Planning and Developing a Successful Almond Orchard

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Happiness is a ton of meats…

at $1.00 per pound!

-1970’s bumper sticker

“Happiness is 4000 pounds…

…at $2.00 per pound!

- 2008 reality

Maximizing almond yield potential
= maximizing sunlight capture

Preplant preparation is the best money you will spend on your orchard

Preplant Preparations Include...

- Site evaluation
- Physical soil modification
- Chemical soil modification
- Fumigation
- Rootstock selection

Evaluation of the Site

- Neighboring crops
- Past Cropping History
- Soil Surveys and Maps
- Aerial Photos
- Backhoe pits
- Soil Sampling & Analysis

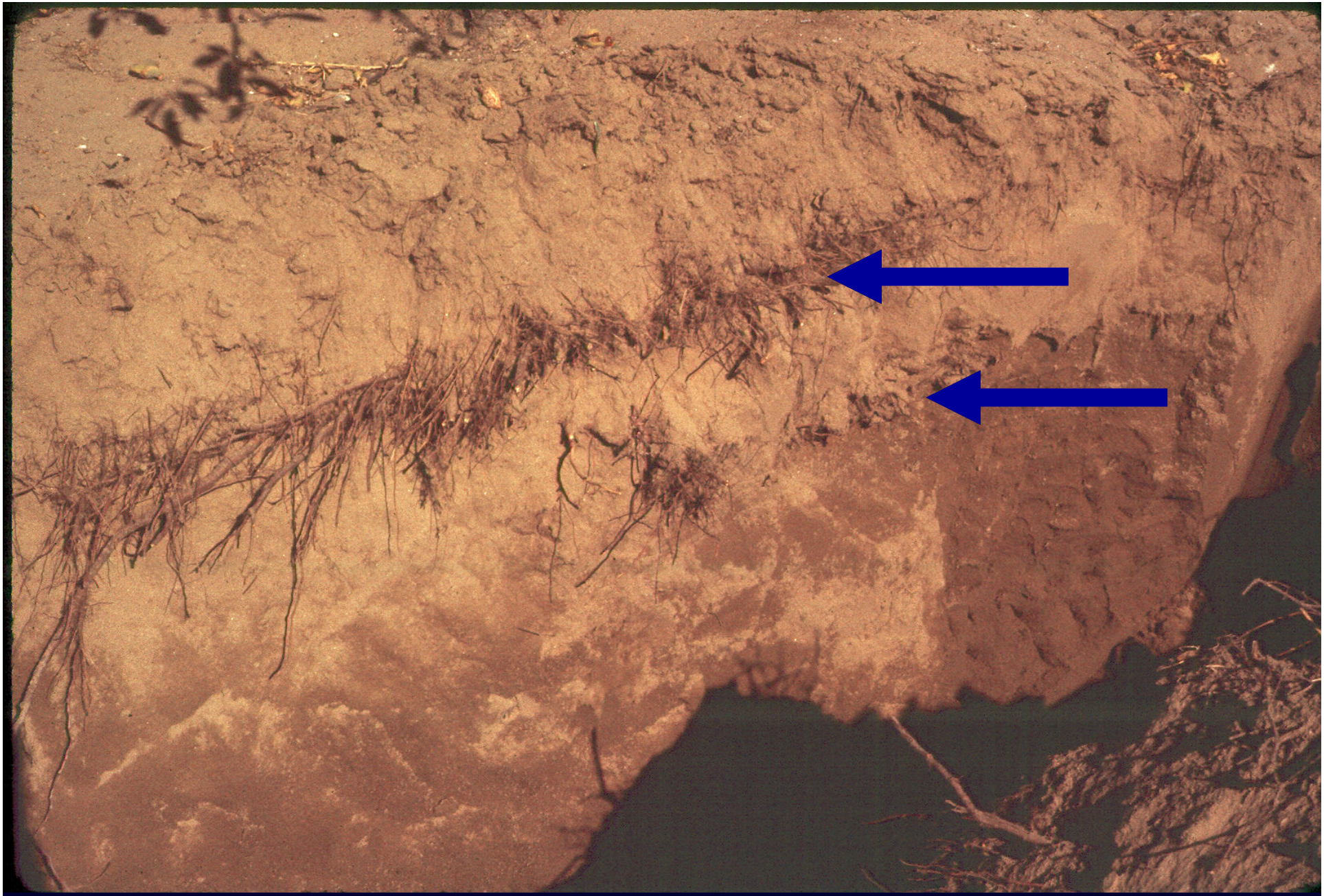
Evaluation of the Site

- **BACKHOE PITS allow evaluation of:**
  - Soil stratification, hardpan or clay layers
  - Water table
  - Rooting depth
  - Buried materials
  - Access for soil sampling

Backhoe Pits

- One pit per 20 acres?
- Make sure to evaluate hills, valleys, previous problem areas, areas of differing vegetation.
- Dig 8 feet deep
- Slope one side to allow access

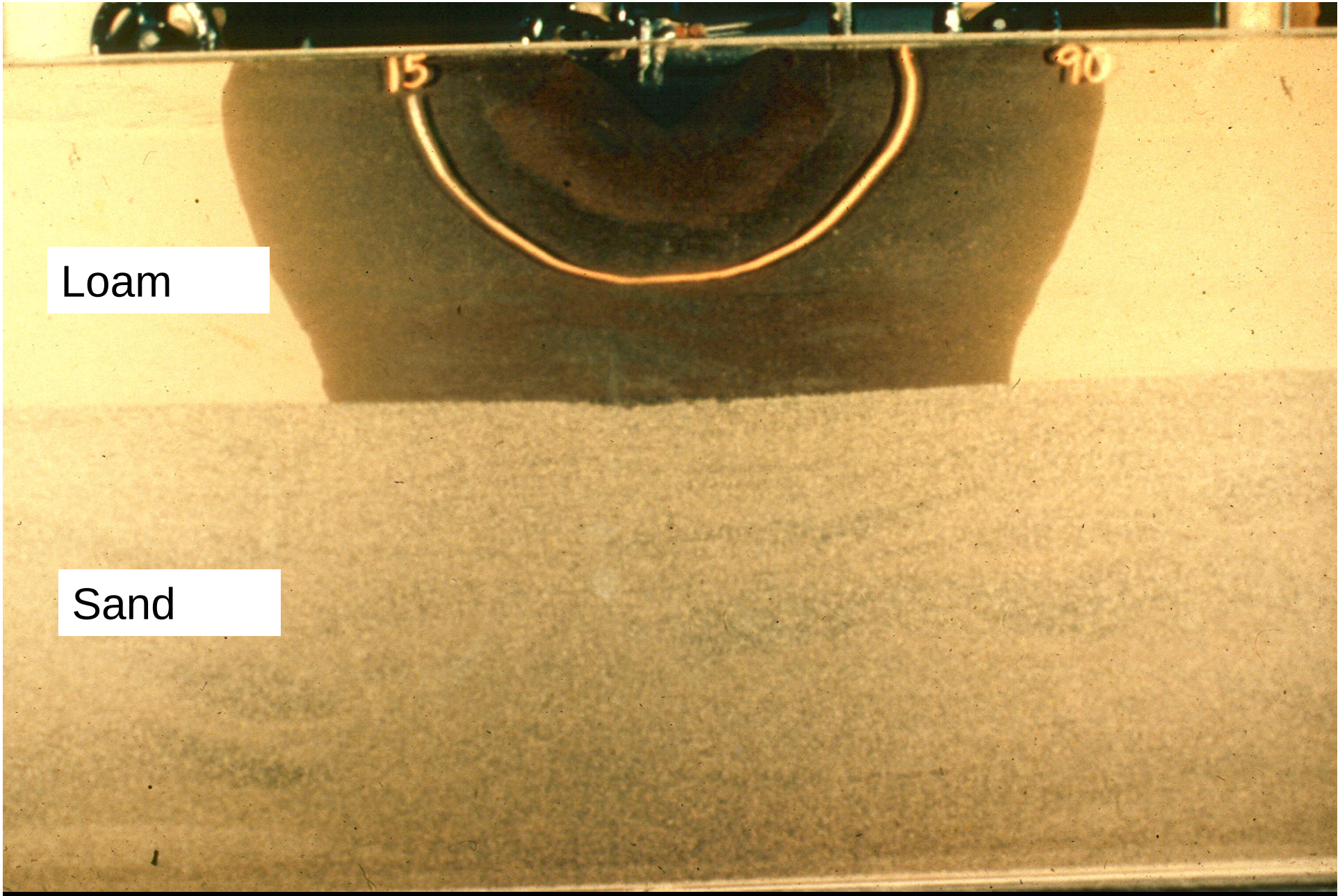
Backhoe pits give you the opportunity to sample soil incrementally through the soil profile



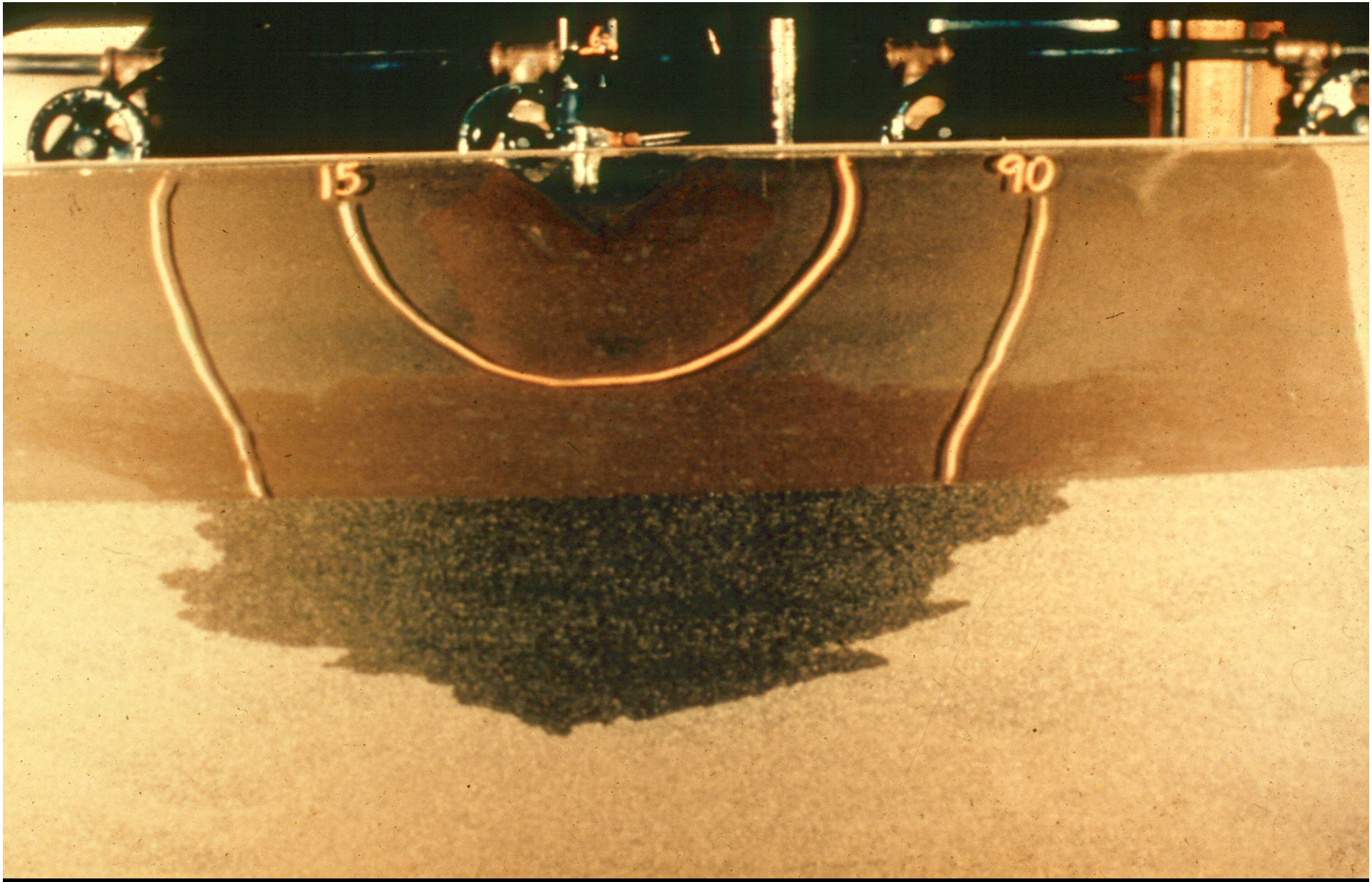
Soil layers restrict root development


Stratified sandy loam soil – restricts water movement through soil profile

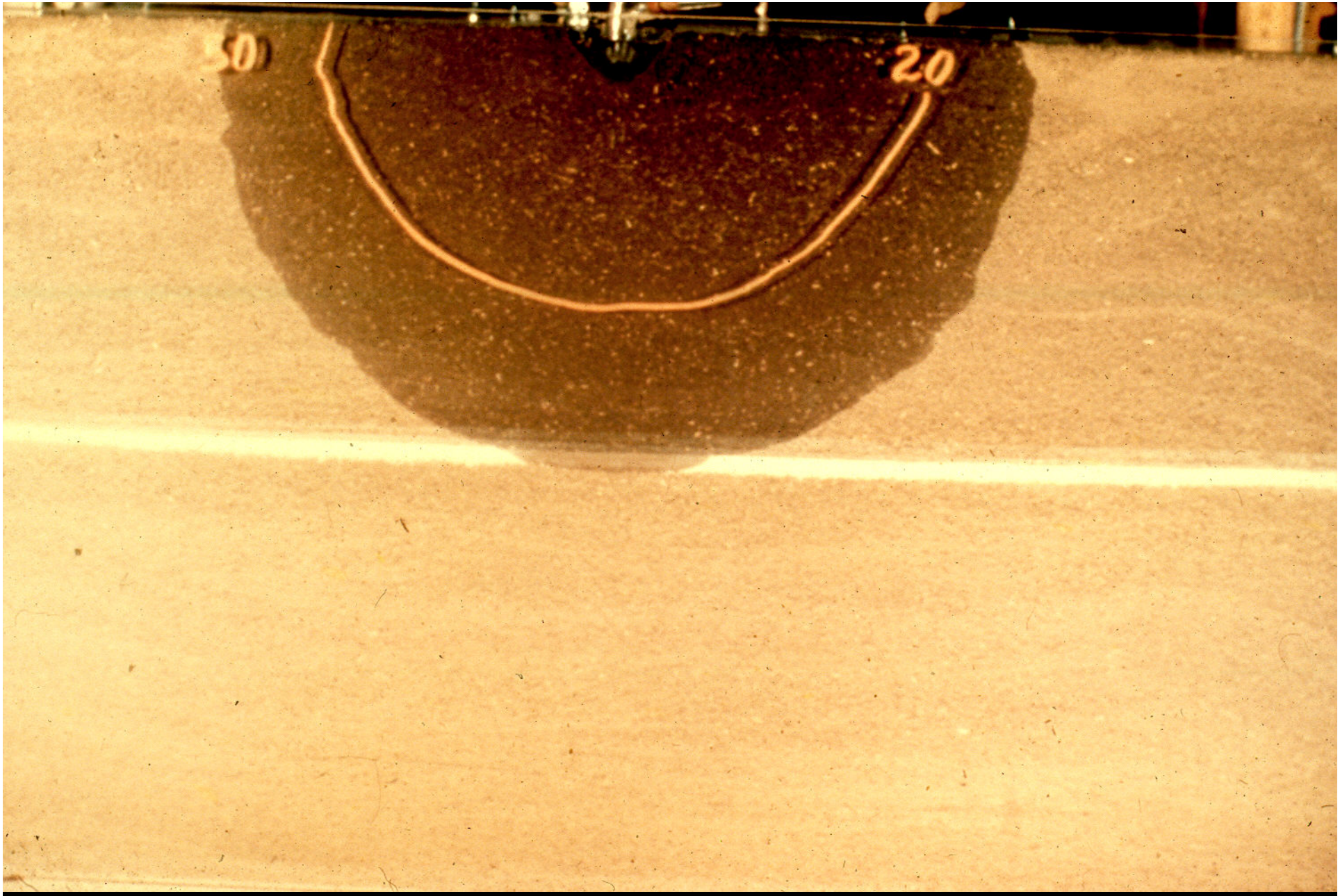
Loamy soil over coarse sand – 45 minute wetting



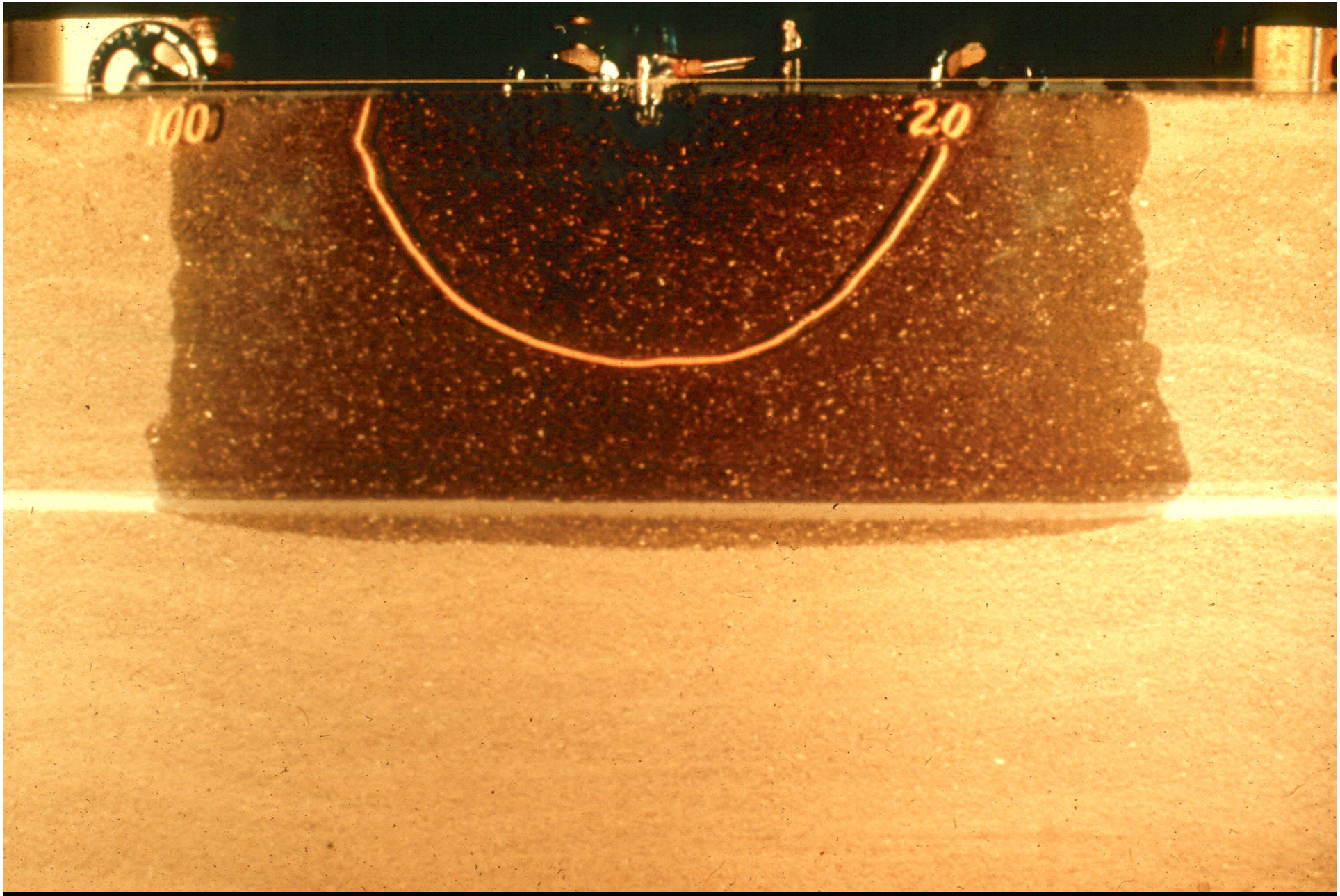
Loamy soil over coarse sand – 90 minute wetting



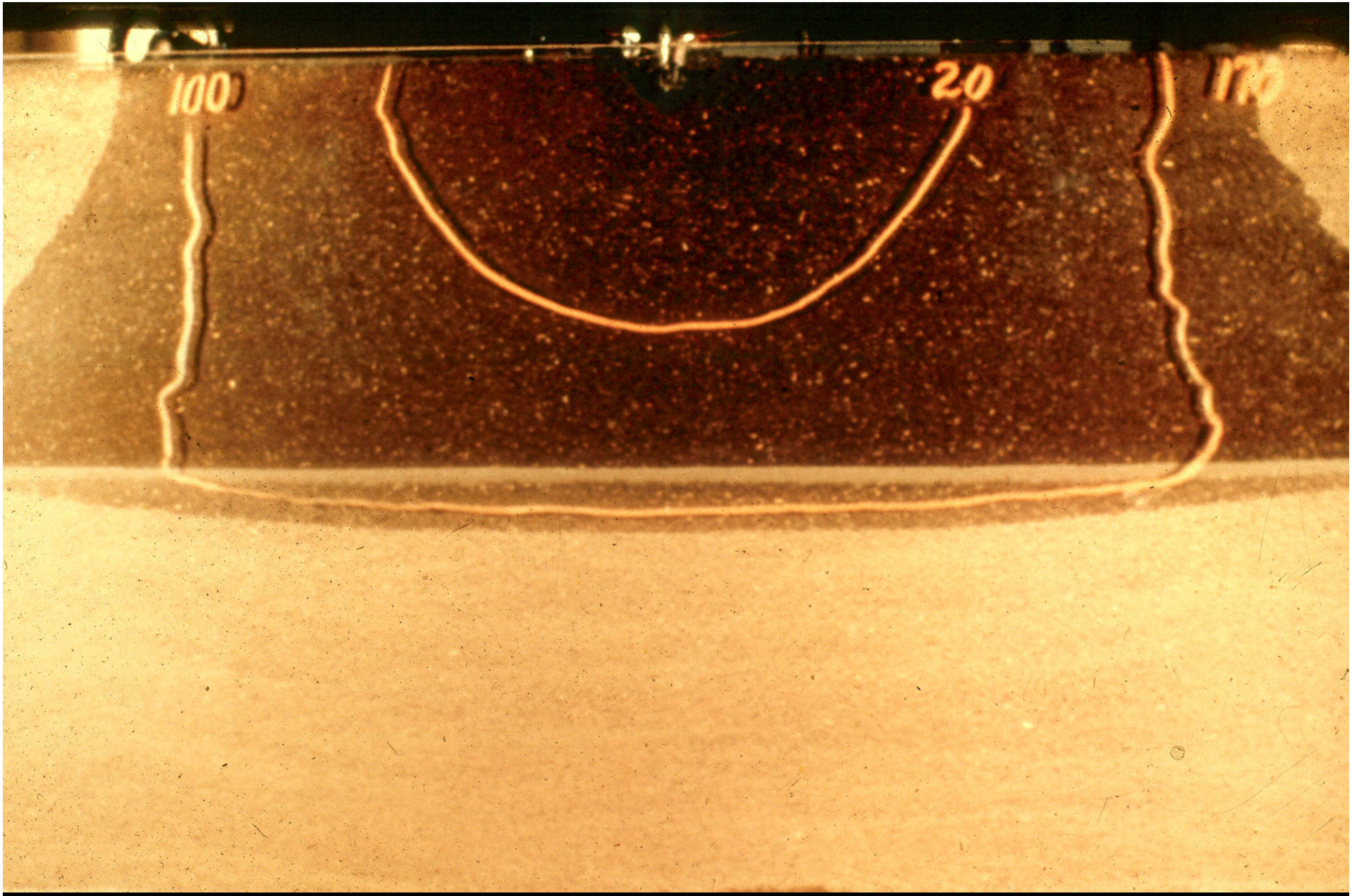
Loamy soil over coarse sand – water moves through only after upper layer saturated



Sandy loam soil with clay lens – 50 minutes



Sandy loam soil with clay lens – 100 minutes

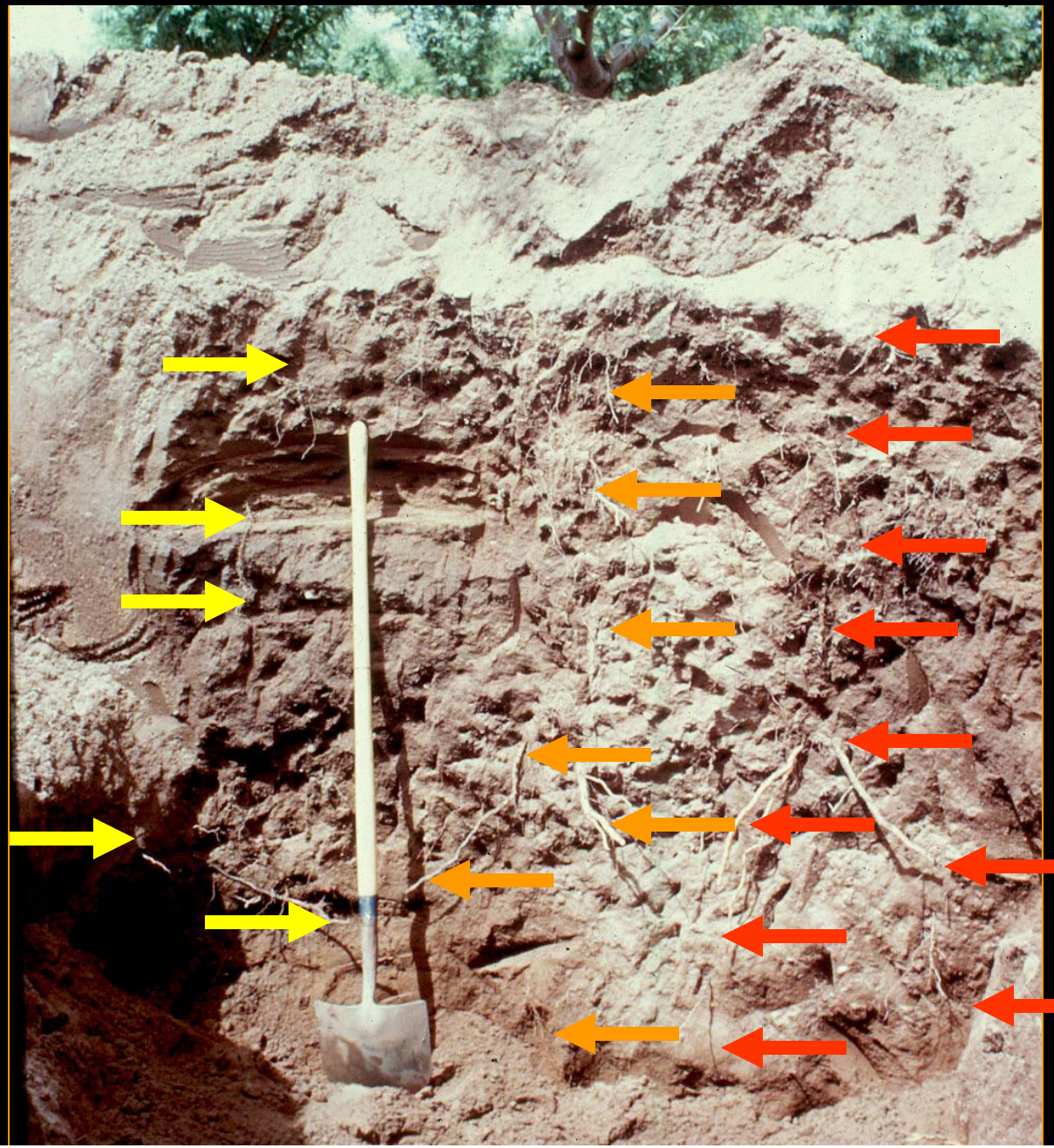


Sandy loam soil with clay lens – 170 minutes

Physical Soil Modification

- Backhoe or excavator
  - Used mostly in sand to loamy soils
  - Stratified soils
  - Excellent for mixing soil layers
  - Dig through all soil layers

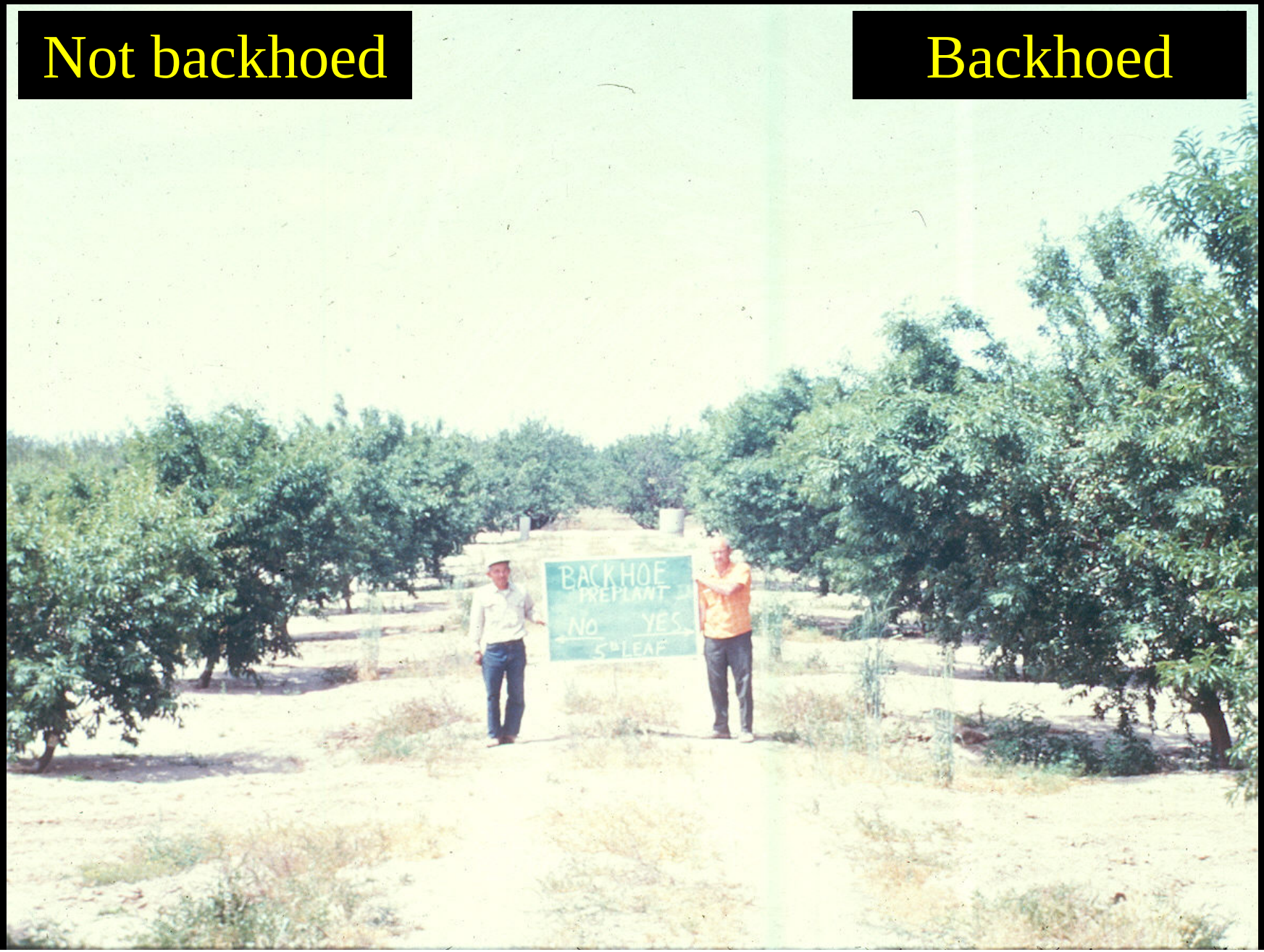
Backhoed trees have roots throughout profile



5th - leaf almonds

Not backhoed

Backhoed



Physical Soil Modification

- Slip plow
  - Used more in heavy, layered ground
  - Not as good as backhoe for mixing
  - Better than ripping

Deep ripping with 6’ shank

- Cheaper than backhoeing, especially in large acreage with thick hardpan
- Does not mix soil well
- Rule of thumb: shank should = 1.5 times depth of layer
- Need to rip two directions
- Must be done when soil is very dry

Addressing Chemical Soil Problems

Soil Sampling & Analysis

- Take samples at 2 or more depths
  - pH (6.5 – 7.0 is target)
  - salts (sodium, chloride, boron)
    - Physically altering the soil profile may allow for improved leaching
    - Add gypsum or sulfur to release sodium from soil
    - Choose alternate rootstock

Soil Sampling & Analysis

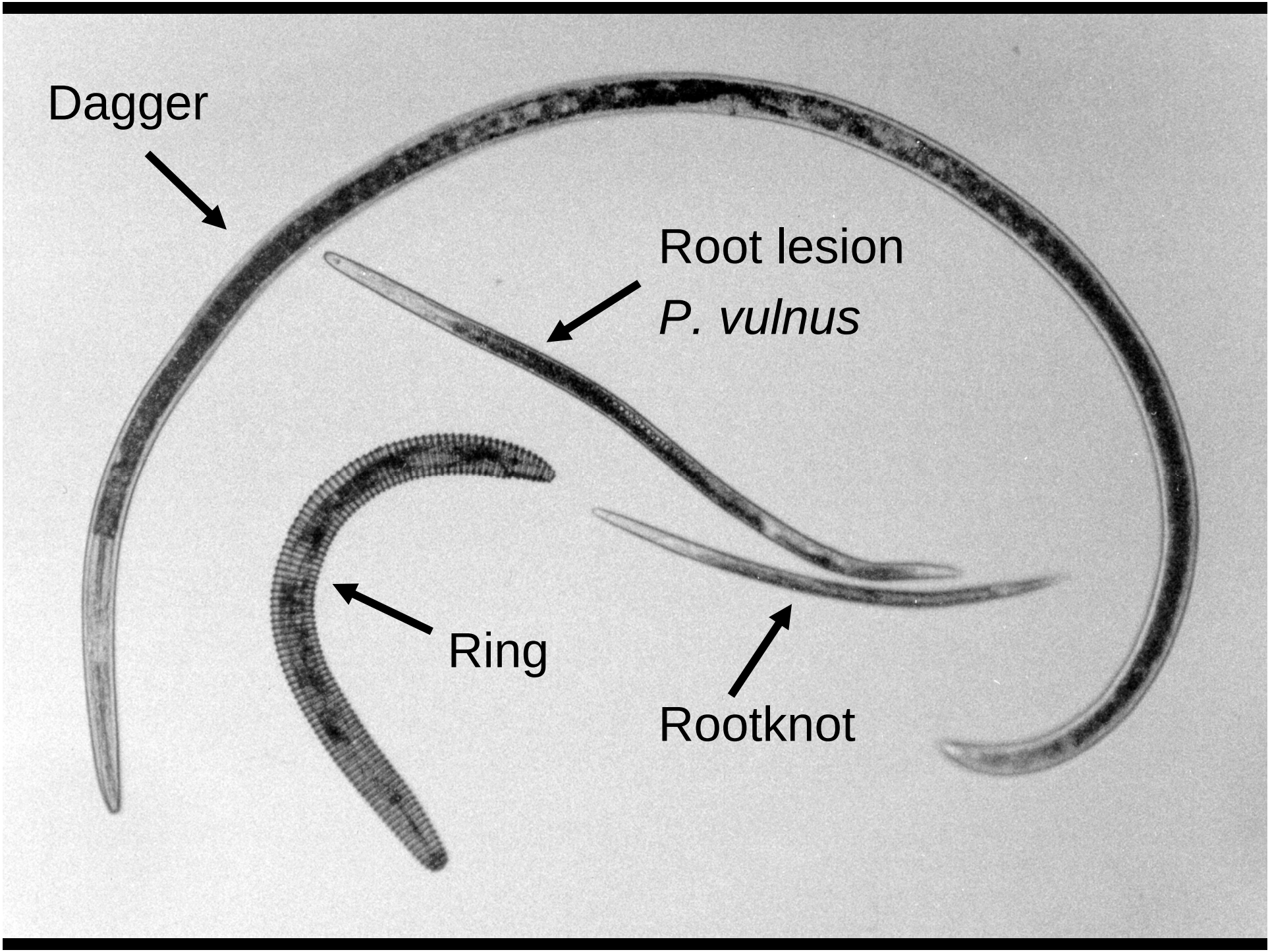
- Addressing Biological Soil Problems
  - Nematodes
  - Oak root fungus
  - Verticillium wilt
    - fumigate
    - choose appropriate rootstock

Dealing with Nematodes and ‘Replant Disease’

Replant problem occurs when a tree or vine is planted back in the same location as a previous tree or vine of same species.

The replant problem includes:

- Pathogenic nematodes
  - Ring
  - Root lesion
  - Root knot
- Pathogenic fungi and other microbes
- Nutrition
- ??


Dagger
Root lesion
P. vulnus
Ring
Rootknot

Bacterial Canker

- Highly correlated to ring nematode
- Sand / loamy sand
- Replanted orchards

How do we reduce the impact of the replant problem?

- Kill / remove old roots
  - Roundup or Garlon before tree removal
- Leave soil fallow for at least one year
- Dry down soil (Sudan grass, etc.)
- Fumigate
- Select proper rootstock

Fumigation

- Disinfests soil of nematodes and soil borne pathogens.
- Important when planting in previous almond, grape or stonefruit site.
- Soil tests, site history determine which fumigant to use.

Fumigants

- In general:
  - Fumigants are gasses at room temperature and standard pressure
  - Soils should be prepared so gas can penetrate deeply and evenly
    - soil deeply modified (ripped)
    - as dry as possible
  - Soil should not be moved after fumigation
    - fumigation is the last step before planting

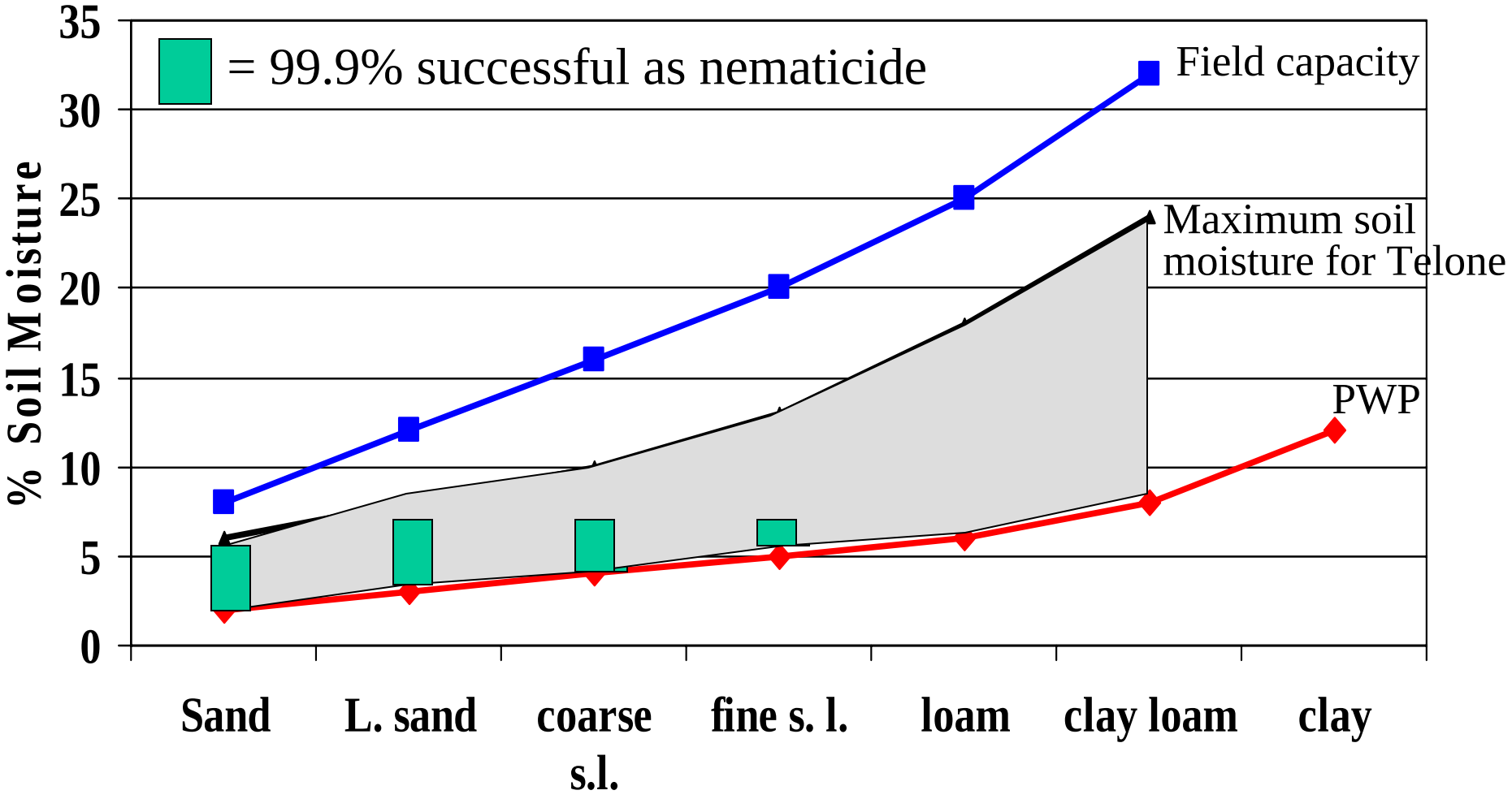
Fumigants

- **Methyl bromide**
  - Nothing better for nematode and disease control
  - Extensive regulatory limitations
  - Was to be phased out by January 1, 2005
  - Exemption for for orchard replacement*****
  - Limit almond use to oak root fungus sites?

Fumigants

- **Telone II**
  - Very good nematicide
  - Weaker on “disease” portion of replant problem
  - Not effective in heavy soils
  - Less effective in moist and / or cold soils than MB
  - Should not be used past November 30?
  - Township caps
  - $550 / treated acre for shanked application

Soil Moisture Conditions Suitable for Telone II Shank Application



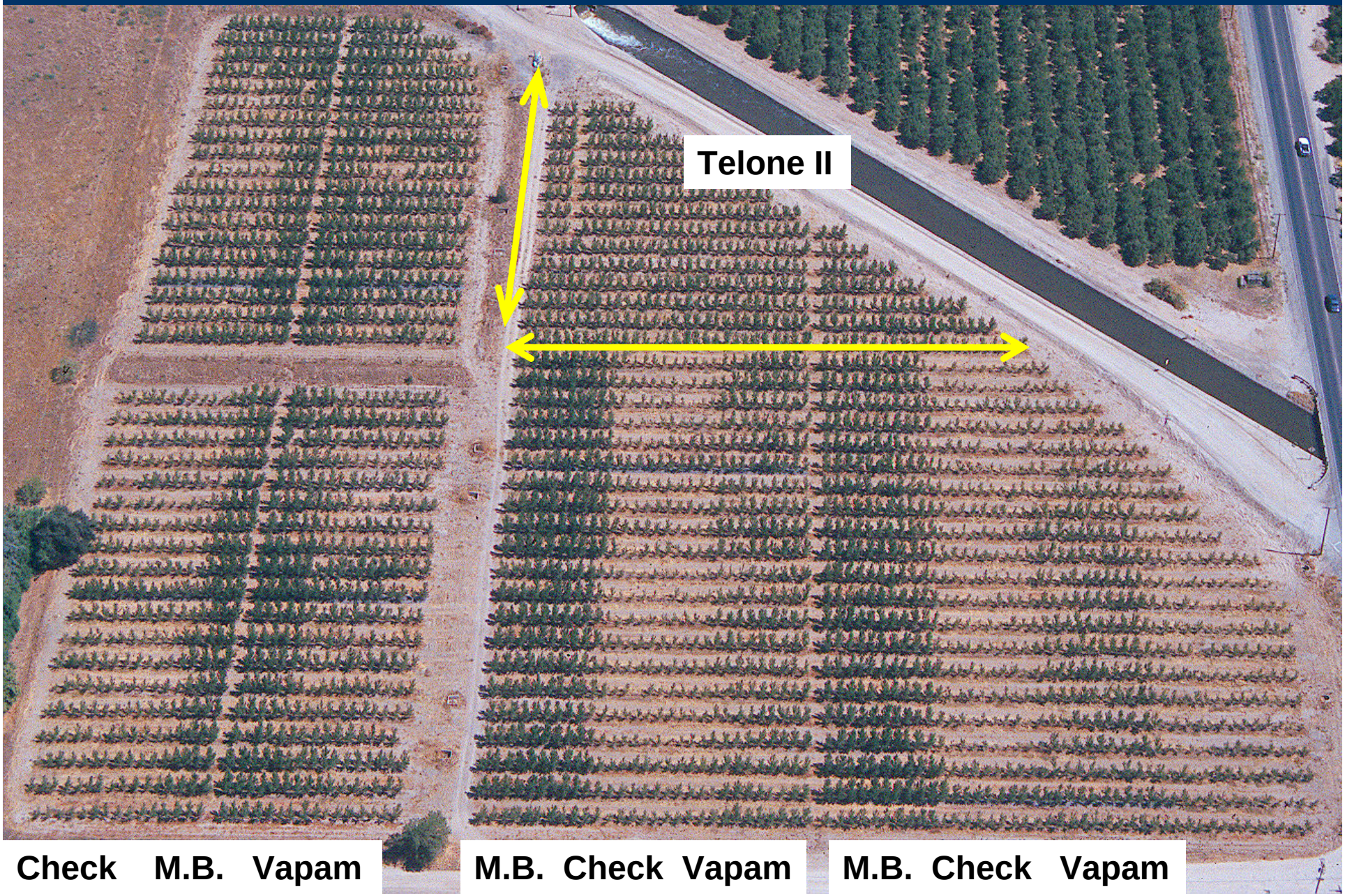
Fumigants

- **Chloropicrin**
  - Weak nematicide
  - Excellent on “disease” portion of replant problem
  - Sometimes used alone in Sac Valley with no nematodes
  - I think it may have a lot of promise for S. J. Valley
  - Should not be used after mid-November

Fumigants

- Telone and chloropicrin can be used in combination
  - Telone C-17
  - Telone C-35
  - Cheaper if applied separately

Peach Replant Trial, Stanislaus County. Sept. 20, 2002
Second leaf 'Loadel' on Lovell Rootstock

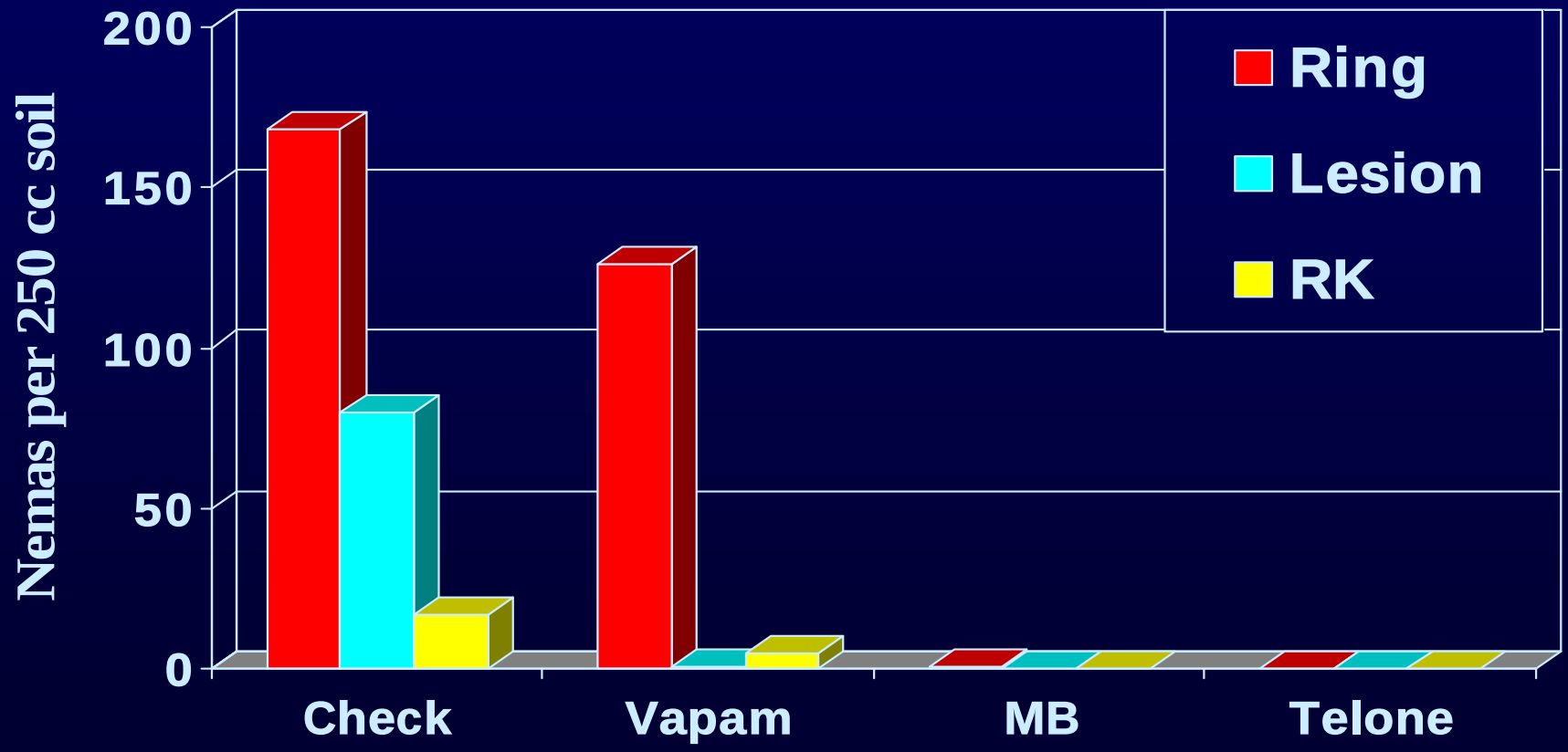


Preplant Fumigant Effects on Native, Pathogenic Nematodes

	Nematodes per Liter of Soil at Time of Planting					
	Unfumed		MB		Vapam	
Soil Depth	Ring	Root Lesion	Ring	Root Lesion	Ring	Root Lesion
1’	13	62	15	0	3	0
2’	165	384	0	0	87	35
3’	698	596	1	0	79	27
4’	913	1041	1	0	11	11
5’	828	588	4	0	0	0
Mean	523 a	534 a	4 b	0 b	36 b	15 b

Pathogenic Nematodes in the Rootzone
One Year After Soil Fumigation

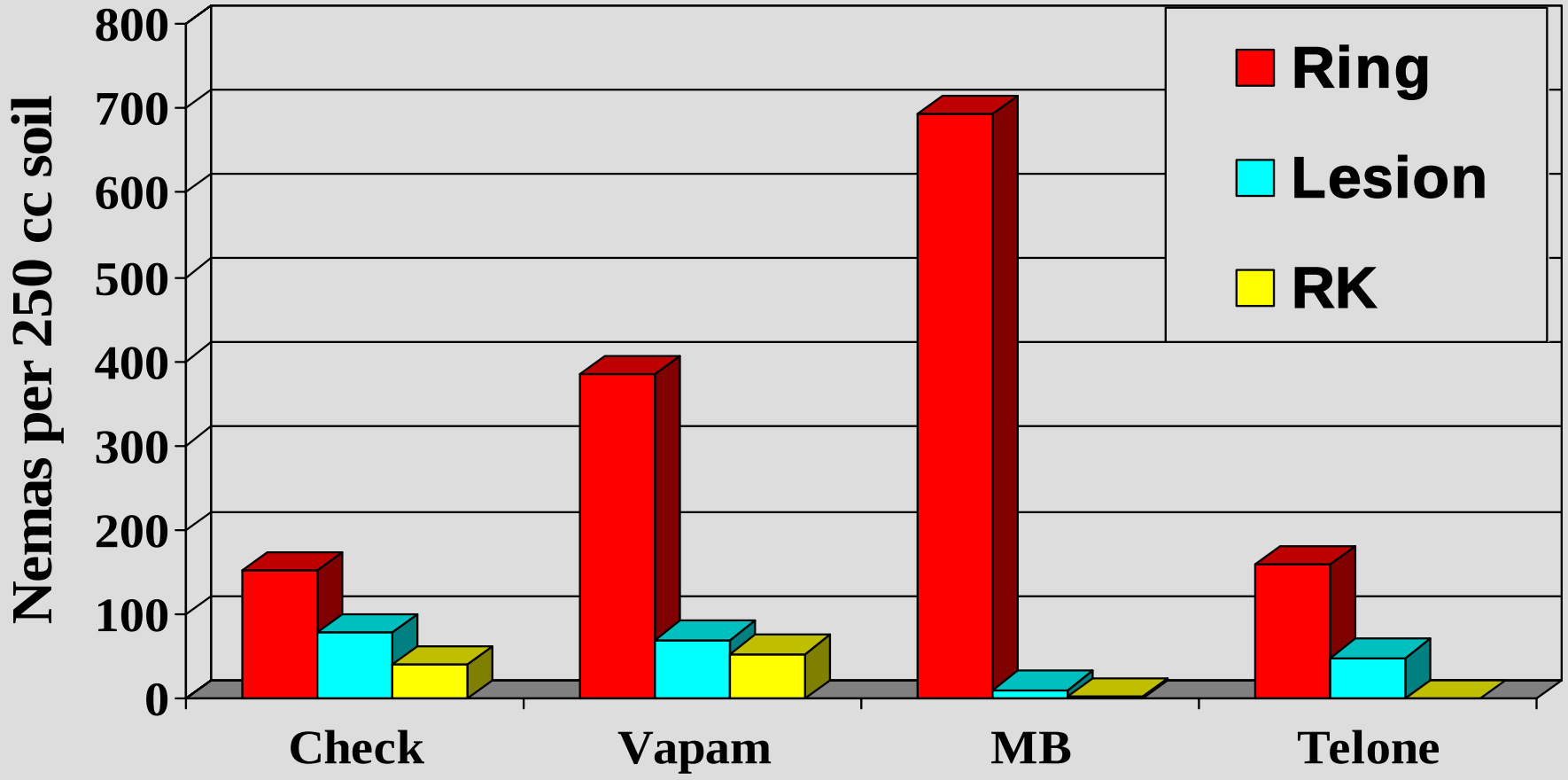
Samples taken October, 2001 at 0-18”



***All nematodes in Vapam treatment found in Rep 3 only.**

Pathogenic Nematodes in the Rootzone Three Years After Soil Fumigation

Samples taken October, 2003 at 0-18”



Effect of Fumigation on Early Yield and Revenue - Peaches

Fumigation Treatment	Cumulative Yield (thru 6th leaf)	Cumulative Revenue	Increase in Revenue per acre
Methyl Bromide	45.1	$12,877	$5,597
Telone II	38.9	$11,216	$3,936
Vapam	37.7	$10,852	$3,572
Unfumigated	25.2	$7,280	--

Choosing the Appropriate Rootstock

Nemaguard

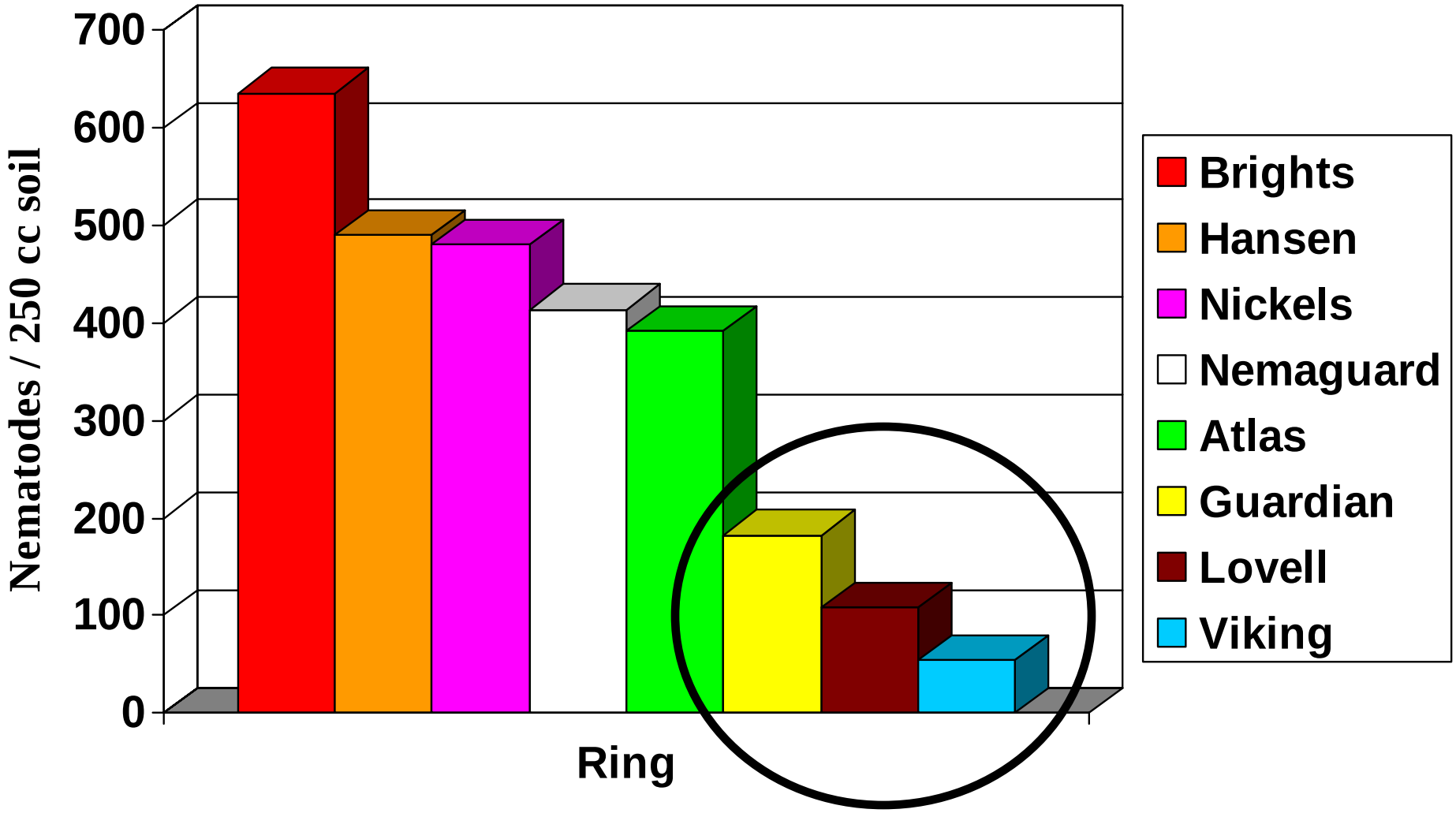
- Advantages
  - "Immune" to rootknot nematode
  - Vigorous rootstock
  - Compatible with all almond varieties
  - Performs well in sandy loam & loam soils
  - "Decent" anchorage

Nemaguard

- Disadvantages
  - *Susceptible to:*
    - Ring & root lesion nematodes
    - Bacterial canker
    - Phytophthora
    - Oak root fungus
    - Crown gall
    - High soil pH / high lime
    - Salt (sodium, chloride, boron)
    - “Heart” rot / wood decay fungi

Soil Numbers of Ring Nematodes as Influenced by Almond Rootstock

Escalon, CA. January, 2005



Salinity Tolerance of P/A Hybrid Rootstocks Compared to Nemaguard & Lovell

Atwater rootstock trial, 2006

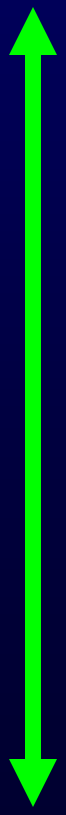
	Na (%)	*Cl (%)*
Nemaguard	**0.64**	**0.22**
Lovell	**0.72**	**0.26**
Hansen	**0.17**	**0.09**
Brights	**0.20**	**0.07**
Critical value	**>0.25%**	**> 0.3%**

Effect of Rootstock on Almond Nutrition

	N	K	B	Ca	Cl	Mg
Nemagrd	2.30	2.76	47	3.84	0.09	64
Lovell	2.28	2.92	47	3.56	0.08	69
Guardian	2.32	2.57	47	3.73	0.08	57
Atlas	2.27	2.70	49	4.23	0.04	77
Viking	2.26	2.99	45	4.11	0.04	94
Nickels	2.13	2.27	42	4.78	0.03	102
Brights	2.09	2.40	42	4.44	0.03	102
Hansen	2.08	2.00	40	5.03	0.03	132

Rootstock Vigor

- Peach / Almond hybrids (Hansen, Bright's, Nickels, Titan, etc.)
- Peach (Nemaguard, Lovell)
- Interspecifics (Viking, Atlas)
- Plum (Marianna 26-24)

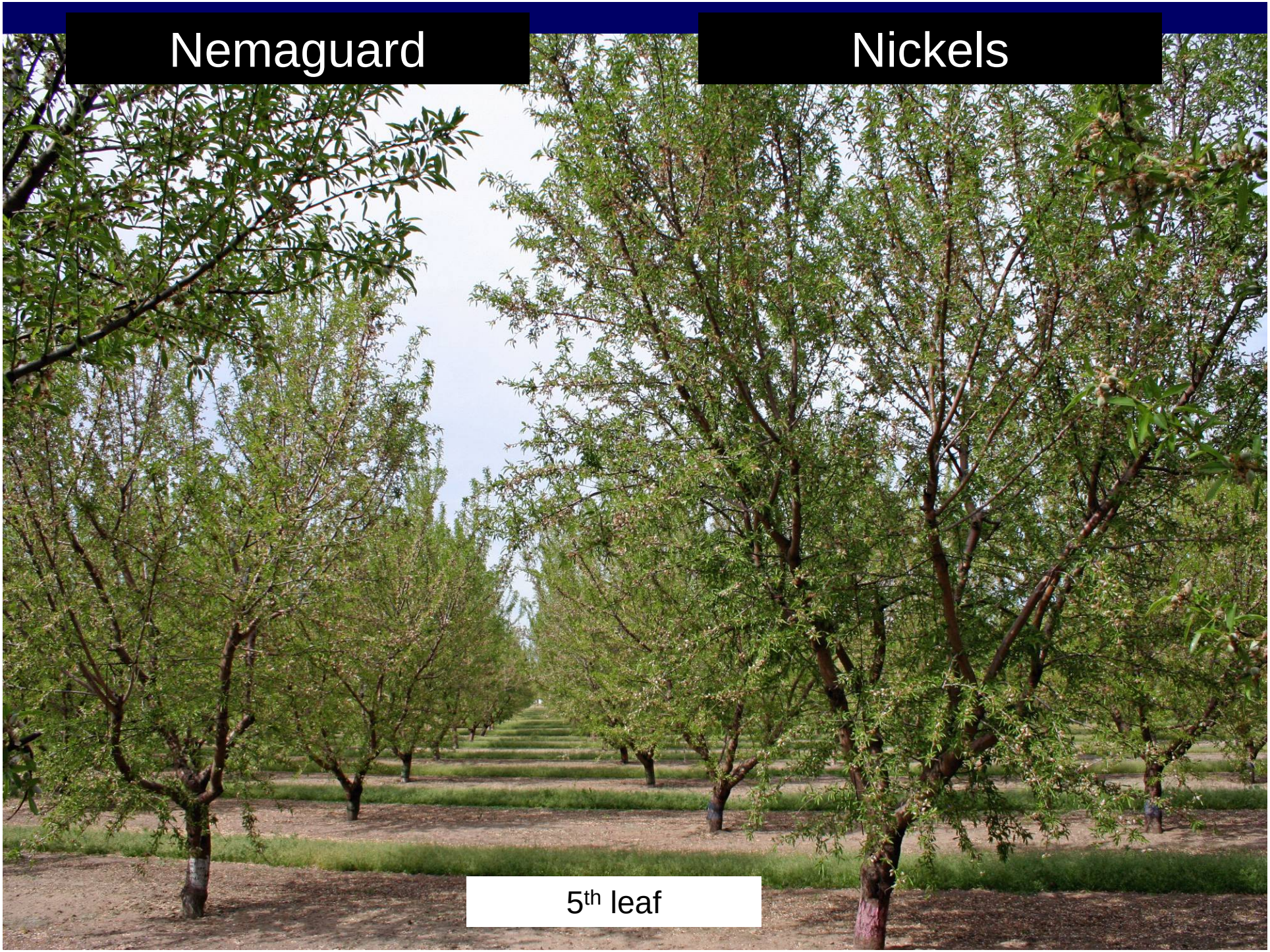


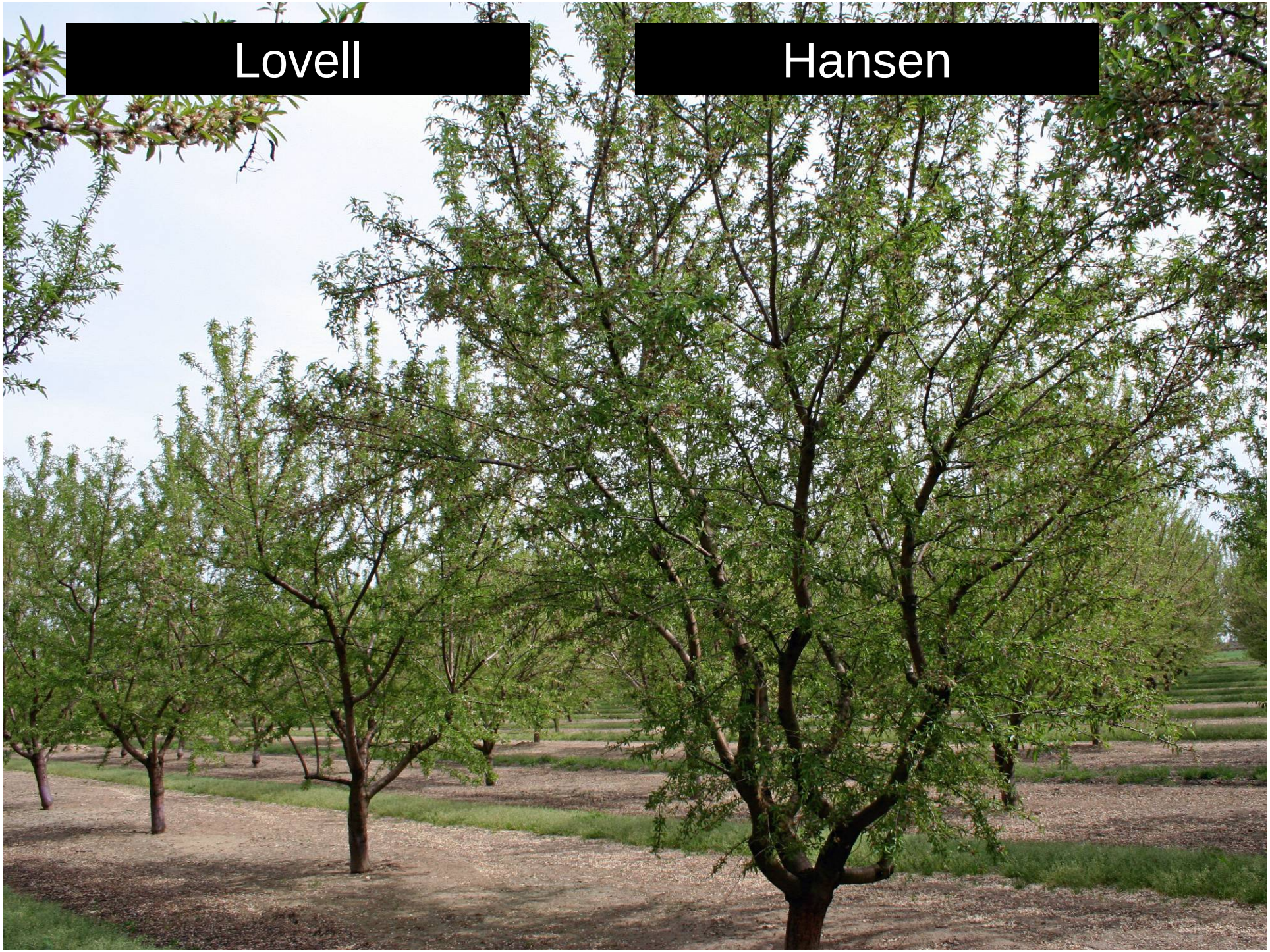
Most Vigorous

(wide spacing)

Least Vigorous

(close spacing)


Nemaguard
Nickels
5th leaf


Lovell
Hansen

Thoughts on Almond Rootstocks

- Peach / almond hybrids
  - Includes Hansen, Bright's, Nickels
  - better than peach in soils with high pH, B, Na or Cl
  - may take in less N, K & B; more Ca & Mg
  - highly susceptible to bacterial canker
  - high vigor: good for Carmel, Wood Colony, etc.
  - Too much vigor for Nonpareil, Padre, etc.?

Thoughts on Almond Rootstocks

- Interspecific Hybrids
  - includes Atlas & Viking
  - better than peach in soils with high pH or chloride
  - may offer some of same benefits as P/A hybrids without susceptibility to bacterial canker or Phytophthora
  - Not more vigor than Nemaguard

Specific Challenges…

- Bacterial canker
  - Lovell (not if rootknot is an issue)
  - Viking
  - Guardian SC-17??

Specific Challenges…

- Alkaline / salty soil or water
  - P/A hybrid (not if heavy soil or ring nemas)
  - Atlas (not if ring nemas)
  - Viking
  - Empyrean 1 or Cadaman??

Specific Challenges…

- Oak root fungus
  - Marianna 26-24 (must use inter-stem with Nonpareil or Butte)
  - Marianna 40?
  - Ishtara? – Appears to be more vigorous than 26-24 with little suckering
  - ~~Hiawatha ? Penta? Tetra? Empyrean 101?~~

ORCHARD DESIGN

- Variety Selection
- Variety arrangement
- Tree spacing
- Planting patterns

Parting thoughts...

- Not fumigating when replanting an orchard is very risky
- Preplant soil modification & fumigating is a much better investment than magic sprays or biological additives.
- Although proper preplant preparation can be expensive, it is cheaper in the long run than doing a lousy job.

Thank You

for Your Attention