Modular Ecological Design: A Fruit and Vegetable Polyculture System for Urban Areas

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IPM Ohio Integrated Pest Management

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- ENTOMOLOGY
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- PLANT PATHOLOGY
- OARDC
- VEGNET

latest updates

The Ohio State Integrated Pest Management (IPM) program is a comprehensive program that is designed to encourage collaboration and innovation among Ohio Agricultural Research and Development Center (OARDC) scientists and Ohio State Extension personnel to better address the pest management needs of the citizens of Ohio. Our goal is to reduce the environmental, economic and social risk associated with managing pests (insect, disease or weed). To accomplish this goal we work with OSU collaborators in 5 areas of emphasis to evaluate and disseminate new IPM information. These areas are Agronomic IPM, High Value Crop IPM, Conservation Partnerships, Pest Diagnostics, and School IPM. In addition this year we will enhance our collaboration with the Cleveland Botanical Garden Green Corp. Urban Youth Program.

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- Annual Reports
- Cornell Organic Guides
- Crop Profiles
- Elements of IPM
- Fruit
- IPM Internal Grant Program
- Lady Beetle Information
- Links
- Modular Ecological Design
- Newsletter
- People

Goals

- Integrated Pest Management
- Ecological Principles
- Polyculture Experiment
- High Tunnels
- What I learned

What is IPM?

- Integrated Pest Management is an ecosystem-based strategy that focuses on long-term prevention of pests through a combinations of techniques (monitoring, forecasting models, biocontrol, cultural control, chemical control).

- Combines the best control tactics to reduce reliance on pesticides, minimize environmental effects, and keep pests at an acceptable level

Integrated Pest Management

- Pest is weed, disease, insect, mite, vertebrate
- Not a chemical free system – good design helps but usually is not enough
  - Pesticides can be used at appropriate times
  - OMRI or organic approved or conventional
- Nature bats last!!!

Ecologically Based IPM

- General Principles
  - Select and grow a diversity of crops that have natural defenses against pests
  - Choose varieties with resistance or tolerance
  - Build the soil with organic matter

Integrated Pest Management
Builds on strengths of natural systems
(Ecomimicry)

- Three concepts
  - Ecosystem Stability
  - Biodiversity
  - Biological Control

Ecosystem Stability

- Ecosystems with more diversity
  - Are more stable
  - Greater resistance
    - Ability to avoid or withstand disturbances
  - Greater resilience
    - Ability to recover from stress

Ecosystem Stability

- Reduce tillage/cultivation - fewer weeds
- Reduce mowing - less disruption, increase beneficials
- Maintain “permanent” ground covers
- Add organic matter - substrate for good MO’s
- Use cover crops - inc. moisture retention
- Use crop rotation - breaks pest cycle
- Increase crop diversity - more difficult to find
- Create corridors - highways of habitat

Integrated Pest Management

- Tries to apply stress to the pests
  - Interrupt their life cycle
  - Remove alternative food sources
- Enhance beneficial population
  - Avoid agrochemicals where possible
  - At least better timing

Integrated Pest Management

- Is a preventative approach
  - Uses little “hammers”
  - Instead of one big “hammer”
- Relies on Biological Control (as much as possible)
  - Beneficial predators and parasites
  - Disease-causing organisms
  - Beneficial fungi and bacteria that inhabit roots

What is Biological Control?

- The regulation of pest population densities below and economic injury level via a biological antagonist

Biological Control Potential?

- Many pest pop. are regulated below plant damaging levels by naturally occurring enemies (500 pests of apples in OH)
- There is extensive evidence for successful biocontrol
- Biocontrol is not a panacea; it will not work in some situations

Biological Control Impediments

- High cost of beneficials - raise plant/prey/predator
- Availability & quality of biologicals
- Lack of research documenting success
  - Success rate (15-20%)
  - Usually best in Greenhouses, Islands, California
- Don't buy bio control insects for small outdoor plots

Enhancing Beneficials/Biocontrol

- Characteristics typical of fields with plenty of indigenous beneficials
  - Fields are small - a lot of edges, natural vegetation
  - Cropping systems are diverse
    - Include perennials and flowering plants
  - Crops are managed with minimal agrichemical inputs
  - Soils high in organic matter, biological activity during off season
    - Covered with mulch or vegetation

Biodiversity
(sp. richness and eveness)

- Spatial diversity - across a landscape, within fields
- Genetic diversity - different varieties, different crops
- Temporal diversity - different crops at different stages of growth

Fertility

- Slow release of nutrients the best,
  - any compost is good compost (yard waste, dairy barn, vermicompost)
- Pests seem to follow the Nitrogen (plant suckers i.e. mites & aphids)
- Too much synthetic fertilizer cause nutritional imbalances

Some Principles of Good Farming/ Gardening

- Plan your farm/garden and set goals
- Look at the whole picture (water, soil, crops, goals)
- Fertility and slope of land
- Learn and grow through reading and meetings
- A farm must be profitable ($, joy)

Given that we will eventually run out of oil, can we design a food production system that is:

- Close to consumers
- Simulates natural systems
  Ecomimicry
- Uses Ecologically Based Pest Management
- Economically viable ≈ $90,000/A
  = $ 10 per ft of row

Modular Ecological Design

Goal - to determine optimal layout of an intensive fruit & vegetable polyculture system that mimics natural systems & can be used by the small periurban or urban farmer.

Modular

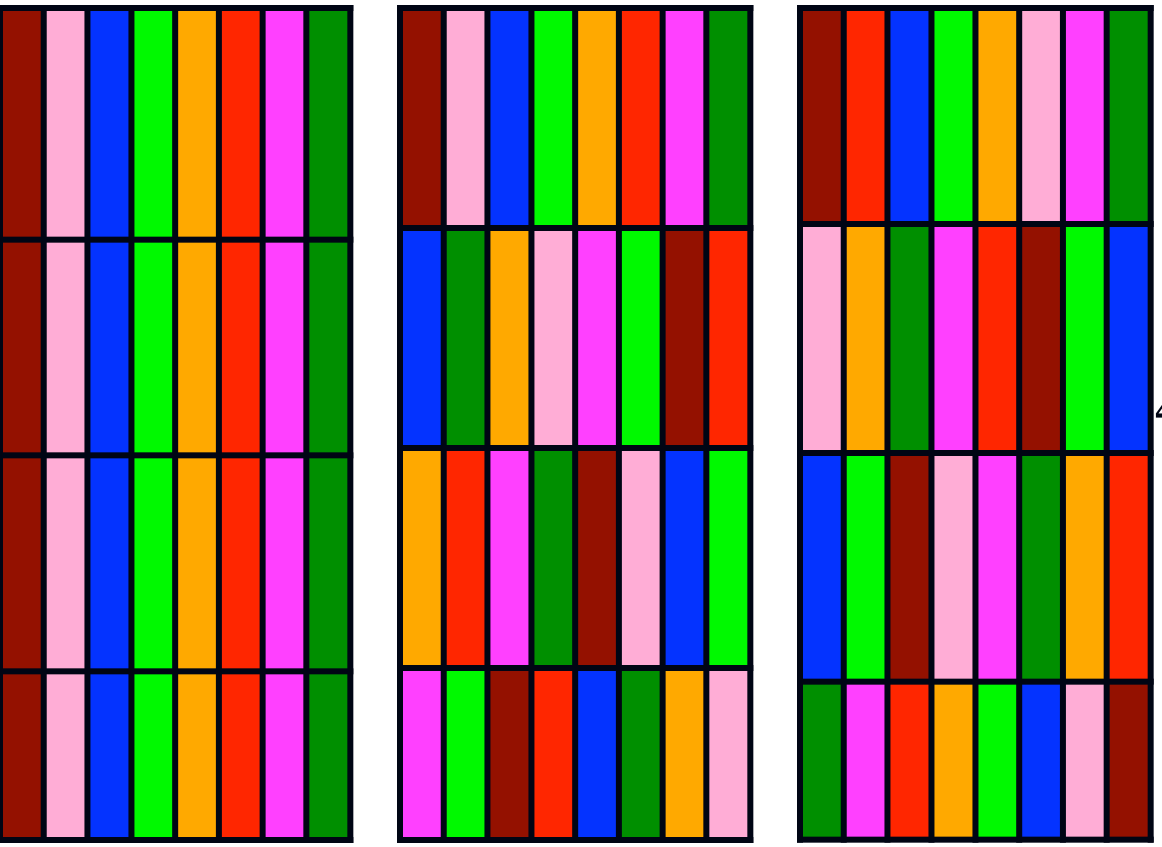
Economics

Pest density

Efficiency

August 2005

Commodities and Treatments



Early, Mid, Late cultivars

4 trees/shrubs

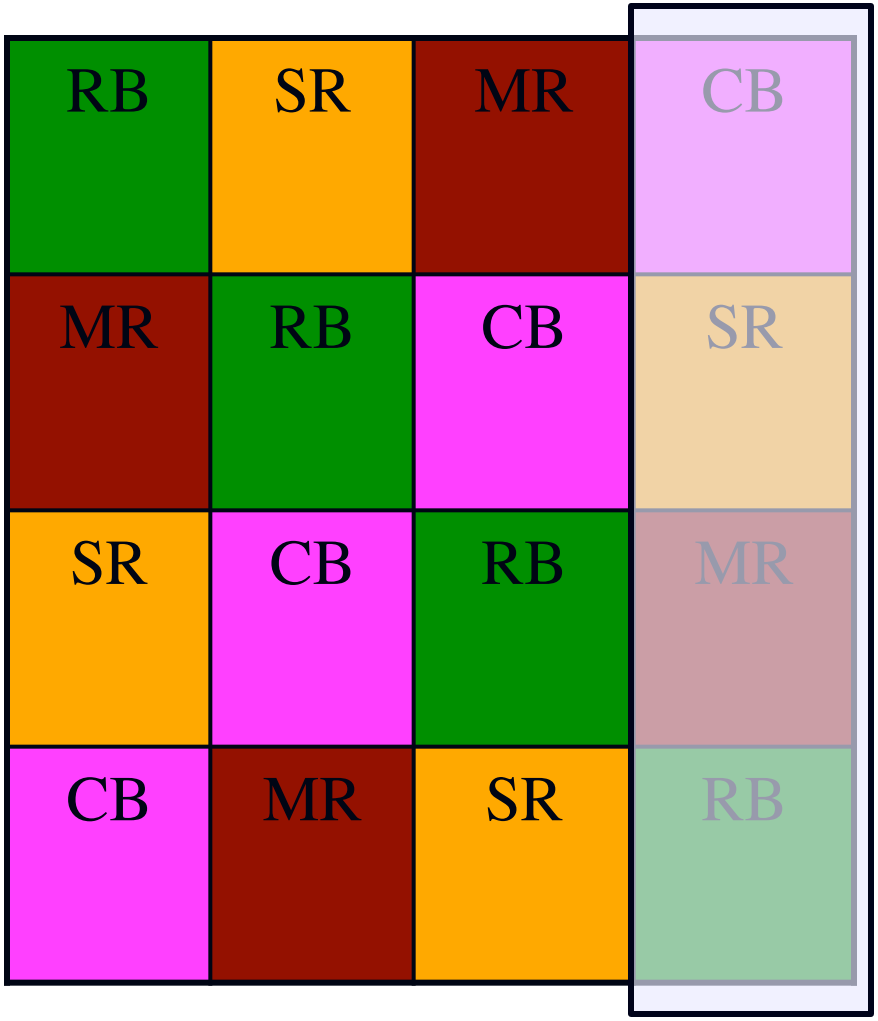
I. Apples(SwC)
II. Peaches
III. Blueberries
IV. Raspberries

4 herbaceous

Strawberries
Edamame soybeans
Tomatoes
Green beans

The fourth treatment (not shown) is a mixed row configuration on raised beds.

Layout of plots



RB = Raised Bed

SR = Solid Row

MR = Mixed Row

CB = Checker Board

Each plot - 44’ x 60’

Total Acres - 1.4 A

4 Treatments Replicated 4 Times, SR, MR, CB, RB

2007

Raised Beds

April 2005
($1.20/ft)

April 2005

Yard Waste Compost
May 2005

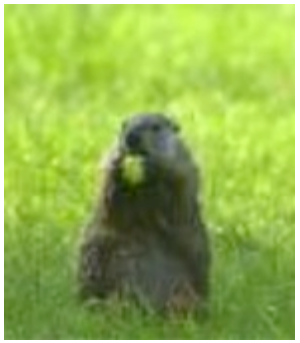
May 2005

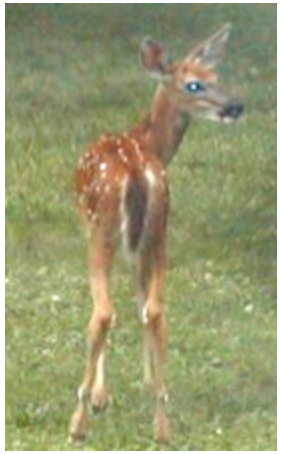
May 2005

Tree and Bush Planting

May 2005

Groundhog, Rabbit, Deer Fence





June 2005

I garden, therefore I fence

June 2006 - Weeding Cost

2005 Weeding Costs - $1.35/ft

Labor hrs (760 hr) = $6,080

2006 Cost - $0.37/ft

Landscape Cloth = $1,250

Labor (214 hr) = $1,612

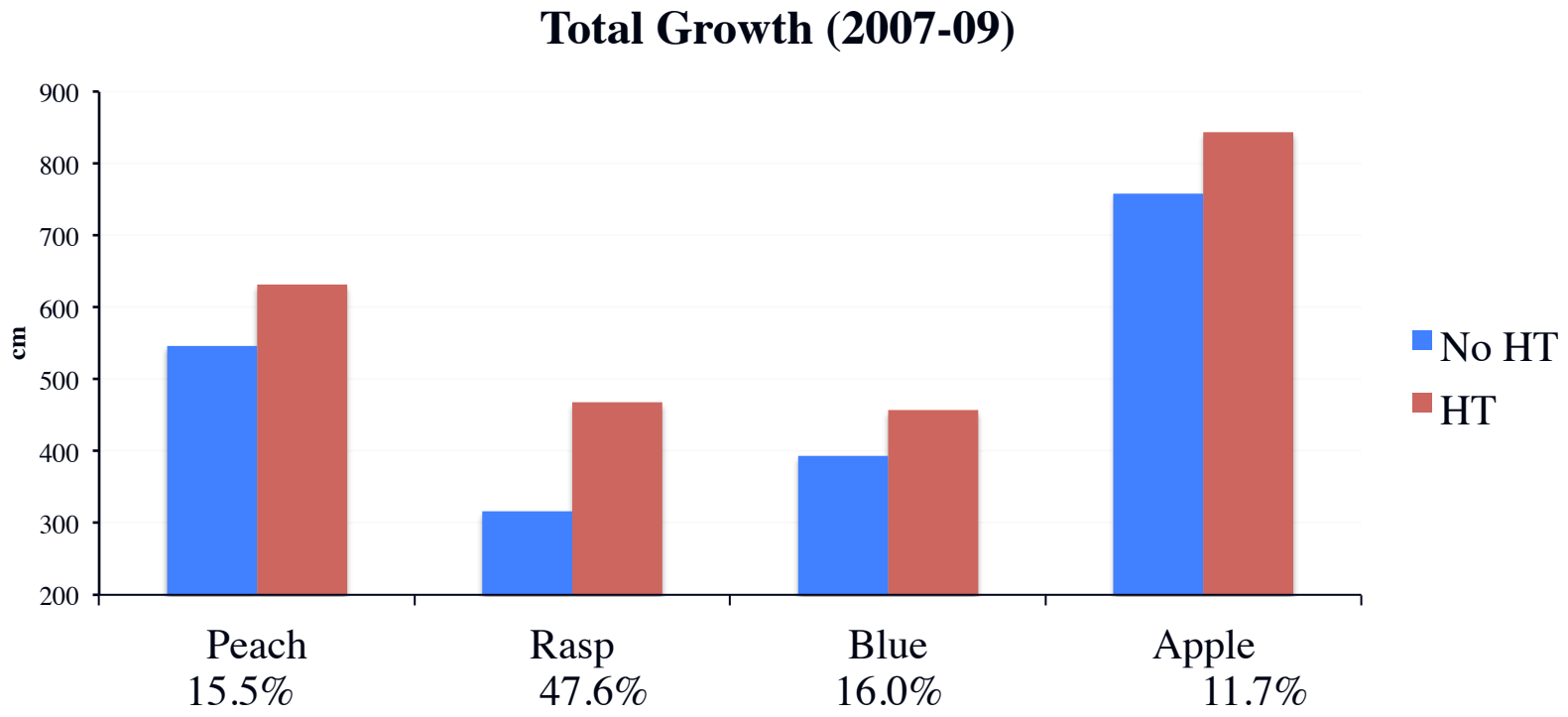
Total = $2,862

Haygrove High Tunnels

HT= $9.50/ft

Bees, High Tunnels & Pollination

High Tunnel Growth



High Tunnel Yield Differences (g/m)

Trt	Straw	S Rasp	F Rasp	Tom	Soy	Blue	SnP
No HT	4673a	2276a	2086a	6806a	1147 a	706a	269a
HT	3779b	1162b	3736b	8764b	1348 b	951a	387a
%	-19%	96%	79%	23%	16%	-	-

Tunnels have a shading impact and reduce wind

Strawberries are primarily wind and gravity pollinated

Percent Marketing Yield (% clean)

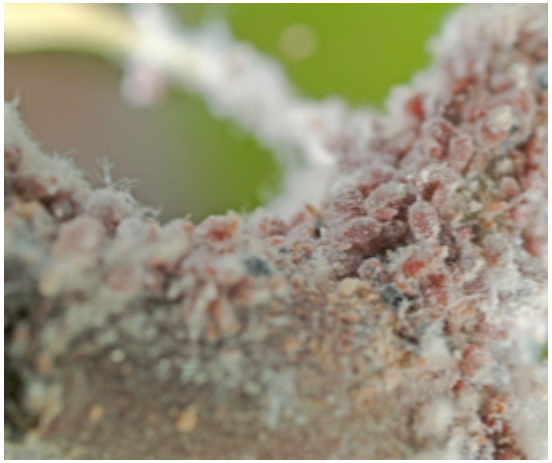
HT	F. Rasp'08	S. Rasp'09	Tomato'07	Apple'08
Yes	74.2 a	74.6 a	81.7 a	27.0 a
No	57.1 b	65.1 b	64.4 b	3.0 b

Percent Marketing Yield
Tomato’07

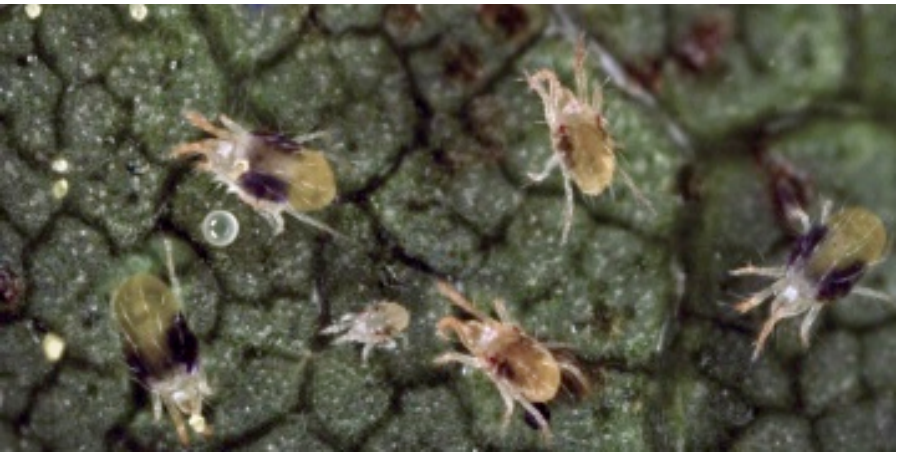
HT	Cracking	Zipper	Mech	Other
Yes	12.5 a	0.4 a	4.8 a	1.3 a
No	27.2 b	0.8 a	6.1 a	2.0 a

Apple Pests – Wooly Apple Aphid

HT	% WAA
Yes	41.7 a
No	1.4 b



Apple Pests – Two Spotted Spider Mite



HT	% ERM
Yes	20.8 a
No	0.0 b

Japanese Beetle

(July-Aug)

Year	No. JB
2005	15,000
2006	60,000
2007	283,000
2008	441,000
2009	162,000
2010	7,200

Trt	
High Tunnel	(3 - 4%)
No HT	(96 - 97%)

Japanese Beetle

(July-Aug) 2006, 2007

	2006		2007	
Crop	No. JB	%	JB	%
Rasp	30,146	52	109,292	39
Peach	22,789	38	11,047	4
Soy	1,851	3	108,239	38
Straw	1,652	3	20,232	7
Blue	1,486	3	32,115	11
Apple	488	1	2,801	1
Tomato	0	0	110	0

Japanese Beetle Raspberry (JB/5ft/date)

Trt	2006	2007
MR	10.4 a	35.0 b
CB	11.7 ab	29.8 c
RB	13.3 bc	43.6 a
SR	15.3 c	37.8 b

Cultivar	2006	2007
Royalty	3.1 a	15.5 a
Carol	12.0 b	36.4 b
Prelude	22.9 c	57.7 c

Royalty

Prelude

Japanese Beetle
Blueberry (JB/5ft/date)

Trt	2007
MR	10.0 a
CB	9.9 a
RB	11.1 a
SR	13.6 a

Cultivar	2007
Duke	14.7 a
Bluecrop	13.9 b
Elliot	4.9 b

Japanese Beetle Traps

- 2 bait types
  - Mimics scent of virgin female
  - Sweet smelling food type of lures
- U of Kentucky research
  - Traps attract more beetles than catch (40-50%)
- Traps are not recommend for control

Arthropod Collections 2005-08

Sweep net samples

Jun, Jul, Aug, Sep, Oct

	Total	Beneficial	Pest	Incidentals
Families	139	53	37	51
Indiv ’05	25,258	16%	54%	30%
‘06	16,202	21%	50%	29%
‘07	24,118	21%	51%	28%
’08	23,493	20%	45%	32%

Insect Individuals (2006)

Crop	% Pest	%Nat. E.
Strawberry	50.3	15.6
Peach	35.7	24.7
Raspberry	51.2	12.5
Blueberry	44.6	23.2
Apple	61.4	17.4
Soybean	48.3	10.5
Potato	73.8	13.6
Tomato	49.5	11.1

Shannon's Diversity Index

Crop	Biodiv 05	Biodiv 06
Strawberry	1.69 d	2.22 a
Peach	2.24 a	1.91 b
Raspberry	1.829 c	1.59 c
Blueberry	1.64 d	1.46 c
Apple	-	1.17 d
Soybean	2.07 b	1.01 de
Potato	-	1.08 d
Tomato	1.61 d	0.84 e
Corn	2.18 ab	-
Green bean	1.89 c	-

Can Intercropping increase biodiversity?

Treatments:

1) Peaches alone
2) Peach intercropped w/ straw.
3) Strawberries alone
4) Straw. Intercropped w/ peach

Is increasing biodiversity good?

Intercropping Biodiversity

Beneficials/Natural Enemies

Treatment	Biodiversity (H')
Peach	0.77 a
Peach inter. w/ straw	0.81 a
Straw	0.52 a
Straw inter. w/ peach	0.62 a

Intercropping Biodiversity

Pest Insects

Treatment	Biodiversity (H')
Peach	0.79 bc
Peach inter. w/ straw	1.13 a
Straw	0.53 c
Straw inter. w/ peach	0.87 a

Is increasing biodiversity good when you increase the biodiversity of pest insects?

Harvest

Harvest Evaluations 2006

Trt	Soy	S.Rasp	Straw	Tom	Pot
SR	32 a	381 a	1407 a	2338 a	486 b
CB	59 b	279 a	1310 a	2083 a	300 a
MR	47 b	289 a	1314 a	2420 a	275 a
RB	56 b	505 a	1619 a	3086 b	475 b
% inc	67	81	24	48	73

Harvest Evaluations 2007

Trt	Straw	S.Rasp	F.Ras	Tom	SnP	Soy	Blue
SR	2984	903	1512	3685	170	1021	882
CB	2707	1034	1429	5429	250	694	551
MR	2542	797	1685	4193	260	880	661
RB	3287	1403	1424	6965	512	1064	662
% inc	20	54	-	57	125	-	-

Total Hours to Harvest all Crops 2005

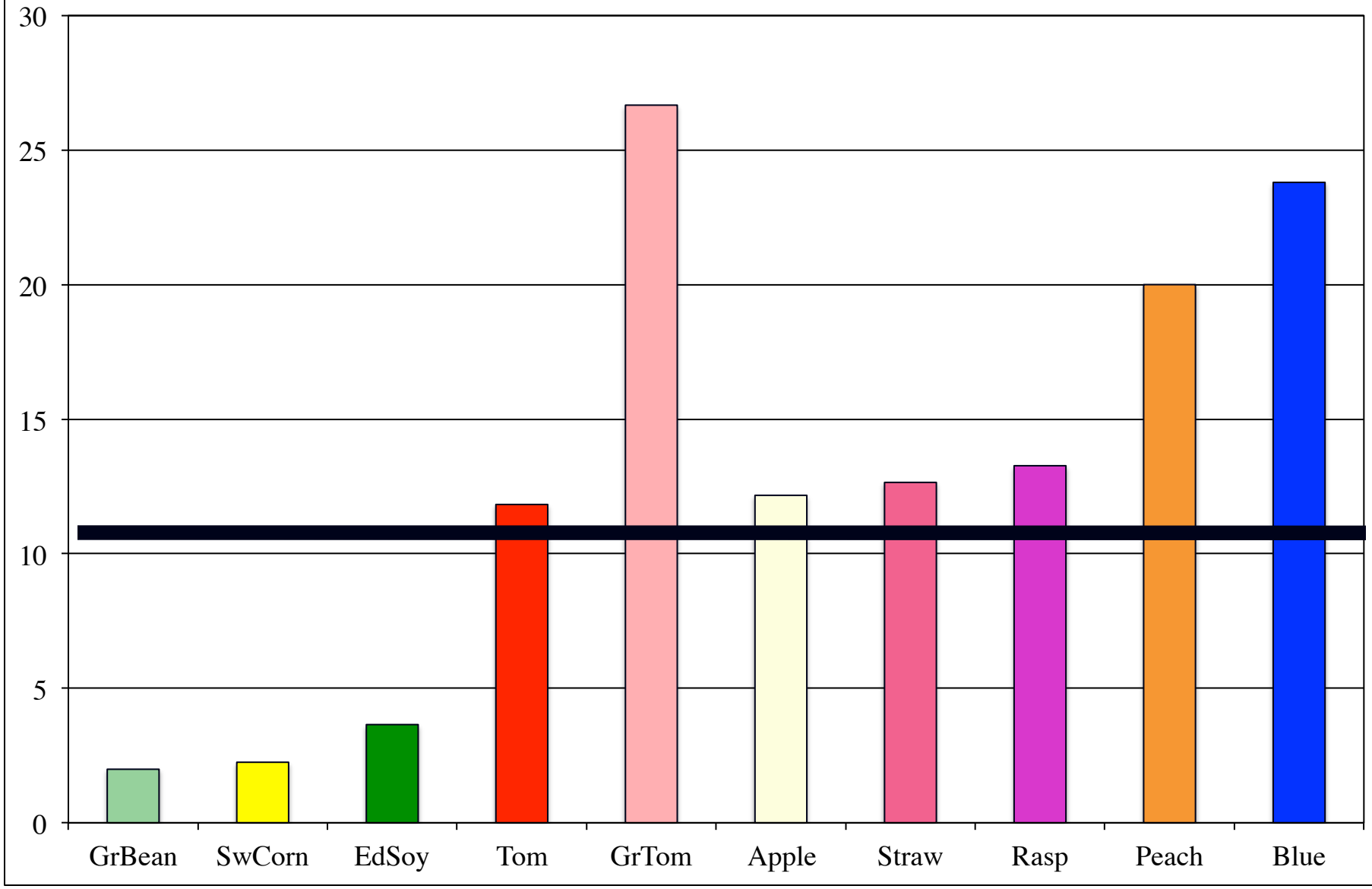
(green beans, tomatoes, sweet corn & soybeans)

Treatment	Hours/Meter/Person
CB	7.31a
MR	6.82a
RB	6.44a
SR	5.78a

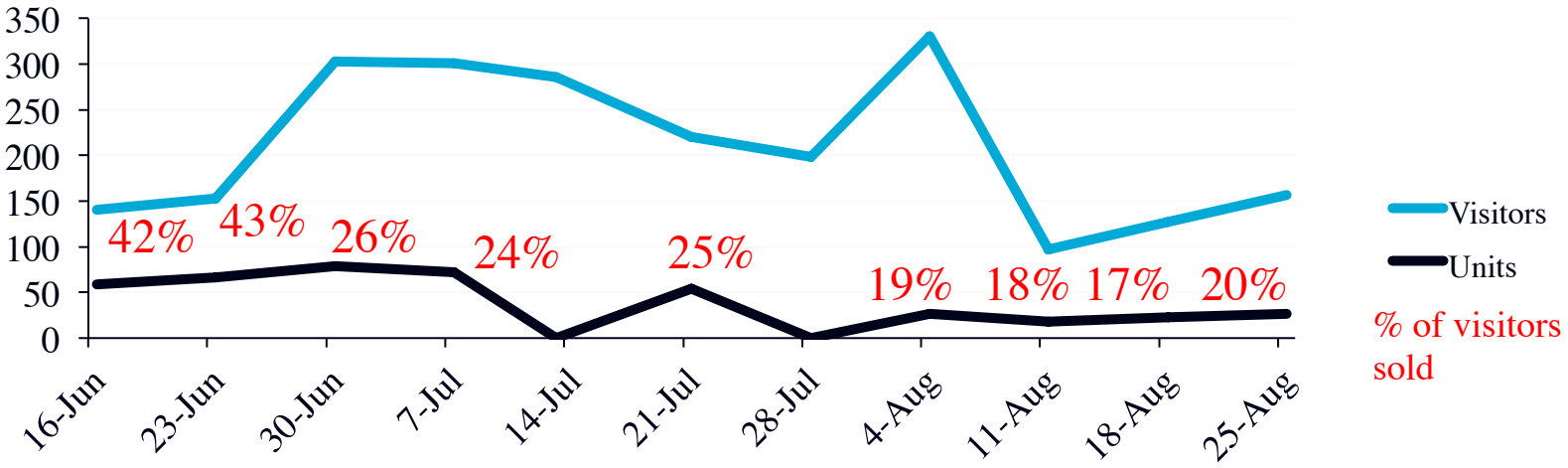
Means followed by the same letter are not significantly different (LSD, P>0.05)

Labor Cost = $1.00/ft for $8/hr for 6 months

Crop Dollars per Foot of Row



OARDC Farmer's Market 2009



Total Season	$2,208
Profit	$1,460
Per Mkt. Day	$20/hr

BioControl Study = $2000

Establishment Costs

2005	
Establishment	
Soil prep	$ 176
Plants	5,015
Fencing/Irrigation	1,956
Sub total	7,147
Weed Control	
Labor - 760h (weed, mulch)	6,080
Mulch (17 truck loads)	4,250
Sub total	10,330
Raised Beds	
Materials	2,280
Total	$19,757

2006	
Seeds	$ 484
Harvest material (qts, pts, container)	292
Weed Control	
Landscape cloth	1,033
Staples	216
Labor -182h	1,456
Sub total	2,705
Trellis	
T-post	290
Lumber	310
Screws, wire	49
Sub total	649
Misc.	590
Total	$4,720

Total investment	$24,477
per plot	1,530 (+ RB $1.20)
$/ft	$3.20 (+ HT= $9.50/ft)

What I've Learned

- High Tunnels – Love 'em and Hate 'em

Love 'em	**Hate 'em**
Season Extension (earliness)	Putting up and taking down plastic
Less JB's, Less Diseases (leaf & fruit rots)	More mites, aphids, thrips, PM, OFM, more Leps?
Can work in rain or cold	Venting in summer
Increase yield and quality	Picking fruit and veg. in November (market?)

What I've Learned

- SR – Easiest to pick
- CB – Most confusing (me and pests)
- MR – Best aesthetic and overall winner
- RB – Most productive

- Nature Bats Last
  - Polyculture systems do reduce pest levels but not enough that you can go without some sort of pest management intervention

What I've Learned

- Nature Bats Last
  - Biggest problems are polyphagous insects such as OFM, JB, PC (lack good biocontrol agents) and voles
- Farmers' Markets are not for me (I question time & money especially in cities in Ag. area)
- I feel I can make money from fruit (except peaches, lack of consistent crop) but vegetables harder (depends on market)
- $10/ft still possible with right consistent crop mix and type of market (sell retail to neighbors)

Acknowledgements

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Parking Lot Project

Questions?