

Performance of new fumigants and updates on steam application technology

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Collaborators

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- ❖ Jim Gerik
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Affiliated Cos.
- ❖ Ian Greene, Ramco
Norcal
- ❖ Jenny Broome, DSA
- ❖ Mike Stangellini, Greg
Vargas, Doug Buessing
TriCal
- ❖ Husein Ajwa

Financial/in-kind support

- ❖ **USDA NIFA Methyl Bromide Transitions**
 - ❖ **2013 -51102-21524; 2015-51102-24114**
- ❖ **California Department of Pesticide Regulation**
- ❖ **California Strawberry Commission**
- ❖ **Support from Reiter Affiliated Co., Driscoll's, NorCal Ramco, Mellano & Co., Joseph & Sons, Gladaway, AMVAC, Isagro, Gema Berry**
- ❖ **A special thanks to TriCal Inc. for fumigant application**

Introduction

- ❖ **Project objective – evaluate fumigant and non-fumigant alternatives**
- ❖ **Fumigant results from flower & strawberry**
- ❖ **Work on steam applicators**
- ❖ **Summary**

FLOWERS

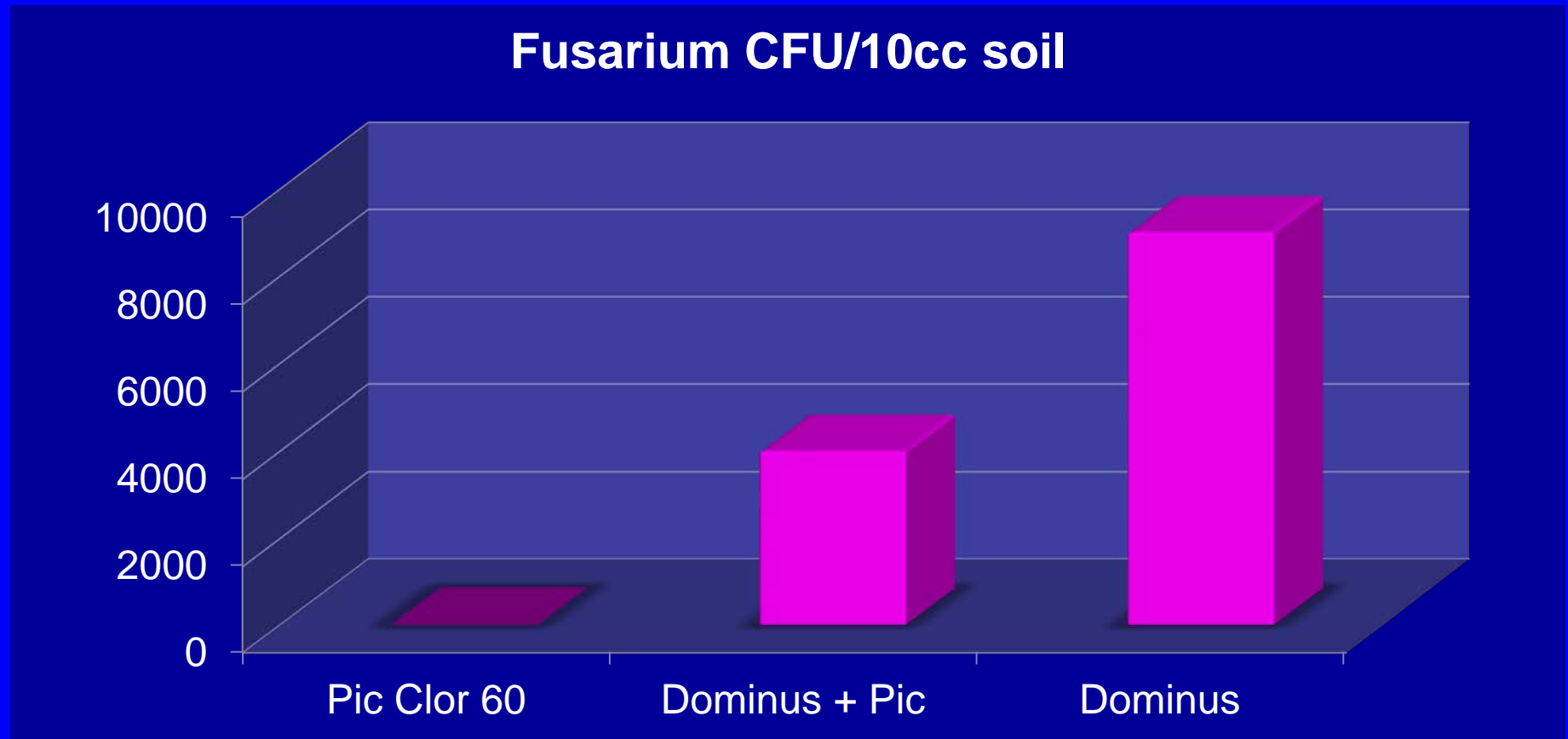


Joseph &
Sons, Santa
Paula, CA

Joseph and Sons, Santa Paula

- ❖ **Cut flowers grown in high tunnels: snap dragon, Dianthus, Amaranthus, Lisianthus**
- ❖ **Tested drip applications of Pic Clor 60 29 GPA, Dominus + Pic 28 + 9.4 GPA, Dominus 40 GPA**
- ❖ **Applied by TriCal Sept 5, 2014 RCB 3 replicates**
- ❖ **Flowers were planted at several intervals over the winter**

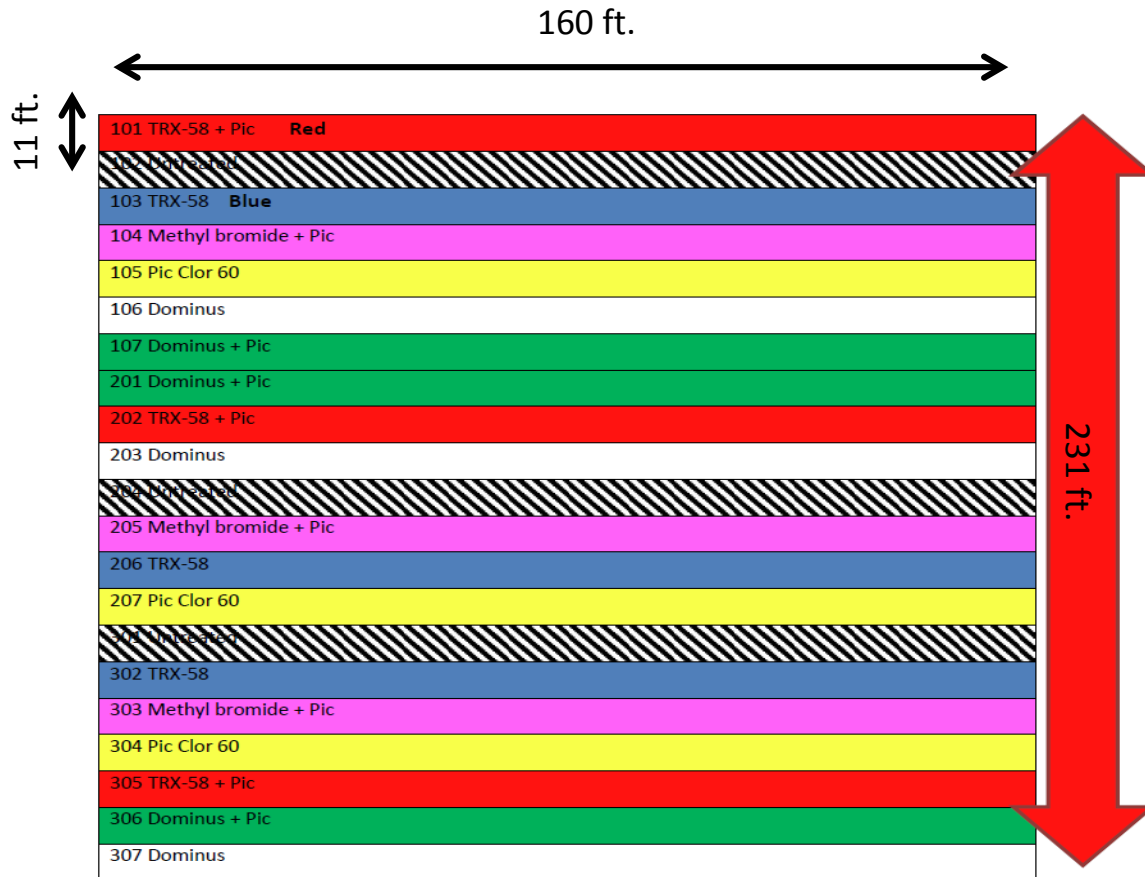
Fusarium control



Soil & Plant Lab.

Pest Control Efficacy of the fumigant TRX-58 in Flower, Mellano & Co.

Carlsbad, CA. Fumigation: 10/2/2014

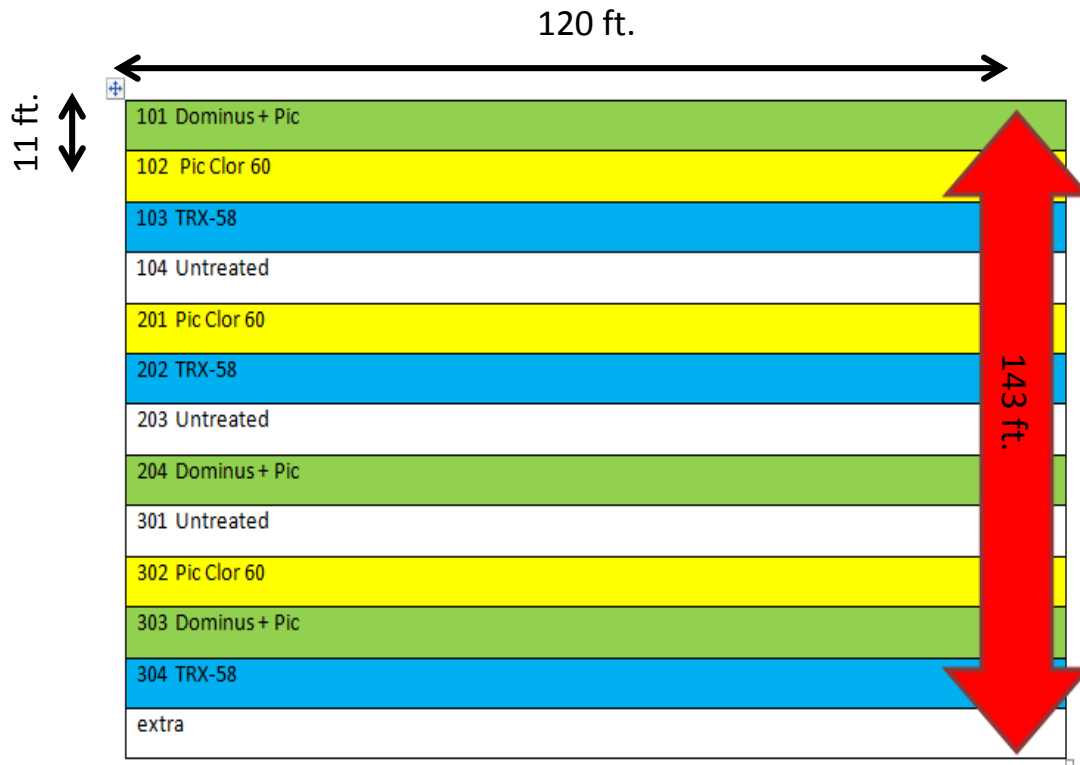


7 Treatments, 3 Replicates

Treatment	Rate
MB Pic	350 lbs/a
Pic Clor 60	350 lbs/a
Dominus + Pic 67:33	40 g/a
Dominus	40 g/a
TRX-58	500 lbs/a
TRX-58 + Pic 67:33	400 lbs /a
non-treated	

Pest Control Efficacy of the fumigant TRX-58 in Flower, Mellano & Co.

San Luis Rey, CA. Fumigation: 11/14/2014



4 Treatments, 3 Replicates

Treatment	Rate
Pic Clor 60	350 lbs/a
Dominus + Pic 67:33	40 g/a
TRX-58	400 lbs/a
Non-treated	-

Pathogen control Carlsbad

Treatment	Rate	Fusarium (p/g soil)		Pythium (p/g soil)	
		PRE	POST	PRE	POST
MBPic	350 lb/A	183	0	17	0 c
Pic-Clor 60	350 lb/A	1365	0	17	0 c
Dominus	40 GPA	259	47	35	80 a
Dominus/Pic	40 GPA	328	38	28	36 b
TRX-58	500 lb/A	469	201	16	0 c
TRX-58/Pic	400 lb/A	210	74	35	1 c
Nontreated	0	350	721	13	39 b

Jim Gerik, USDA-ARS

Weed control Carlsbad

Treatment	Rate	Ranunculus	Delphinium	Weed time
		Weeds (no./A)		Hrs. /A
MBPic	350 lb/A	8,349 c	6,587 b	69 e
Pic-Clor 60	350 lb/A	1,597 c	2,569 b	99 cde
Dominus	40 GPA	61,976 a	54,629 a	223 ab
Dominus/Pic	40 GPA	30,686 abc	43,319 a	169 bc
TRX-58	500 lb/A	17,134 bc	1,742 b	87 de
TRX-58/Pic	400 lb/A	27,564 abc	7,050 b	157 bcd
Nontreated	0	52,708 ab	51,480 a	266 a

Pathogen control San Luis Rey

Treatment	Rate	Fusarium (p/g soil)		Pythium (p/g soil)	
		PRE	POST	PRE	POST
Pic-Clor 60	350 lb/A	1184	286 bc	439	0 b
Dominus/Pic	40 GPA	1112	424 b	867	0 b
TRX-58/Pic	400 lb/A	1030	89 c	803	0 b
Nontreated	0	1197	2515 a	811	40 a

Jim Gerik, USDA-ARS

Weed control San Luis Rey

Treatment	Rate	Weed densities	
		No./A	Hr./A
Pic-Clor 60	350 lb/A	2807 ab	12 b
Dominus/Pic	40 GPA	629 b	10 b
TRX-58/Pic	400 lb/A	194 b	11 b
Nontreated	0	7018 a	19 a

Pest Control Efficacy of the fumigant TRX-58 in Flower:

SUMMARY

Weed Control



- Dominus and Dominus/Pic combinations not very effective
- TRX-58 in the same range of efficacy of Pic-Clor and MB
- Use of TRX-58 keeps labor costs on same level as Pic-Clor

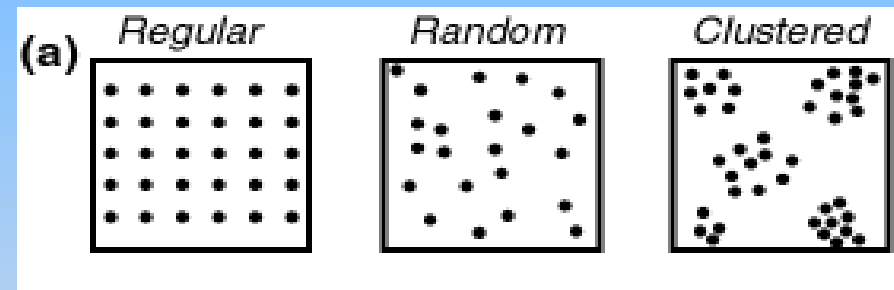
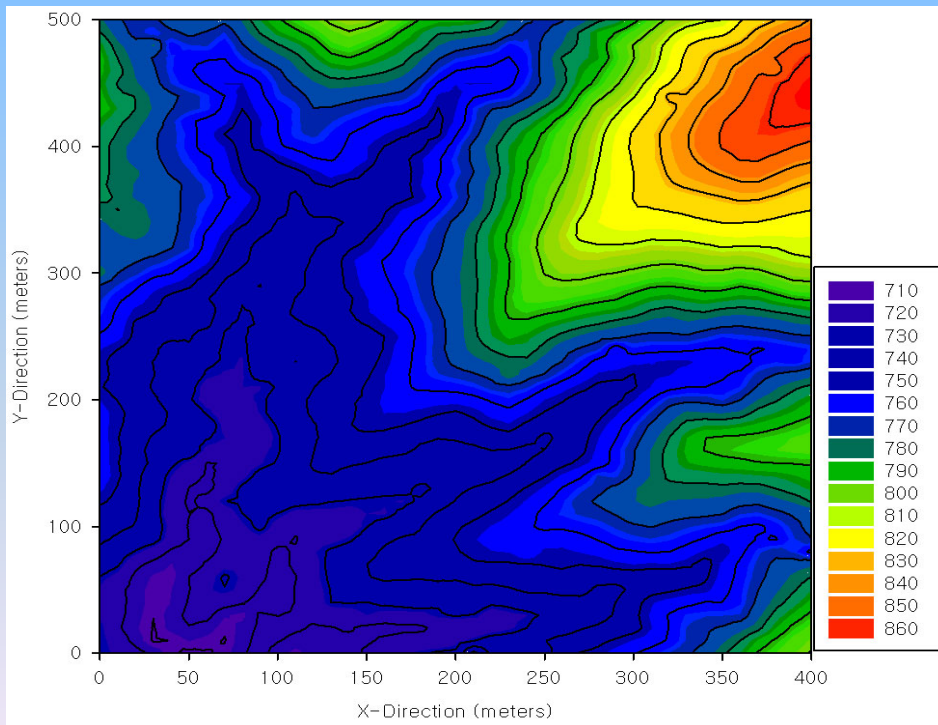
Pathogen Control



- Dominus and Dominus/Pic combinations not effective against *Fusarium* ssp. and results varied with *Pythium* ssp.
- Good efficacy of TRX-58 against *Pythium* ssp.
- Medium efficacy of TRX-58 against *Fusarium* ssp. But results vary by trial

PEST MANIPULATION- SPATIAL PEST VARIATION

❖ Pathogens are not uniformly distributed yet we treat them as uniform



THEORETICAL PIC DOSE REQUIRED TO CONTROL A KNOWN PEST POPULATION

Area	Acres (Field %)	Pathogen severity (10=severe, 0= none)	Chloropicrin dose needed (lbs./A)	Chloropicrin used (lbs.)
A	12 (15%)	9	300	3,600
B	24 (30%)	4	100	2,400
C	44 (55%)	0	0	0
TOTAL	80 (100%)			6,000

80 acres receiving 250 lbs./A of Pic = 20,000 lbs. Pic

DIAGNOSTIC TESTING OF SOILBORNE PESTS

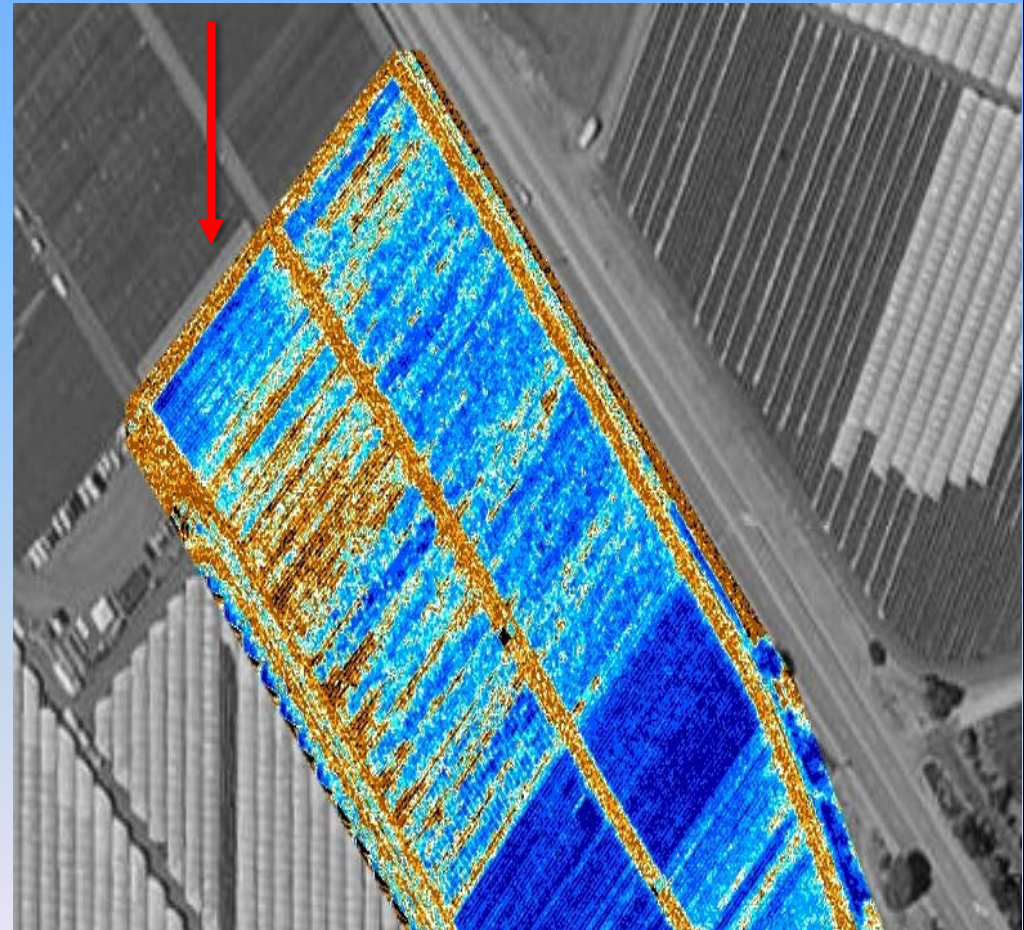
- ❖ **Poole et al. 2015 Phytopathology 105:1069-1079 used DNA testing of soil for pathogens to predict root diseases in wheat with a high degree of accuracy**
- ❖ **At what point will the cost of field mapping of soilborne diseases become cheap enough to pay for with reduced fumigant expense?**

DIAGNOSTIC TESTS – PLANT TISSUE

- ❖ Iso thermal detection of *Phytophthora* spp. from tissue in 15 min – Steve Koike is validating
- ❖ Targets are *Macrophomina* p., *Fusarium* o., *Pythium* u.

EXAMPLE: VIGOR

Test area Ranch (TCR, Watsonville, CA): *Macrophomina phaseolina* pressure



May 2015

September 2015

Strawberry Trials

- ❖ Strawberry field
 - ❖ Fumigant trial at Salinas
 - ❖ Steam trials 2 at Salinas and 1 in Watsonville



Dominus (AITC) K-Pam evaluation in strawberry

- ❖ **Treatments 2014-15 – Drip applied**
 - ❖ **Control**
 - ❖ **K-Pam 31 & 62 GPA**
 - ❖ **Dominus 20 & 40 GPA**
 - ❖ **Pic Clor 60 20 GPA**
 - ❖ **Pic Clor 60 fb K-Pam 20 fb 31 GPA**
 - ❖ **Pic Clor 60 fb Dominus 20 fb 20 GPA**
 - ❖ **K-Pam fb Dominus 31 fb 20 GPA**
- ❖ **4 replicates per treatment, Oct 11 & 15, 2014**
- ❖ **Weed seed bioassay, local weeds, nematodes, Pythium, Verticillium 9 & 18”**

Pathogen control

Treatment	Rate	Nematode	Pythium	Verticillium
	GPA	No./ 50 g soil	PPg soil	MS/g soil
K-Pam	31	18 c	42 bc	3 bc
K-Pam	62	65 bc	27 bc	5 bc
Dominus	20	179 bc	149 bc	8 bc
Dominus	40	252 b	221 b	11 b
Pic fb K-Pam	20 fb 31	1 c	0 c	2 c
Pic fb Dominus	20 fb 20	1 c	0 c	1 c
K-Pam fb Dominus	31 fb 20	3 c	0 c	8 bc
Nontreated	0	1806 a	1239 a	40 a

Becky Westerdahl, nematodes; Frank Martin, Pythium; and Steve Koike, Verticillium.

Weed densities and fruit yield

Treatment	Rate	Weeds	fruit
	GPA	No./ A	Lbs./A
K-Pam	31	13,068 b	53,462 c
K-Pam	62	17,424 b	58,314 abc
Dominus	20	13,068 b	58,494 ab
Dominus	40	8,712 b	56,978 bc
Pic fb K-Pam	20 fb 31	13,068 b	60,103 ab
Pic fb Dominus	20 fb 20	8,712 b	62,206 a
K-Pam fb Dominus	31 fb 20	13,068 b	58,499 ab
Nontreated	0	165,528 a	56,422 bc

Summary, strawberry

❖ Dominus

- ❖ Weak control of nematodes, Pythium**
- ❖ Suppresses Verticillium & weeds**
- ❖ Fruit yields were highest when Pic was included in the treatment**

DIRECT-FIRE STEAM GENERATORS



❖ Advantages

- ❖ No steam boiler
- ❖ Very efficient
- ❖ Water hardness

Johnson Gas Appliance, Cedar Rapids, IA

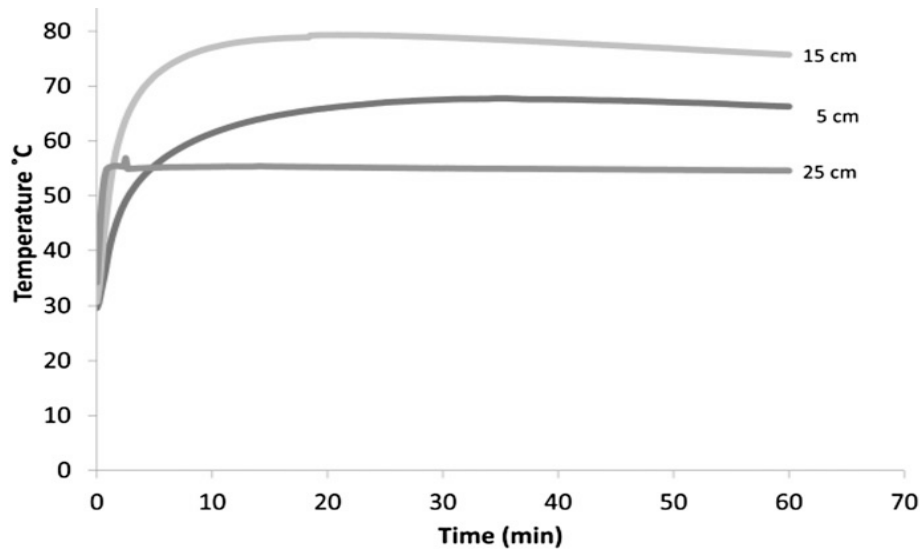
STEAM MACHINE: NEW PROTOTYPE 2



STEAM MACHINES: TEMPERATURE!

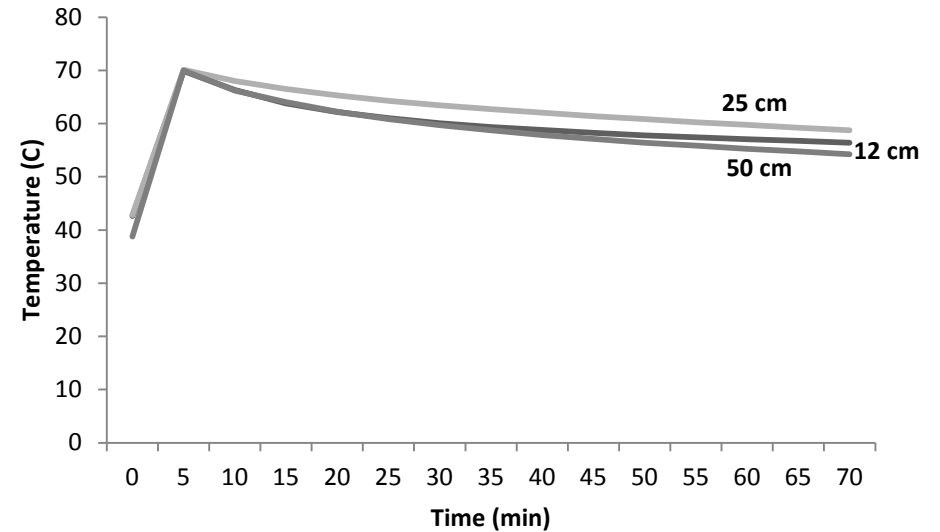
PROTOTYPE 1: Year 2011

- Build for 52" beds
- Speed: 31 – 51 hours/acre
- \$ 3.500 - 4.500 / acre



PROTOTYPE 2: Year 2015

- Build to treat flat fields
- Estimated speed: ca.10 – 15 hours/acre
- Estimated costs ca. \$ 2.500 / acre



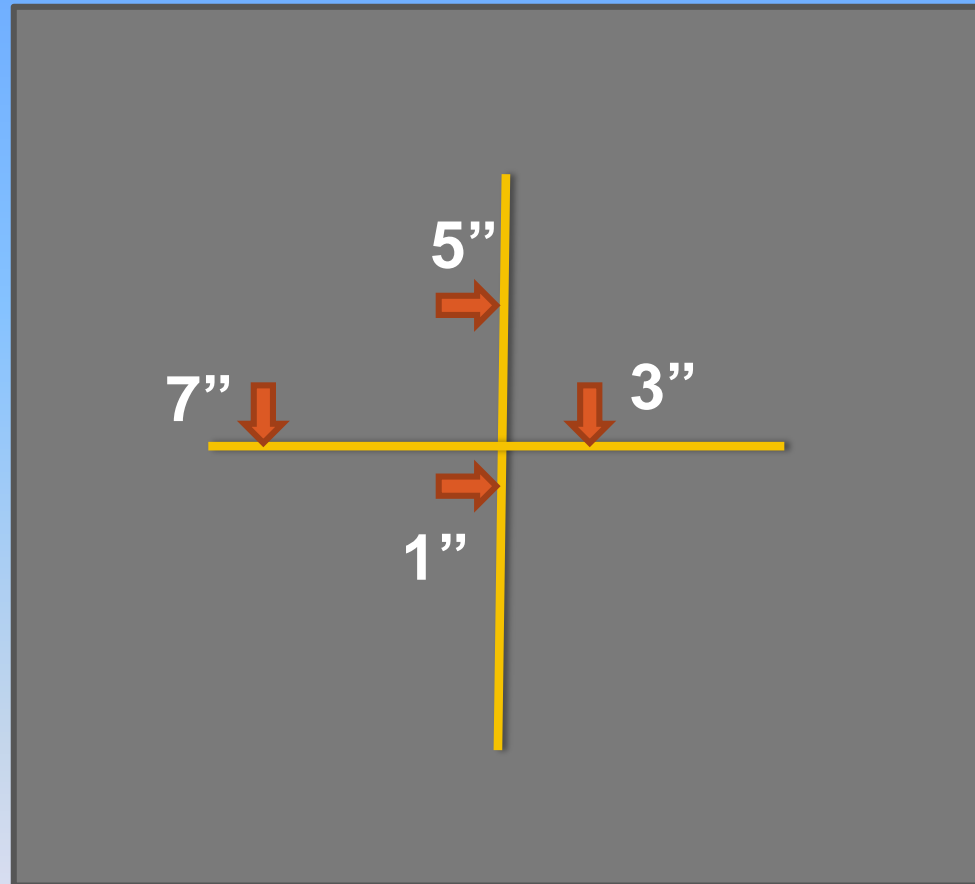
STEAM COSTS – DIRECT FIRE

- ❖ Our Oct. 2015 fuel use numbers were 862 GPA propane (100% coverage)
- ❖ Propane cost \$1.44-1.52/Gal (Oct. 2015) \$1,287/A
- ❖ We are confident that we can improve upon this cost/A

DOMINUS CO-APPLIED WITH STEAM

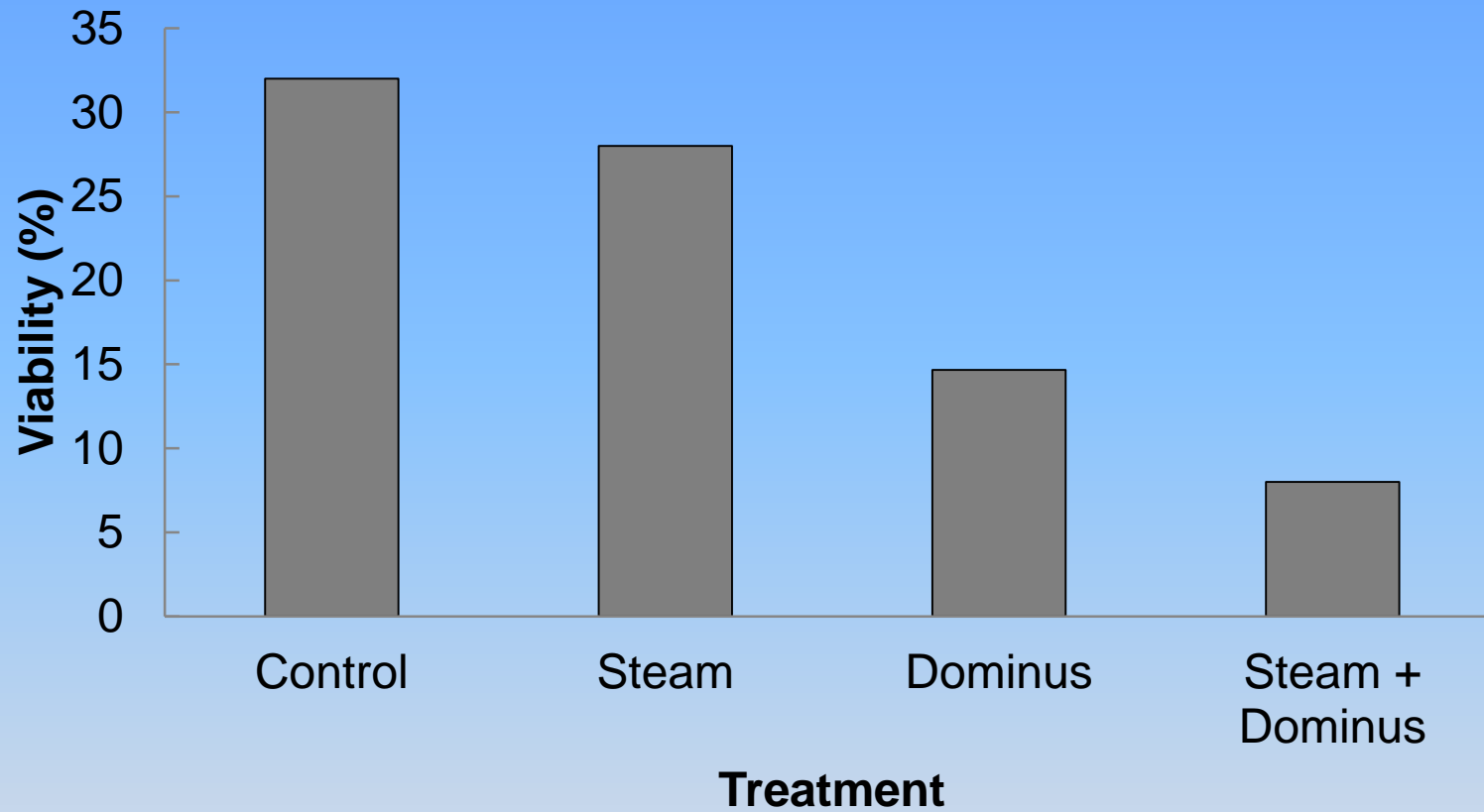


DOMINUS CO-APPLIED WITH STEAM



Injection point
in center
Sample
location 1, 3, 5,
7 inches from
center

Viability of Purslane seeds @ 7 Inches from injection point



THE ESSENTIAL ROLE FOR STEAM

- ❖ **It is a non-fumigant method that kills soil pests in minutes - consistently**
- ❖ **Steam can be a component in a variety of non-fumigant solutions**
- ❖ **Steam is a stand-alone soil disinfestation treatment**
- ❖ **Steam application is compatible with a custom fumigant business**

EXAMPLE: VIGOR

Organic Ranch (Fuji Rd., Salinas CA) high salt levels in Spring and *Verticillium dahliae* pressure

Non-Treated Steam + MSM

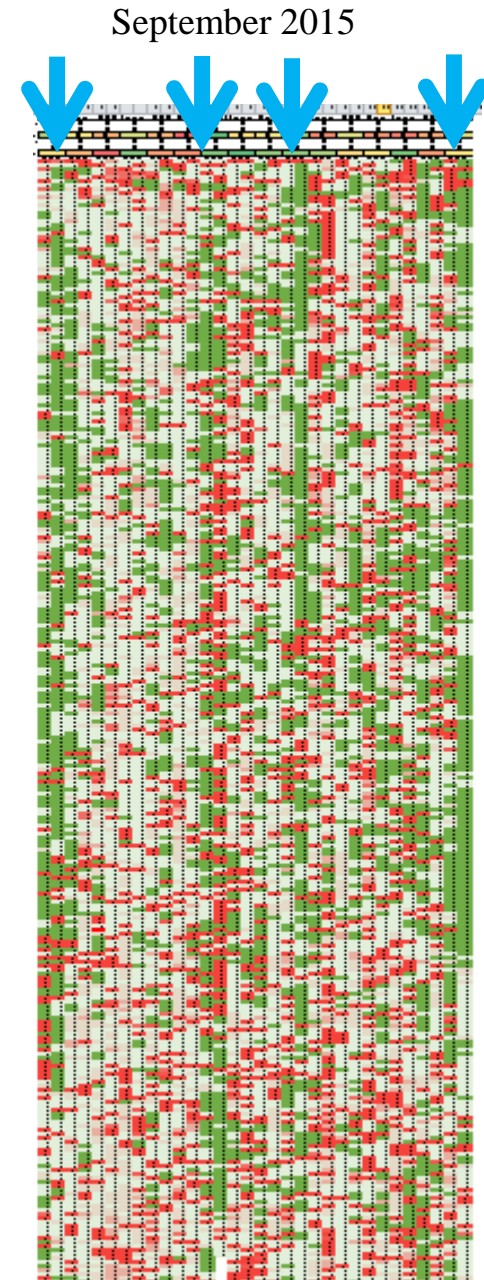
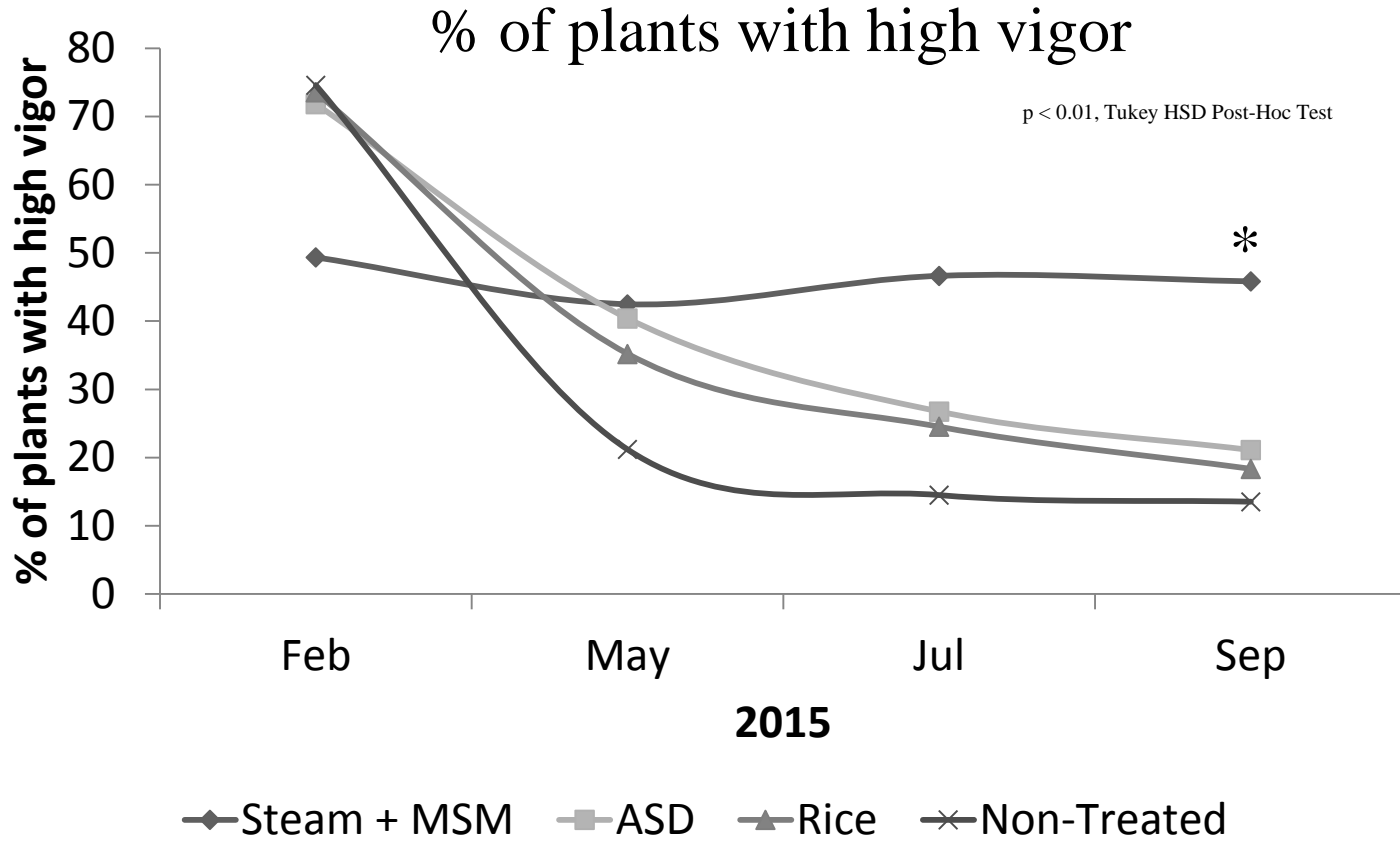
Steam + MSM ASD + Rice



September 2015

EXAMPLE: VIGOR

Organic Ranch (Fuji Rd., Salinas CA) high salt levels in Spring and *Verticillium dahliae* pressure

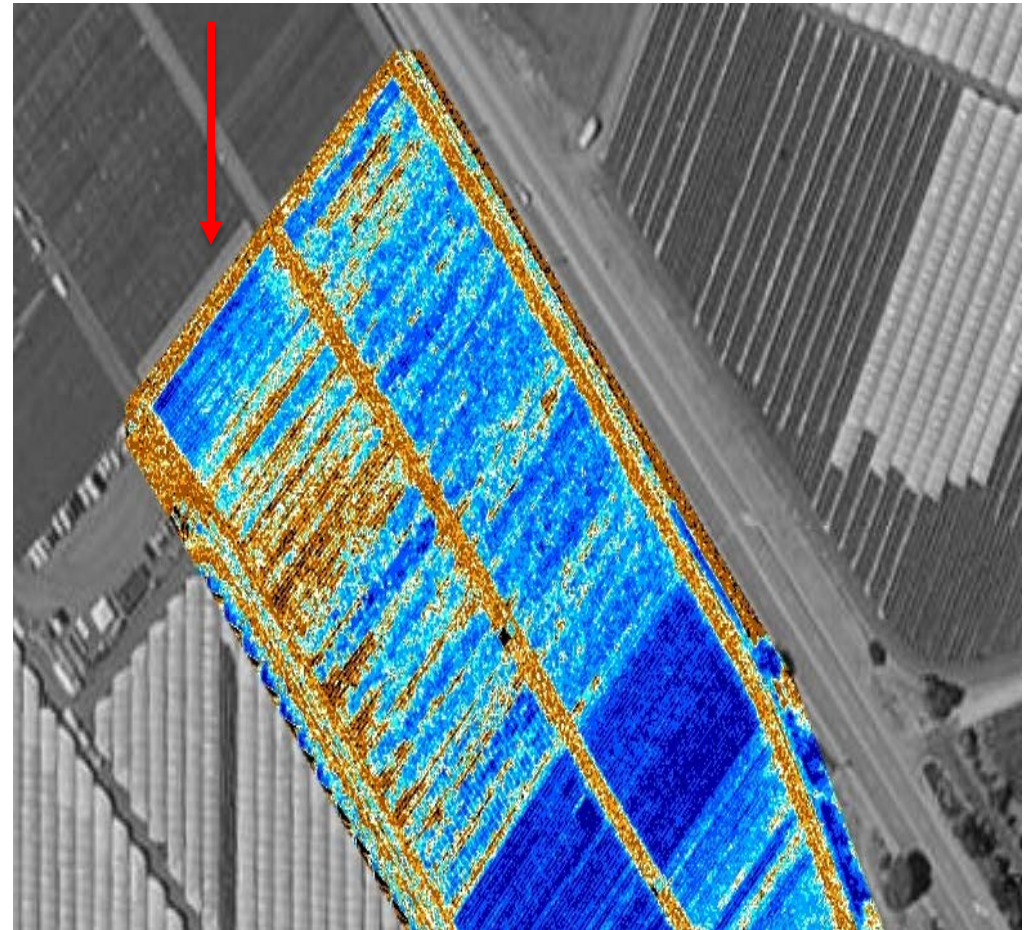


Dark Green = high vigor. Red = dead. Blue arrows indicate steamed beds

	Total Yield per season(%)
Non-Treated	100 %
Rice	113 %
ASD + Rice	121 %
Steam + MSM	151 %

EXAMPLE: VIGOR

Organic Ranch (TCR, Watsonville, CA): *Macrophomina phaseolina* pressure



May 2015

September 2015

PROPOSED UC EXTENSION POSITION

- ❖ **At Salinas field station, within 4 hours of most California strawberries**
- ❖ **Possible areas of focus:**
 - ❖ Production research eg. Chilling requirements
 - ❖ Management of organic strawberry
 - ❖ Sustainable small fruit production
 - ❖ Strawberry nursery production, pest management, others
 - ❖ Fumigant research – fruiting fields and nurseries
- ❖ **Form a research cluster with new USDA Salinas hires**
- ❖ **We are asking for your input and support letters**
- ❖ **This is a permanent UC-funded position**