

Soil problems and their management



Constraints:

- **Chemical**
- **Biological**
- **Physical**

Strawberry Replant Disorder

Root Symptoms

- **Patchy-complete blackening of main/perennial roots**
- **Deterioration of perennial & feeder roots**
- **Smaller root systems**



Strawberry Replant Disorder

Field Symptoms

- **Above ground structure stunted, reddened & collapsed**
- **Wilting of leaves**
- **Lack of runnering**
- **Decline of vigor & productivity**

Replant Disorder

Biotic Components

Black Root Rot

- *Pratylenchus penetrans*



- *Rhizoctonia* spp



- *Pythium* spp.



Other associated organisms

- *Verticillium albo-atrum*
- *Fusarium* spp.
- *Cylindrocarpon* spp.
- *Phytophthora* spp.
- *Idriella lunata*
- Others

Farm survey: What factors are associated with poor strawberry root health?

Sampled 104 variables on each of two sites at 27 farms across the state

Variables most strongly associated with poor root health were:

- Cumulative years in strawberry production
- Age of the planting
- Soil compaction
- Use of terbacil herbicide
- Use of metalaxyl fungicide
- Fumigation

(Wing, Pritts and Wilcox, 1995, HortScience 30:86-90)

Strawberry Replant Disorder

Control Methods

- Virgin soil
- Resistant varieties
- Root dips
- Soil preparation
 - Fumigation
 - Compost and organic amendments
 - Nutrient amendments
 - Raised beds
 - Solarization
 - Cover crops



Field being fumigated with Methyl Bromide

Materials & Methods

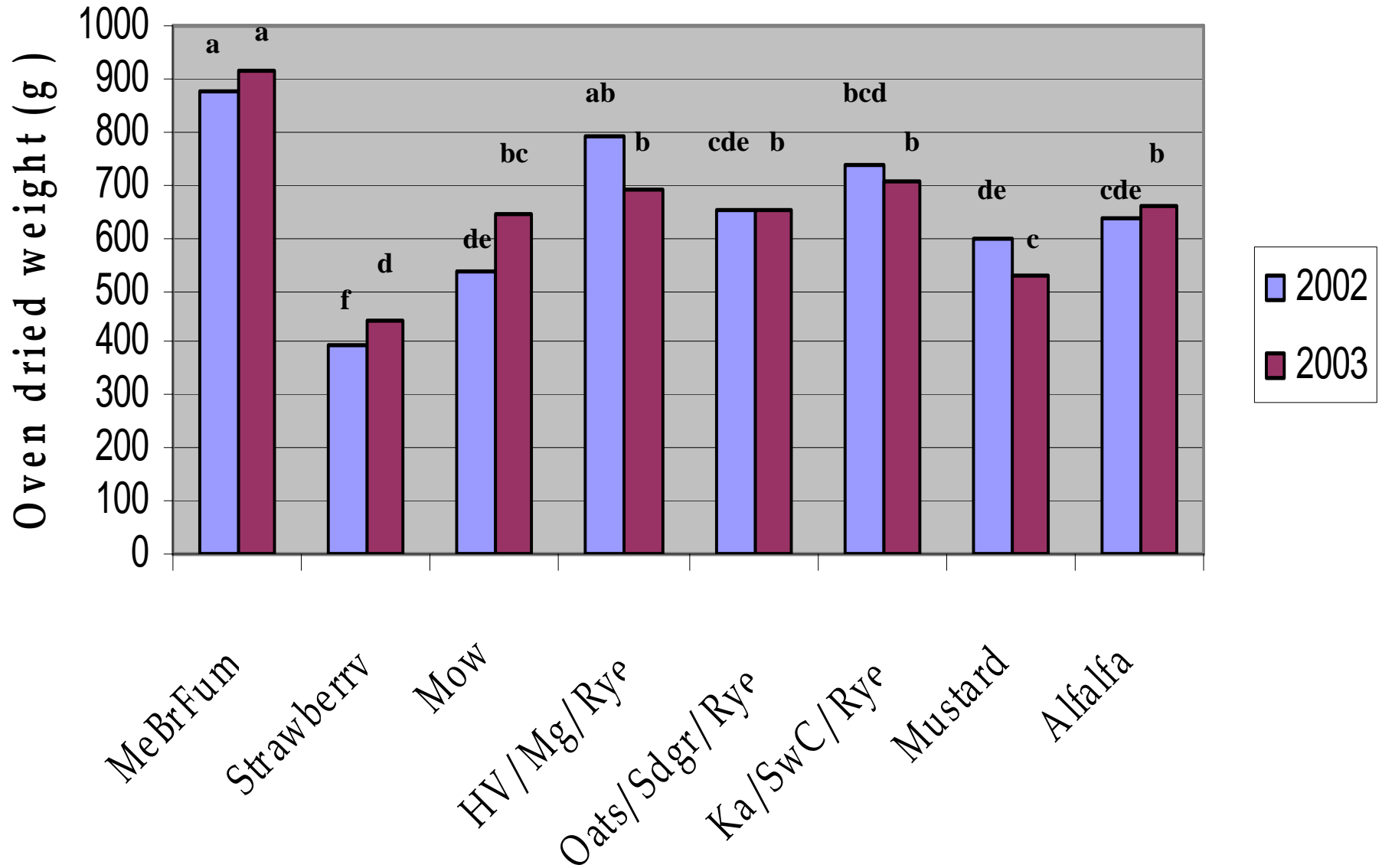
Field Study

- Experimental Design
 - RCBD
 - Eight Treatments (following 7 years in strawberry):
 - Continuous Strawberry (2 more years)
 - Mowed Weedy Fallow
 - Fumigation (MeBr)
 - Alfalfa (perennial)
 - Mustard (3 crops)
 - Kale → Sweet Corn → Rye
 - Hairy Vetch → Marigold → Rye
 - Oats → Sudangrass → Rye
 - Four Replicate Blocks
 - Rotations August 1999 → April 2001

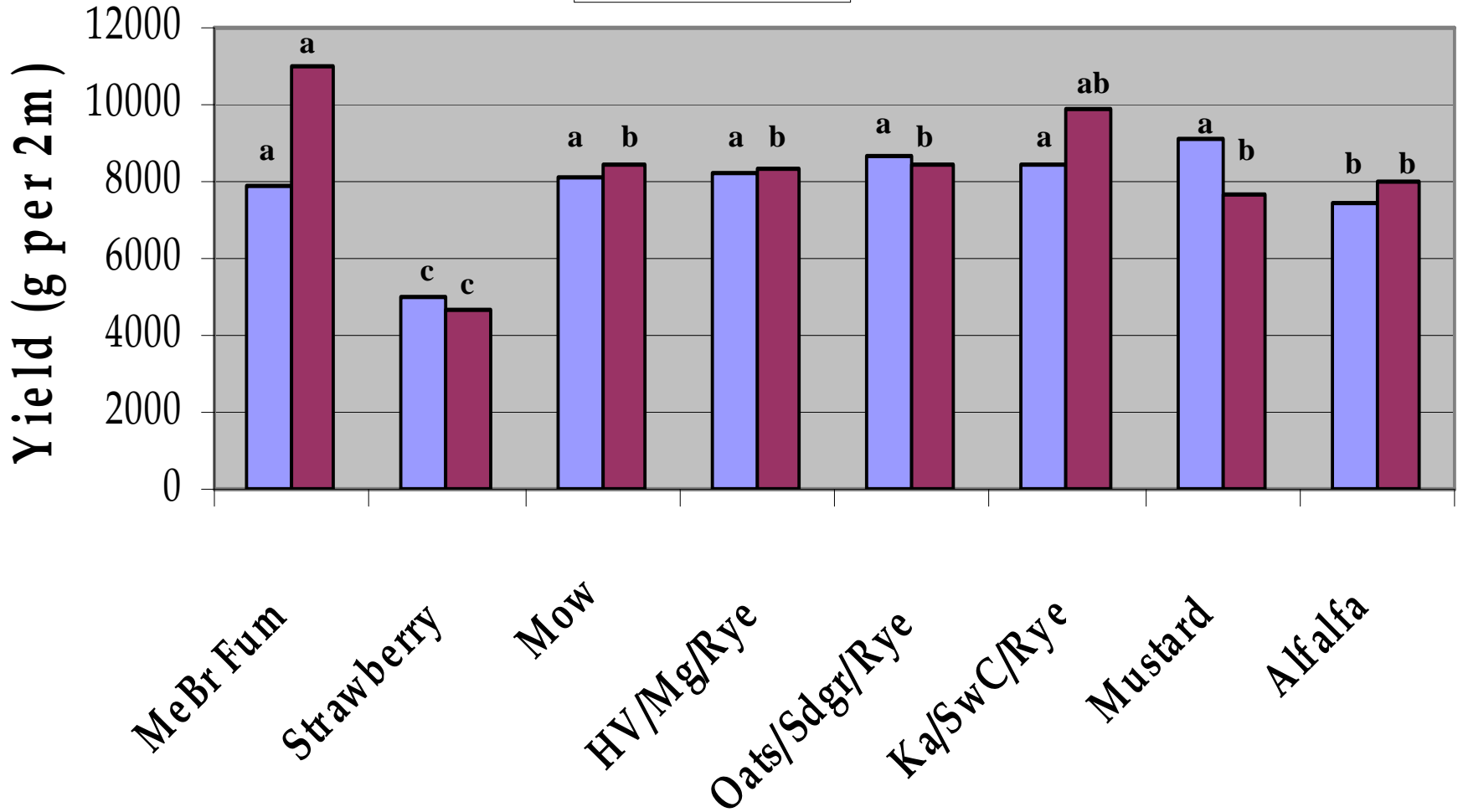
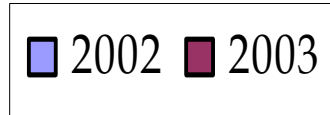




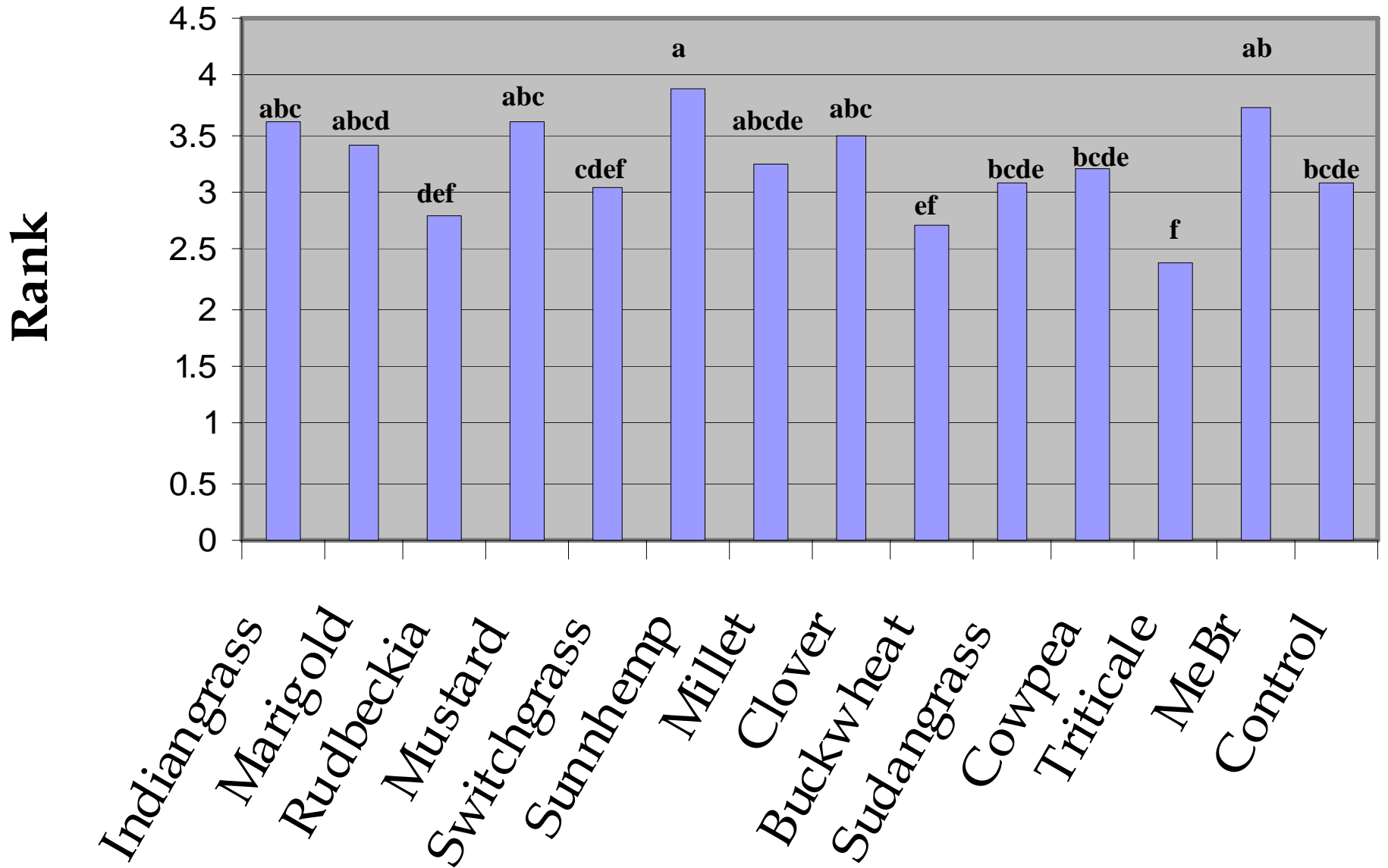
Foliar Biomass



Fruit Yield 2002 & 2003



Root Vigor Ranking



Trends

1. Continuous strawberry increases replant disorders
2. Mixed rotations and certain preplant cover crops have
 - significantly reduced fungal CFUs & weediness
 - similar effect as MeBr on increasing yield & biomass

USDA-funded project: Alternatives to methyl bromide for alleviating replant problems

- Cover crops
- Composts
- Fumigation



USDA-funded project: An integrated approach

- Six farms (New York, Maryland, Michigan)
- Factorial experiment
 - Cultivar (Allstar and Cavendish)
 - +/- fumigation
 - +/- compost amendment
 - +/- fungicidal preplant root dip













12 9'03

Control – No amendments or preplant treatment



Fumigation



Compost: No other amendments



Cover crop – No fumigation



Observations:

- Cover-cropping and compost amendments can match the performance of fumigation in many situations

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Does compaction affect root health directly or indirectly (e.g. through pathogens that develop under poorer drainage)?



Questions:

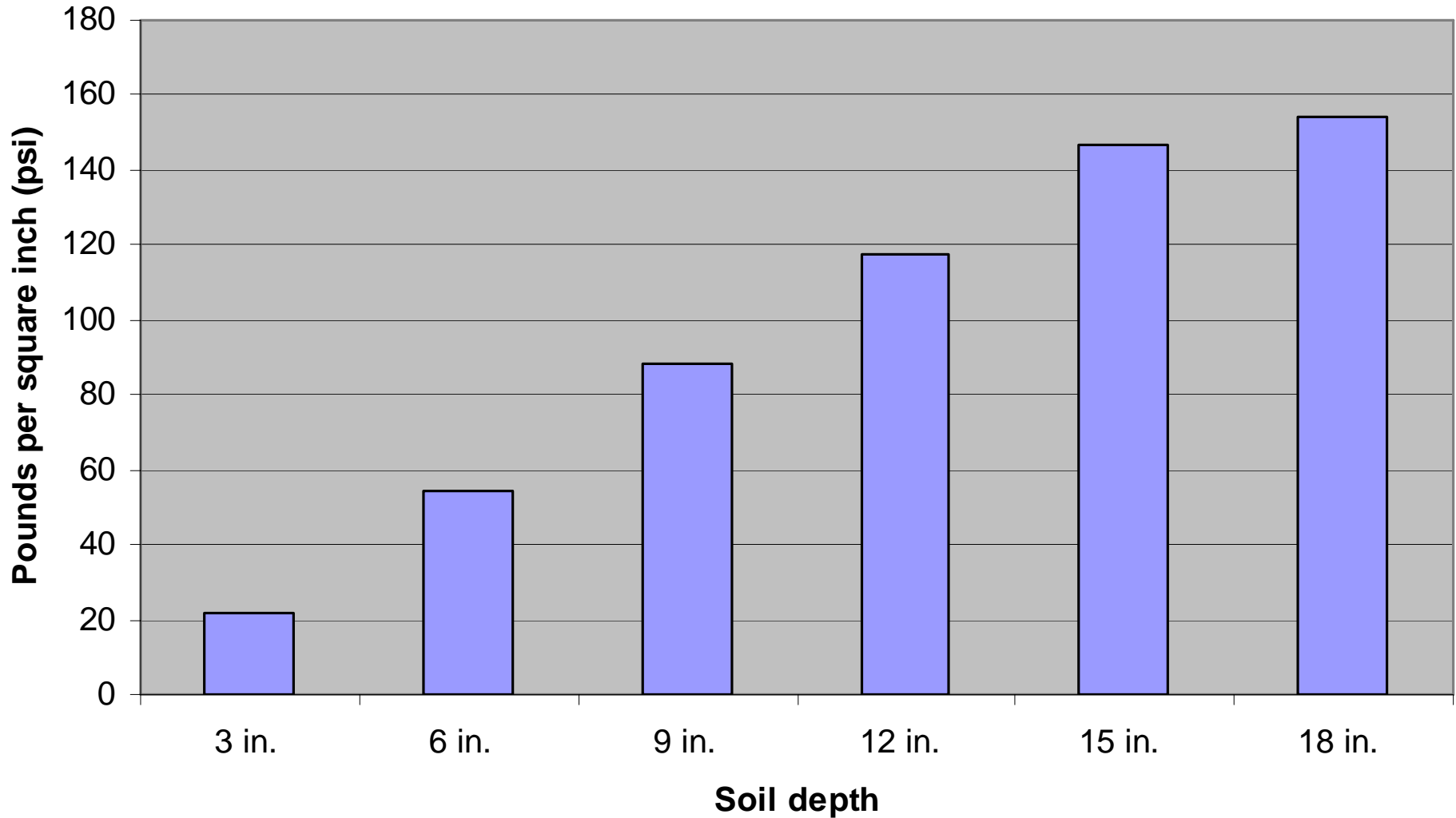
- How compacted are typical strawberry soils?
- What happens to soil compaction over time in a strawberry field?
- How tolerant are strawberry plants to compaction?
- Are strawberry plants more susceptible to pathogens when soils are compacted?

Question #1: How compacted are typical strawberry soils?

Survey of 10 sites on 17 farms in 2006

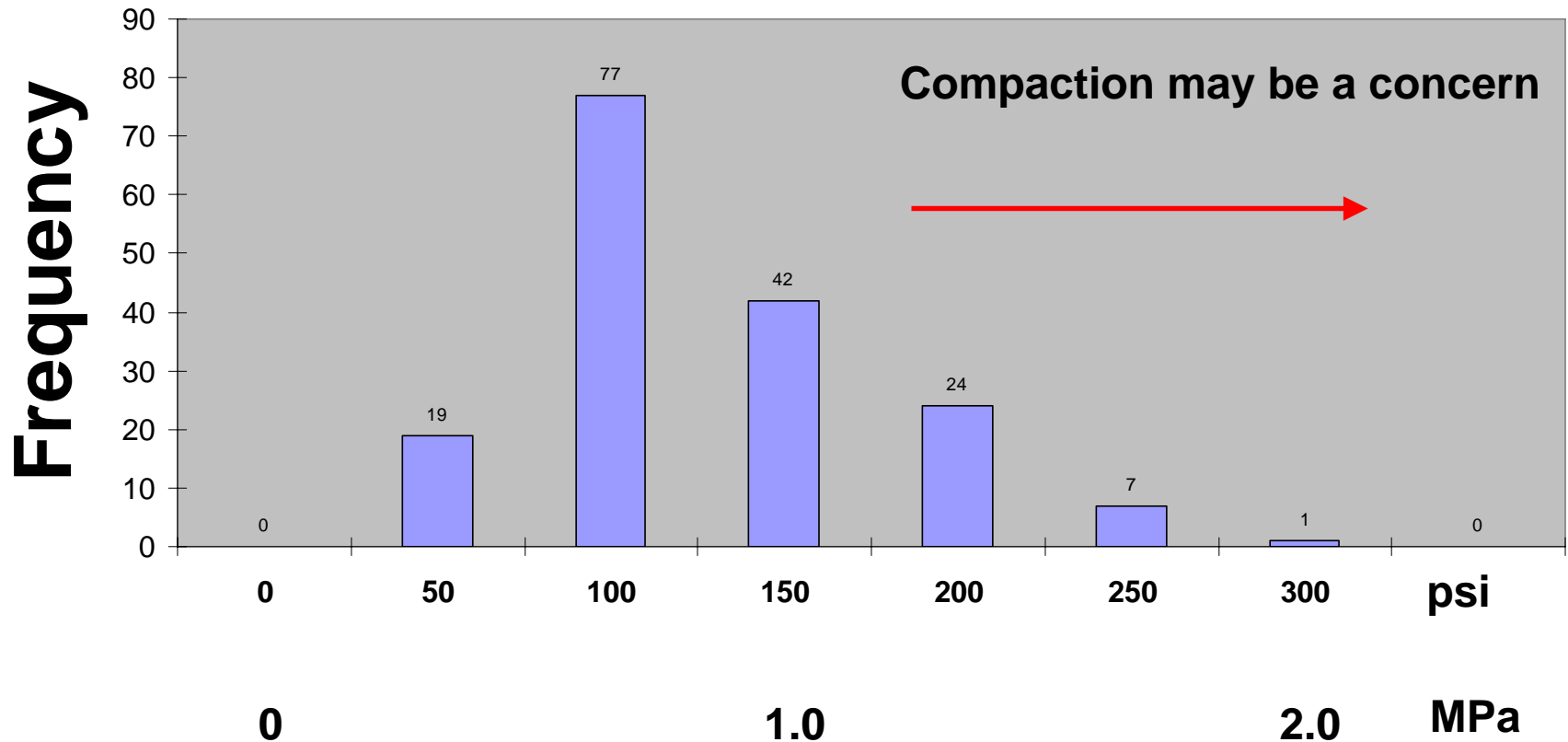
(0 – 1.24 MPa)

Soil Compaction vs Soil Depth, Average All Fields



Distribution of compaction readings at 10 sites in 17 commercial fields

Histogram- All Fields, 12" depth



- The majority of strawberry fields we examined did not appear to have serious compaction problems

but

Question #2: What happens to strawberry fields over time?

- One strawberry farm
 - One $\frac{1}{4}$ acre field planted each year for the past 7 years
 - No tractors, just PYO traffic and walk-behind tillers
 - Ten penetrometer readings at six depths in each field
-
- There was no trend towards increasing compaction with time when heavy equipment is not used

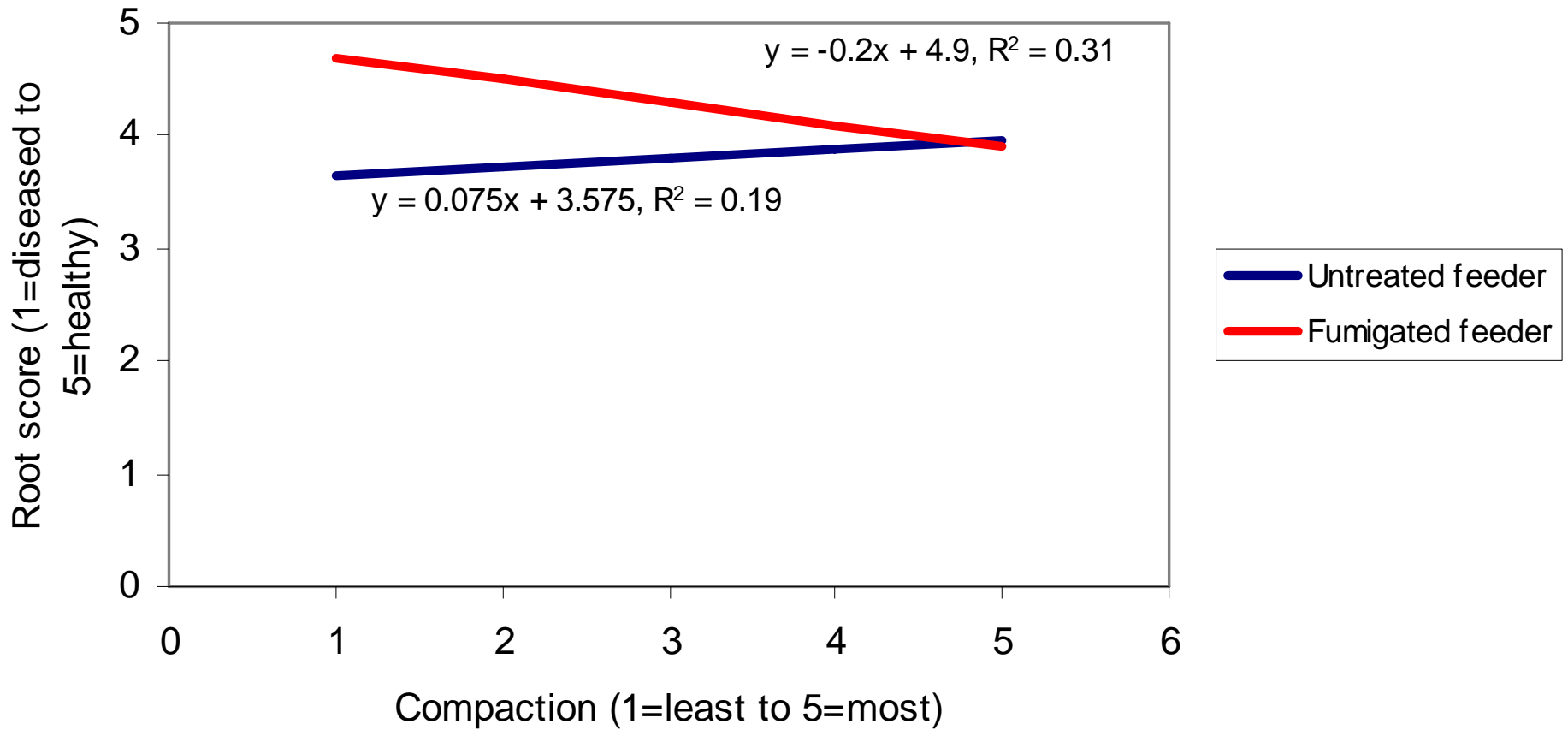


Question #3: Does soil compaction interact with soil pathogens to compromise root systems?

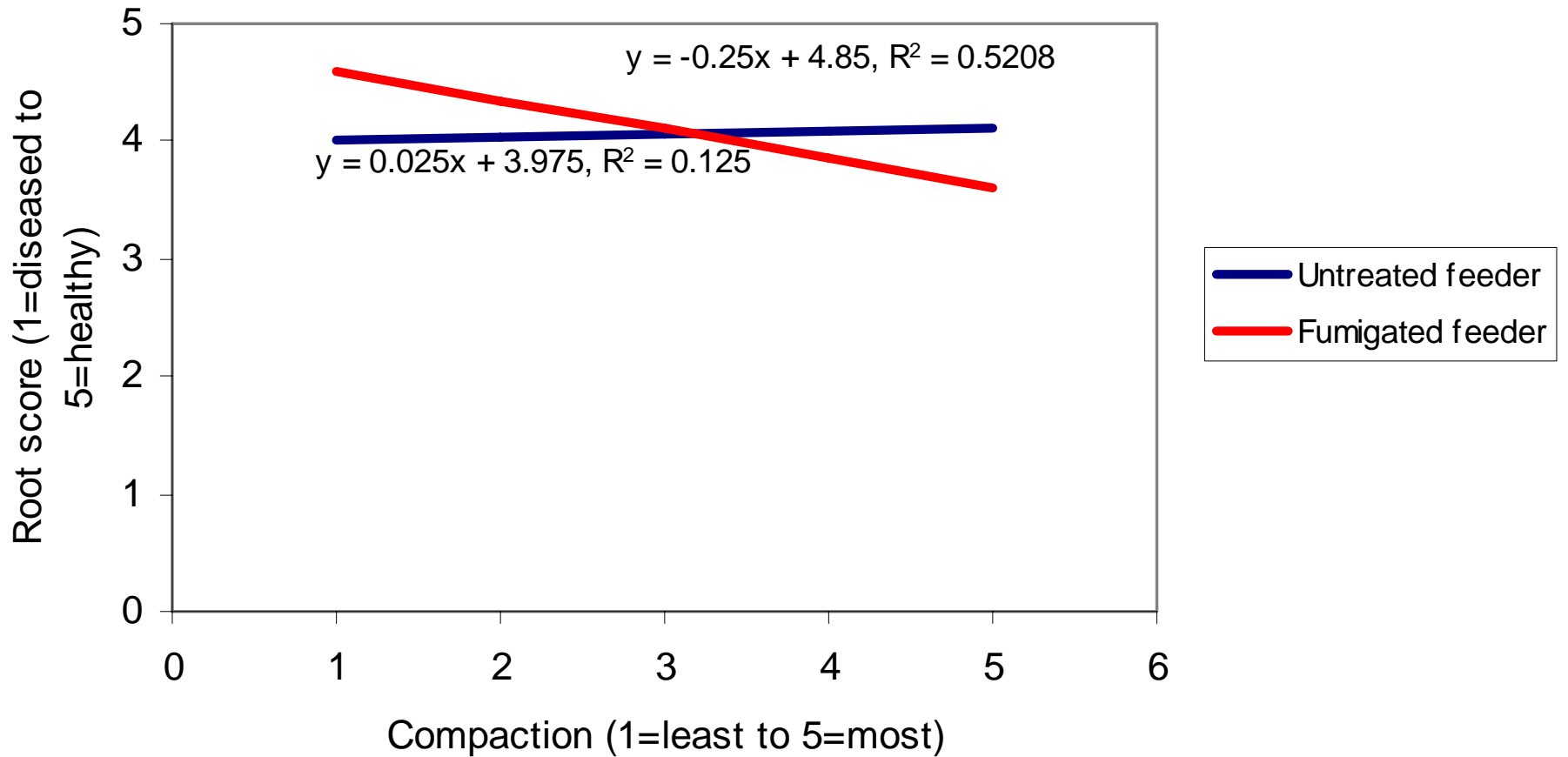
Experiment

- “Unhealthy” soil was obtained from three farms across NYS
- Divided into two lots, one half was fumigated
- Soil placed in pots and compacted to 5 levels of bulk density (0.6 – 1.2 g/cm³)
- Strawberry plants grown in the pots for one year
- Roots and plant growth evaluated

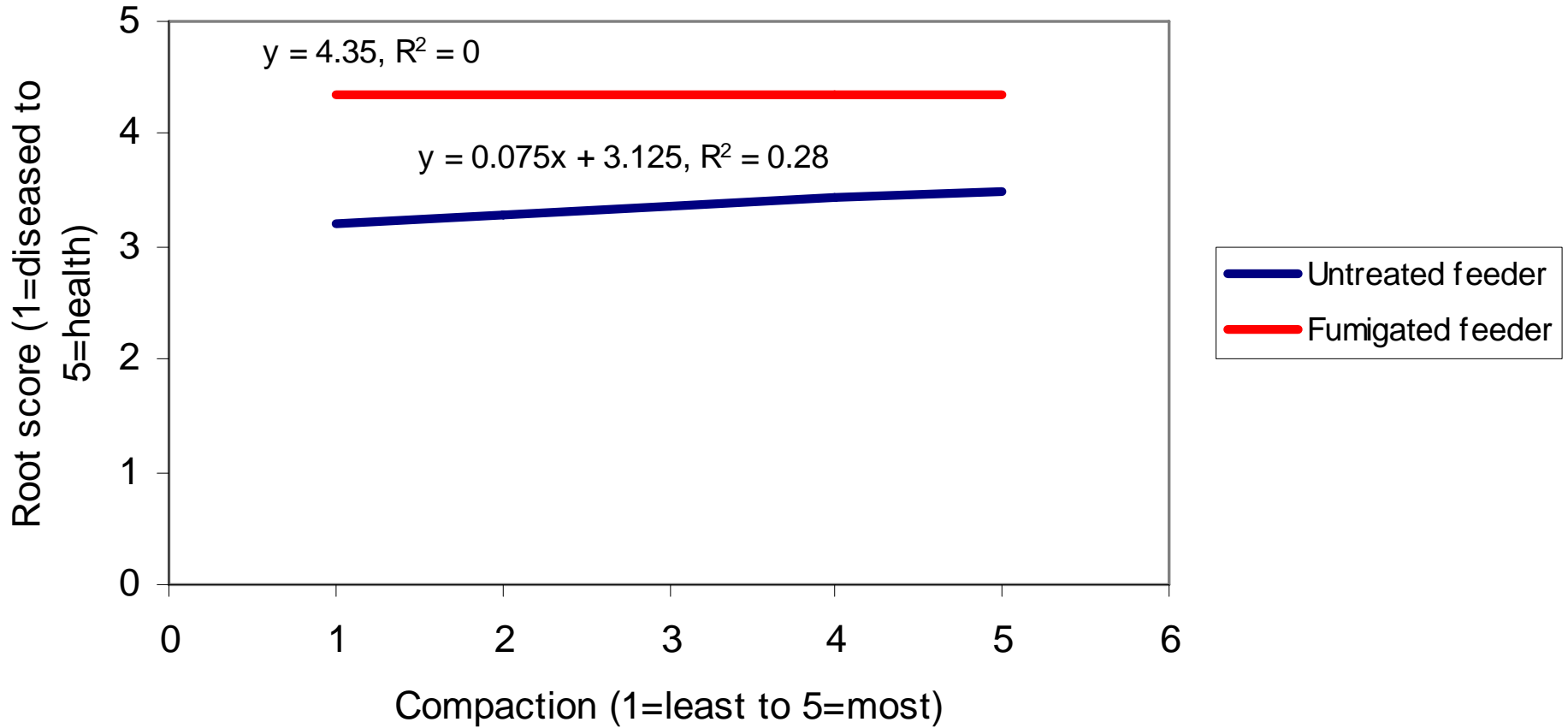
Shortcake Farm



Brown's Berry Patch



Iron Kettle Farm



In general, roots of plants grown in fumigated soils were more healthy than plants grown in unfumigated soils

but

Soil compaction only slightly compromised root health, and then only in some fumigated soils.

Question #4: How tolerant are strawberries to compaction in the field?

Experiment (2004)

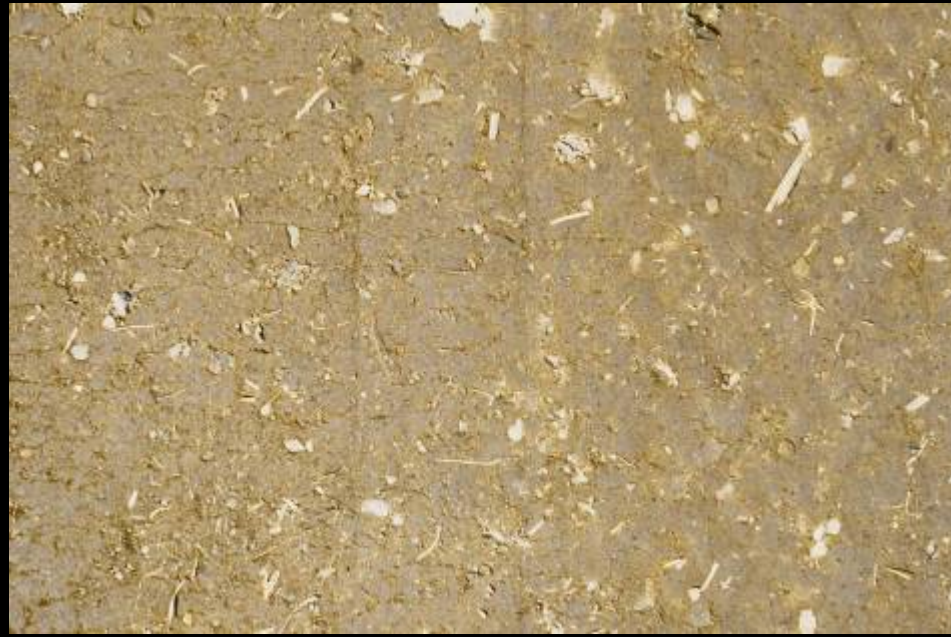
- Virgin site with excellent drainage
- Three levels (whole plots) of preplant soil compaction (none, moderate, heavy) plus no preplant compaction with subsequent subsoiling
- Subplots consisted of three maintenance levels for three years (no tractors, light equipment, heavy equipment)

Mike on the Rhino . . .























Bulk density
Macroporosity
Mesoporosity
Microporosity
Residual porosity



**Preplant treatment effects on soil were still observable after three years
Penetrometer readings (2006 data)**

Soil depth (cm)

Treatment	8	16	24	32	40	48
Subsoil	89	97	117	182	264	298
Minimum	158	234	247	256	269	322
Moderate	198	253	252	263	283	312
Maximum	210	272	295	302	317	344

Bulk densities of 1.35 – 1.65 g/cm³

Post-plant treatment effects on soil were maintained after three years (2006 data)

Treatment	Soil depth (cm)					
	8	16	24	32	40	48
Minimum	104	155	178	211	249	289
Moderate	152	212	225	234	264	299
Maximum	236	277	281	308	338	370

Preplant treatments had an impact on runner production and yield in the first fruiting year.

Treatment	Daughter plants* (#/m)	Yield* (kg/4 m)	Individual fruit weight (g)
Minimum	44.0	7.83	12.0
Moderate	31.0	7.73	12.2
Maximum	28.6	7.19	12.1

**A similar trend was continued into 2006,
but the impact was not large (<10%).**

Treatment	Yield* (kg/4 m)	Individual fruit weight* (g)
Minimum	22.0	13.9
Moderate	21.2	12.4
Maximum	20.3	12.7

No differences were found from post-plant treatments in the first fruiting year.

Treatment	Daughter plants (#/m)	Yield (kg/4 m)	Individual fruit weight (g)
Minimum	35.7	7.47	12.1
Moderate	31.0	7.90	12.0
Maximum	36.7	7.38	12.2

Post-plant treatments had an impact only on individual fruit weight after 3 years.

Treatment	Yield (kg/4 m)	Individual fruit weight (g)*
Minimum	20.7	13.6
Moderate	21.3	13.0
Maximum	21.7	12.6

The most compacted treatments still supported extremely high yields (for the Northeast)

38,000 lbs/acre or 43 tons/ha

Conclusions:

Plant health, yield and fruit size are greatest in uncompacted, fumigated soils

but

In the absence of poor drainage, strawberries are remarkably tolerant of soil compaction (up to 1.7 g/cm³)

Compaction is probably not a major limiting factor in most strawberry fields in the Northeast, provided drainage is good.

Yields and size were reduced by about 10% when strawberries were planted into compacted soils.

Between row compaction had little impact on strawberry growth and yield.

Soil pathogens are the greatest threat

