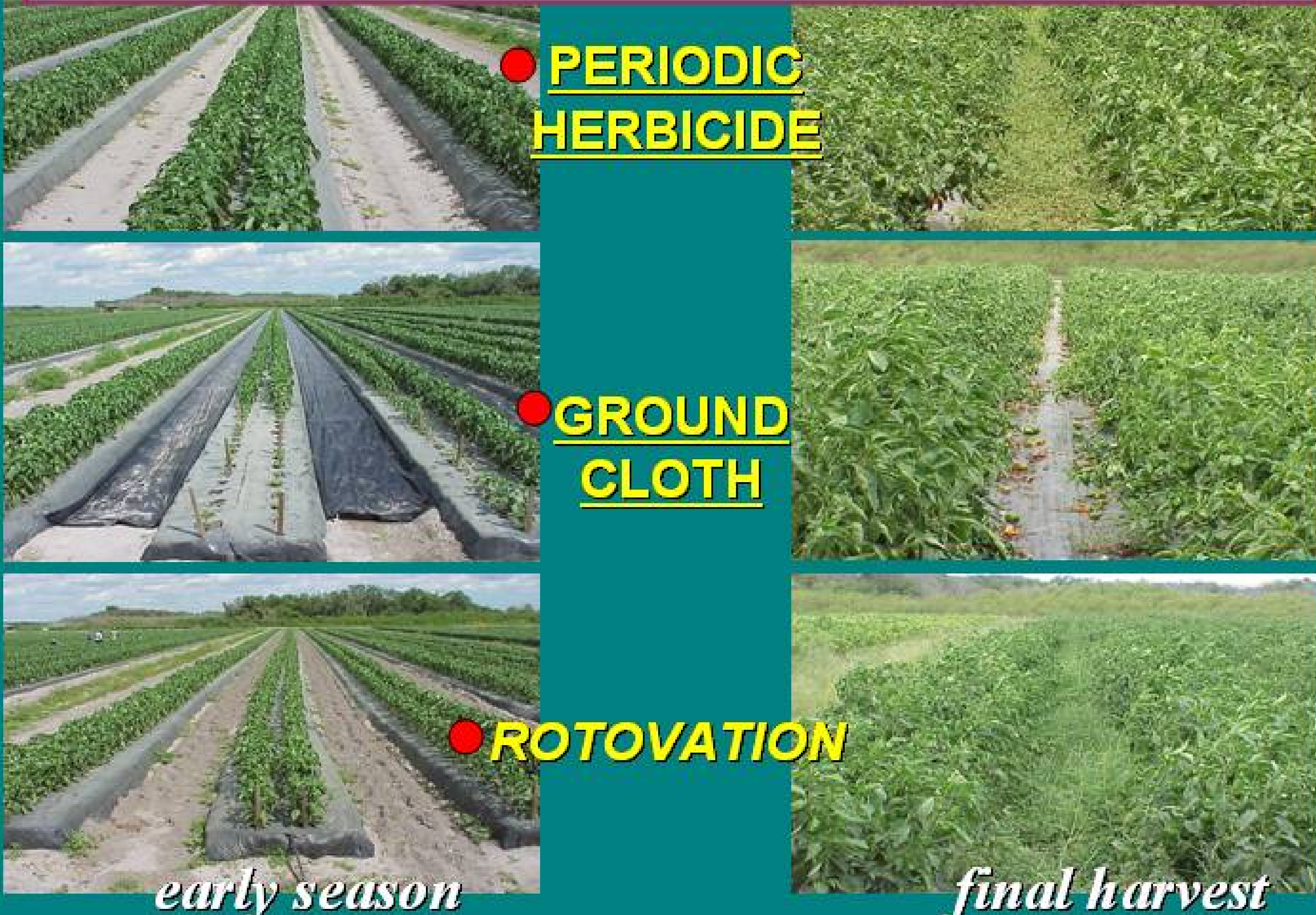
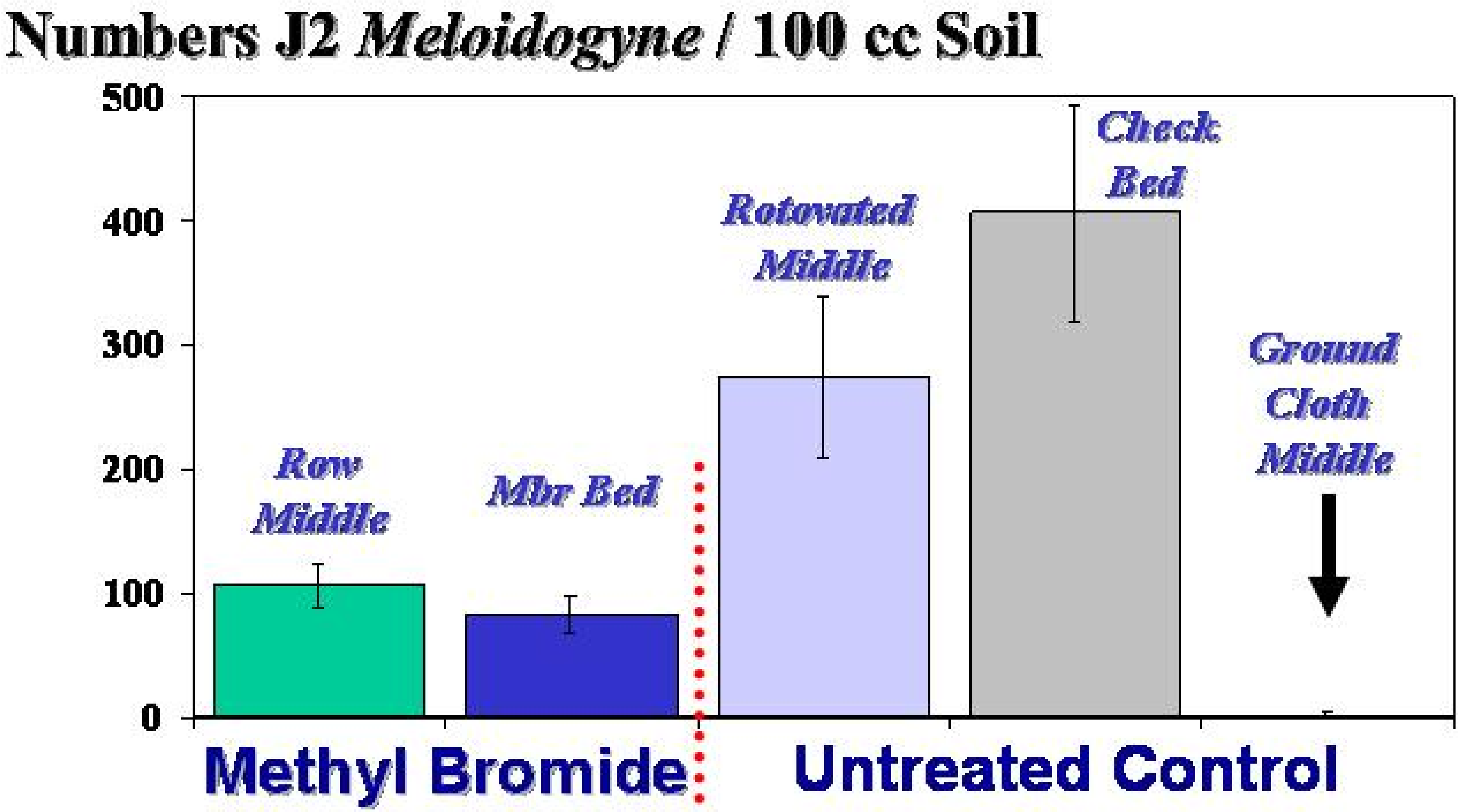
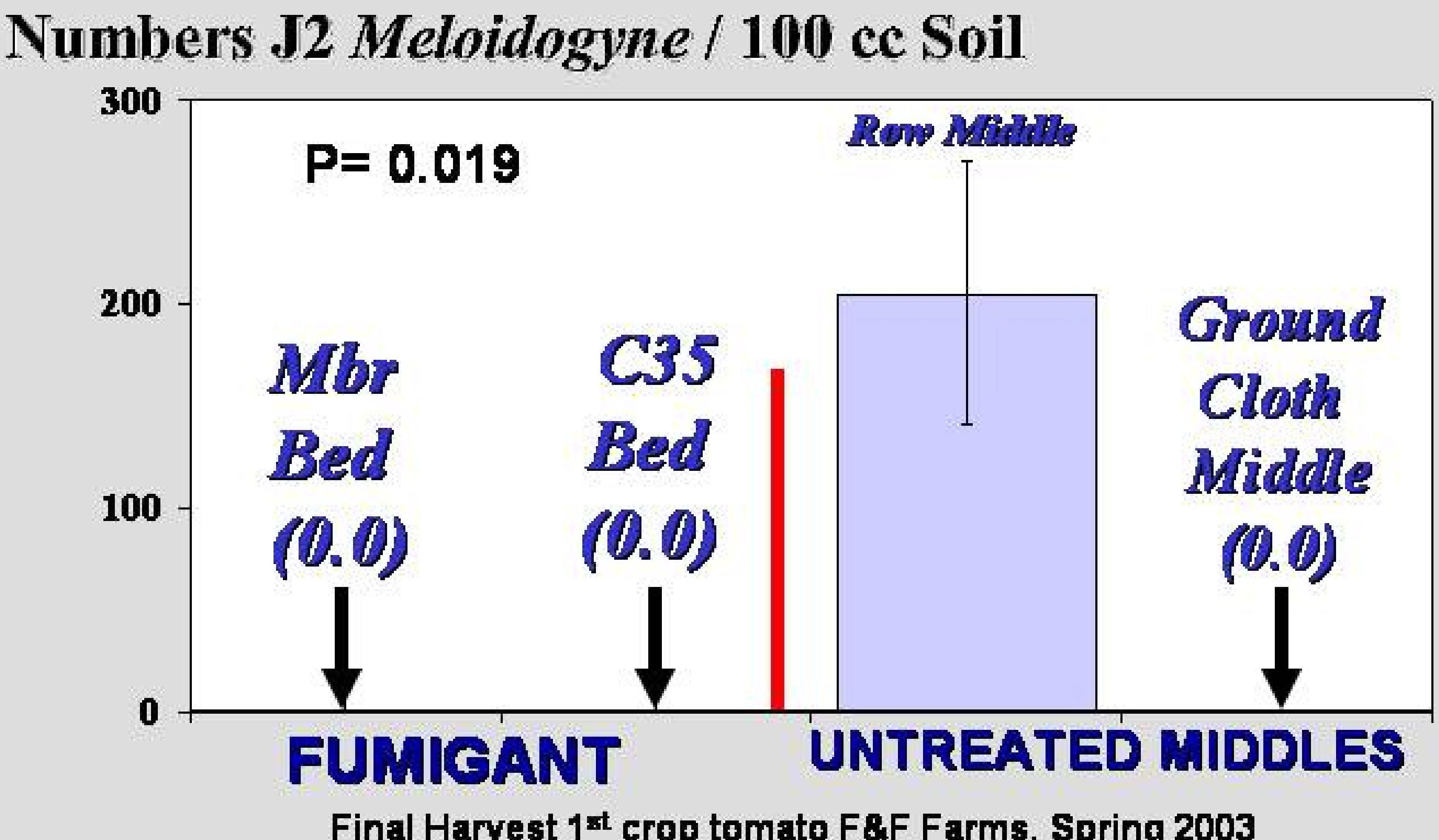


Fig. 5. Number of root-knot nematodes from row middles, raised plant beds, or below ground cloth cover in nonfumigated (check) or soil fumigated locations. Weed / Middles ManagementGround Cloth Trial – Fall 2002



After 1st pepper crop

Fig. 6. Number of root-knot nematodes from row middles, raised plant beds, or below ground cloth cover in nonfumigated (check) or soil fumigated locations. Weed / Middles Management Ground Cloth Trial – Spring 2003



GENERAL CONCLUSIONS

- *Host range is wide, with few nonhosts*

- *Nematode population growth can be extensive, and is functionally related to weed density and root biomass*

- *Nematodes <u>cannot</u> be effectively managed without simultaneous consideration of weed management*

GENERAL CONCLUSIONS

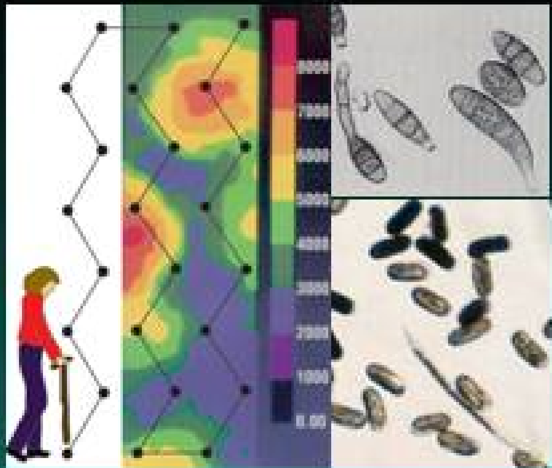
DOES LONG TERM NEED FOR SOIL FUMIGATION ARISE FROM WEED GROWTH IN MIDDLES?

INTEGRATED PEST MANAGEMENT -TOMATO

Herbicide Selection MATRIX to simultaneously consider PRIORITY weeds for nematode control

	POST EMERGENCE				PRE EMERGENCE			
Weed Species	Dacthal	Sencor	Poast	Sandea	Tillam	Treflan	Devrinol	NEMATODE PRIORITY RANKING
Sedges	Poor	Poor	?	E	G-E	Poor	Poor	Low
Grasses	F-G	P-F	G-E	Poor	?	G-E	E	Moderate
Pigweed	F-G	G	NONE	G	?	G-E	F-G	High
Primrose	F-G	E	NONE	?	?	G	G	Moderate
Eclipta	?	F-G	NONE	?	?	F-G	Poor	Moderate
Pusley	F	G	F-G	Poor	?	E	G-E	Low-mod
Purslane	G	G	NONE	Poor	?	E	G	Very high
Nightshade	F	Poor	NONE	Poor	?	Poor	Poor	High
Ragweed	?	G	NONE	G	?	Poor	?	Low

NONE	Poor	P-F	Fair	F-G	Good	G-E	Excellent



Need for Integrated System

With MBr : SAMPLING NOT REQUIRED !

After MBr: More Complex Decision Making Process regarding Selection & Integration of Alternatives

New IPM Requirements:

ECONOMICALLY ACCEPTIBLE PEST MONITORING PROGRAMS !!!

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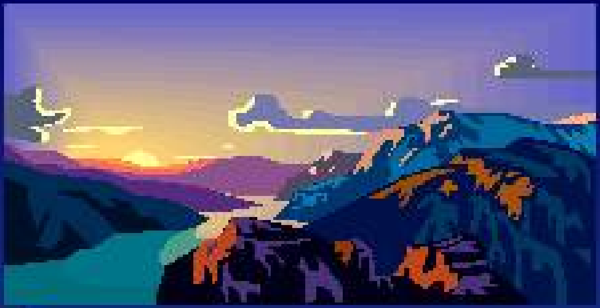
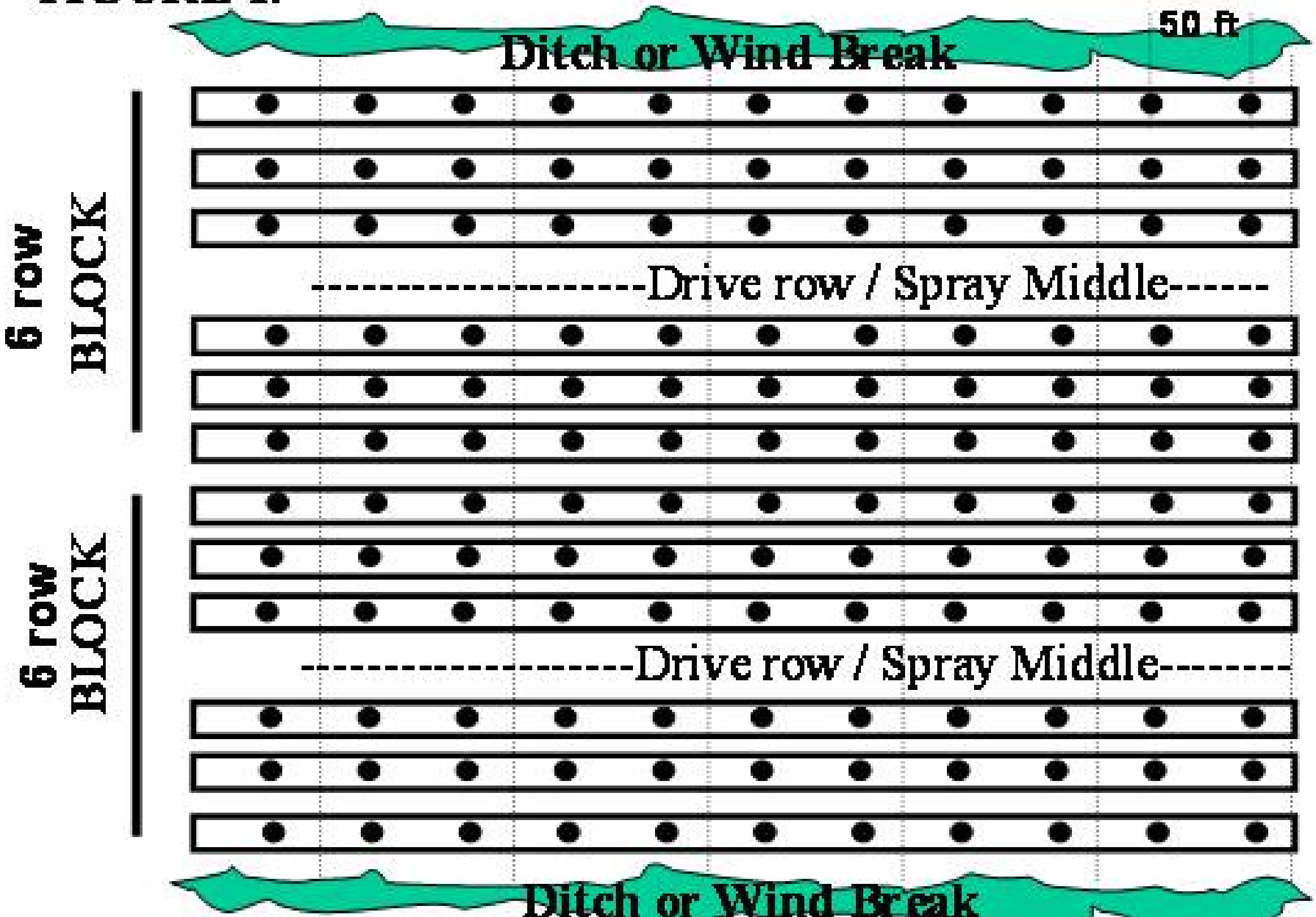


Grower Conducted Surveys for Field Diagnosis and Sampling for Root - Knot Nematode Based on Root Gall Indices.

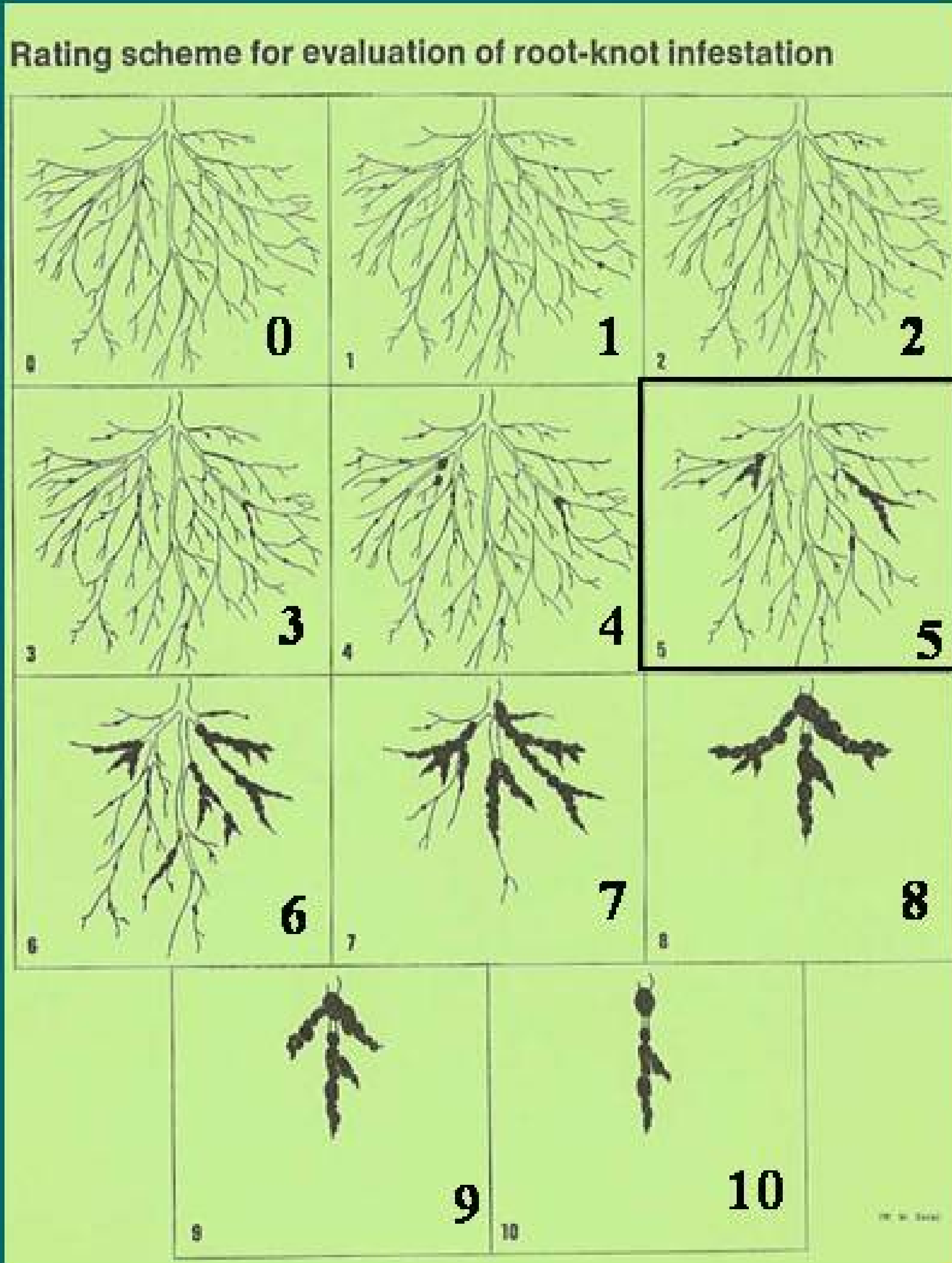
PATTERN OF PLANT REMOVAL

FIGURE 1.

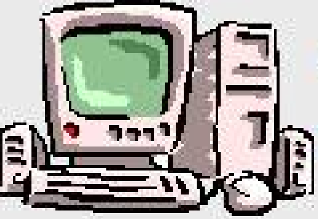


The basic sampling unit: A grower defined spray block or land

● Sites for removal and gall indexing of a crop plant based on 50 ft increments of plant row.

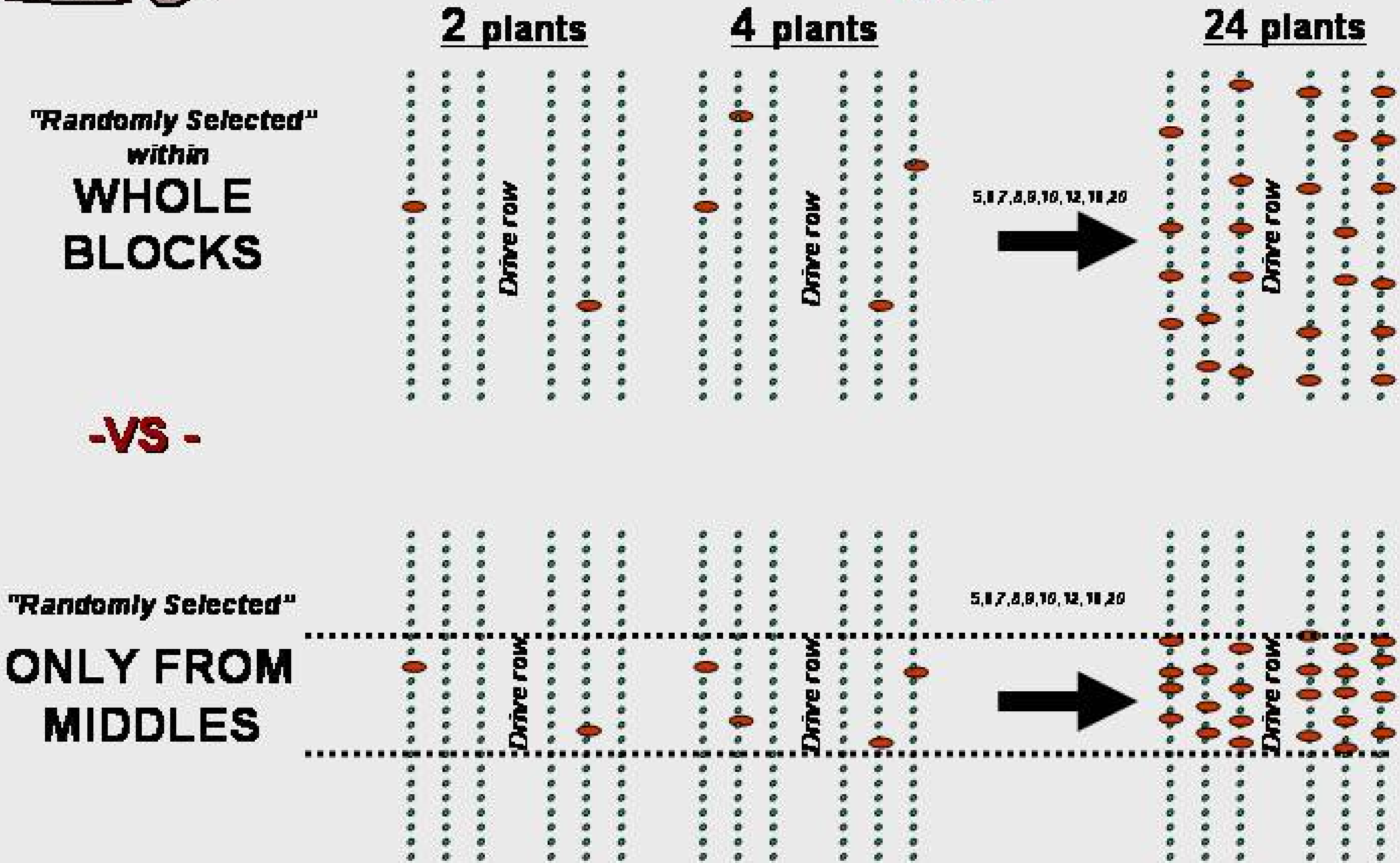


VISUAL ACUITY OF GROWER ROOT GALL = 5.0

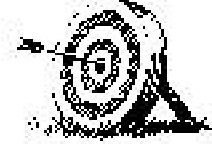


Designed Computer Simulation to Randomly & Repeatedly Subsample Each Dataset by SPRAY BLOCK 250 times:

(6 row)



The sampling scheme must exhibit:



PRECISION

Frequency in which Sample Mean is Less than or Greater than defined level of Accuracy

(20 or 25%)

ACCURACY

is defined to be how close the Sample mean must be to the True population mean.

(20 or 25%)

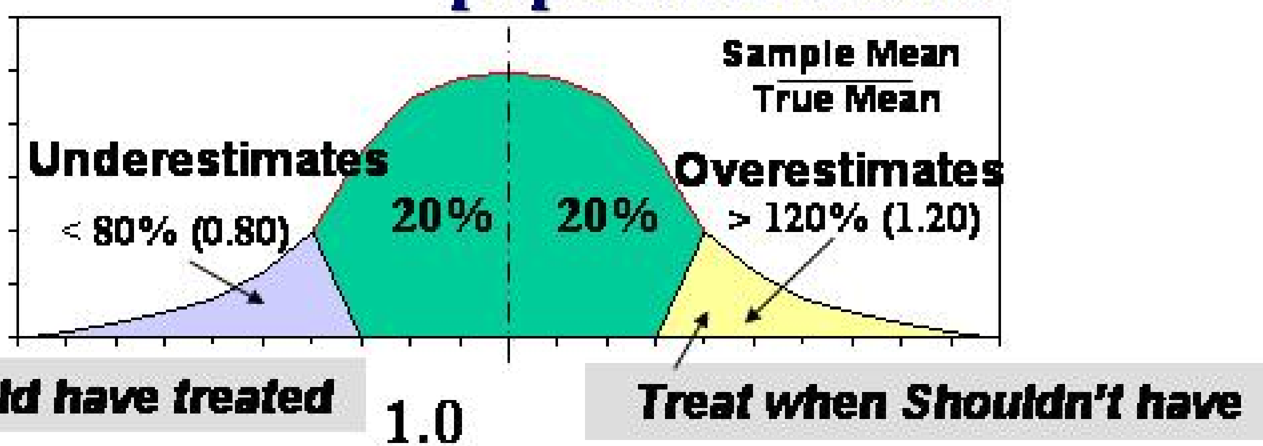
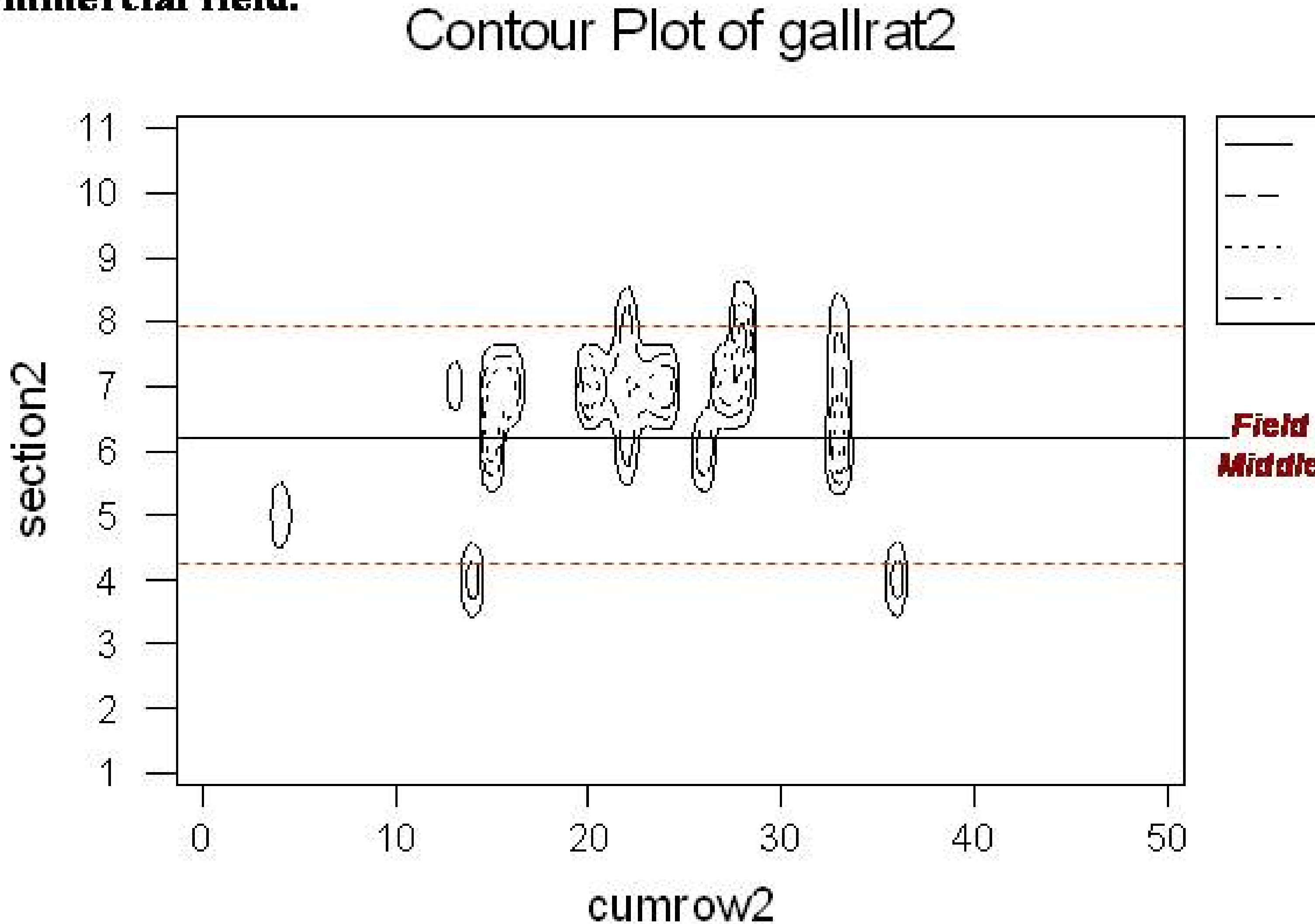


Figure 11. Spatial distribution of root knot nematode galling on roots of eggplant in a commercial field.

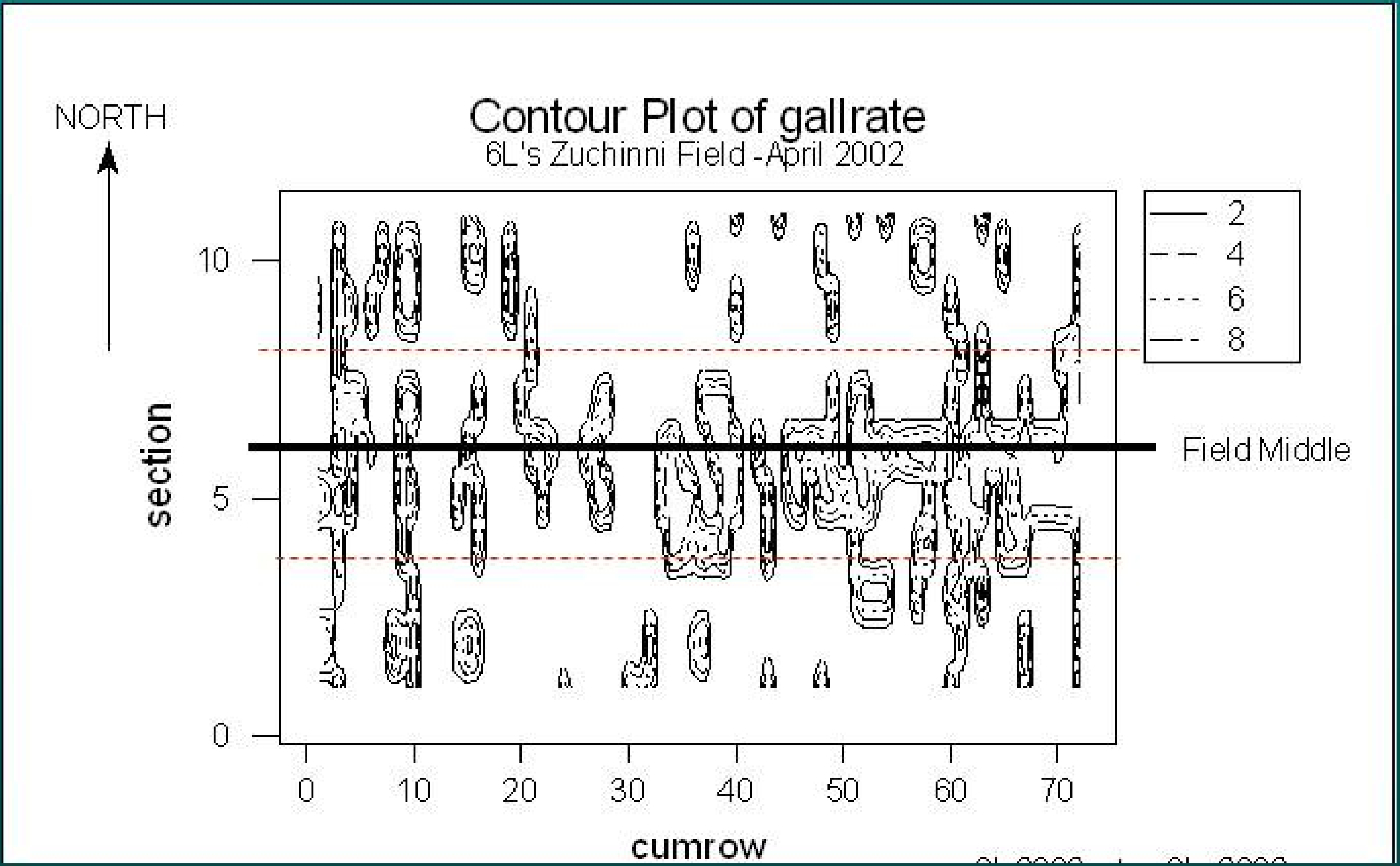


FIELD 41N4

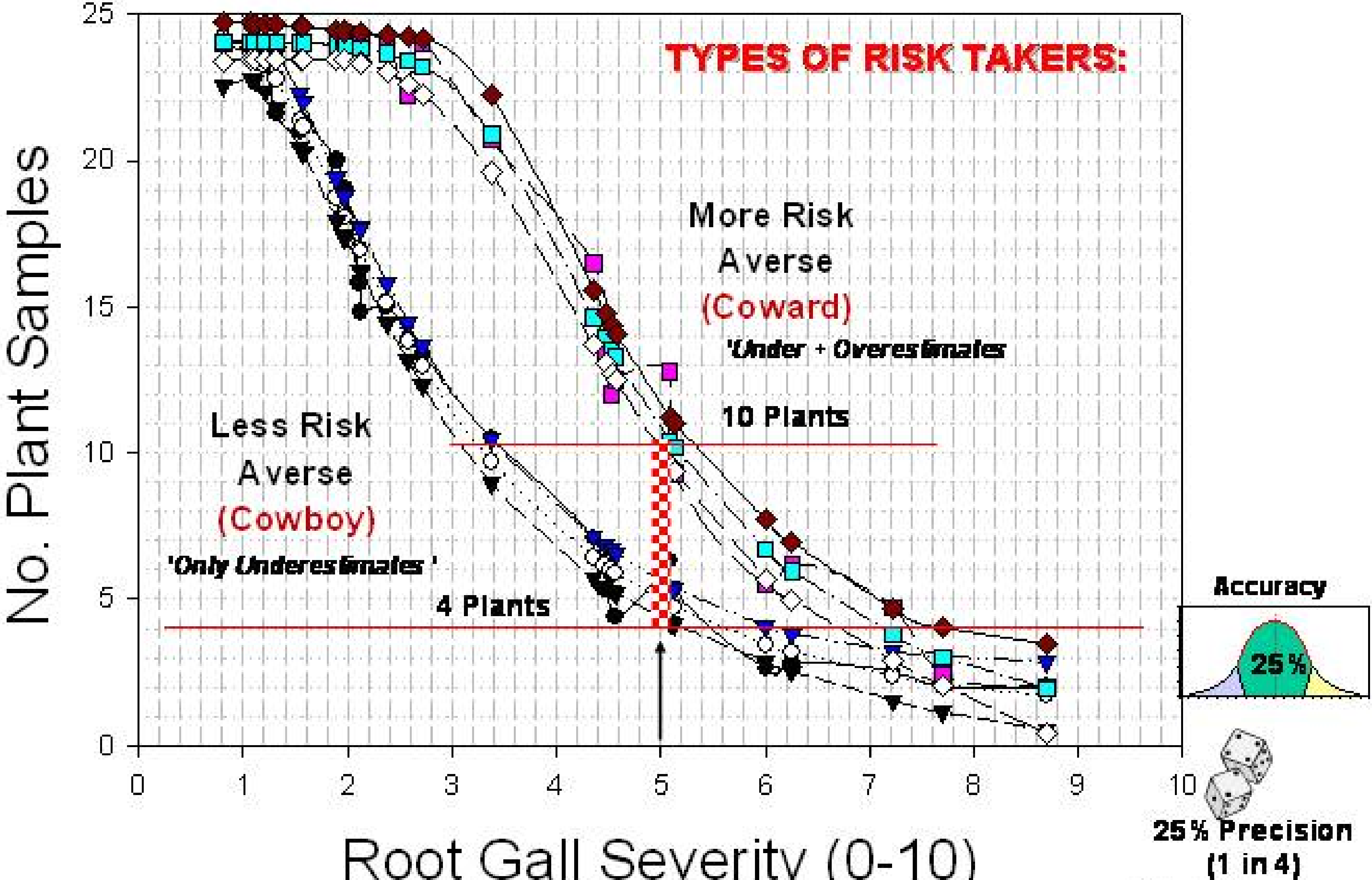
Blocks 30 thru 37

22 of 528 plants infested

Figure 12. Spatial distribution of root knot nematode galling on roots of zuchinni in a commercial field.



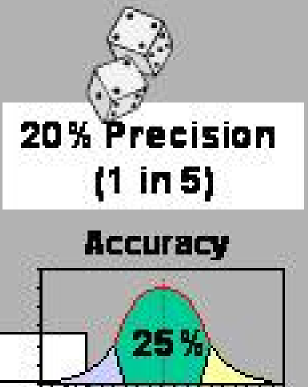
No. PLANT SAMPLES REQUIRED FOR RISK TAKERS WHO CONSIDER ONLY UNDERESTIMATES - WITH MORE RISK AVERSE PEOPLE WHO CANNOT ACCEPT EITHER UNDERESTIMATES OR OVERESTIMATES OF THE TRUE MEAN MORE THAN 25% OF THE TIME

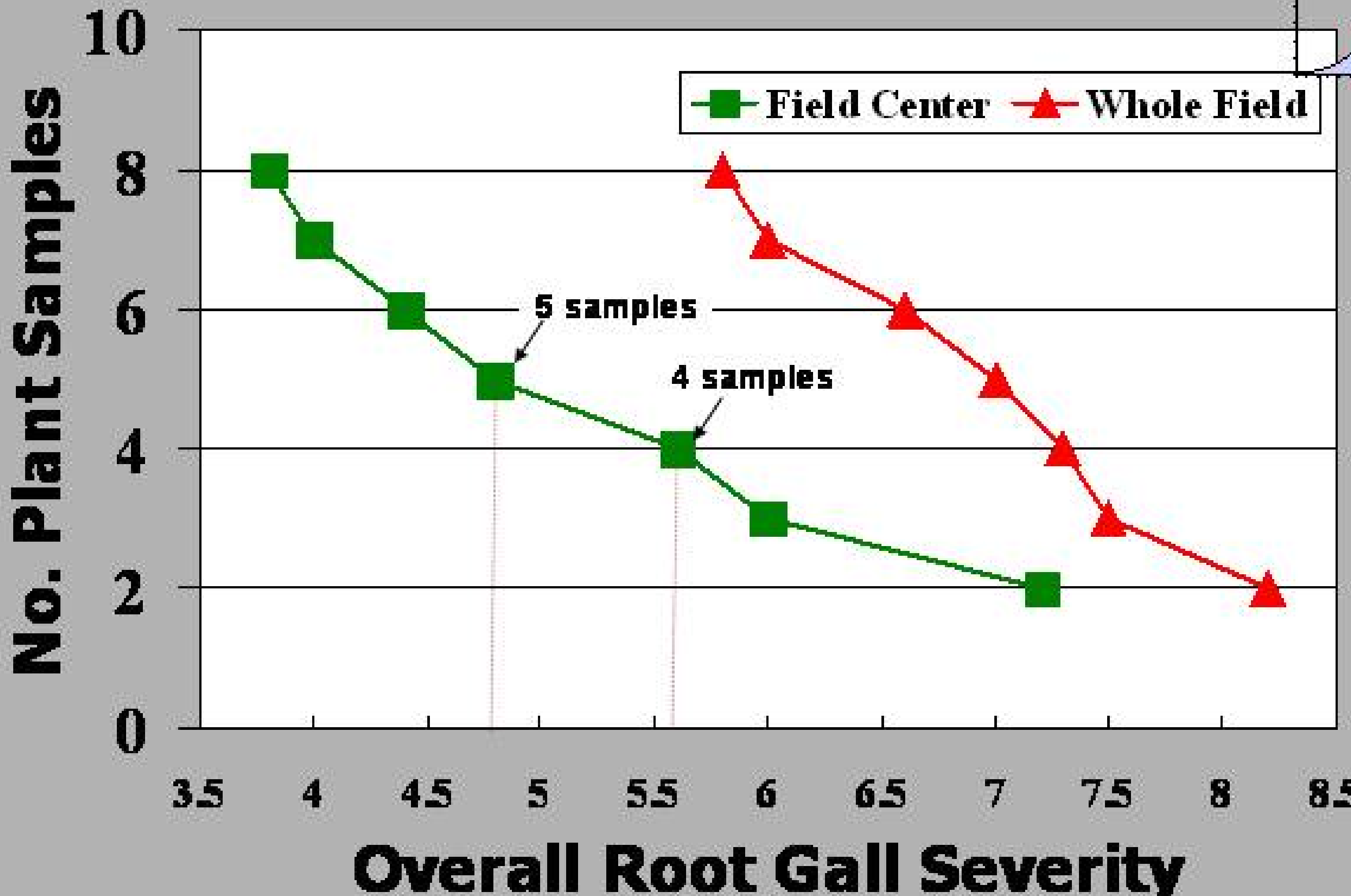


The less risk you accept the more the sample requirement

Whole Block
25LT25 vs. 25TOT25

Plant Sample Requirements for estimates within 25% of mean; 80% of time





- Fewer samples required from field centers than from whole field
- Fewer samples required as nematode field severity and distribution increases

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GENERAL CONCLUSIONS

- *Numbers of Plant Samples per Spray Block Dependent upon Overall FIELD Infestation Level*

- *Higher the Overall FIELD Infestation level The Fewer the Plant Samples Required*

- *The Less Risk a Person is Willing to Accept, The More Samples Required*

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GENERAL CONCLUSIONS (cont')

In-Field ROOT GALL Bioassay Technique
Accurate / Reliable System for:
Nematode Population / Disease Assessment

WITH AS FEW AS:

4 - 5 Plants /6 row Spray Block
(8 Plants / acre)

GENERAL CONCLUSIONS

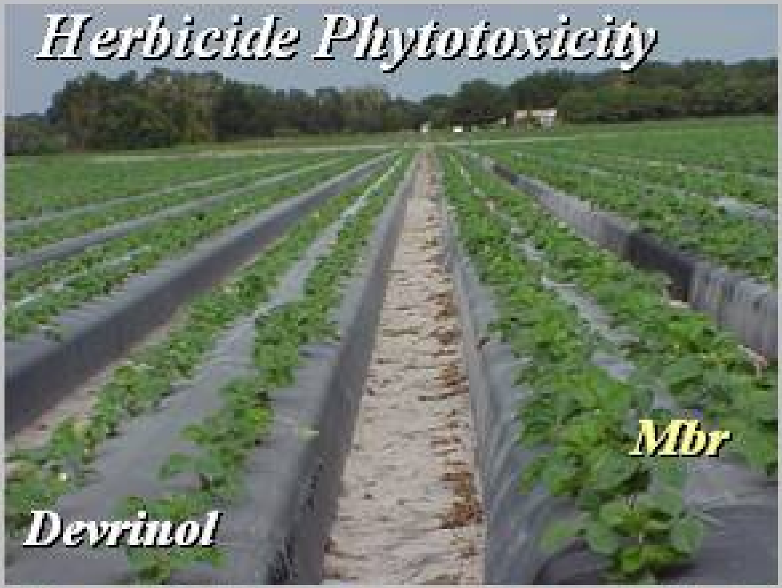
POST METHYL BROMIDE ERA

Requirements:

INTEGRATED STRATEGIES

- Chemical Combinations *Particularly Chloropicrin*
- New Land Preparation Requirements
- Chemigation Considerations
- Coupling Weed Management Tactics
- Nematode Monitoring Systems

Even with Integrated Systems:
"RESPONSE INCONSISTENCY"



CONTRIBUTING FACTORS:
(controllable / uncontrollable)

- **CHEMICAL**
- **PHYSICAL**
- **BIOLOGICAL**
- **ENVIRONMENTAL**
- **HUMAN**

Bottom line: With Alternatives:
SOME INCONSISTENCY
IS UNADVOIDABLE

Tactic Transferability:

Physical, Chemical, Cultural, Biological Approaches:

EDAPHIC

BIOTIC

CLIMATIC

CULTURAL

TACTICS CAN'T GO EVERYWHERE, ENFORCING INDEPENDENT DEVELOPMENT & EVALUATION

LONG TERM IMPACTS & DOUBLE CROPPING

Pickles following fumigated Pepper

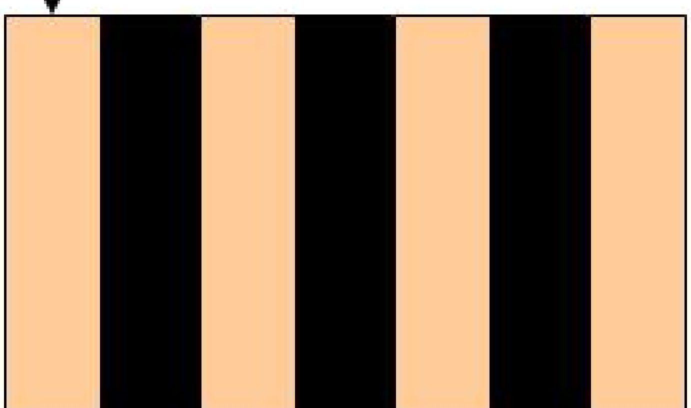
Definition of Rate:

One Acre
43,560 sq ft

BROADCAST RATE:

98/2	400 lb /a	43.9 g ai / m^2
67/33	350 lb /a	26.3 g ai / m^2

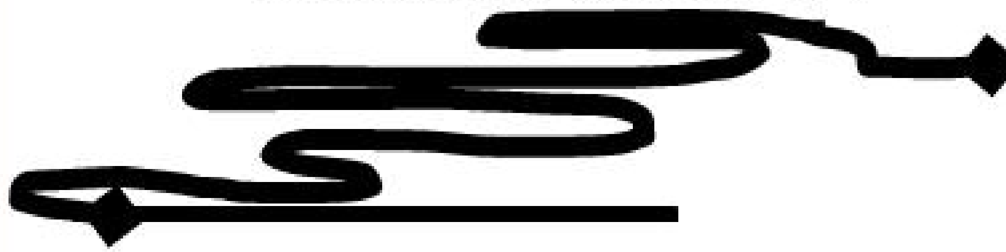
Row Middles



Plastic covered 3ft wide beds with row spacings of 6 feet

Per TREATED ACRE

14,520 Linear Feet of TREATED ROW is one acre (43,560 ft^2)



Form.	Rate	Metric Ai Mbr
Form.	Rate	Equivalent
98/2	400 lb /a	43.9 g ai / m^2
67/33	350 lb /a	26.3 g ai / m^2

Black Root Rot of Strawberry
and
Phytophthora crown rot

Strawberry healthy roots (A) as compared with those of Black Root Rot (B). Close up of diseased root (C,D). Observe fungal mycelia in D.

Procedure

RHIZOCTONIA SPP.,
FUSARIUM SPP.
OTHER FUNGI

ALKALINE WATER AGAR (AWA)

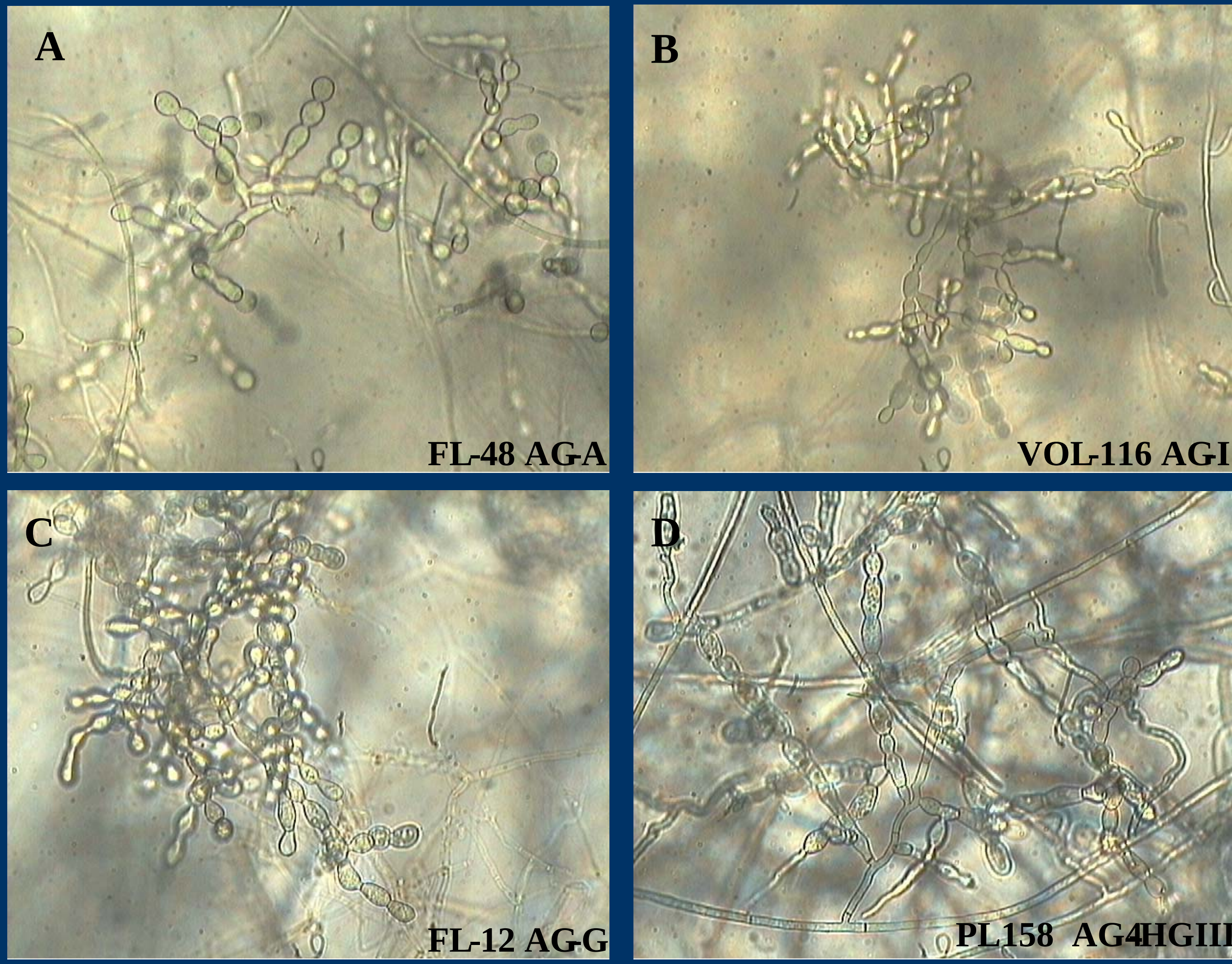
PDA 30

PYTHIUM SPP.
OTHER FUNGI

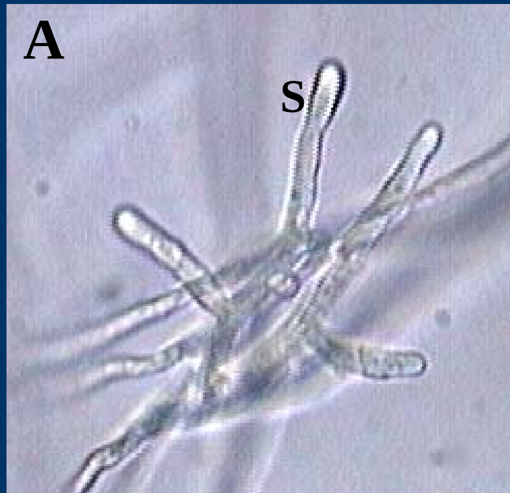
CORN MEAL AGAR + ANTIBIOTICS
(PARP)

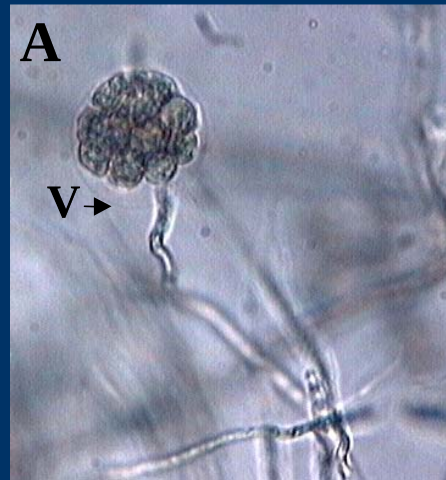
CMA

GRASS-LEAF-WATER



Monilioid cells of *R. fragariae* = A, B, C, and *R. solani* = D

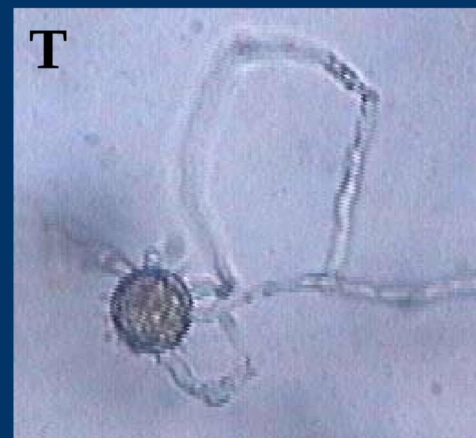




Pythium Group "F"

P. ultimum

P. irregulare



P. spinosum

Anamorph stage (A), Sporangium (S), vesicle (V) and teleomorph (T) , Antheridium (A), Oogonium (Og), and Oospore (O) of *Pythium* spp.

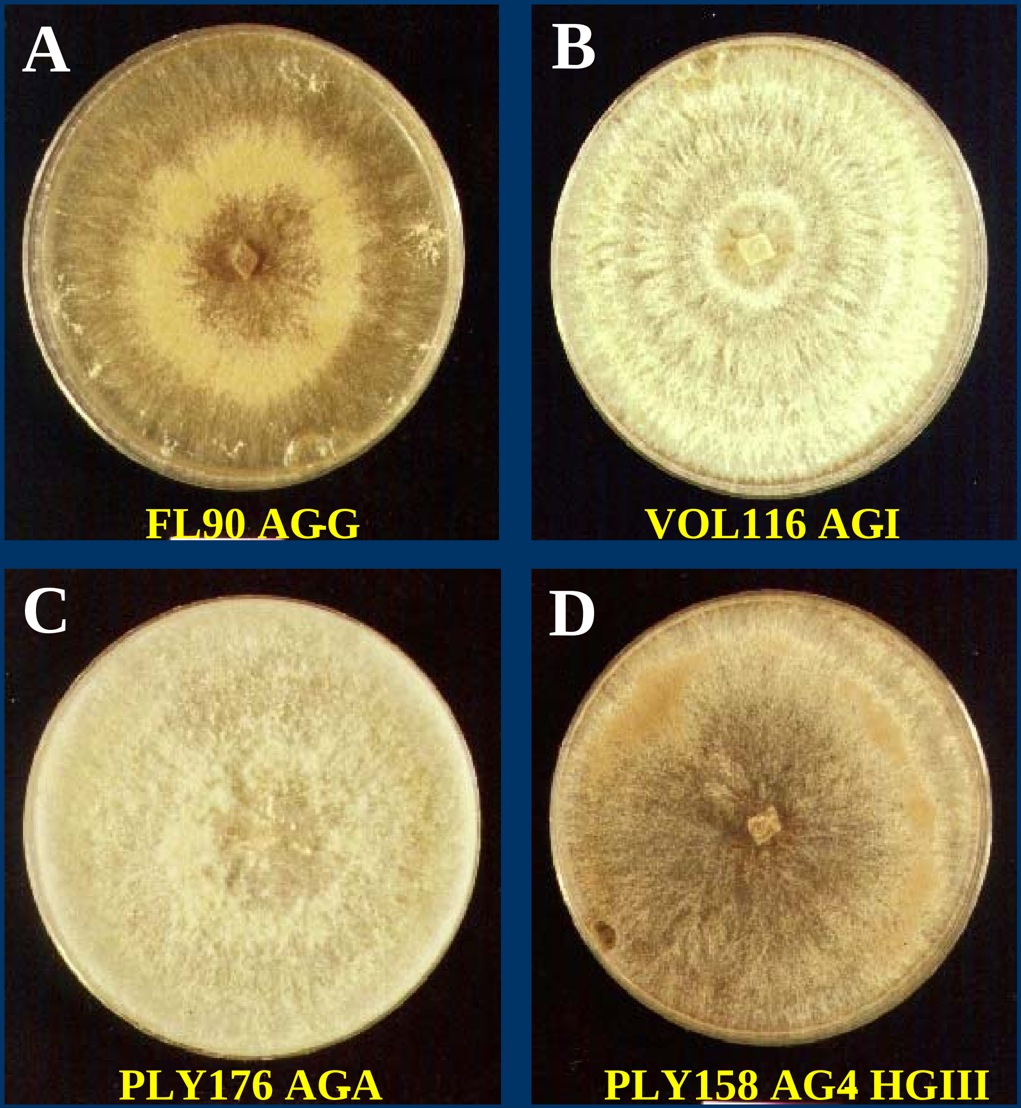


Fig. 3 . Colony morphology of *R. fragariae* = A, B, C, and *R. solani* = D in PDA 30

Pathogens to Control

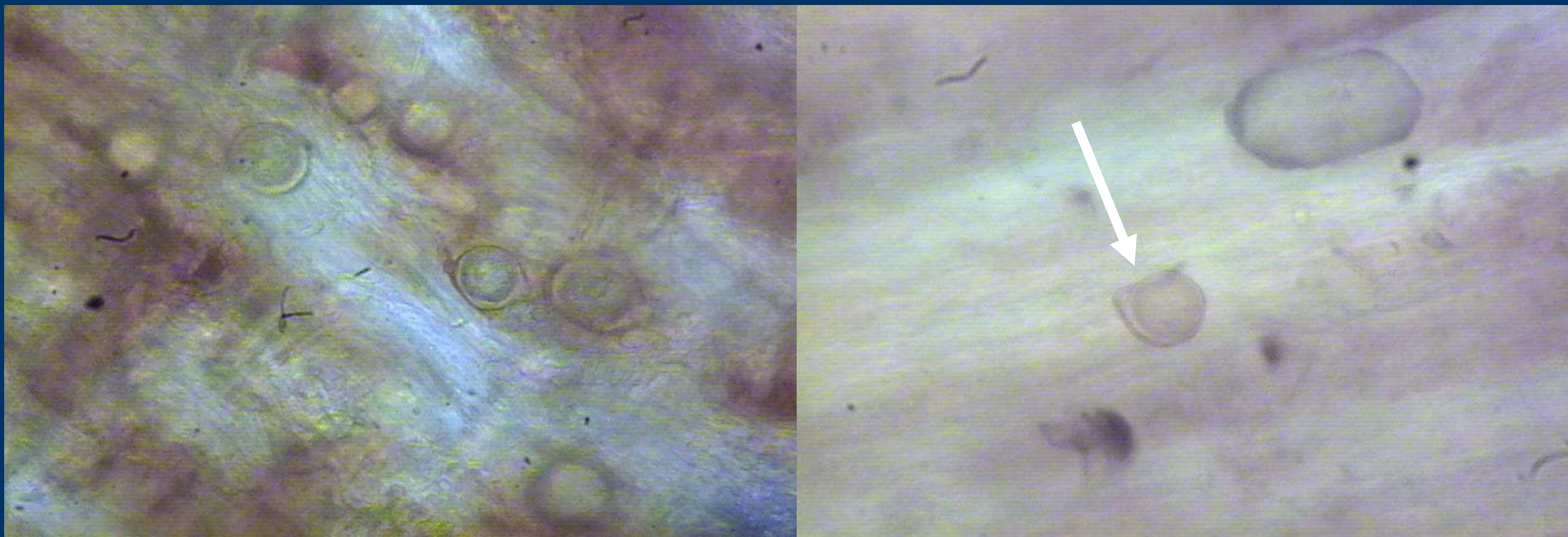
- *Rhizoctonia fragariae* : AG-G, AG-A, AG-I
- *Pythium irregulare*, *Pythium spinosum*, *Pythium artotrogus*, *Pythium HS*
- *Fusarium solani* and *Fusarium oxysporum*

Table 1. Distribution of organisms isolated from strawberries affected with Black root rot disease in North Carolina. Year 1998

FUNGI	LOCALITIES				
	FLETCHER	VOLLMER	PLYMOUTH	CLAYTON	TOTAL
Rhizoctonia spp.	**50**	**15**	**9**	**2**	**76**
R. fragariae	30	15	6	2	53
A	11	7	3		21
I		3			3
G	10				10
unknown	9	5	2	2	18
R. solani AG4-HGIII			1		
Rhizoctonia sp.	20		3		23
Pythium spp.	**12**	**9**	**21**	**47**	**89**
P. artotrogus		4	1		5
P. irregulare		1	6	23	30
P. paroecandrum		1			1
P. ultimum				1	1
Pythium "F"		3	4		7
Pythium "HS"	2				2
Pythium sp.	10		10	23	43
Fusarium spp.	**7**	**4**	**13**	**9**	**33**
F. oxysporum	1	2			3
F. solani	2		6	1	9
Fusarium sp.	4	2	7	8	21
OTHERS	**10**	**7**	**8**	**21**	**46**
Alternaria sp.				2	2
Aspergillus sp.			1	2	3
Cephalosporium sp		2	3		5
Cylindrocarpon sp.	1				1
Cylindrosporium sp.	1				1
Epiccocum sp.				3	3
Mucor sp.	7	2	1	6	16
Penicillium sp.	1	3		7	11
Trichoderma sp.			3	1	4
TOTAL OF ISOLATES					**244**

Abad, Louws, Grabowski, Fernandez

Phytophthora Crown Rot:

Tomato Diseases

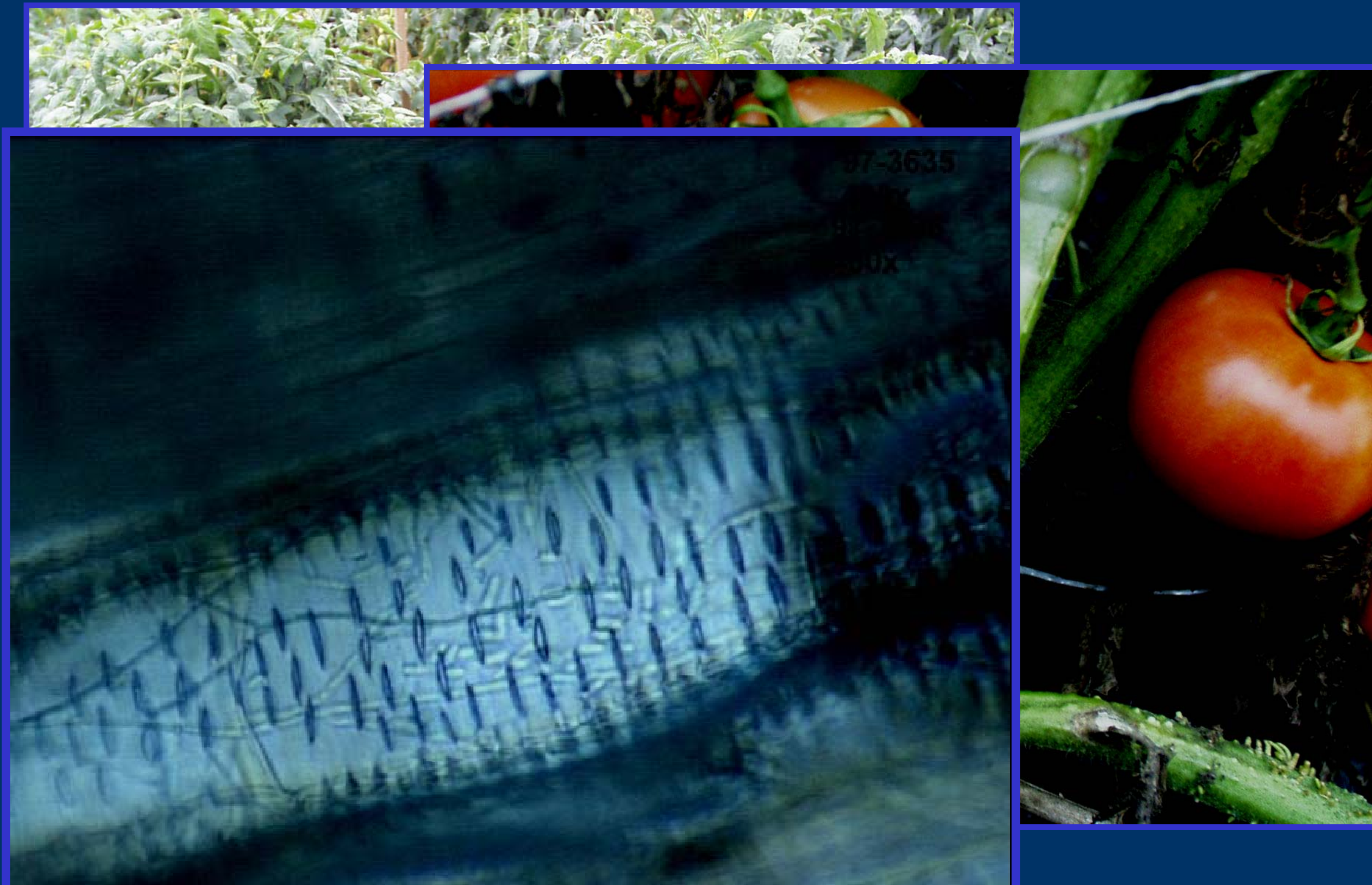
Tomato Disease	Resistance	Avoidance	Cultural practices	Fumigate	Chemical	Other
Verticillium race 1	*					
Verticillium wilt race 2				*		
Southern bacterial wilt	?	*	*	*		
Fusarium race 1	*					
Fusarium wilt race 3	*	*		*		
Southern stem blight			*	*	*	*
Root knot nematodes	*			*	*	
Phytophthora			*		*	
Pith necrosis			*			
Pythium root rot			*		*	

PRIMARY SOILBORNE DISEASES

Verticillium wilt race 2

Southern bacterial wilt

Fusarium wilt race 3



Southern Stem Blight

DAMPING OFF

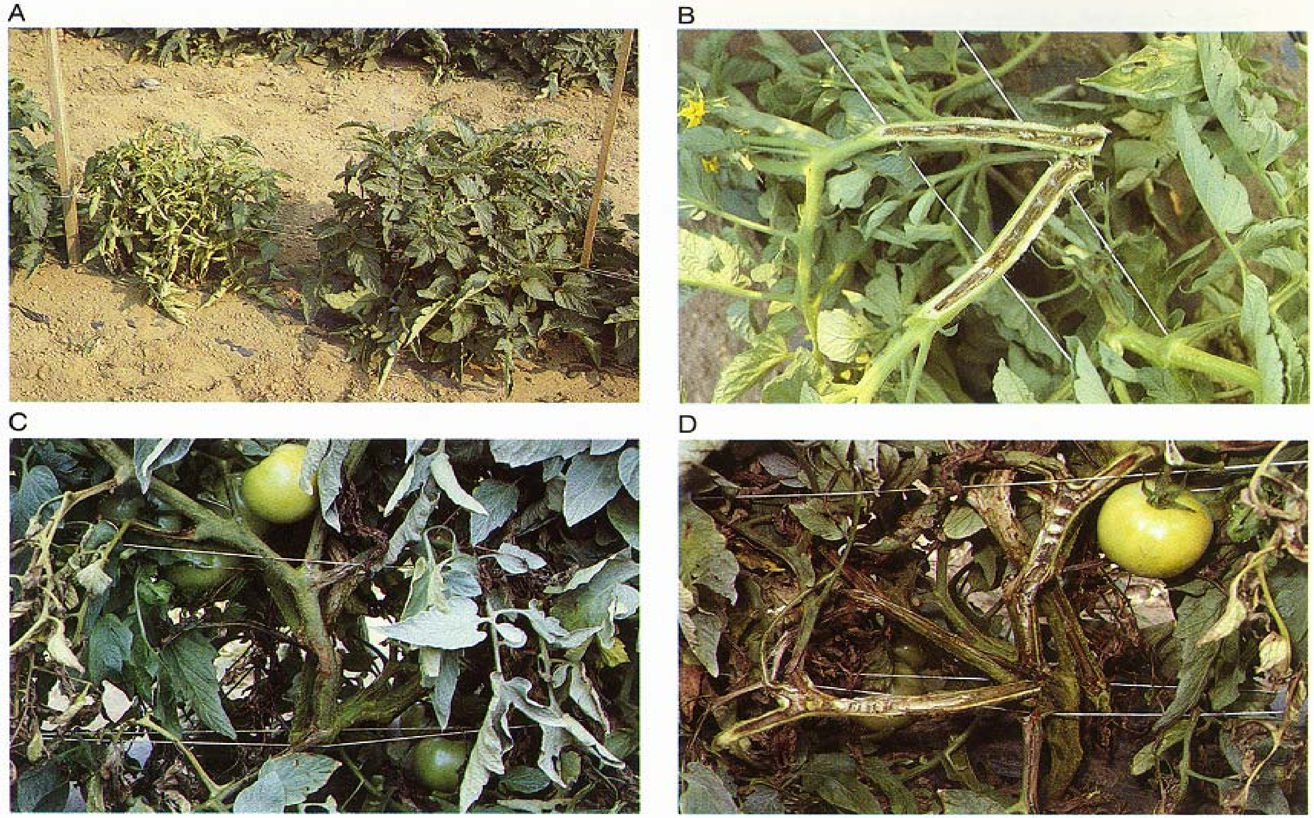


Figure 1. Symptoms of pith necrosis:

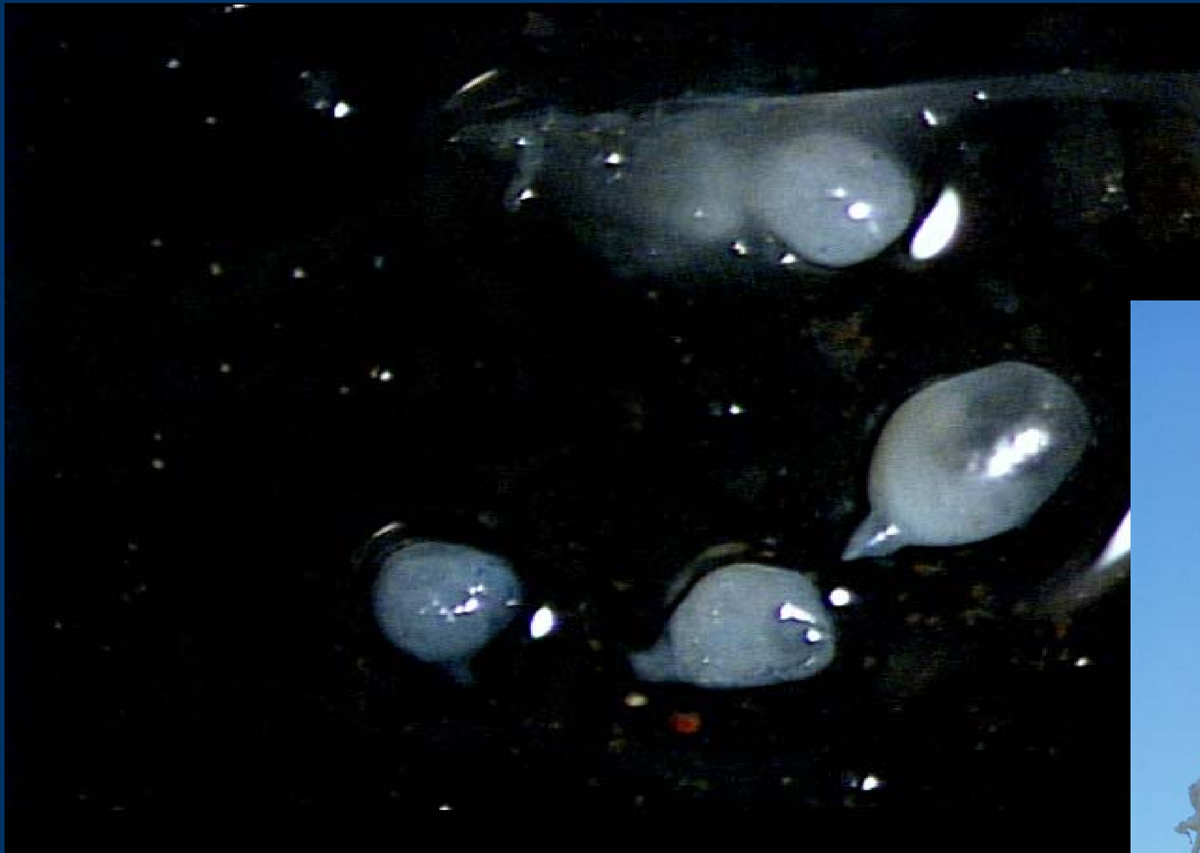
A. Four-week-old "Mountain Pride" tomato plants. Note stunting of the diseased plant.

B. Internal appearance of the main stem of the diseased plant shown in (A). Note discoloration, hollowing, and adventitious root initials in the pith.

C. Pith necrosis in a ten-week-old "Mountain Delight" tomato plant. Note browning of the stem and collapse of several leaf petioles. Even with severe pith necrosis, this plant is still bearing fruit.

D. Internal appearance of the main stem of the diseased plant shown in (C). Note dark brown discoloration and disking in the pith.

E. Severe pith necrosis. Note adventitious roots in affected area.



Tomato Root Knot Nematode
Mature Female
38x 97-5196

PEPPER PHYTOPHTHORA CROWN & ROOT ROT

SYMPTOMS: FOLIAR BLIGHT/FRUIT ROT

SYMPTOMS: PROCESSING/FRESH

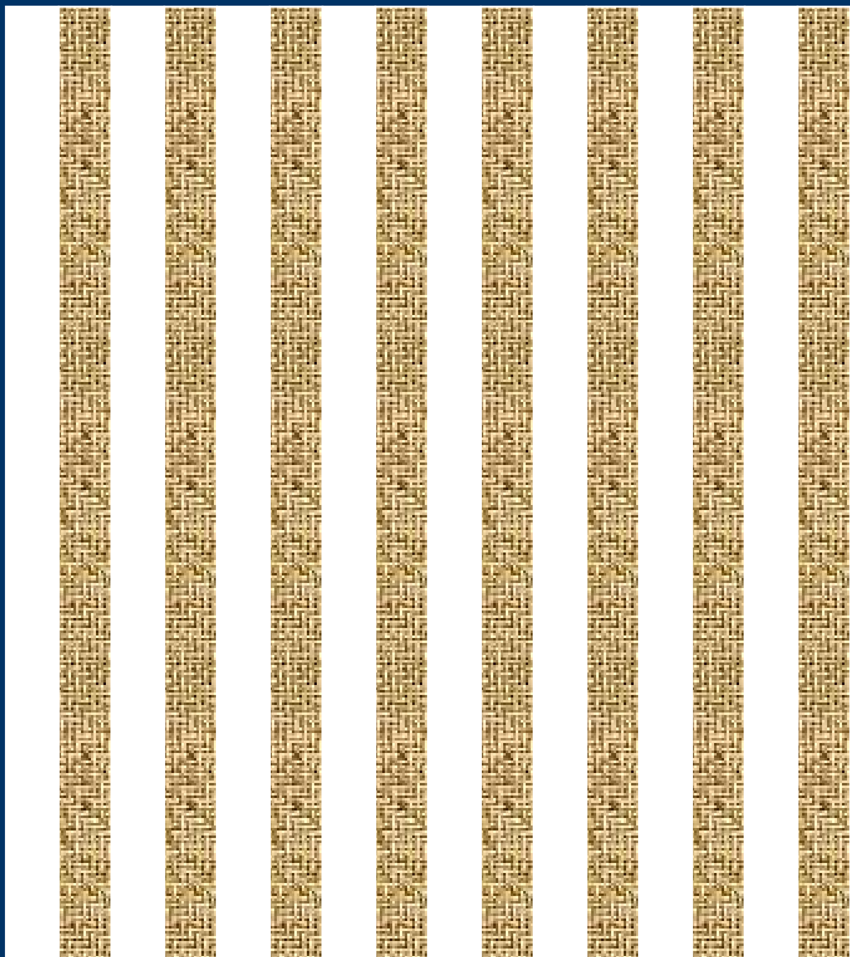
Fumigants and Methods of Application

	Plant Back	DRIP	SHANK
Telone-C35	21 days	No	Yes
InLine	21 days	Yes	No
Chloropic	14-21 days	Yes	Yes
Vapam / K-Pam	14-21 days	Yes	Yes
Midas (iodomethane)	7-14 days	Yes	Yes
SEP-100 (sodium azide)	14 days	Yes	No
Propozone (propylene oxide)	14-21 days	Yes	Yes

What does the application rate mean?

8 rows covering 1 acre block

Rows are 1089 feet long



30 inch beds on 5 foot centers
=2.5 ft wide beds and 2.5 ft wide alleys

43560 sq ft per acre/2.5 feet bed width
= 17,424 but only half is under plastic
= 8,712 linear feet under plastic/physical acre
= 21,780 sq. ft is treated

Telone C35 Broadcast application Rate
35 gallons/acre

Thus, we would apply T-C35 at a rate of 35 gallons/treated acre (43560 sq. ft; 17,424 linear feet with 2.5 foot beds). In this case, this one acre block with 21,780 sq. ft under plastic will receive 17.5 gallons of product. Treated acre means the actually land area treated.

Q: How much product would be dispensed if the grower treated 2178 linear feet?

Injection of Chemicals into Drip Irrigation Systems

Garry L. Grabow, PhD, PE

Overview

- Principles of Chemical Injection
- Injector Types
- Operation
- Example

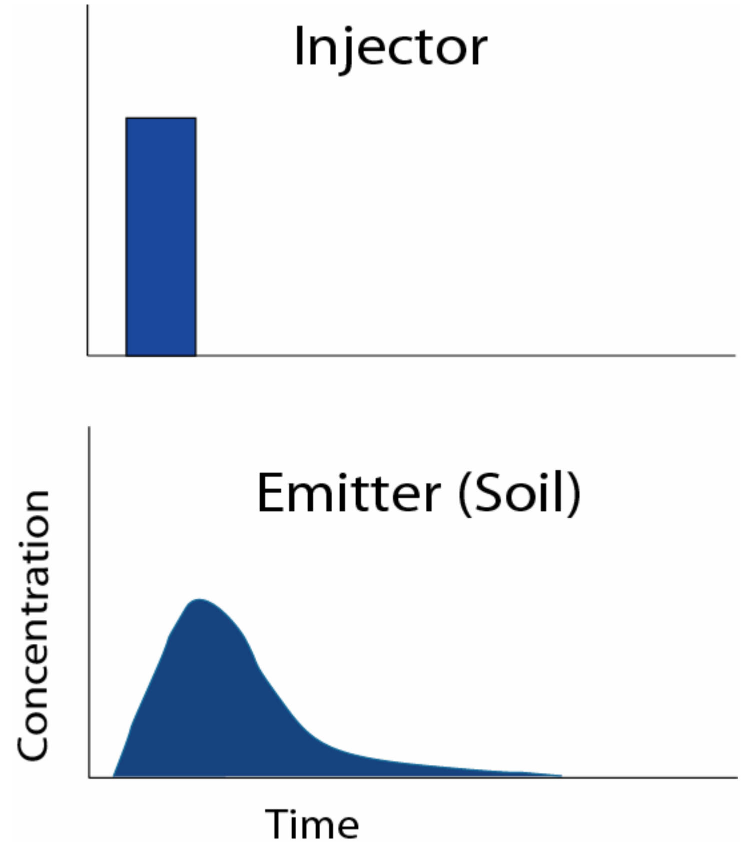
Potential Benefits

- Better than shank injection (Guo, et al.[1])
- Can use prior to plant and post plant (herbicide)
- No additional equipment if already have a drip system with injection unit

[1] J. Environ. Qual. 33:2149-2156 (2004).

Injection Considerations

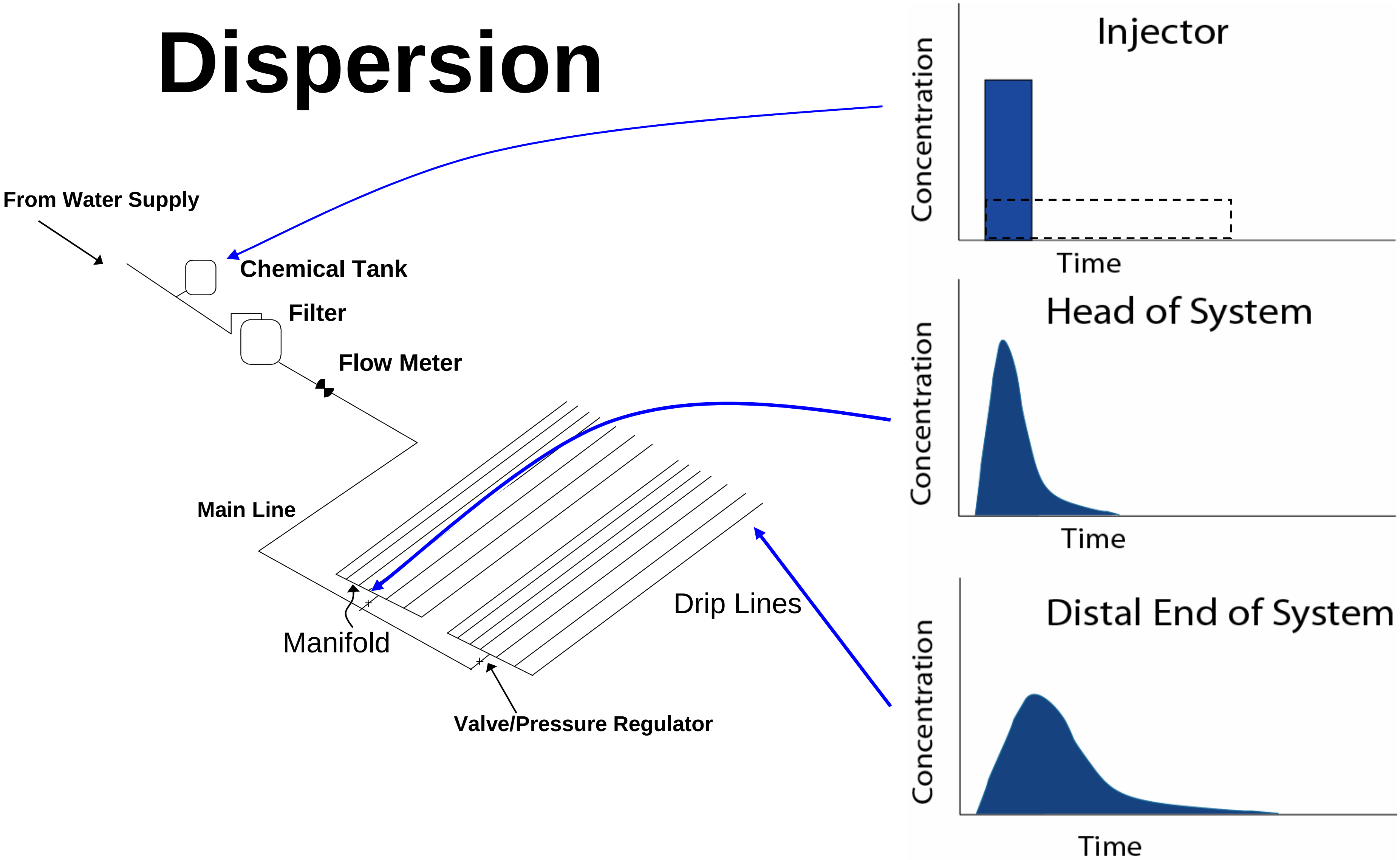
- Better to inject over whole duration of irrigation rather than in a “slug” of chemicals introduced at first of cycle-leave enough time to flush chemicals out of system
- May want to use multiple cycles



Injection Considerations

- Limit injection time to prevent over-application of water that will leach chemicals

Dispersion



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University of Florida[1]

1 Nematode Management in Commercial Vegetable Production
J.W. Noling, 2002

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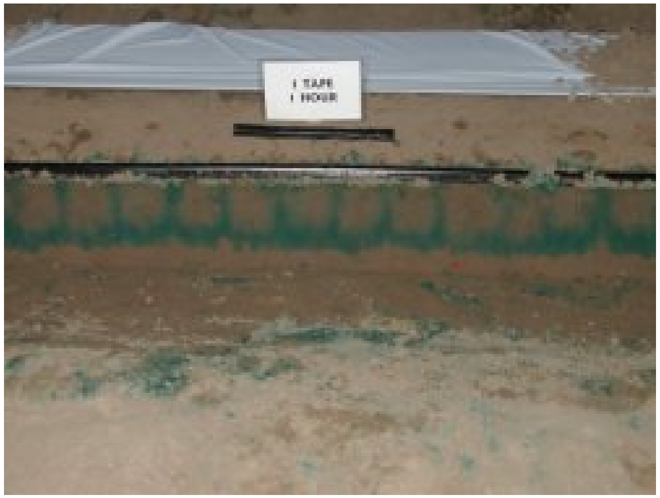
Water distribution along drip line



4-inch emitter spacing

12-inch emitter spacing

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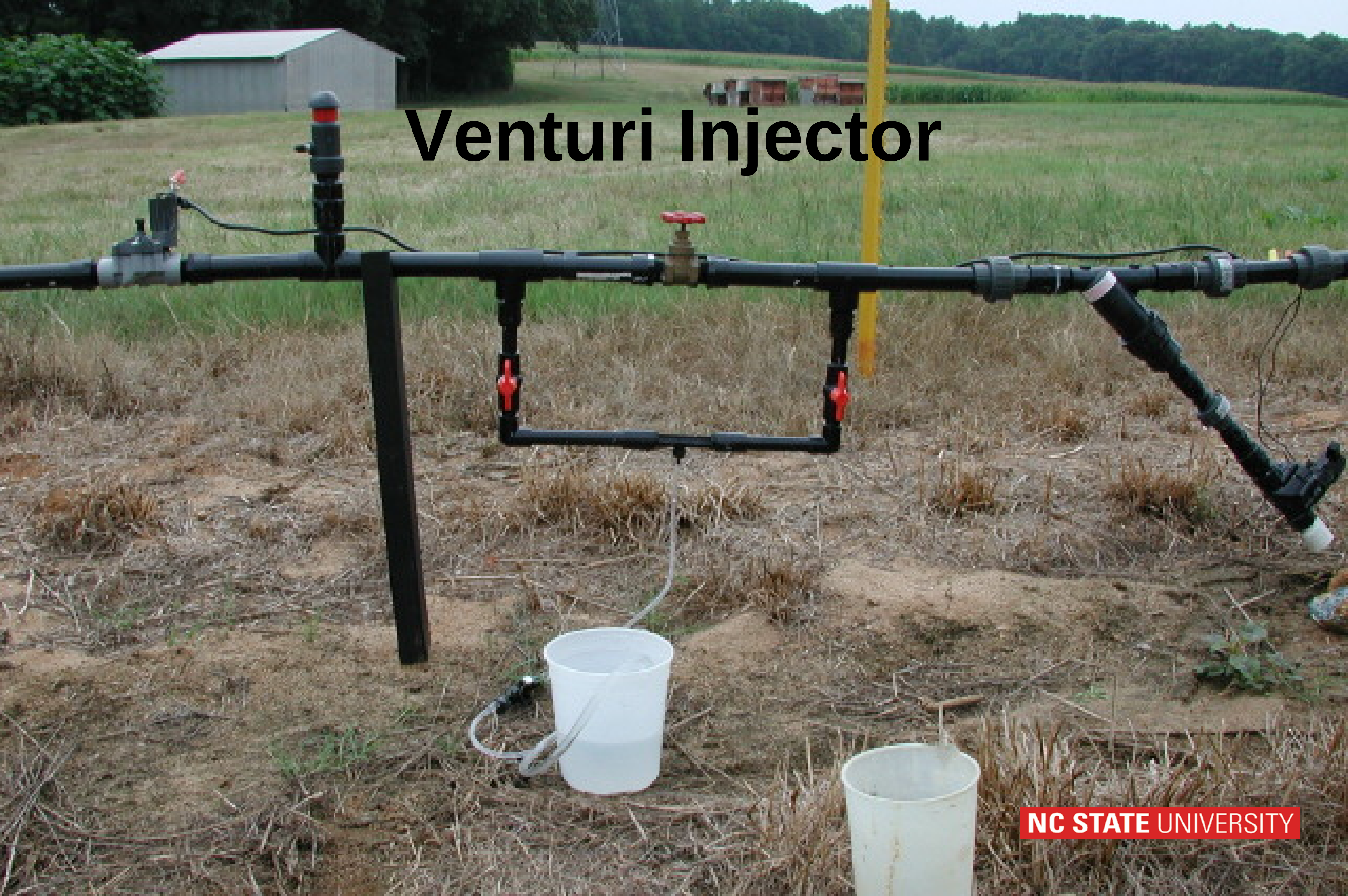
Wetting Patterns

Application rates

- Actual wetted area may not be full bed width
- Application rates may have to be adjusted from broadcast rates

$$DripRate = \frac{wetted\ width}{row\ spacing} \times broadcast\ rate$$


Venturi Injector
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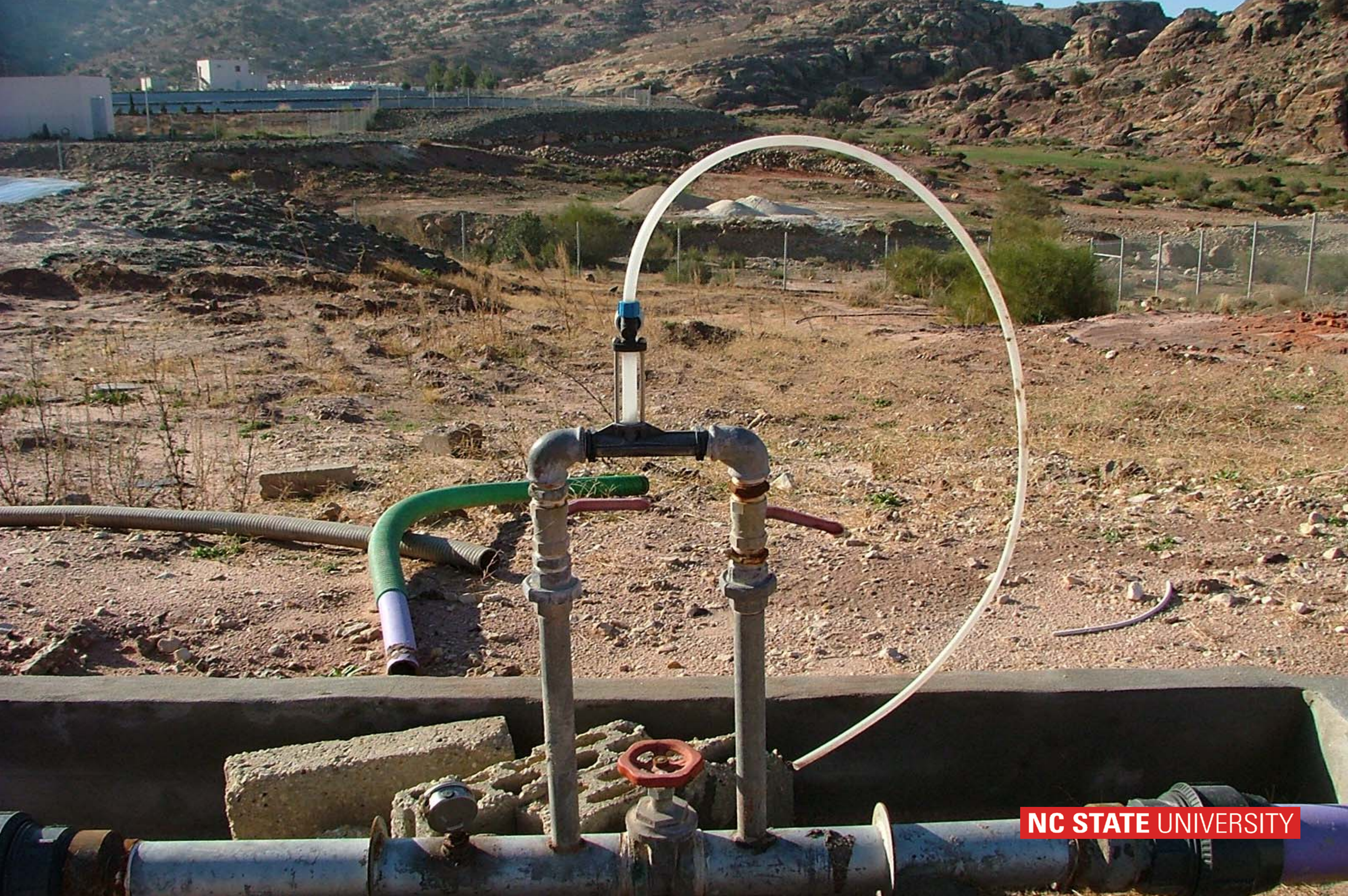
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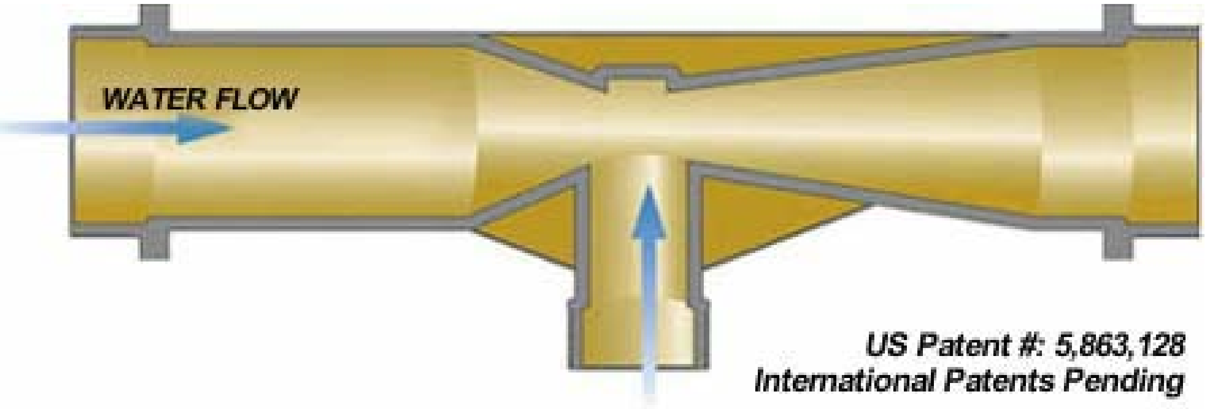
Venturi Injector



- Cheap
- Injection proportions 6:1 to 50:1
- Will need a bigger stock tank, unless on bypass system
- Best to calibrate these injector types

Dosatron

- Water pump – no electricity required
- Proportional injector 1:64-1:500
- Models designed for flow rates of .1 to 500 gpm
- Don't allow for acid injection normally

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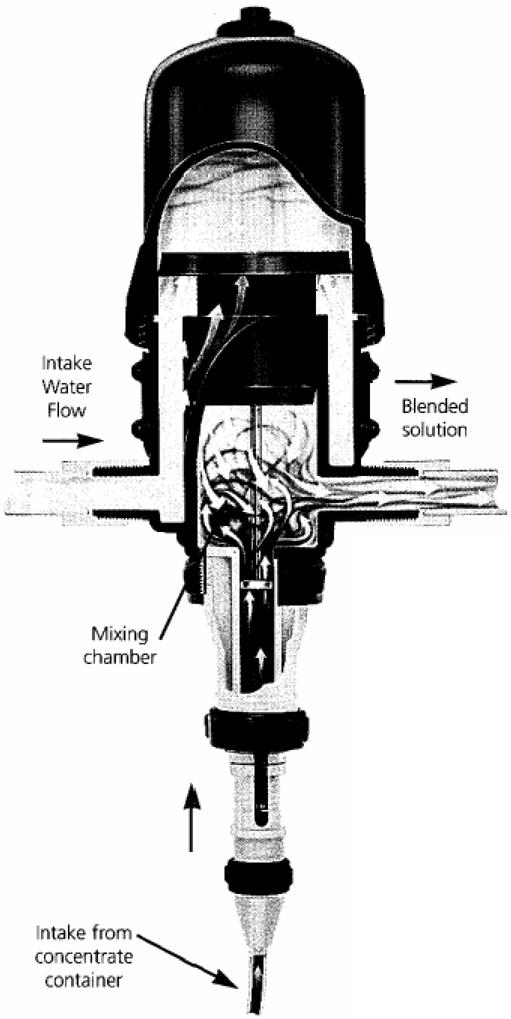
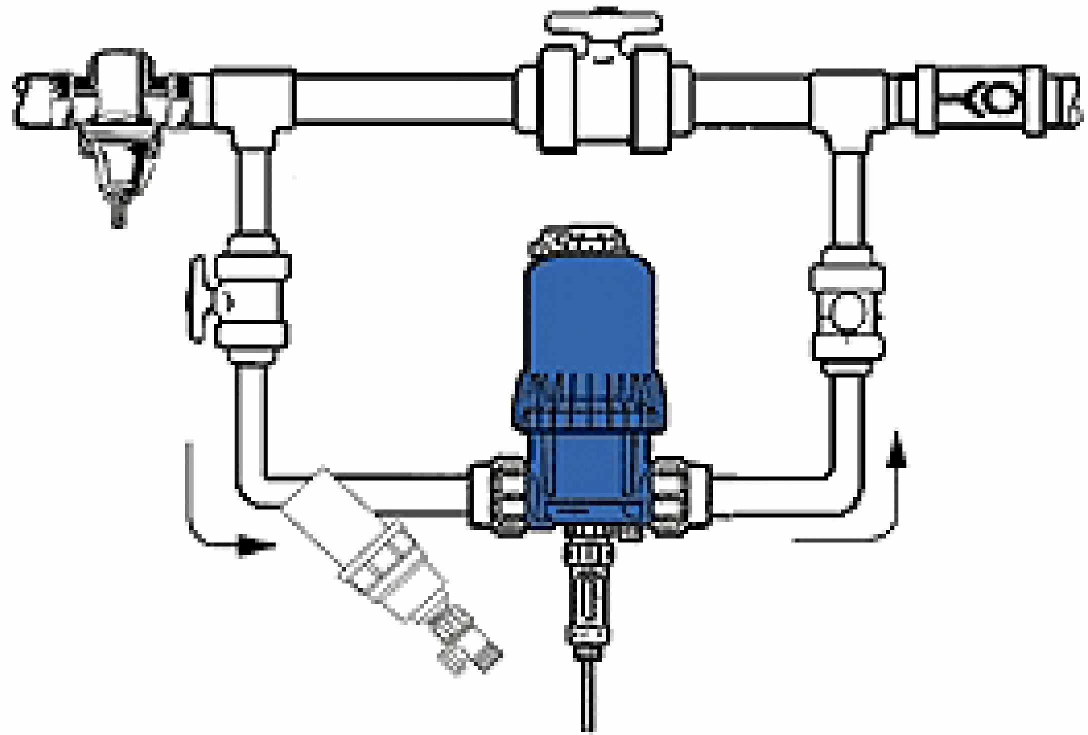
Dosatron





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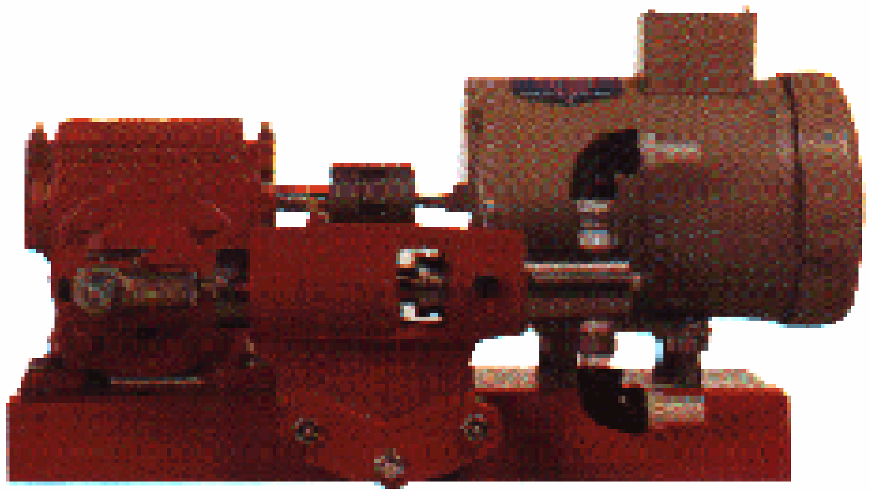
Metering Pump



- Positive displacement
- Flow does not vary with system pressure
- Some units are variable speed and interlinked with system to vary injection rate
- Can do low rates (acid)

California

Nitrogen pressurized cylinder with fumigant

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Revised August, 2003
Now includes Fertigation

CHEMIGATION & FERTIGATION:

ANTI-POLLUTION DEVICES FOR IRRIGATION SYSTEMS

Chemigation: The application of pesticides through an irrigation system to land, crops, and/or plants indoors or outdoors.

August 2003 Revisions

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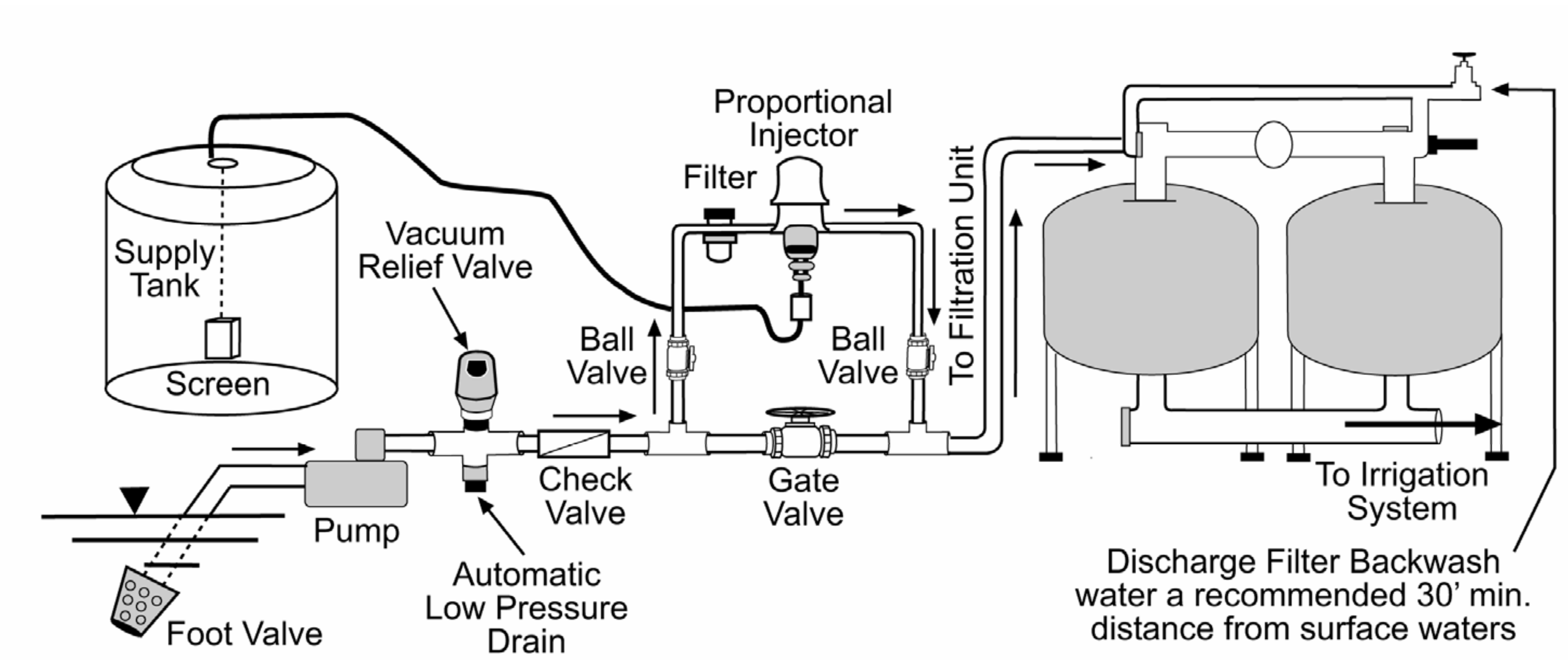
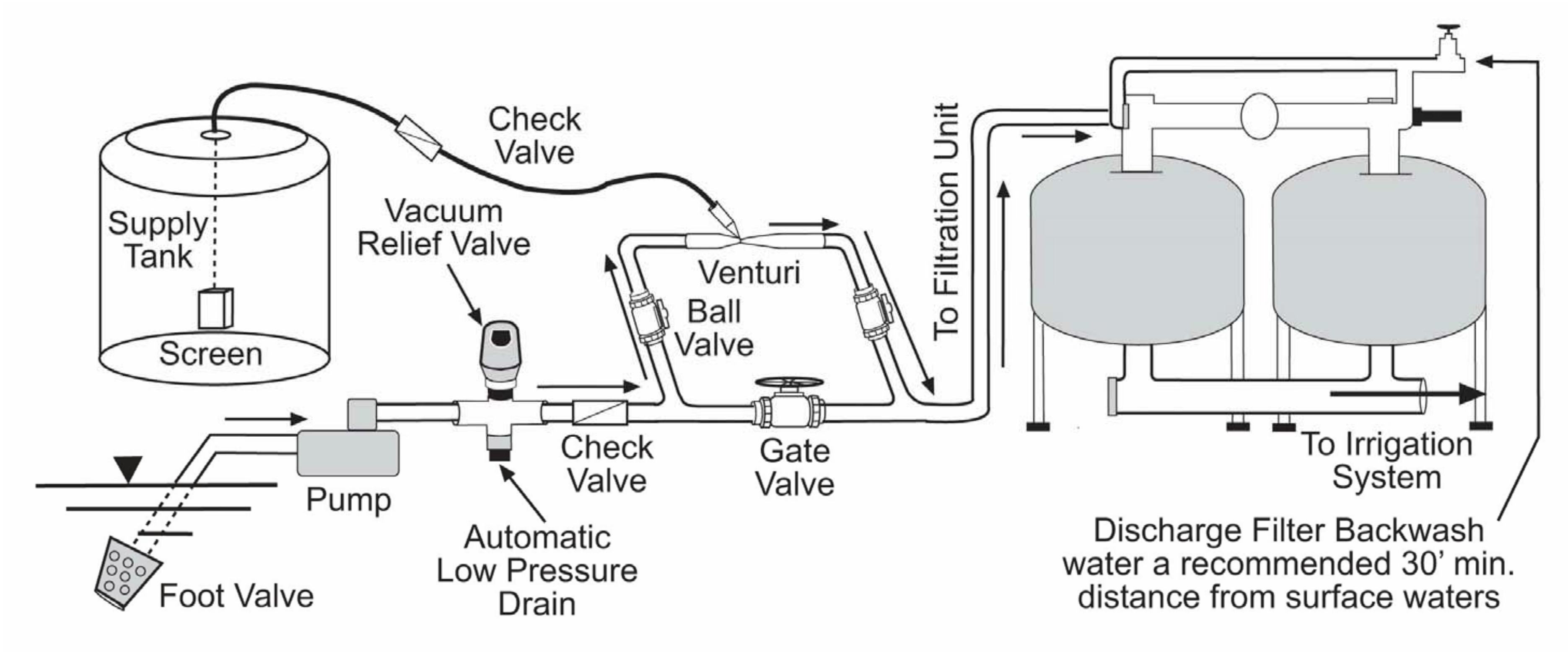
NC Regulations
Proportional Injector



NC STATE UNIVERSITY

NC Regulations
Venturi



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J.A. Desaeger, A.S. Csinos, J.E. Laska
Coastal Plain Experiment Station, Dept. of Plant Pathology, University of Georgia, Tifton, GA, 31793
DRIP-APPLIED SOIL PESTICIDES FOR NEMATODE CONTROL IN DOUBLE-CROPPED VEGETABLE SYSTEMS

Tifton Georgia

NC STATE UNIVERSITY

TIFTON SANDY LOAM

- 88% sand
- 9% silt
- <1% OM

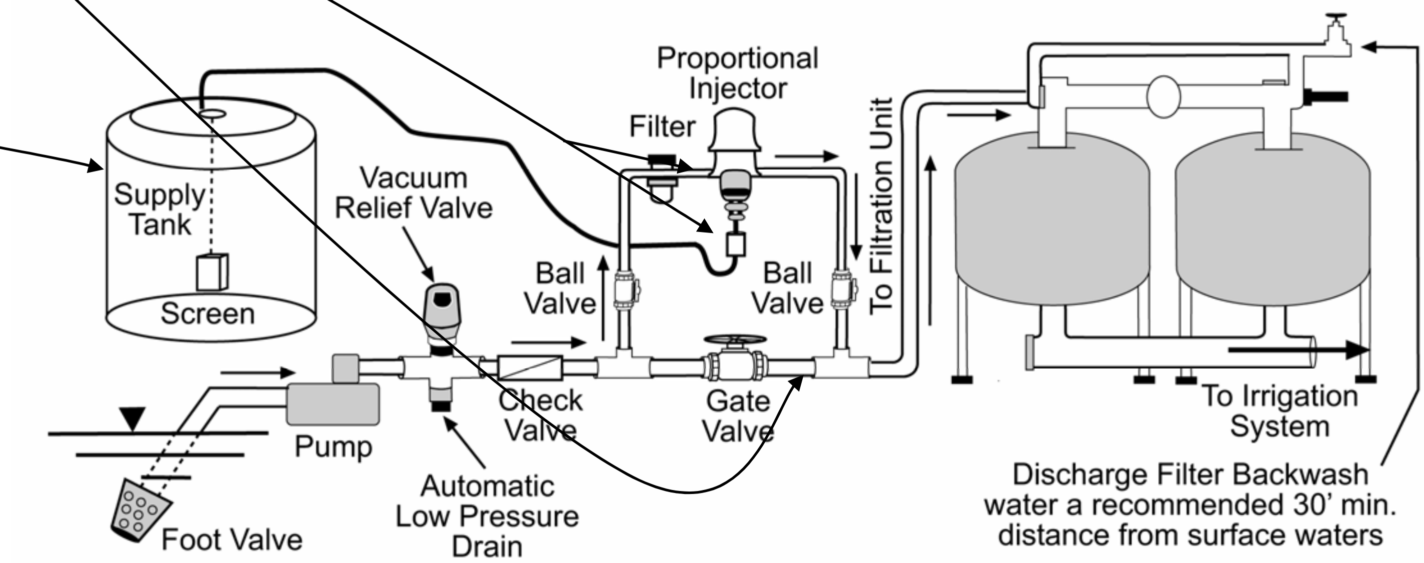
- Poor water holding capacity
- Difficult to apply water / chemical entire bed

Injecting the proper amount

- Target may be
  - Mass per area (e.g. lbs/acre)
  - Concentration (more typical for chlorine)

Injecting the proper amount

- Sources of dilution
  - Stock solution (diluted raw chemical)
- Injection ratio
- Bypass flow



Injecting the Proper Amount

- Convert pounds of formulated material to pounds of active ingredient
- Dissolve material required into stock solution, e.g. lbs/acre x acres to be treated (gal/acre=lbs/acre / lbs/gal)
- Adjust volume of stock solution (dilution) and/or injection ratio to obtain adjust application duration

Injecting the Proper Amount Calibration

- May be easier (and better) especially if you have bypass flow to calibrate
- Measure volume of solution injected and volume of total flow over set period of time

Example

Given: a 3-hour injection period to apply 0.4 inches of water (total area basis). You wish to inject for 2.5 hours

What is the injection rate (gallons per hour) required to apply 200l/ha (21.4 g/acre) to 10.0 acres

What if the rate were 200 lbs/acre?

MIDAS

Midas™, (Iodomethane, TM-425)

Chemical Name:	Iodomethane, (Methyl Iodide)
Product Type:	Soil Fumigant
Family of Chemistry:	Alkyl Halide
Geography:	World-wide
Signal Word:	Danger-Poison
Toxicity Class:	I
Formulations:	98:2 Iodomethane:Chloropicrin other
Target Pests:	Weed seeds, plant parasitic nematodes, soil-born fungi and bacteria
Crops:	Strawberries, fresh market tomatoes, peppers, cut flowers and bulbs, trees, conifer nurseries, vines, turf, and other
Comments:	Toxicology and efficacy studies are ongoing. Earliest plant back 7 days REI 36 hours

Application Information

- Factors to consider…
  - Pest identification and incidence
    - Disease, weed seeds, nematodes and insects
  - Soil type
    - Heavy to light texture
  - Ground preparation
    - Tilth, presence of plant / weed trash
  - Environmental
    - Temperature, moisture content

- Soil Pathogens 120 – 175 lbs/A
- Nematodes 100 – 150 lbs/A
- Weed Seeds 100 – 150 lbs/A
- Insects 100 – 150 lbs/A

Application Methods

Flat Fume / Broadcast

Bed Shank

Drip Injection

Tarp:
Standard or VIF
Shallow to 12” – required
Deep +18” - Optional

Iodomethane Efficacy Comparison

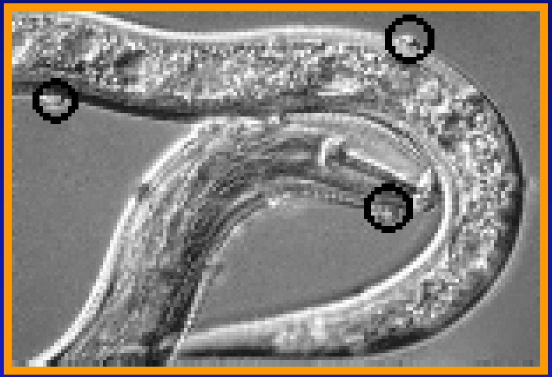
Data listed on the following slides represents efficacy trials conducted by University, USDA-ARS and Private Contractors. The rating system is compiled to show the technical feasibility between Iodomethane and Methyl Bromide

(+) = Comparable: Iodomethane control is lower than Methyl Bromide's but not statistically different

(++) = Equal: Iodomethane control is at least equal to but not statistically different from Methyl Bromide's

(+++) = Better: Iodomethane control is statistically greater than Methyl Bromide's

MIDAS Nematode Control



Pratylenchus sp.
Lesion nematode ++

Belonolaimus sp.
Sting nematode ++

Meloidogyne incognita
Root knot nematode ++

Heterodera schachtii
Cyst nematode +++

Xiphenema americanum
Dagger nematode ++

Tylenchulus semipenetrans
Citrus nematode ++

Paratylenchulus spp.
Pin nematode ++

Aphelenchoides spp.
Bud and Leaf ++

Paratrichodorus spp.
Stubby root nematode ++

Tylenchorhynchus spp.
Stunt nematode ++

Overall Rating = ++

(+) = Comparable (++) = Equal (+++) = Better

MIDAS

MIDAS Disease Control

Verticillium dahliae +++
Phytophthora cactorum +++
Phytophthora cinnamomi +
Phytophthora citrophthora ++
Fusarium oxysporum ++
Rhizoctonia solani +++
Pythium ultimum ++
Pythium aphanidermatum ++
Gliocladium virens ++
Colletotrichium gloesporioides ++
Cylindrocladium spp. ++
Sclerotinia spp. ++

Overall Rating = ++

(+) = Comparable (++) = Equal (+++) = Better

MIDAS

MIDAS Weed Seed Control

Mallow ++
Nutsedge ++
Bluegrass ++
Rye ++
Sowthistle +++
Bermuda ++
Purslane ++
Vetch +
Filaree +
Groundsel +
Lambsquarters ++
Pigweed ++
Crabgrass +
Carpetweed +++

Bindweed +++
Knotweed ++
Chickweed ++
Mustard ++
Spurge +
Nettle +
Clover ++
Hairy Nightshade ++
London Rocket ++
Pineapple Weed ++
Shepherds Purse ++
Skunk Weed ++
Volunteers ++

Overall Rating = ++

(+) = Comparable (++) = Equal (+++) = Better

MIDAS

IR-4 Support Request

- EPA has agreed to consider an "All Crops" registration based on a reduced site and crop residue program for Iodomethane
  - CHEMSAC has approved this protocol
  - No parent residues present in Tomato and Strawberry

All Crops Rationale

- D. Thompson proposed a 1X and 3X use rate on wheat and radish
- Radish is a root crop, short season, maximum opportunity to accumulate residues
- Wheat is a crop that often picks up residues when other crops do not
- 5 locations proposed, major geographic regions (FL, CA, MI/OH, OR/WA, NY/NJ)

Registration Timeline

- EPA
  - EPA is committed to give a registration decision by the end of 2003.
- STATES
  - Florida – Awaiting US EPA decision.
    - No delay in registration expected.
  - California – Is considering a *conditional* registration based upon favorable Interim Chronic study (2004) results.

Moving California East
an analysis of the plasticulture system for vegetable production

Doug Sanders

Horticultural Science

NC State University

Agroenvironmental Differences physical

California

- ▲Soil moisture- steady
- ▲Temperature- more diurnal change
- ▲Soil nutrients- more CEC=10-45

Back East

- ▼Soil moisture- erratic
- ▼Temperature- less differential
- ▼Soil nutrients- less CEC=2-30

PLANTS RESPOND QUICKLY

TOMATO

WATERMELON

PLASTICULTURE → CROP GROWTH

How Plasticulture Changes the Agroenvironment

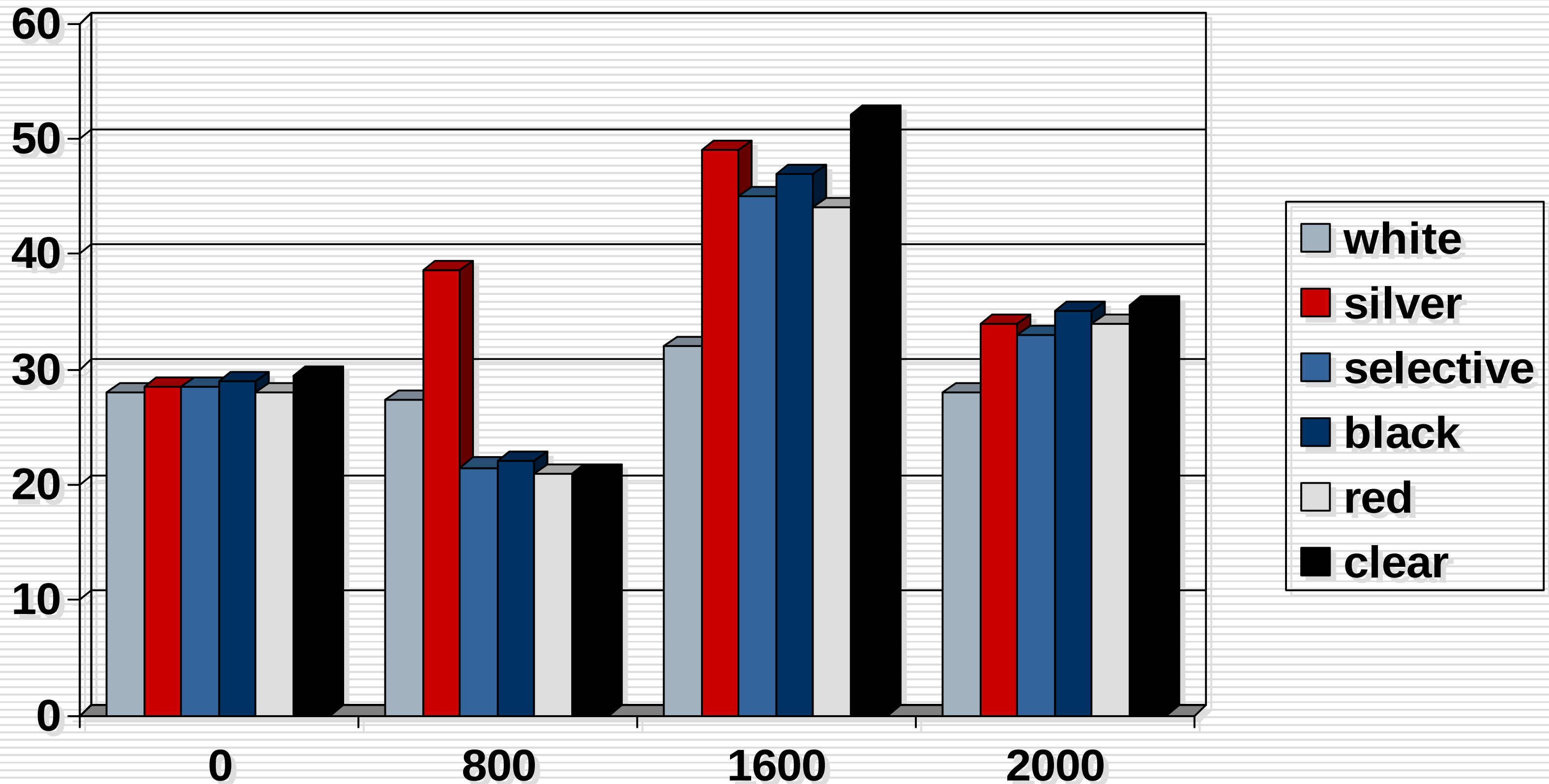
- Warmer soils
- Less evaporation
- Greater carbon dioxide
- Cleaner fruit
- More consistent soil moisture
- Nutrients on demand
- Warmer air
- Altered light quality
- Pest populations

How Plasticulture Changes the Agroenvironment

- Warmer soils

Warmer soils

Soil temperature C @ 50 mm



How Plasticulture Changes the Agroenvironment

- Warmer soils
- Less evaporation

How Plasticulture Changes the Agroenvironment

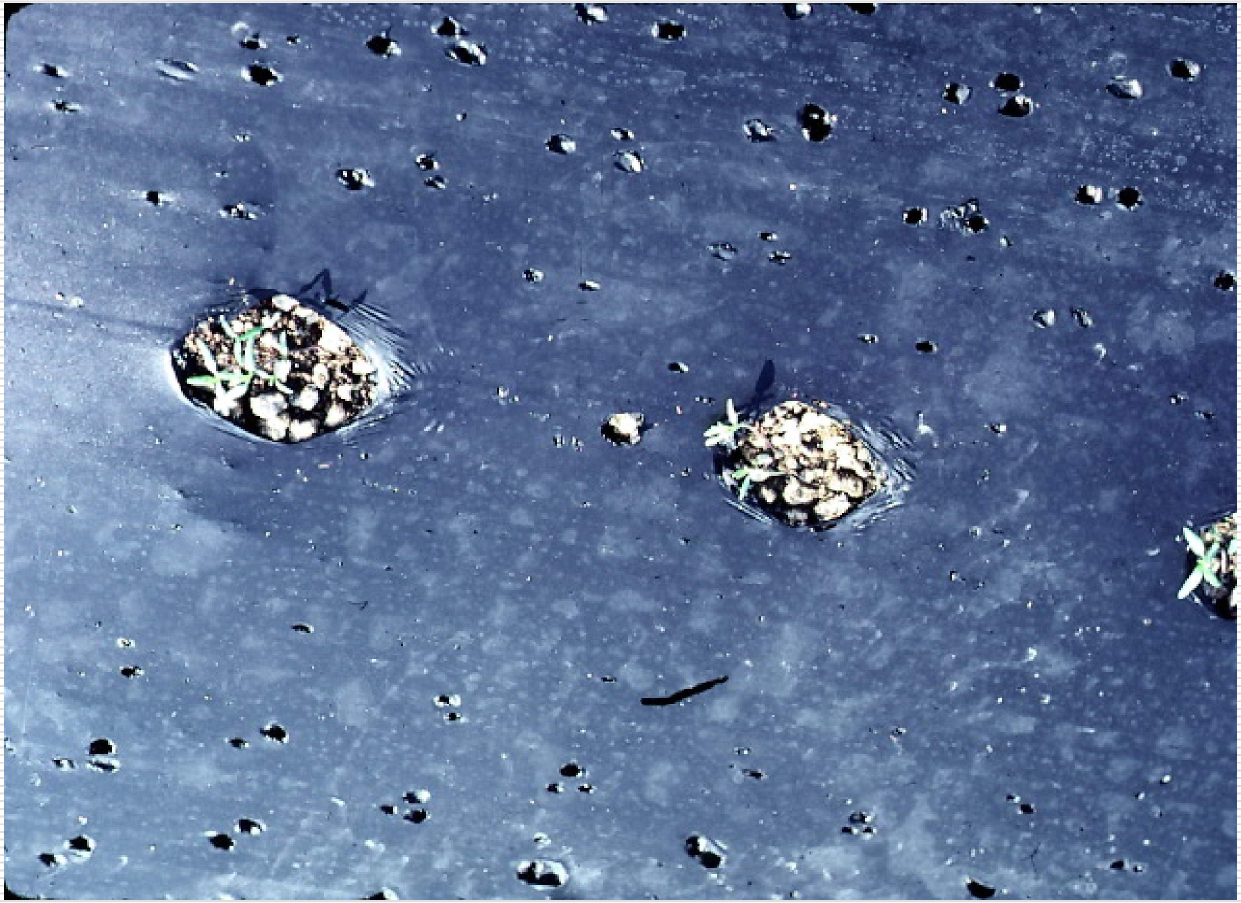
- Warmer soils
- Less evaporation
- Greater carbon dioxide
- Cleaner fruit

Cleaner fruit

How Plasticulture Changes the Agroenvironment

- Warmer soils
- Less evaporation
- Greater carbon dioxide
- Cleaner fruit
- More consistent soil moisture

BEFORE DRIP



IMPROVEMENT WITH DRIP

More consistent soil moisture

How Plasticulture Changes the Agroenvironment

- Warmer soils
- Less evaporation
- Greater carbon dioxide
- Cleaner fruit
- More consistent soil moisture
- Nutrients on demand

Fertilizer injectors

Water drive

Piston injector

Fertilizer Sources for Drip

Material	Solubility
calcium nitrate (15.5-0-0)	8.51
potassium nitrate (13-0-44 or 46)	1.08
ammonium nitrate (34-0-0)	9.84
sodium nitrate (16-0-0)	6.08
urea (29.9-0-0)	6.51
diammonium phosphate (6-17-0)	3.58
nitrate of soda potash (15-0-14)	9.80
potassium thiosulfate (0-0-25)	11.00

EXCESSIVE GROWTH
TOO MUCH NUTRIENT

How Plasticulture Changes the Agroenvironment

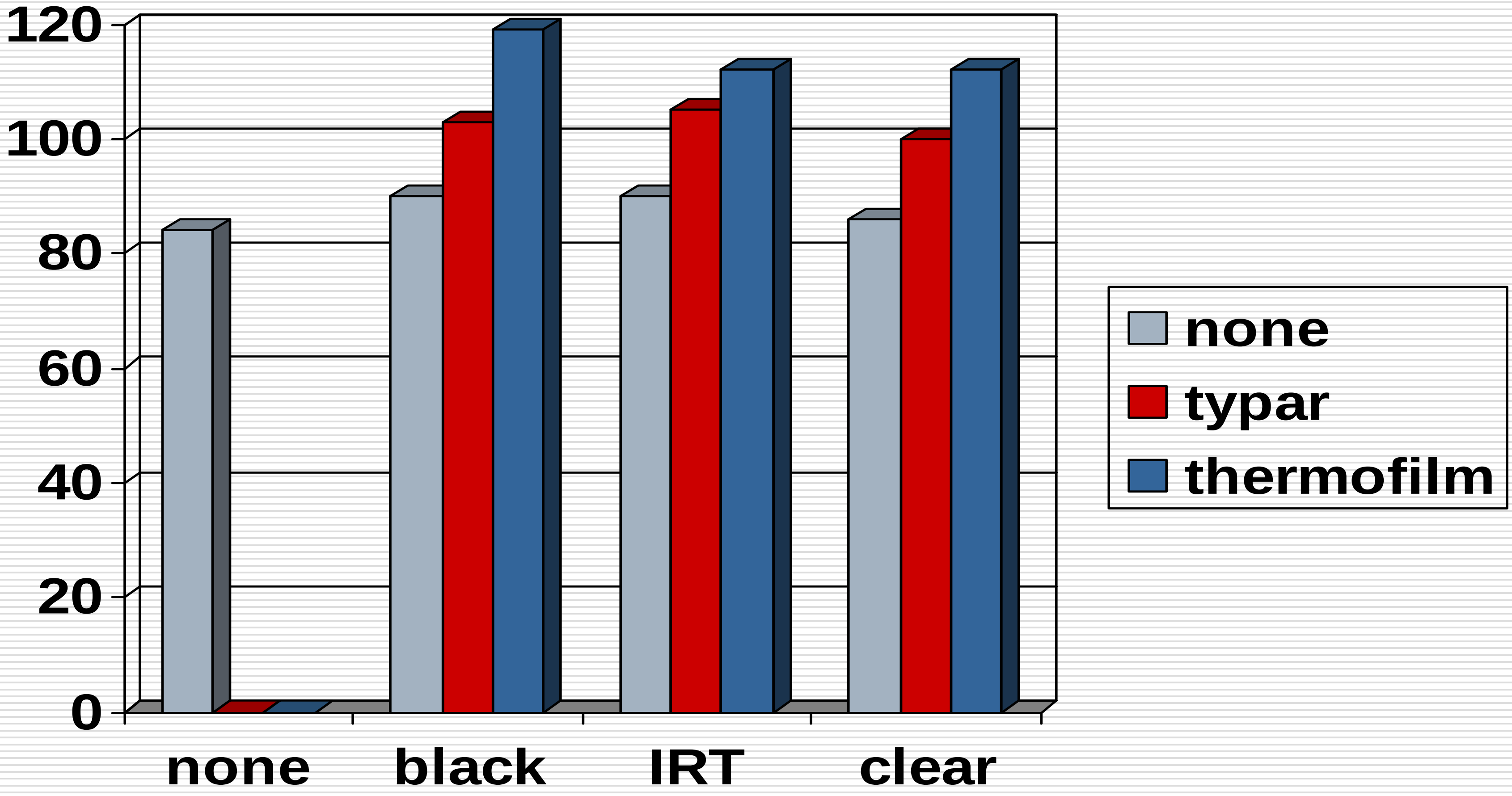
- Warmer soils
- Less evaporation
- Greater carbon dioxide
- Cleaner fruit
- More consistent soil moisture
- Nutrients on demand
- Warmer air

ADD WHITE WHEN AIR TEMP>30

PAINT WORKS ALSO

Air temperature

Mulch and row cover



How Plasticulture Changes the Agroenvironment

- Warmer soils
- Less evaporation
- Greater carbon dioxide
- Cleaner fruit
- More consistent soil moisture
- Nutrients on demand
- Warmer air
- Altered light quality

LIGHT QUALITY

Altered light quality

- RED PLASTIC

- RED PLASTIC

PAINT ALTERNATIVE

How Plasticulture Changes the Agroenvironment

- Warmer soils
- Less evaporation
- Greater carbon dioxide
- Cleaner fruit
- More consistent soil moisture
- Nutrients on demand
- Warmer air
- Altered light quality
- Pest populations

Pest populations
Weeds

Pest populations
Weeds

- NEARLY CLEAN

HERBICIDES PRIOR TO CROP

WEED SPRAYERS

Pest populations

<u>Diseases</u>

Pest populations
Diseases

SOUTHERN BAC.

RHIZOCTONIA

Pest populations
Diseases

NEMATODES

NEMATODES

tomatoes

PLANTS RESPOND QUICKLY

TOMATO

WATERMELON

COMMERIAL TOMATO FIELDS

NC/TN FIELD

FLORIDA

Average Yield Response to Plasticulture (per acre)

Crop	Plasticult.	Inc.of NC	NET inc
E cantaloupe	6000 fruits	4X	$1500
W cantaloupe	15000 fruits	5X	2400
Cucumbers	1200 bu	5X	4000
Pepper	2000 bu	4-6X	4000
Squash	800 bu	4X	2400
Tomato	25-3500 Ct	3X	6000
Watermelon	3000 fruits	4X	1200

NONE vs PLASTIC vs DRIP

PLASTIC W WO DRIP

Total season mkt tomato yield from drip and black plastic mulch

	Bare ground		Black plastic	
Year	- Irr.	+ Irr.	- Irr.	+ Irr.
		(T/A)		
normal	70.1	76.6	80.3	77.8
early dry	58.8	66.4	58.6	97.0*
late dry	51.8	97.6*	56.2	107.3*

LSD*(0.05)* plastic=8.5; irrigation=14.7

T/A x 80=25 lb ct/A

Tomato net returns from drip and black plastic

Year	Bare ground -Irr.	Bare ground + Irr.	Black plastic - Irr.	Black plastic + Irr.
	($1,000/A)			
normal	13.2	13.8	14.5	13.9
dry early	7.9	9.2	7.4	14.2
dry late	7.3	15.1	7.7	16.4

LSD*(0.05)* irr. = 3.1. LSD*(0.05)* plastic = NS

Plastic-no drip

Plastic & drip influence pepper early total yield (box/A)

Plastic	Drip centibar	Not dry YR 1	Dry early YR 2	Dry late YR 3
No	No	212c	572e	249c
No	-0.3	314bc	847cd	886b
Yes	No	515a	772de	165c
Yes	-0.3	575a	1176ab	1219a

Plastic & drip influence pepper early return ($/A)

Plastic	Drip centibar	Not dry YR 1	Dry early YR 2	Dry late YR 3
No	No	2195c	6288d	2689d
No	-0.3	3184bc	9260cd	9025a
Yes	No	5804a	8225de	1982c
Yes	-0.3	5782a	12398ab	10831a

Muskmelon K and N sources

Treatment	Mkt No.	Avg Wt	S S
KNO_3 + $Ca(NO_3)$	6045	4.9	9.3
KNO_3 + $NaNO_3$	6536	4.1	9.5
KNO_3 + Trisert CB	6095	4.2	8.6
KTS + $Ca(NO_3)_2$	6435	4.5	8.7
KTS + $NaNO_3$	5990	4.4	8.4
KTS + Trisert CB	5614	4.0	9.3
LSD	1385 ns	0.7 ns	1.1 ns

?PLASTIC QUALITY?

OTHER CROPS

- STRAWBERRIES STAKED EGGPLANT

OTHER CROPS

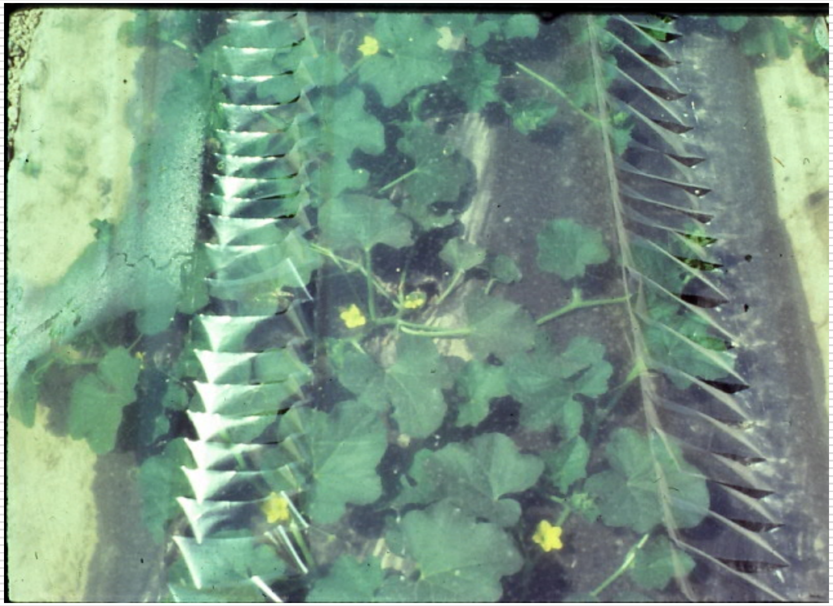
SEEDED BEANS

BEAN SEEDER

Second crops

SPECIAL STUFF

SPECIAL STUFF



Fertilizer injectors

TMB injector

Small venturi

Fertilizer injectors

Water drive

Piston injector

FERTIGATION EQUIPMENT

Water drive

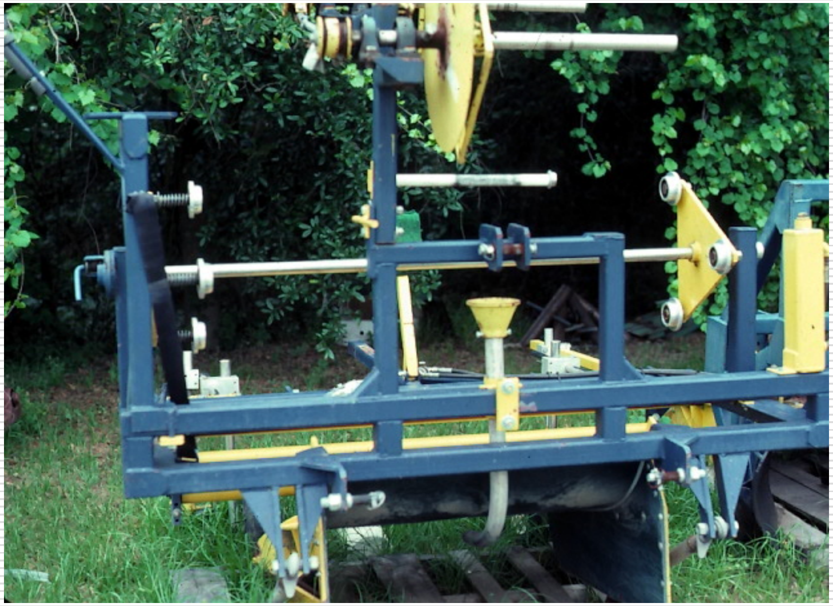
Backflow

TECHNOLOGY/EQUIPMENT

TECHNOLOGY/EQUIPMENT

TECHNOLOGY/EQUIPMENT

PLASTIC EQUIPMENT



FILTRATION FOR DRIP

FILTRATION FOR DRIP

DRIP PRESSURE REGULATORS

SPECIALIZED EQUIPMENT

SPECIAL CULTURAL NEEDS

Drain ends

Lateral drains needed

How Plasticulture Changes the Agroenvironment

- Warmer soils
- Less evaporation
- Greater carbon dioxide
- Cleaner fruit
- More consistent soil moisture
- Nutrients on demand
- Warmer air
- Altered light quality
- Pest populations

HOT SET VARIETIES OF TOMATO

BROCCOLI
COLLARDS
CABBAGE

LETTUCE
ONIONS
LETTUCE
+ONIONS

SNAP BEANS
G. PEAS
S. SQUASH
CUCUMBER

CANTALOUPE
TRANSPLANT

BROCCOLI
COLLARDS
CABBAGE
S. PEAS

LETTUCE
ONIONS
LETTUCE
+ONIONS

SNAP BEANS
G. PEAS
S. SQUASH*
CUCUMBER*

SUMMER SQUASH OR CUCUMBERS

BROCCOLI
COLLARDS
CABBAGE

LETTUCE
ONIONS
LETTUCE
+ONIONS

SNAP BEANS
G. PEAS
CUCUMBER*
S. SQUASH*

SWEET
CORN
(TRANSPLANT?)

BROCCOLI
COLLARDS
CABBAGE

LETTUCE
ONIONS
LETTUCE
+ONIONS

SNAP BEANS
G. PEAS
S. SQUASH
CUCUMBER

BEGINNING AND END SUCCESSFUL PLASTICULTURE

ON FARM RESEARCH

Generation 1 – finding non-ozone depleting fumigant alternatives (tactic substitution)

Generation 2 – finding non-fumigants and focus on IPM tactics (tactic diversification)

Generation 3 – focussing on the pathogens and pests and reduce their presence (avoidance/suppression)

Generation 4 – mutal vision

STRENGTHENING EXTENSION THROUGH ON-FARM RESEARCH

Adapted from:Roger Crickenberger for: Alternative Research Strategies for Sustainable Farming Systems SARE PDP training. September 21, 2000

1. What are the essential elements or tenets of on-farm research?
2. Strengthening the professional extension worker
3. Strengthening the program foundation
4. Strengthening farmer capacities and information
5. Challenges and limitations
6. Application of on-farm generated research

Alternative Approaches to On-Farm Research and Technology Exchange. 1995. Francis, Janke, Mundy, and King, editors. Extension and Education Materials for Sustainable Agriculture: Volume 3. University of Nebraska-Lincoln. Lincoln, NE

How to Discover Money $aving Opportunities: A Farmer's Guide to On-Farm Research. 1990. Janke, Thompson, McNamara, and Cramer. Rodale Institute. Emmaus, PA.

How to Conduct Research on Your Farm or Ranch. 1999. Sustainable Agriculture Network.

Strawberry Flower Power & Troubleshooting

Expo Workshop

Nov. 3, 2004

Welcome to High Point

- A busy year!
- Still lots of things "to do" on the farm
- Introduce speakers

Taking a different approach today…

Strawberry “Flower Power”

Introduce some new concepts …

We can gain better control of our crop if we understand some important ideas related to Vegetative & Reproductive Balance of the Plant

Vegetative Phase (the nursery)

Reproductive Phase (our farm)

Getting from there to here…

The nursery

My farm

Takes us on an interesting journey...

- A journey that is influenced by a number of factors we don't understand!
- Perhaps, if we understand these unseen "forces" better, we can achieve a more desirable outcome!

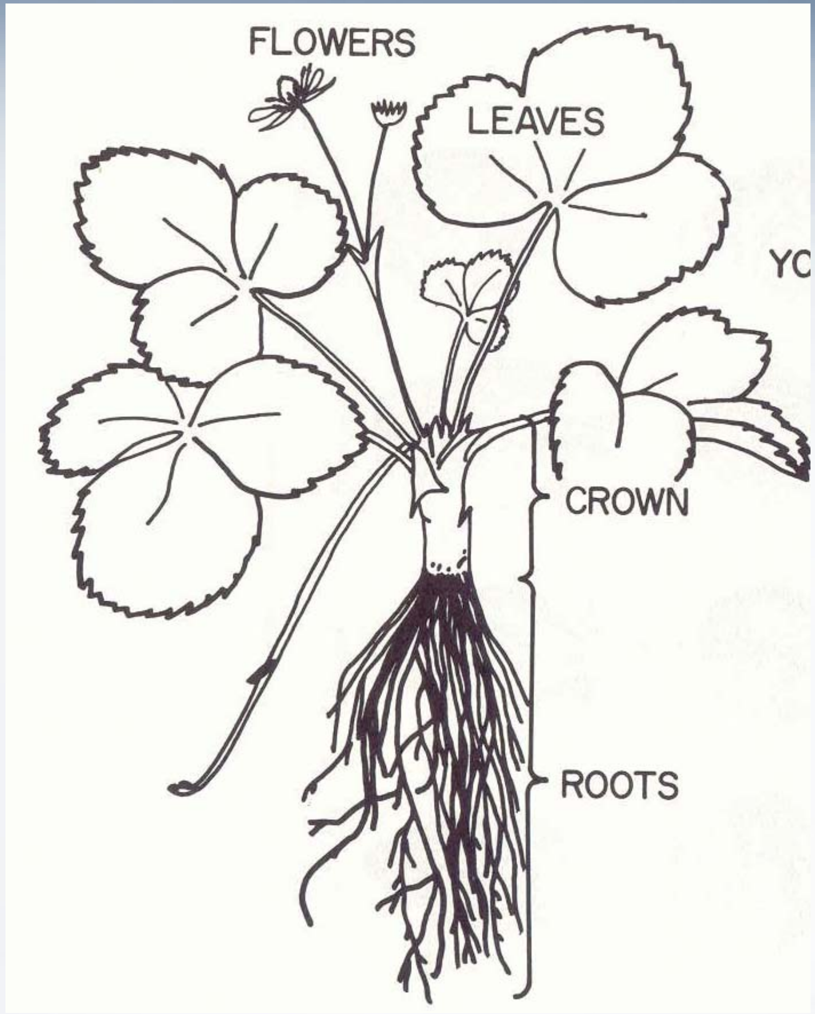
So, when did I get started on this?

It really started in St. Louis (1980)

Professor Dana's Talk…

The Strawberry Plant and Its Environment

This part I understood (anatomy)



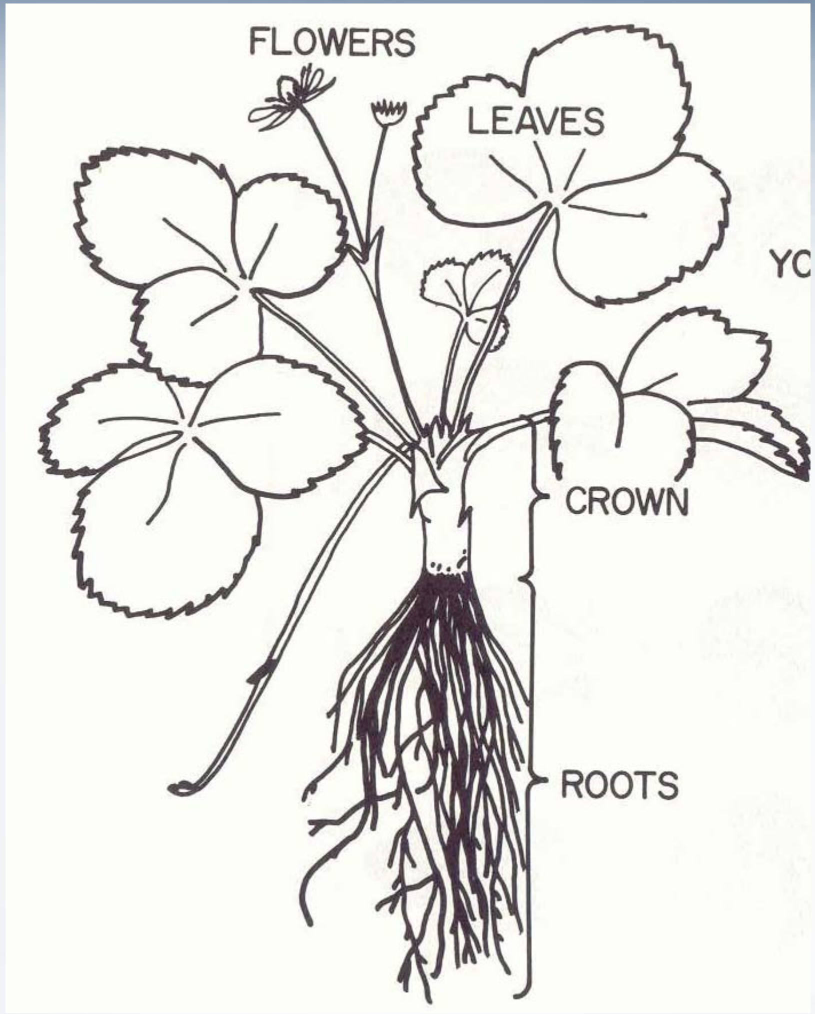
The Plant & Its Environment – how they interact, is where I needed help…

- Environmental factors
  - That control vegetative growth
    - Stolons (runners)
    - Leaves
    - Branch crowns
  - That control reproductive growth
    - Flowering
    - Fruiting
  - Can we bring about a better balance?

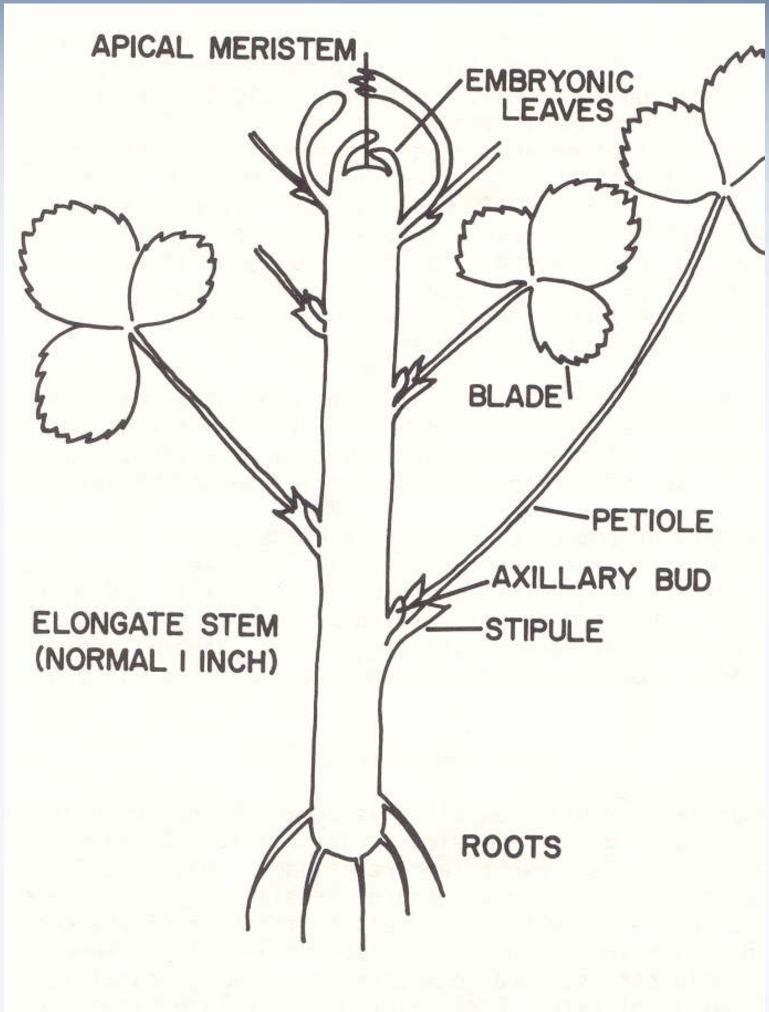
Why this is so important…

- A fruit grower is interested in not just total yield
- But, is it a “quality crop”
  - Fruit size and appearance
- Is the crop “concentrated”?
  - Can you keep up with the harvest
- Are there “ways” to influence the above by having greater knowledge of these environmental factors?

Why is daylength so important?



Exaggerated view of crown…



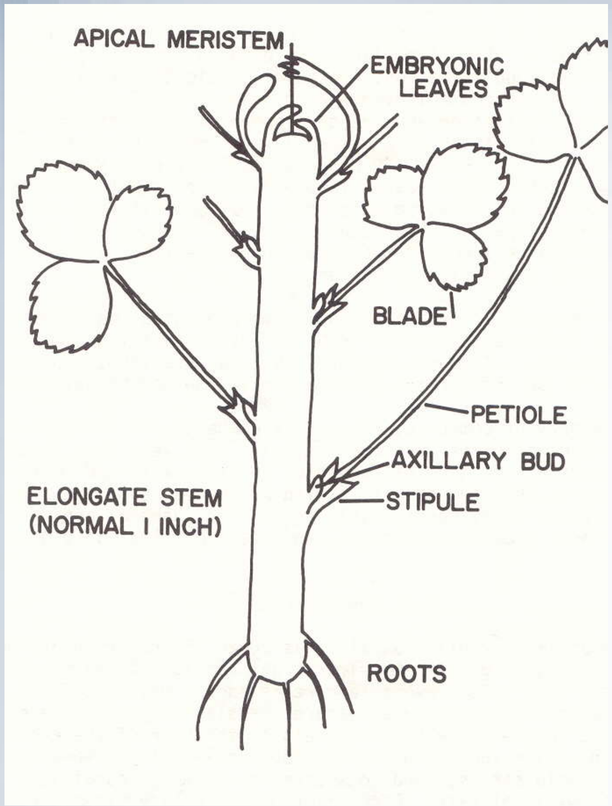
Research – identification

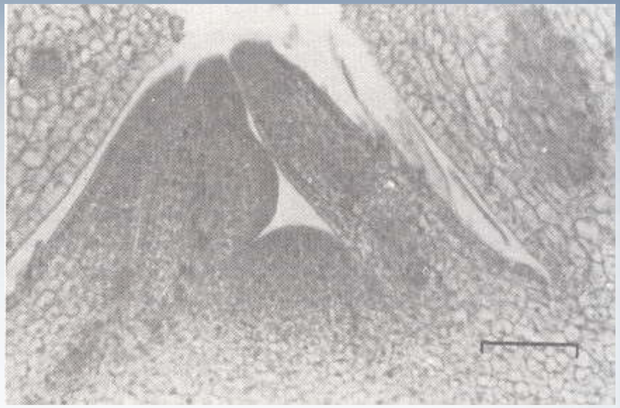
J. AMER. SOC. HORT. SCI. 110(6):808–811. 1985.

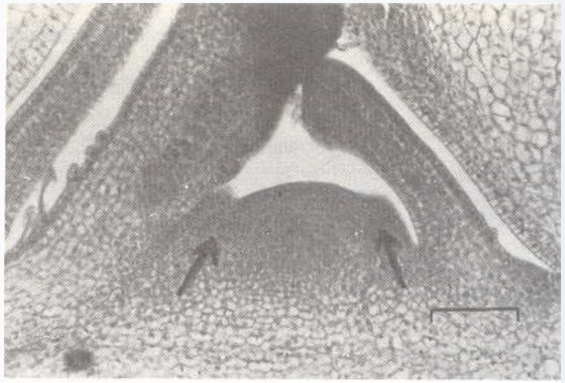
Comparison of Three Methods for Determining the Floral or Vegetative Status of Strawberry Plants

Edward F. Durner[1] and E. Barclay Poling[2]

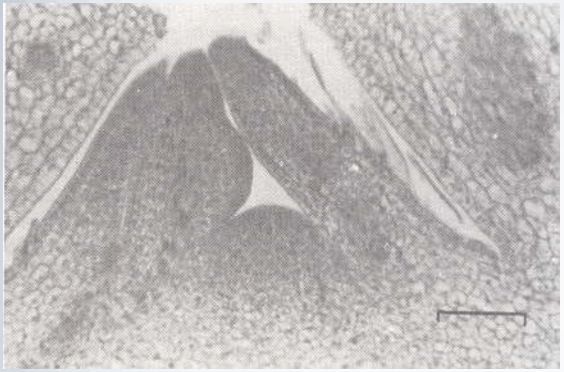
What is “critical” photoperiod?

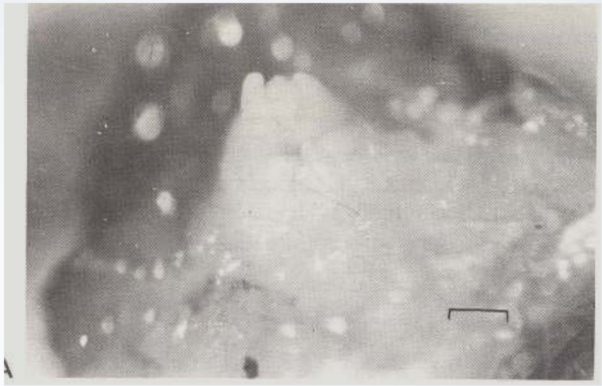




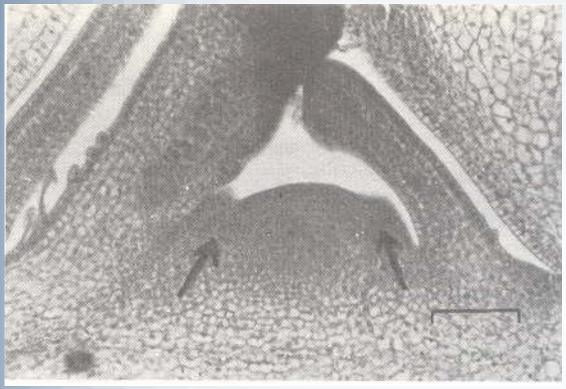


First stage – vegetative apex

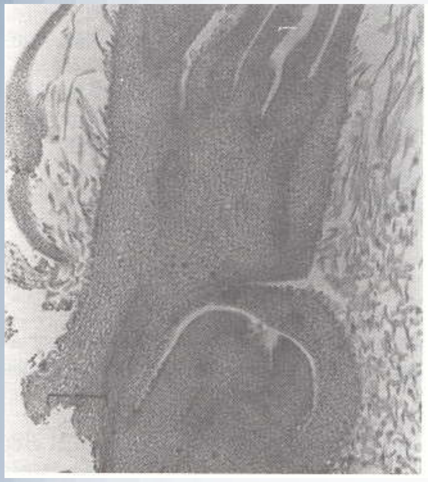


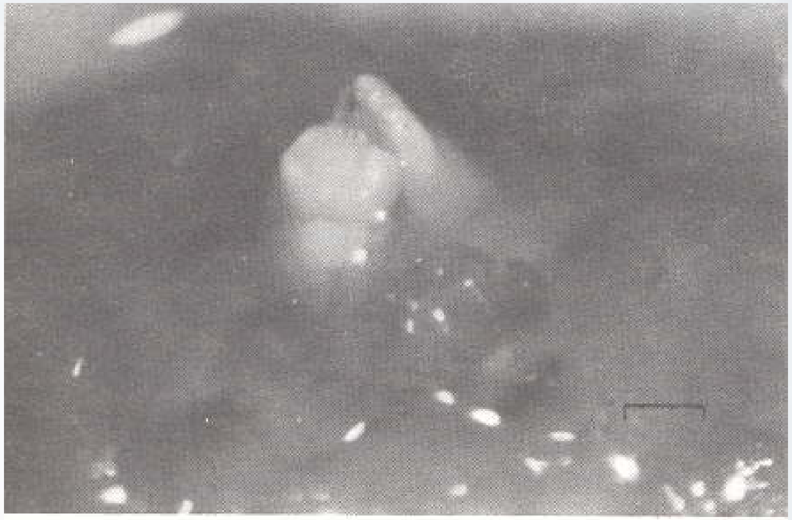


Second stage - transitioning



Reproductive (looks like a “molar”)





Research – when does it happen?

Table 1. Number of plants out of 5 considered floral by dissection or by forcing under long day greenhouse conditions.[z]

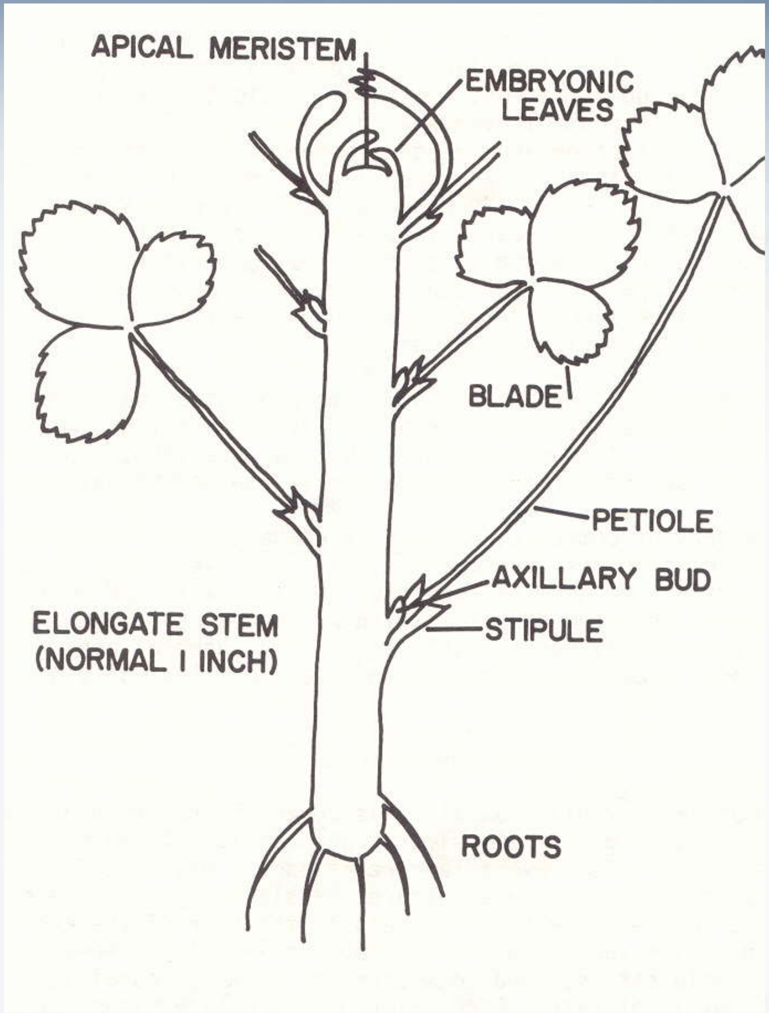
Cultivar	Method of detection	Sample date: September 7	September 14	September 21	September 28	October 5	October 12	October 19
Allstar	Dissected	0	0	0	2	5	5	5
	Forced	0	5	4	4	5	4	4
		(22)	(22)	(16)	(11)	(10)	(8)	(7)
Tribute	Dissected	0	0	0	1	5	5	5
	Forced	3	3	3	4	5	5	---[y]
		(17)	(13)	(12)	(7)	(7)	(6)	---
Apollo	Dissected	0	0	0	0	5	5	5
	Forced	0	0	0	0	3	1	3
		(22)	(22)	(22)	(22)	(18)	(17)	(14)
Earliglow	Dissected	0	0	0	3	5	5	5
	Forced	1	2	1	4	5	5	5
		(21)	(22)	(15)	(9)	(8)	(7)	(5)
Sequoia	Dissected	0	0	0	0	5	5	5
	Forced	0	0	0	4	3	3	2
		(22)	(22)	(22)	(14)	(18)	(16)	(15)
Titan	Dissected	0	0	0	0	1	2	5
	Forced	0	0	0	0	0	1	4
		(22)	(22)	(22)	(22)	(22)	(16)	(13)

[z]Number in parenthesis is the number of weeks under greenhouse conditions before the emergence of the first cluster. Some samples did not produce clusters after 22 weeks.
[y]Indicates missing data.

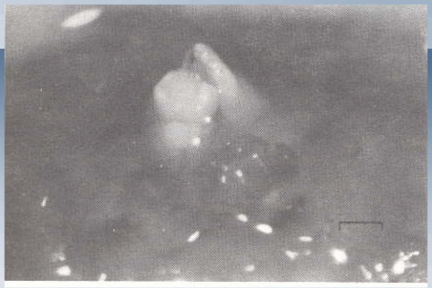
Research: floral initiation Chandler

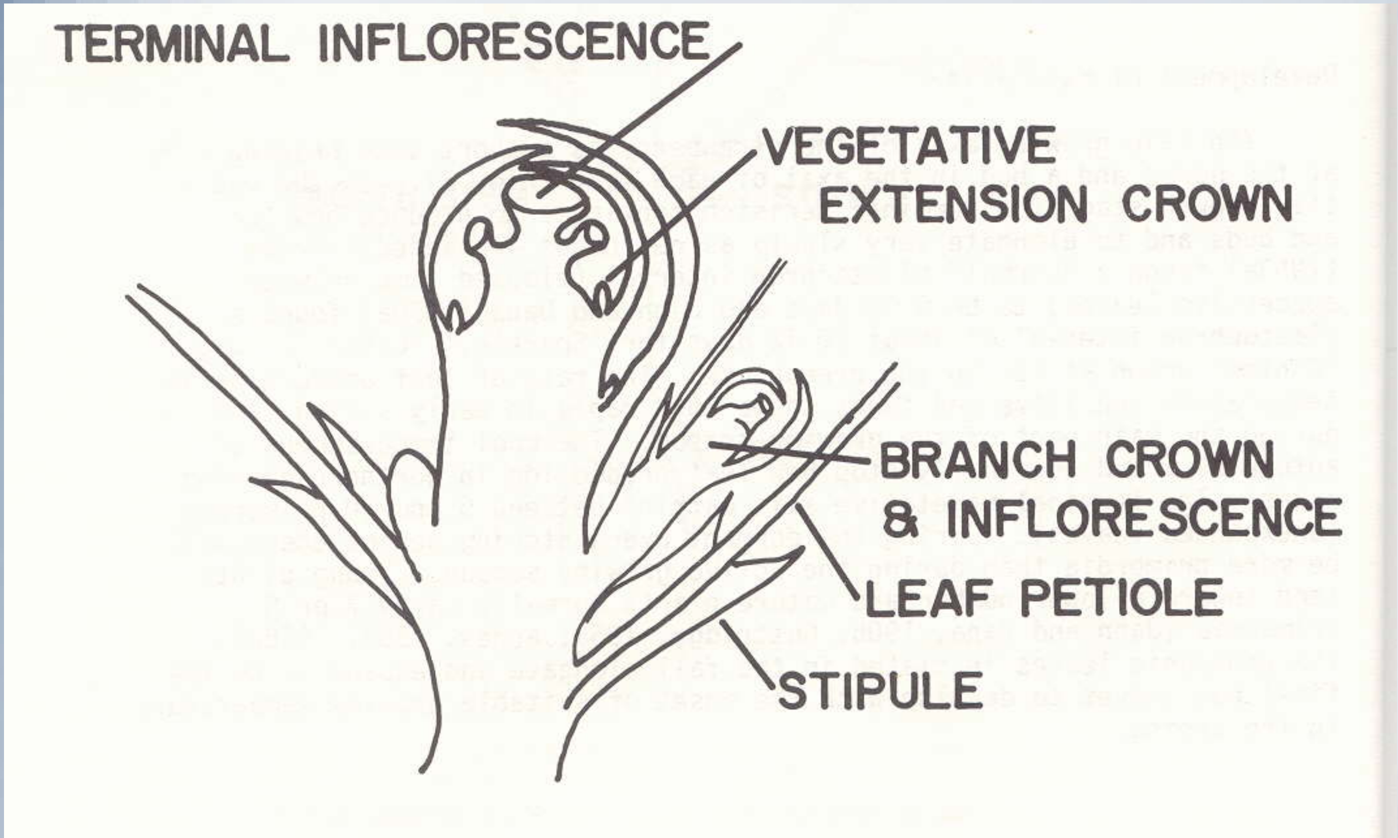
- Requires 2 weeks of inductive conditions…
  - Daylength less than 12 ½ hours
  - Or, uninterrupted night of 11 ½ hours
- Temperature is less important to “triggering” floral initiation
- Temperature has more influence “Afterwards”

Back to St. Louis…



Exaggerated view of a new inflorescence at terminal position

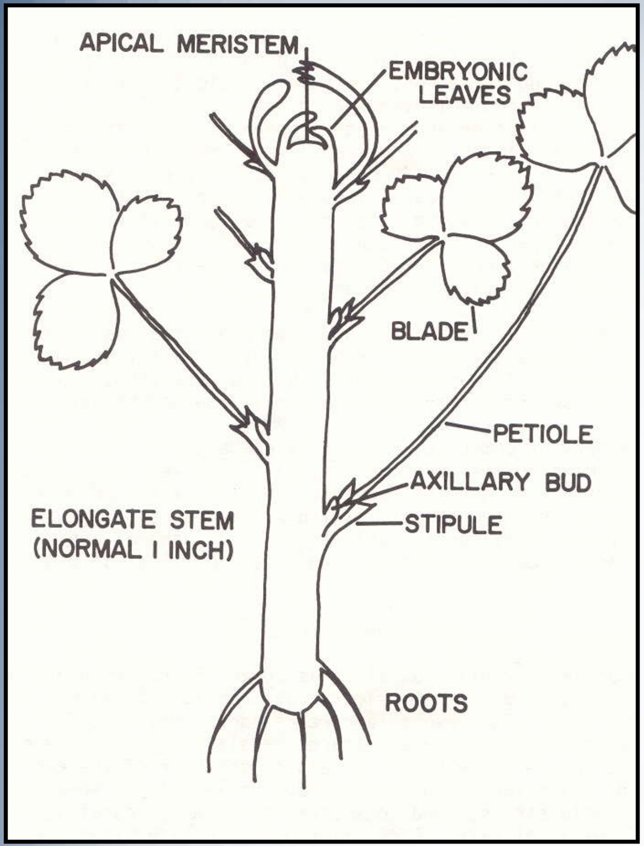


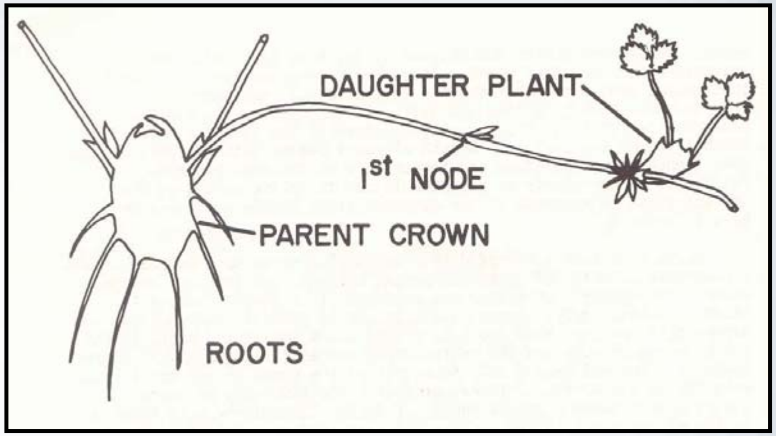


What else is happening?

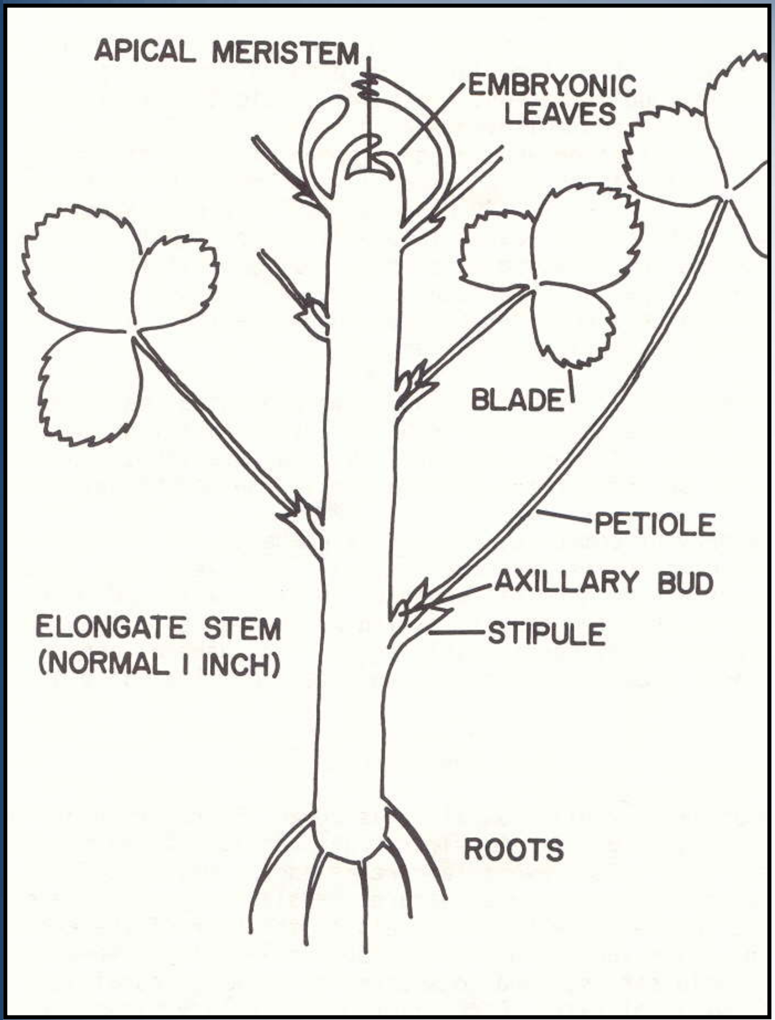
- When critical photoperiod is met
- How are other processes affected?
  - Like branch crown development
  - Like runnering
- How is temperature involved?

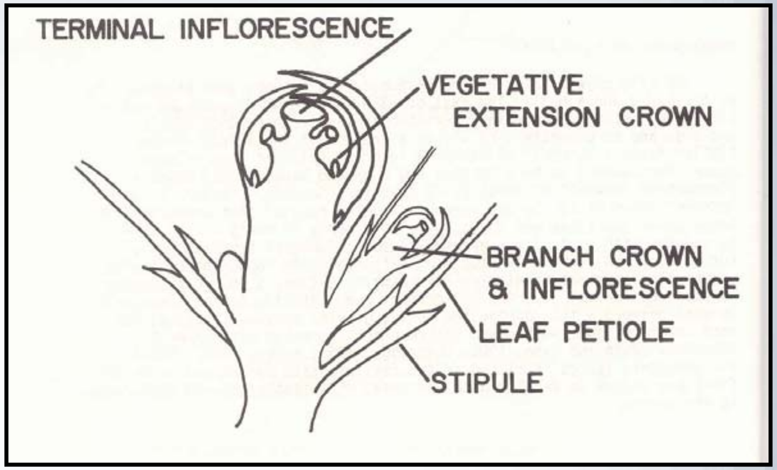
Runnering…


APICAL MERISTEM
EMBRYONIC LEAVES
BLADE
PETIOLE
AXILLARY BUD
STIPULE
ELONGATE STEM (NORMAL I INCH)
ROOTS

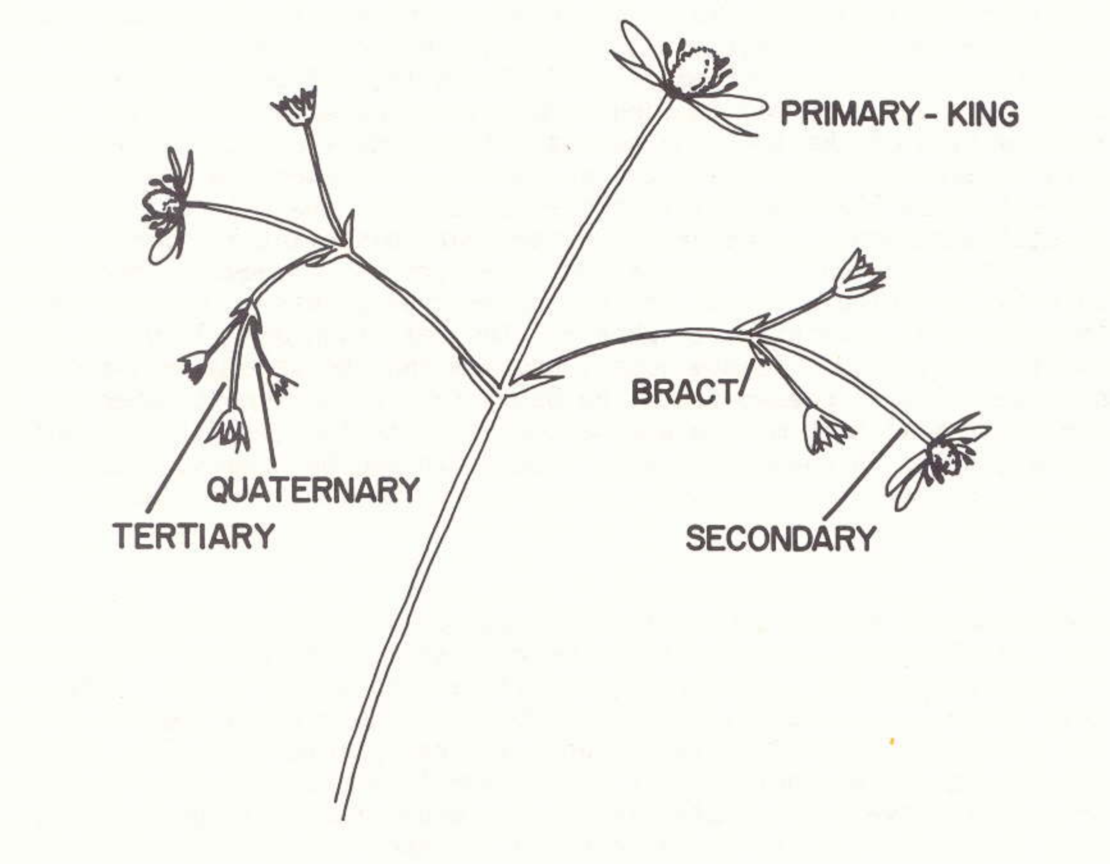

DAUGHTER PLANT
1st NODE
PARENT CROWN
ROOTS

Branch crown formation

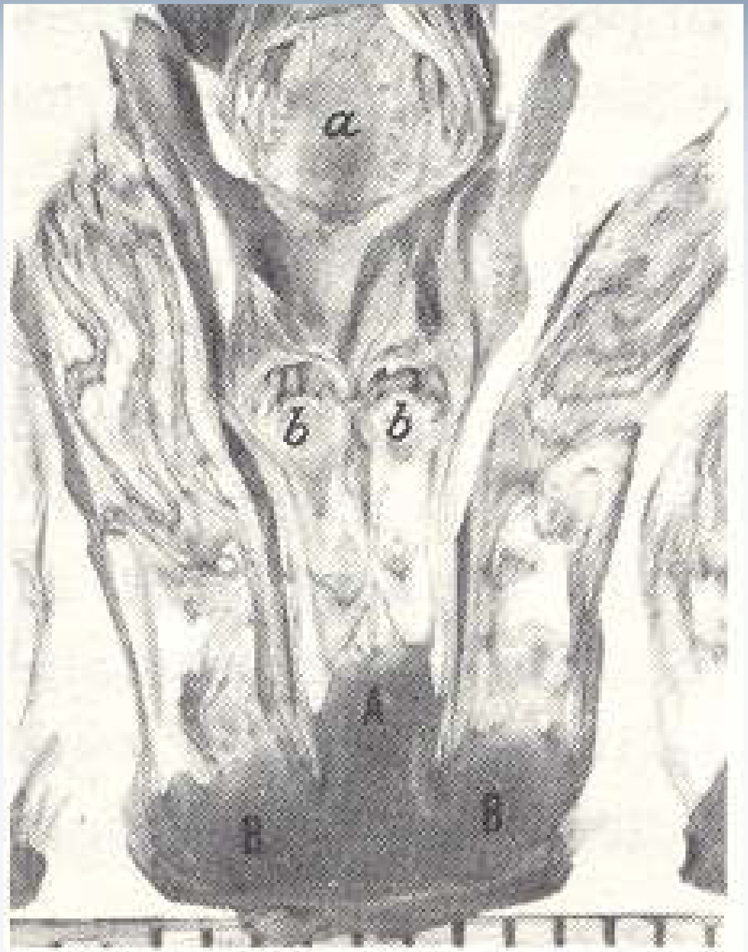




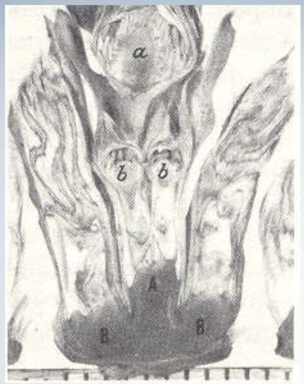
What terminates at each crown?

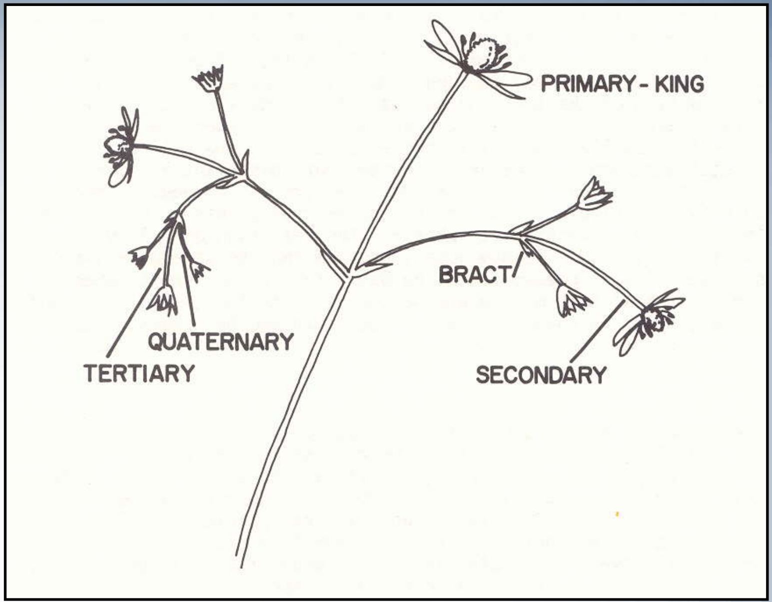


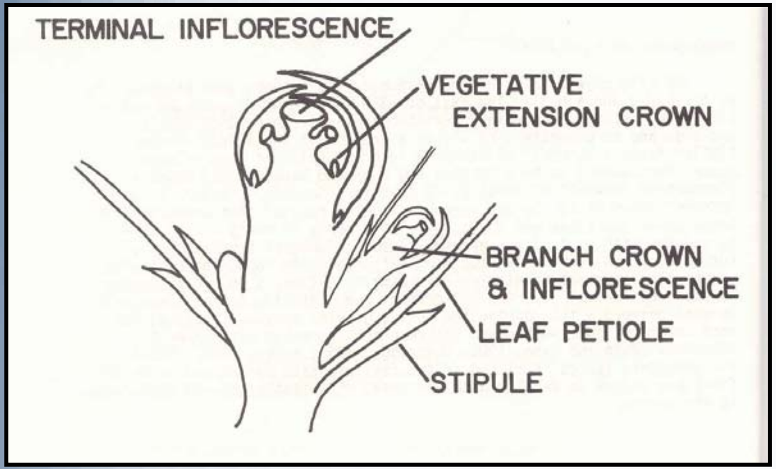
Here is how it looks in November



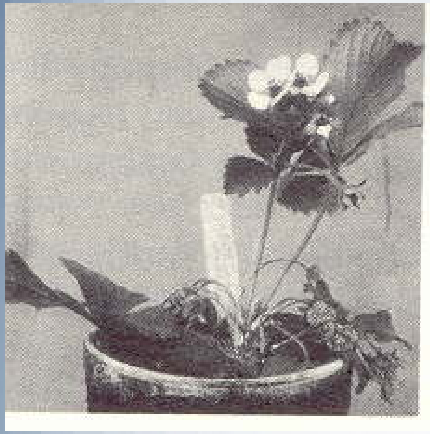
Late fall and spring…

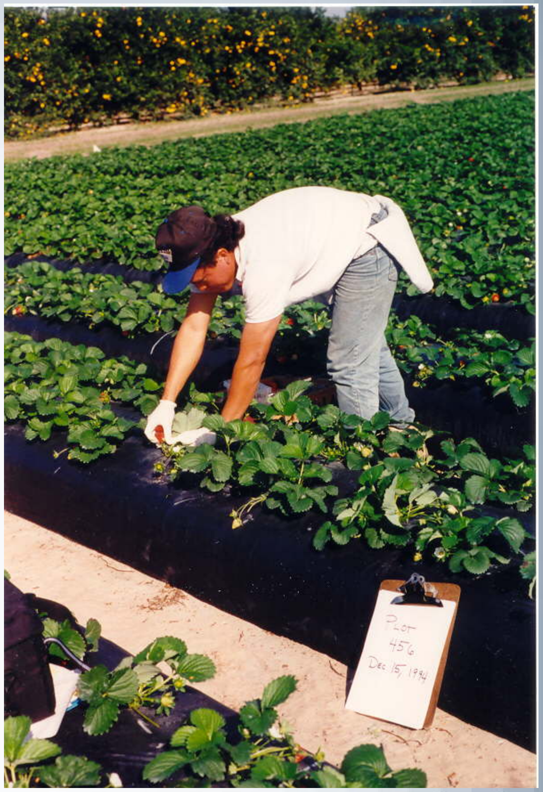






Putting this all together…





Stem berry

Balance

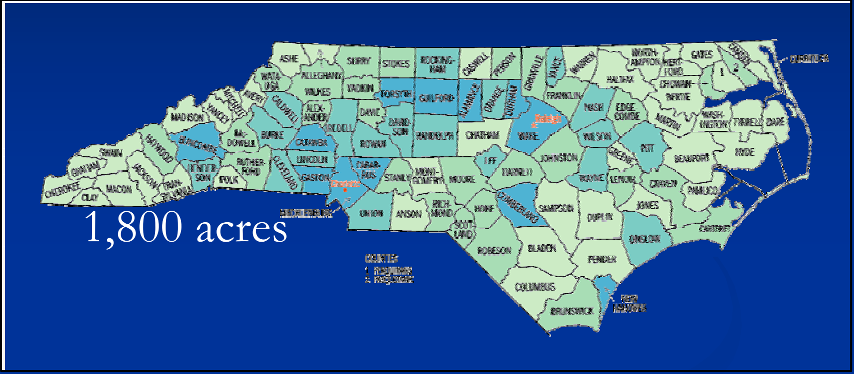
Strawberry production, plant-back trials, and implications of fumigant trials/work

Barclay Poling
Professor & Extension Specialist
NCSU - Hort. Sci. Dept.

Outline

- Part 1 – Strawberry production (taking an integrated approach)
- Part 2 – Plant-back trials (10:35 – 10:50)
- Part 3 – Nursery fume trials (10:50 – 10:55)

1 acre per 3,750 people



Strawberry Plasticulture

Big changes over the last 20 years in Mid-South

Strawberry Production Systems…

- Matted row – traditional growing system in Mid-South
  - Bare-root, dormant plants in spring
  - 1 year waiting period for crop
  - Renovation for 2nd and 3rd year
  - Very susceptible to rains and botrytis (and red stele)
- Strawberry plasticulture – started in 1980's in NC
  - Raised beds, plastic film, and MeBr fumigation (in-row)
  - Annual planting system (carryover discouraged)
    - Crop in 7 months for 5 to 7 weeks
    - Earlier and larger berries (for faster picking)
    - Mainly California cultivars (e.g. Chandler, Camarosa)
    - Plug plants became available in the early 1990's

Goal Today: Put Pre-plant Fumigation w/MeBr in Context

- Strawberry plasticulture (1,800 acres)
  - Methyl bromide:chloropicrin
    - 98:2 formulation (1 week plant-back)
    - 67:33 formulation (2 week plant-back)
- Nursery fumigation (200 acres)
  - Methyl bromide:chloropicrin
    - 67:33 formulation

Strawberry Plasticulture

- Highly intensive management system (vs. MR)
  - It is a "collection" of practices and technologies that require careful/timely execution (even the best farmers have a hard time with plasticulture)
  - Very knowledge-intensive enterprise that requires an understanding of how things "work together"
    - e.g. the plant's vegetative & reproductive development
    - e.g. how fumigation interacts with planting date to influence ultimate plant size, yield and fruit quality
- With such a "complex system" extension plays a crucial support role!

Extension Support

Interpretation of:

  - Plant tissue reports (deciding on fertility program)
  - PDIC reports
  - Berry-mg advisories

- Digital photographs from the field to specialists
- On-farm trials with alternative fumigants
- Beneficial site visits to plasticulture operations
  - e.g. recent January ’05 freezes ~ assessing injury

Pre-plant Meetings for Growers – 7/22/04 Nash-Franklin Counties

Sharing lots of information/experiences – good and bad!

It was a Meeting like this in Orangeburg, SC, led to CUE in 2005

Investigating Recent Freeze Effects Led to An Interesting MeBr Story

Background Information

- Fresh dugs planted 9/25/04; plugs 10/03/04
- Organic and conventional (methyl bromide) plantings
- Row covers first applied December 15th
- December 20, 2004 – Minimum 11°F
- Warm-up first 2 weeks Jan. '05
  - 10 to 20 F warmer than usual
  - Chandler broke dormancy (2-3 new leaves)
- Row covers re-applied on January 15th
- January 17th – Minimum temperature 13 F
- January 18th – Minimum temperature 12 F
- Covers off February 5-7
- February 15th – Site visit
  - Issue #1 – cold injury?
  - Issue #2 – plant size, earliness


Organic Camarosa

Feb 15, 2005

Organic field

Plug
Set 10/3/04

Fresh Dug
Set 9/25/04

Organic FD Camarosa (8" dia.)

Knife 8 ¾ inches

Organic Fresh dugs – slightly larger size than plugs

Notice all of the winter blossoms → source of botrytis crown rot

Methyl Bromide Fumigated – Camarosa (same source)

Planted 9/25/04; row cover 2nd half Dec; no row cover in first 2 weeks of Jan.; re-apply Jan 15

Camarosa – Lewis Nursery Fresh Dugs (9/25/04)

Organic

Methyl bromide

Photograph – 2/15/05

5 Branch Crowns + Main Crown

Virtually NO INJURY (11 F Dec, 12 F Jan 18)

Organic FD Camarosa (8" dia.)

Only 1 branch crown on Camarosa Fresh Dug on Organic Ground

Camarosa planted same date

Organic

1 branch crown

Methyl Bromide

5 branch crowns

Same Farm – Feb. 2002

Is this too large?

February 15, 2005


Jan. 8, 2002
Bad memory!


Spring 2002
Crop load - excessive

Jan 2002

May 2002


2 branch crowns
NC – Feb 16


3 crowns
NC – March 9


Main crown
Set Oct 6


Late
April - Clayton
4-5 crowns

Goal

35 Successful Blossoms/Plant
= 1.5 lbs/plant
= 26,250 lbs/acre

What Plant Back Studies Have Taught Us About Crown Number

- 2003-2004 Trial Clayton Central Crops
- Iodomethane 98:2 formulation (2 rates) vs. Telone C-35, plus control
- Three planting dates for Chandler plugs
  - 25 Sep
  - 2 Oct
  - 9 Oct
- Very good growing season overall (vs. 2002-2003 season…cold fall season)

Why is plant-back important?

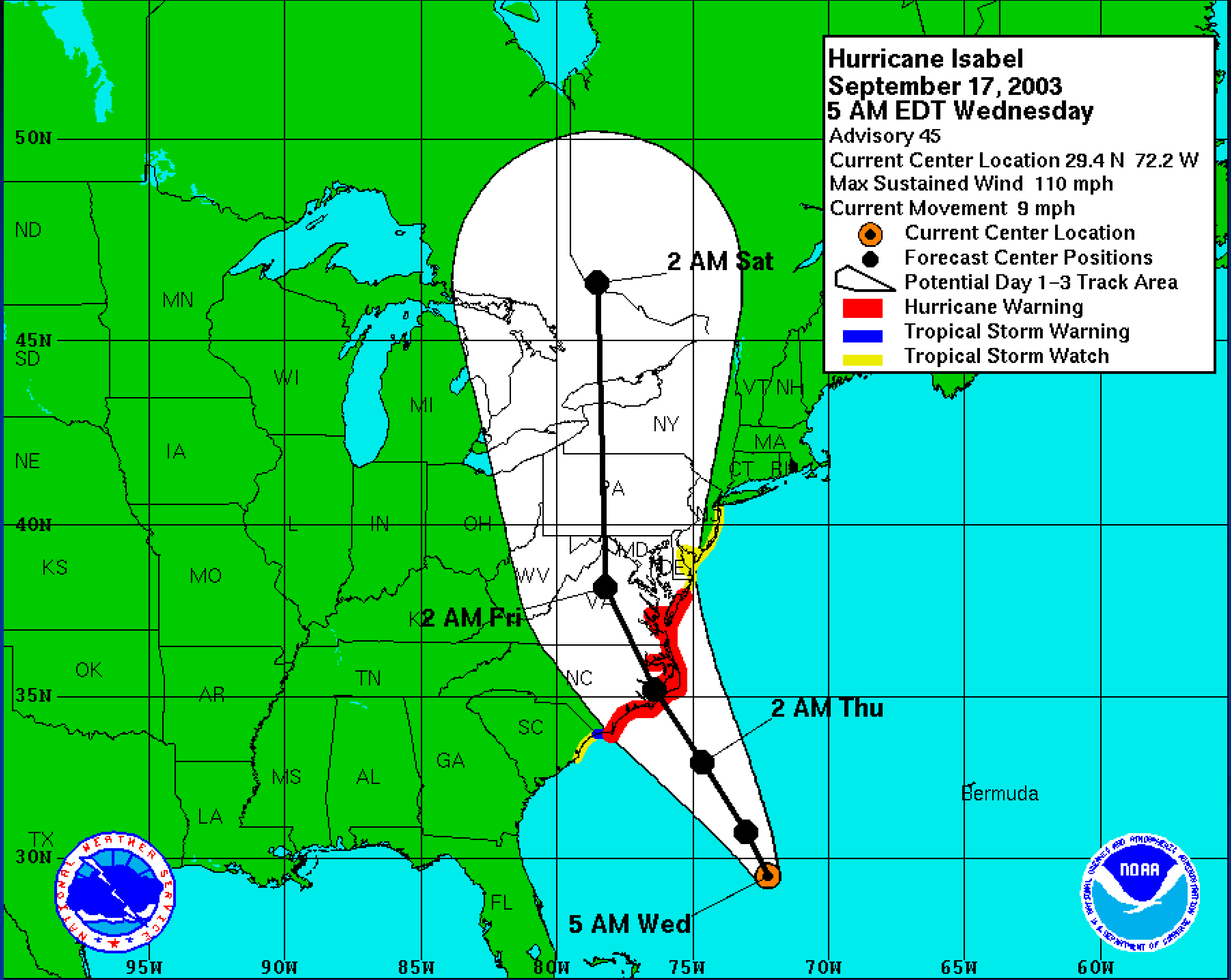
Early August

End August

MeBr:pic

In-row (2 weeks)

Wait 2-3 weeks (3rd wk Sept)


Hurricane Isabel
September 17, 2003
5 AM EDT Wednesday
Advisory 45
Current Center Location 29.4 N 72.2 W
Max Sustained Wind 110 mph
Current Movement 9 mph
Current Center Location
Forecast Center Positions
Potential Day 1-3 Track Area
Hurricane Warning
Tropical Storm Warning
Tropical Storm Watch
2 AM Sat
2 AM Fri
2 AM Thu
5 AM Wed
Bermuda
50N
45N
40N
35N
30N
95W
90W
85W
80W
75W
70W
65W
60W
ND
SD
NE
KS
OK
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MO
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MI
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TN
AL
OH
KY
GA
FL
SC
NC
VA
WV
MD
DE
PA
NJ
NY
CT
RI
MA
VT
NH

Part 2. Plant-back trials

- Actual scenario for 2003-2004 crop
  - September 17, 2003 – Isabel on track for landfall
    - Fortunately stayed east and impacted VA Beach
  - Heavy rains!
  - Research team fumigated at Clayton on Sept. 19th
    - 1 week plant-back fumigant required for first plant date
      - Sept. 25, 2003 (no registered materials to do this)
      - October 2, 2003 (o.k. for MeBr:Pic 67:33 – 2 week plant-back)
      - October 9, 2003 (o.k. for Alternatives requiring 3 weeks)

What was the outcome?

Plant-back (Date)	Market Yield (lb/A)	Ave. Size (g/berry)	Ave. Crown (# plant)	Ave. Flower (# plant)
1 week (9/25)	24,447 a	14.4 31/clam	6.6	44.4
2 week (10/2)	24,416 a	15.21 29/clam	6.4	41.8
3 week (10/9)	23,421 a	17.05 26/clam	5.8	35.7

What about in 2002-2003?

Plant-back (Date)	Market Yield (lb/A)	Ave. Size (g/berry)	Ave. Crown (# plant)	Ave. Flower (# plant)
1 week (9/27)	20,487 a (24,447)	16.4 14.4	5.25 (6.6)	24.7 44.4
2 week (10/4)	16,666 b (24,416)	18.4 15.2	4.70 (6.4)	23.0 41.8
3 week (10/11)	9,449 c (23,421)	20.4 17.0	4.20 (5.8)	20.9 35.7

What does this mean?

- Planting date in 2002 had huge effect
  - Earlier was better
- Planting date in 2003 was not important
  - Earlier was very undesirable from "quality" standpoint with smaller berries (31.5/clamshell) with 9/25/03
  - Later was best from quality standpoint (23,421 lb/A, and 26 berries per clamshell (16 oz)
- Planting date is not consistent!
- Why regional growers have gone to "staggering"

Fumigant Effect?

	2003 Mkt Yield (lb/A)	2004 Mkt Yield (lb/A)
IM98 (75 #)	16,378 a	25,461 a
IM (60#)	16,072 a	25,073 a
Telone C35	14,152 b	24,491 a
Control	NA	21, 257 b

Can the fumigation effect be more important?

Sticking with our theme of strawberry plasticulture being so unpredictable!

Franklin County, North Carolina

Background Information

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Plug

Branch Crowns

Camarosa	Organic	Methyl Bromide
Fresh dug (9/25)	1	5
Plug (10/3)	3	NA

Let’s review this…

- Looking for plants about 8-9” dia
  - Mid-February
- 3 nice branch crowns
- Producing about 1.5 lb/plant of high quality fruit

Let's keep thinking about this…

- Feb. 15, 2005 on-site visit
- Camarosa plugs on organic soil had 3 br. crowns
- Camarosa fresh dugs on organic had 1 br. crown
- Camarosa fresh dugs on MeBr had 5 br. crown

- Evaluation
- Just right
- Too little
- Too many

No Methyl Bromide

When you meet with a farmer…

- Look beyond methyl bromide issue…
- Plant type factor
- Plant date factor
- Soil prep factor
- Nursery plant quality
- Plant N and irrigation

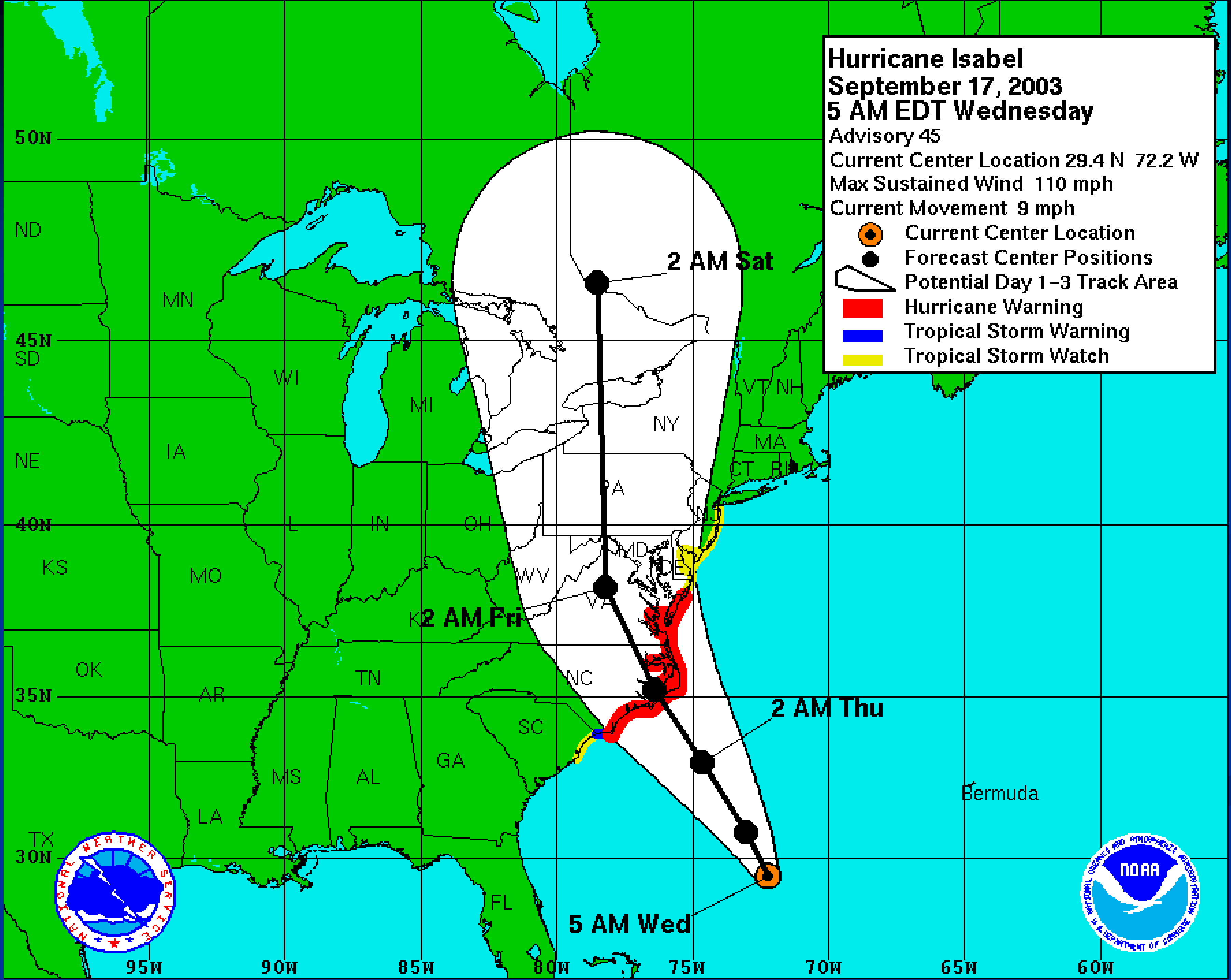
Agents need to know there are multiple ways to over-invigorate plants and exceed desired size…


2 branch crowns
NC – Feb 16


3 crowns
NC – March 9


Main crown
Set Oct 6


Late
April - Clayton
4-5 crowns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Max Sustained Wind 110 mph
Current Movement 9 mph
Current Center Location
Forecast Center Positions
Potential Day 1-3 Track Area
Hurricane Warning
Tropical Storm Warning
Tropical Storm Watch
2 AM Sat
2 AM Fri
2 AM Thu
5 AM Wed
Bermuda
50N
45N
40N
35N
30N
95W
90W
85W
80W
75W
70W
65W
60W
ND
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MN
WI
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KS
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OK
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TN
NC
SC
GA
AL
MS
LA
TX
FL
NOAA

Let's Summarize

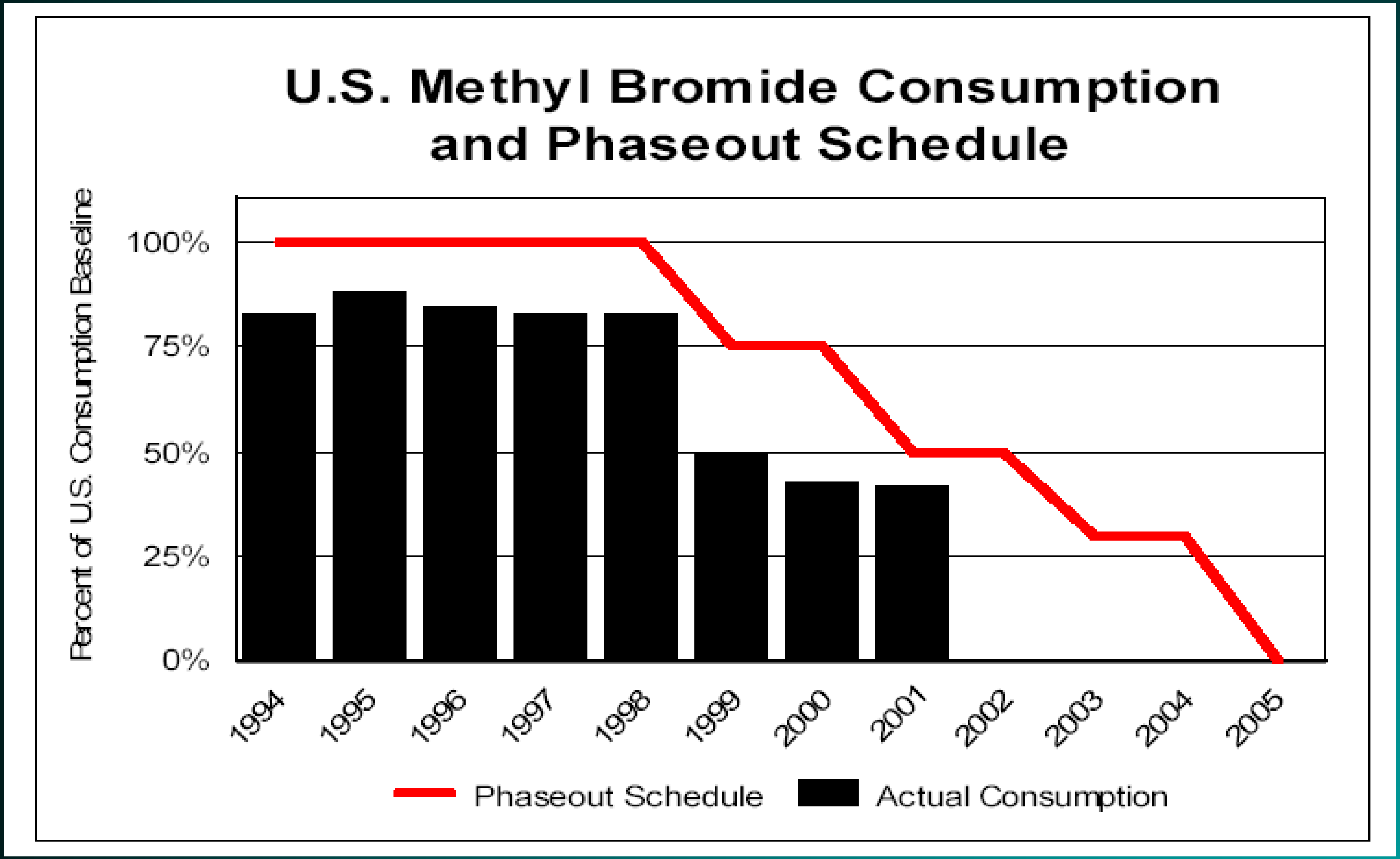
- Important ways to "invigorate" strawberry plant
  - 1. Planting date – greatest influence of all factors
    - Early planting – get excess branch crowns (>5)
    - Late planting – too few branch crowns (<2)
  - 2. Plant type – can be very important
    - Plugs – establish more quickly than fd (about 5 days)
    - Bare-root fresh dugs
  - 3. Fumigant & Plastic Mulch Bed (can be very sign.)
  - 4. Mild fall and winter (can be very significant)
  - 5. Application of row covers

Thanks

Weed Management

David Monks
Dept. of Horticultural Science

Methyl Bromide Phase-Out



Source: U.S. EPA and Steve Toth


Non Treated


Untreated nutsedge

Nutsedge Control Measures

• Hand removal/cultivation/tillage	P
• Chloropicrin/Telone/Vapam	P
• Methyl bromide	F to E
• Rotation with effective herbicides	F to E
• Herbicides	P to E

Without Nutsedge Control

- One nutsedge can infest an 8.5 by 10 feet area by the end of the growing season.
- Densities often can be as high as 200 to 300 plants per m^2

Methyl Bromide CUE

- Based on methyl bromide control of nutsedge consistently
- Alternatives often give unacceptable control

Without Methyl Bromide

- Nutsedge (yellow and purple) densities will increase (nutsedge from hole and growing through plastic).
- Broadleaf weeds from hole will increase
- Thus, overall weed densities will increase greatly.
- Farmers will be faced with a high population of weeds that will grow at a fast rate.

Supplement Weed Control by Alternative Fumigants??

- Increase use of hand removal of weeds.
  - 2 to 4 times per season
  - $ per 1000
- Use of herbicides applied to bed under plastic.
- Use of herbicide over the top of crop and plastic.

Problems Faced

- Lack of herbicides that will control nutsedge.
- Lack of crop safety.
- Relatively few herbicides that are registered for use in the row in plasticulture.

Crops

Nutsedge control (herbicides)

Tomato, cucumber, cantaloupe

No nutsedge control (herbicides)

Strawberry, pepper, squash, watermelon