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The Evolution of Weed Management in Vegetable Production Systems

Nathan Boyd, PhD


SCOPE


Row Middle
Planting
hole
Plastic

The History of Weed Management

HISTORY OF WEED MANAGEMENT

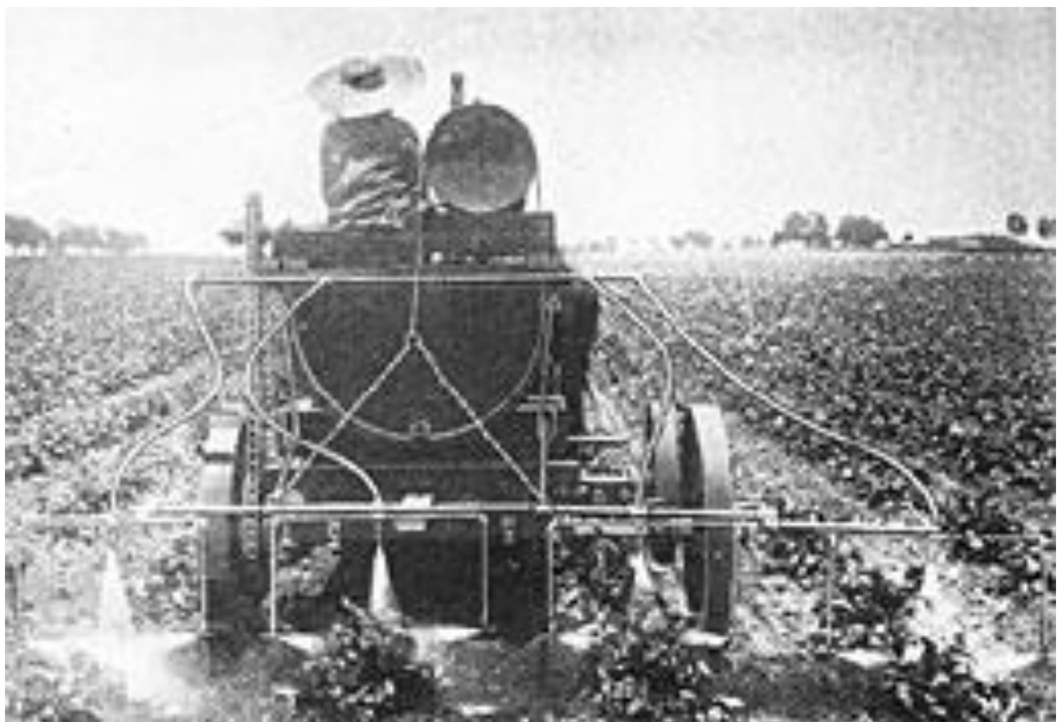
- Biblical references
- *I passed by the field of the sluggard And by the vineyard of the man lacking sense, And behold, it was completely overgrown with thistles; Its surface was covered with nettles.   Proverbs 24:30-31*
- Weed management varied very little until the 18th century

1900-1941

- Accidental discovery in France that inorganic salts control broadleaf weeds
- Early herbicides included copper nitrate, ammonium salts, sulfuric acid, and others for weed control in grain crops

2,4-D (1941)

- 2,4-dichlorophenoxyacetic acid first synthesized in 1941
- 2,4-D is highly effective, used at low doses, and cheap to produce



Early herbicide sprayer. NSHS.

UF | 1950s and 1960s

- Late 1950 and early 1960 atrazine, simazine, dicamba, linuron, alachlor, and DCPA were all introduced
- Transformation from tillage and hand labor to herbicides
- Introduction of Paraquat made no-tillage a viable option for the first time ever

1970’s and 1980’s

- Glyphosate introduced in the early 1970’s
- In the 1980’s was the first decade where the rate of soil erosion decreased rather than increased
- Introduction of many new low input products with greater environmental safety

1980 and 2000+

-Regulation
-$ of registration
-Herbicide resistant weeds

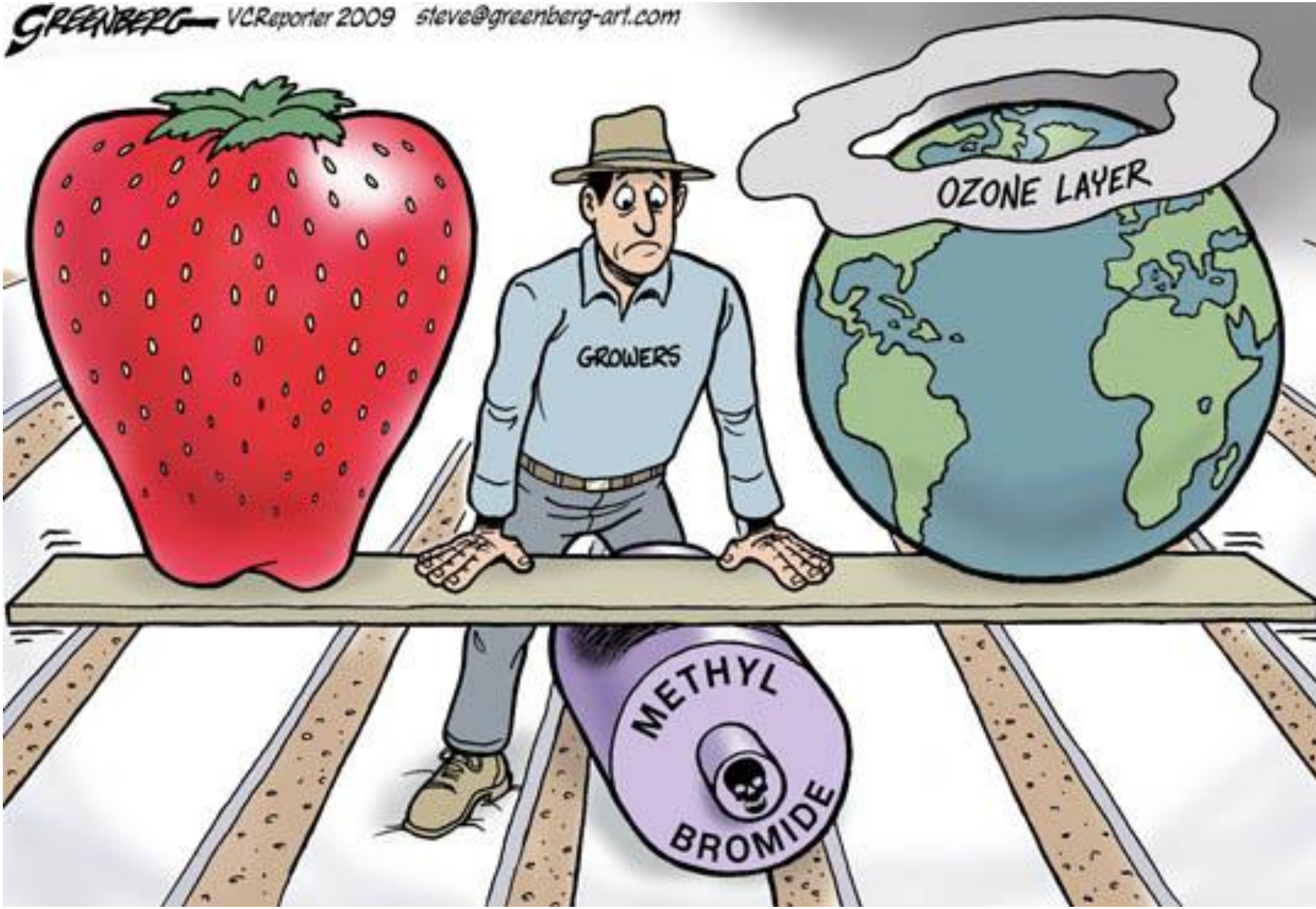
-No. of new herbicides
-Public perception of
 pesticides

American Black Nightshade - Paraquat

Goosegrass
- Paraquat

Ragweed Parthenium
- glyphosate

Ragweed Parthenium
- glyphosate

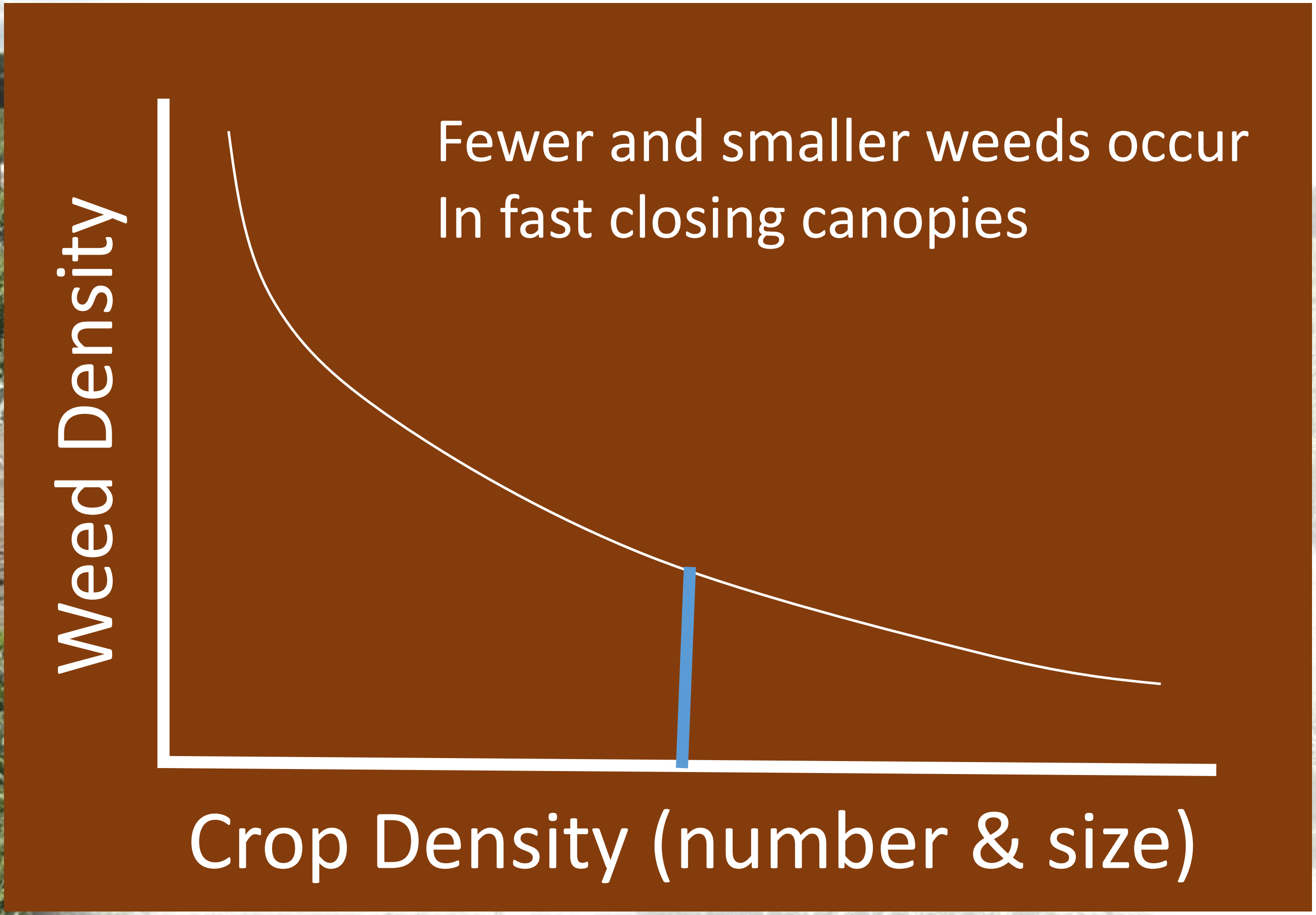

GREENBERG VCReporter 2009 steve@greenberg-art.com
OZONE LAYER
GROWERS
METHYL BROMIDE

Current Situation

- Limited herbicides available for specialty crops
- Limited number of herbicides in the pipeline
- Registered fumigants tend to provide poor or inconsistent weed control
- More intensive production


Fallow Program-

Planting Density



Chickweed Under Cover Crops 64 Days After Planting

	Legume-Rye	Mustard	Rye
1x Seeding Rate			
3x Seeding Rate			


Fallow Program-


Fumigation-


Herbicides

FUMIGANTS

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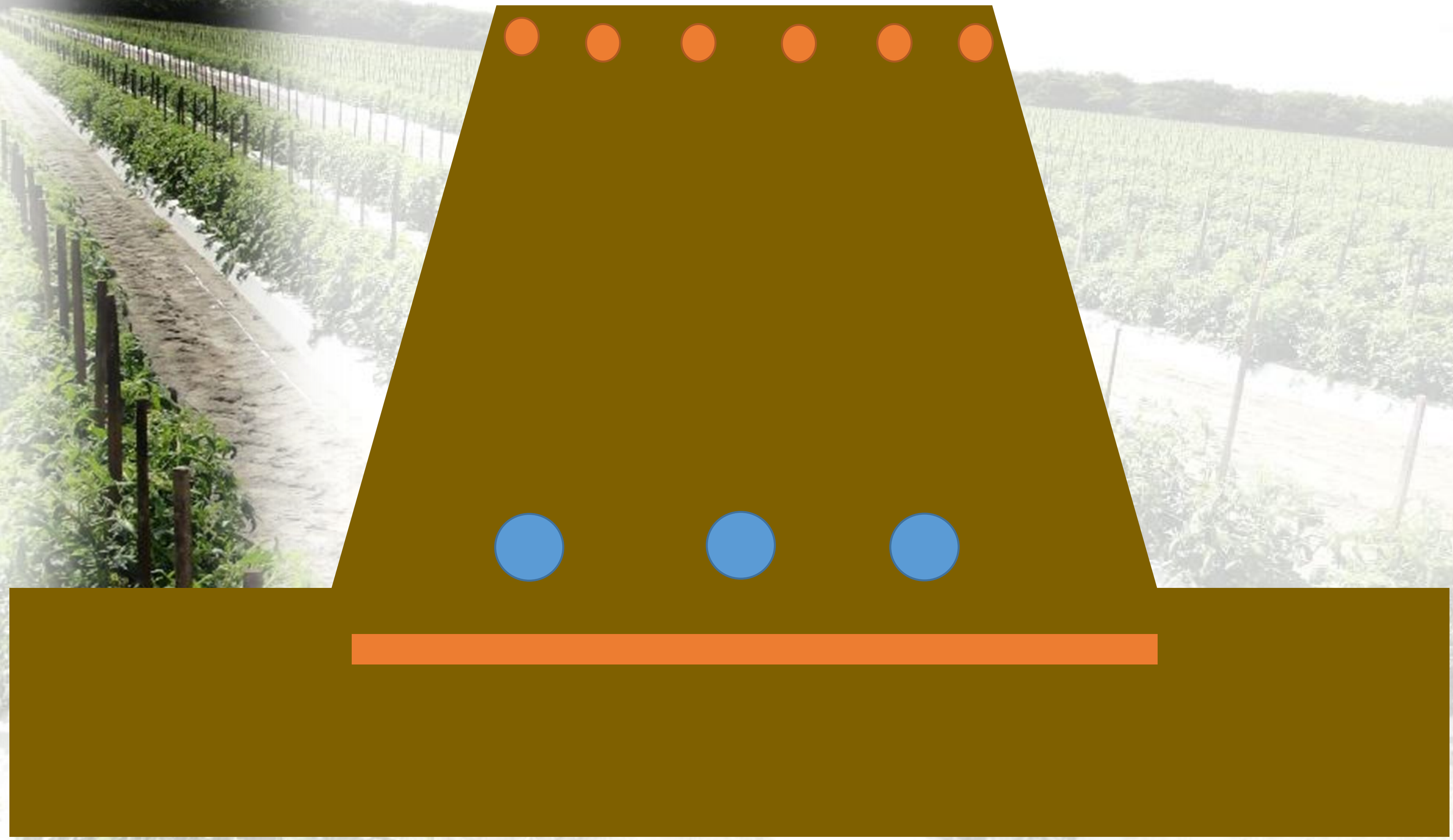
Fumigant Placement

Fumigant Placement



Fumigant Placement

Fumigant	Metam Potassium	Fall 2014	Spring 2015
		----nutsedge 10 m^{-2}----	
Nontreated	Nontreated	46 a 91%	99 a 65%
	4”	4 bc	35 bcd
	12”	17 ab	53 ab
	4 & 12”	2 c	37 bc
DMDS	Nontreated	2 c	16 cd
	4”	0 c	1 f
	12”	3 c	2 cde
	4 & 12”	0 c	1 f
DMDS (70%) + Pic (21%)	Nontreated	0 c	1f
	4”	0 c	1 f
	12”	1 c	1 f
	4 & 12”	0 c	1 f
1,3-D (39%) + Pic (60%)	Nontreated	3 c	2 ef
	4”	2 c	1 f
	12”	1 c	2 ef
	4 & 12”	0 c	1 f

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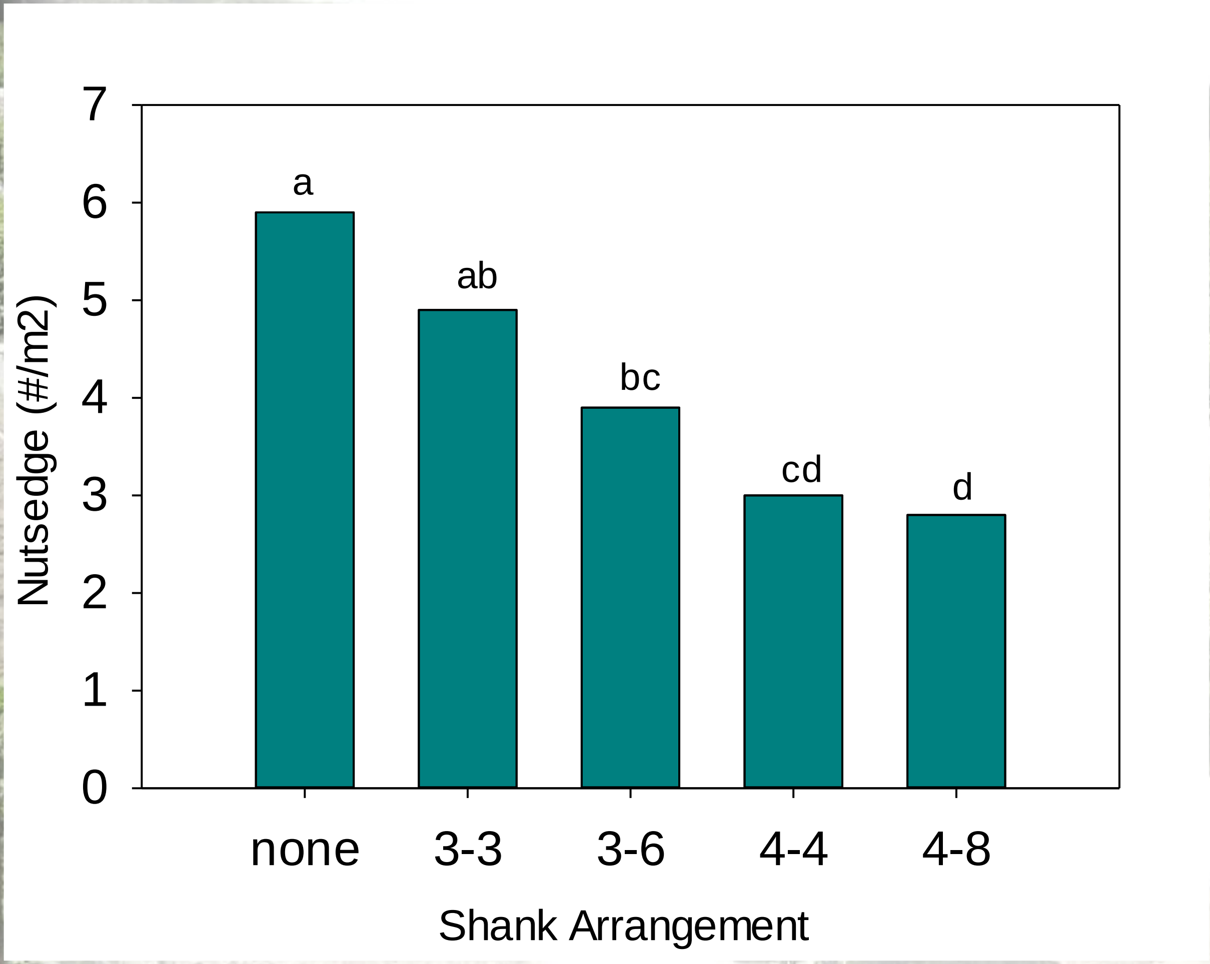
Multi-Port Trials

3 shanks – 6 streams
4 shanks – 8 streams

3 shanks – 3 streams
4 shanks – 4 streams

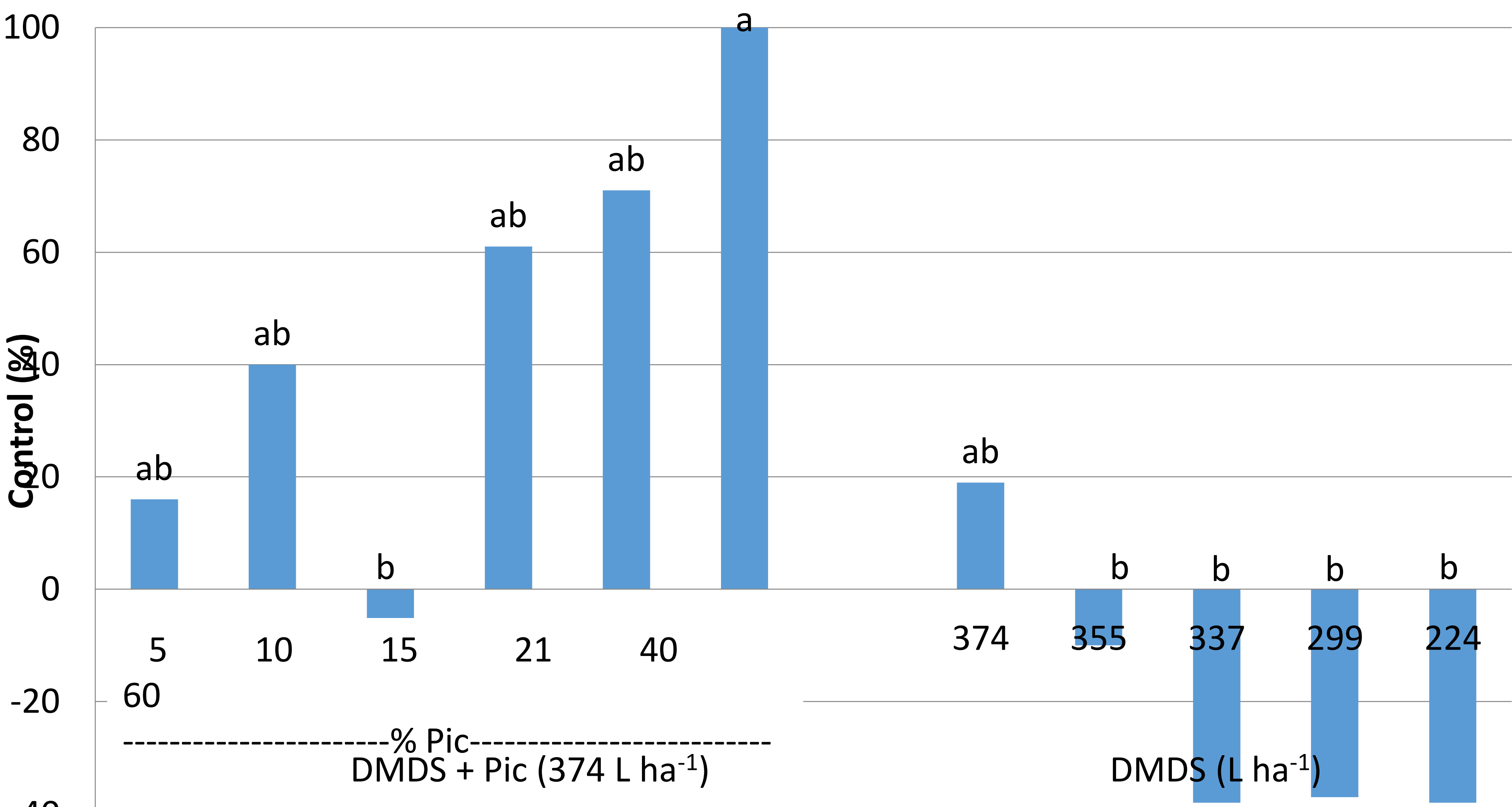
Nutsedge Counts (K-Pam)



Fumigant
Rate and Ratio

Purple nutsedge, 13 WATP (Fall Experiment)

Time x treatment interaction = 0.0119; nontreated control = 152 weeds m^{-2}



Bars with different letters indicate significant differences between treatments

374 L ha^{-1} (95% DMDS + 5% Pic)


Early season


Middle season


Late season

374 L ha^{-1} (79% DMDS + 21% Pic)

Early season | Middle season | Late season

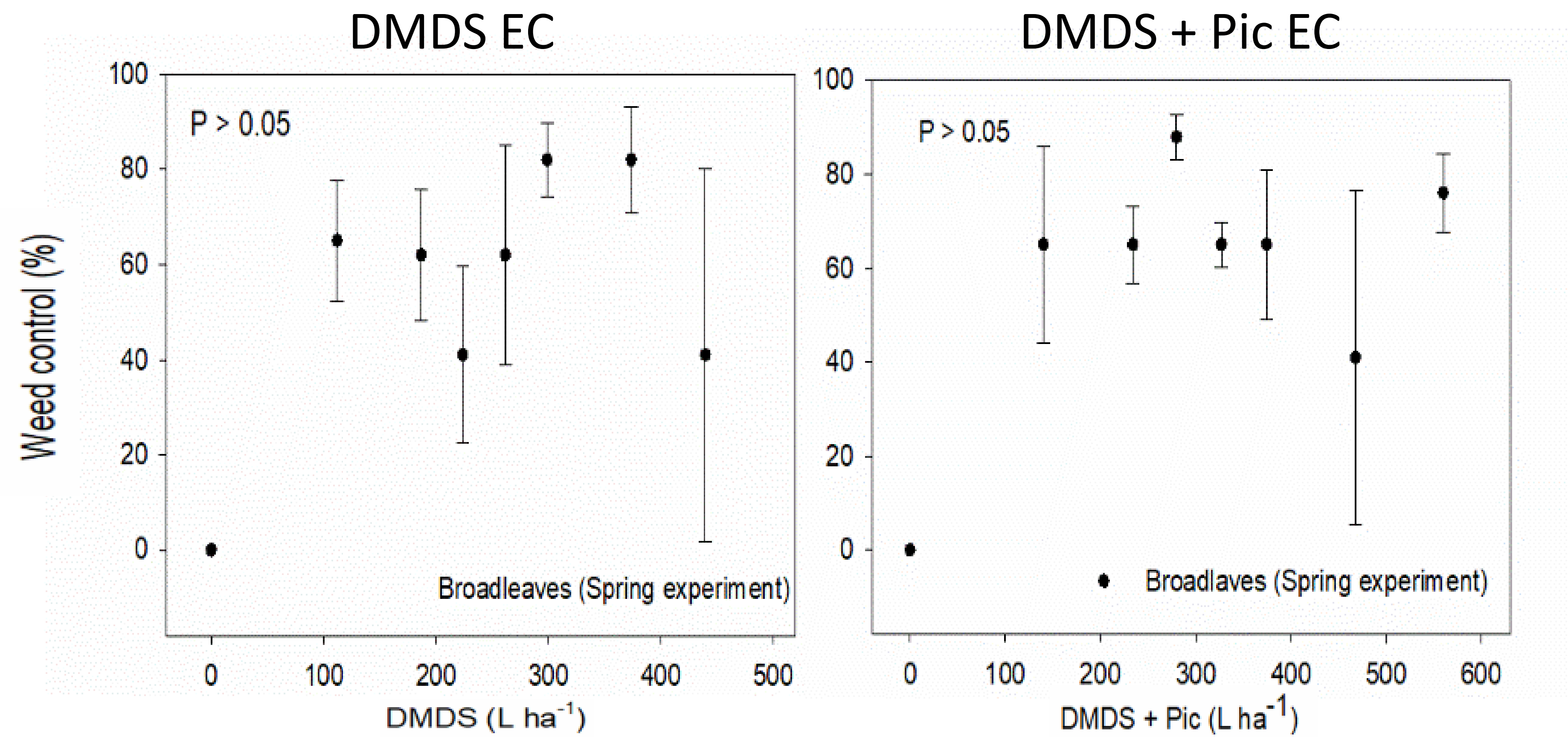
374 L ha^{-1} (40% DMDS + 60% Pic)

Early season

Middle season

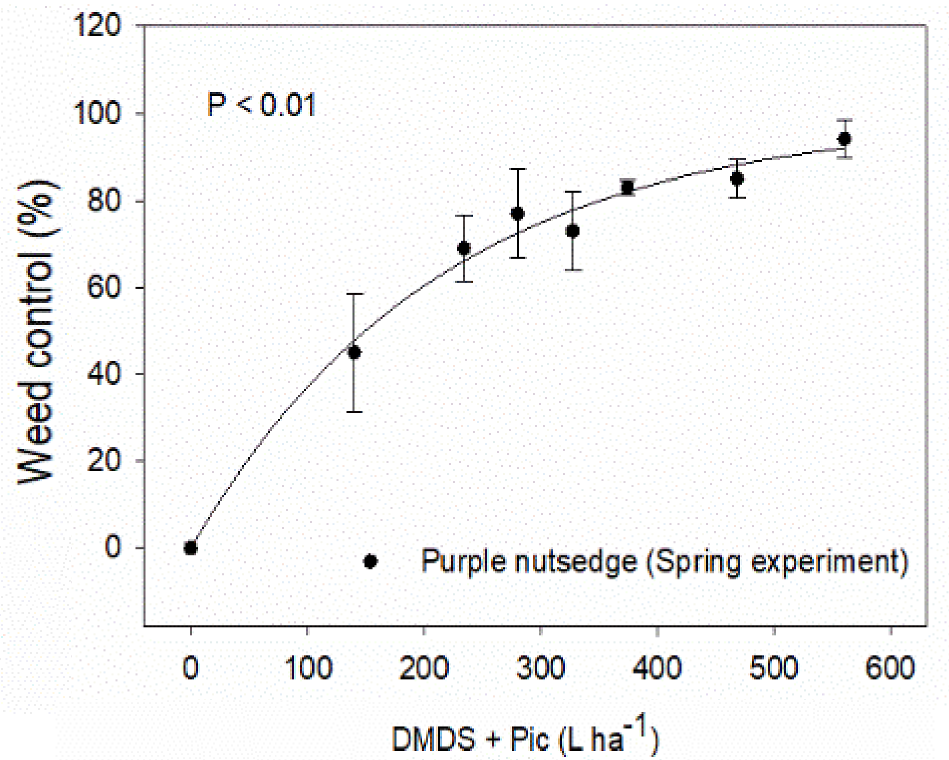
Late season

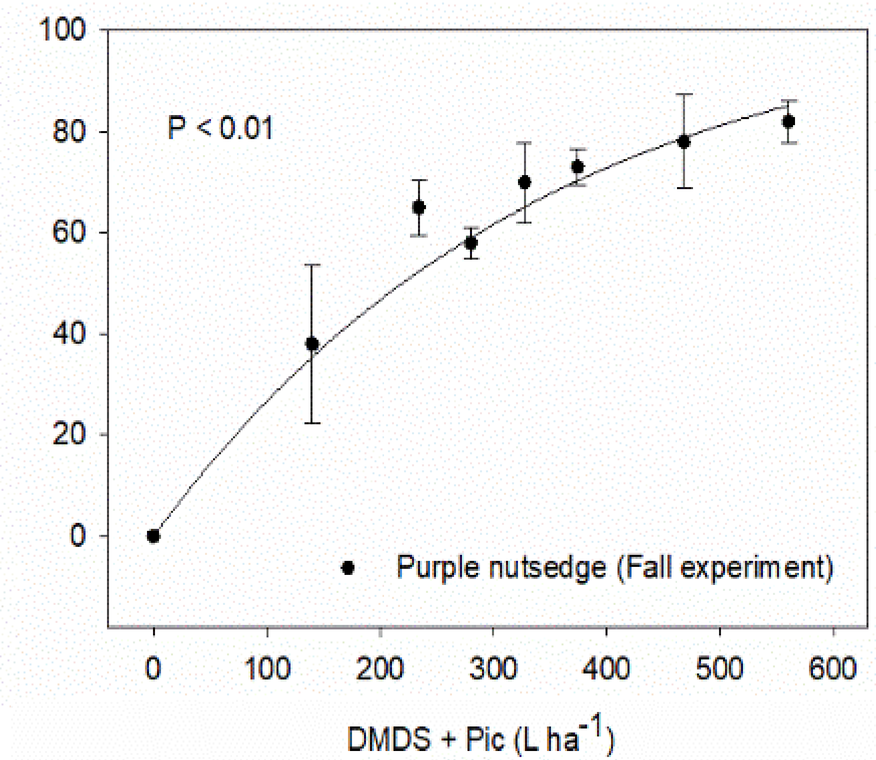
Control of Broadleaf Weeds (Spring Experiment)



Estimated rate required to control 50% (ER_{50}) or 80% (ER_{80}) broadleaf weeds was not determined.

Purple Nutsedge Control (DMDS + Pic EC)





Experiment	R^2	ER_{50}	95% CI for ER_{50}	ER_{80}	95% CI for ER_{80}
		----------------------------------L ha^{-1}----------------------------------			
Spring Experiment	0.81	150	114 – 186	350	275 – 428
Fall Experiment	0.78	200	142 – 258	500	406 – 594

Abbreviation: CI, confidence interval

Late Season Weed Control (DMDS EC)

Non-fumigant control

440 L ha^{-1} DMDS EC

262 L ha^{-1} DMDS EC

112 L ha^{-1} DMDS EC

Late Season Weed Control (DMDS + Pic EC)

Non-fumigant control

560 L ha^{-1} DMDS + Pic EC

374 L ha^{-1} DMDS + Pic EC

140 L ha^{-1} DMDS + Pic EC

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Fumigant Type - Ethanedinitrile (EDN)

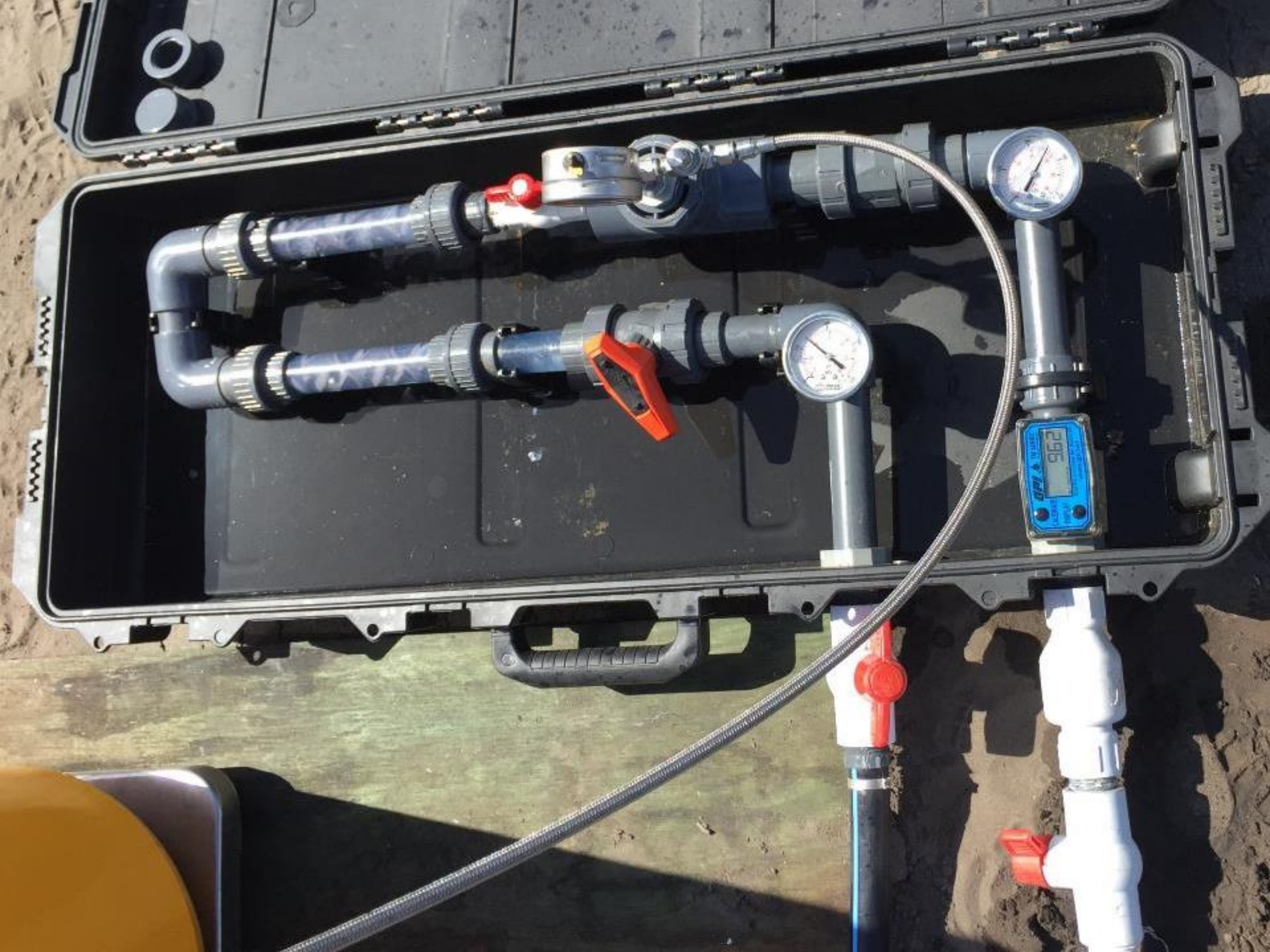
Desirable Properties of EDN

EDN

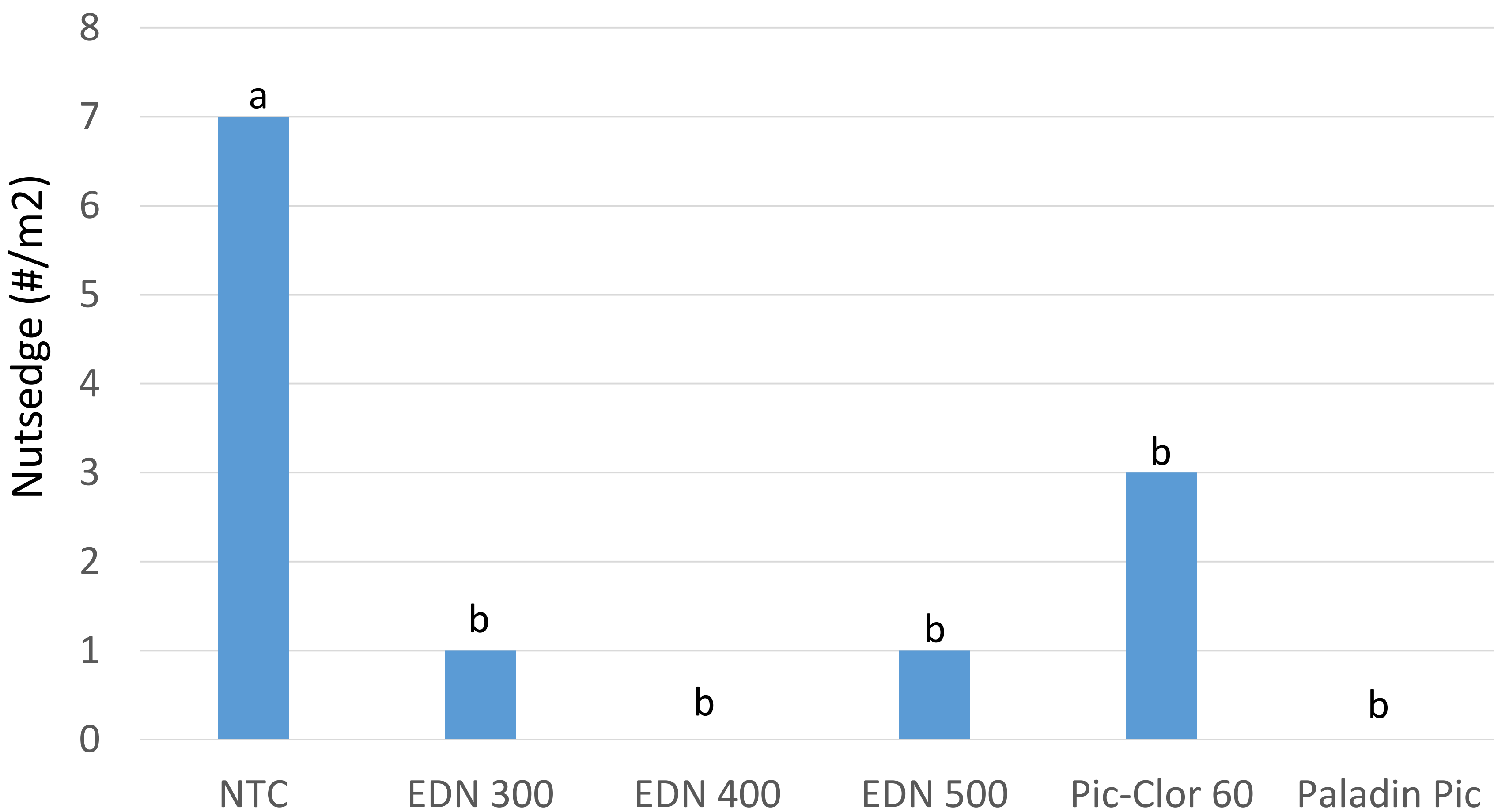
- Boiling point: -21 C
- Vapor pressure: 515 kPa

Methyl Bromide

- Boiling point: 3.6 C
- Vapor pressure: 214 kPa



Nutsedge Counts




Nontreated


300 lbs EDN


400 lbs EDN

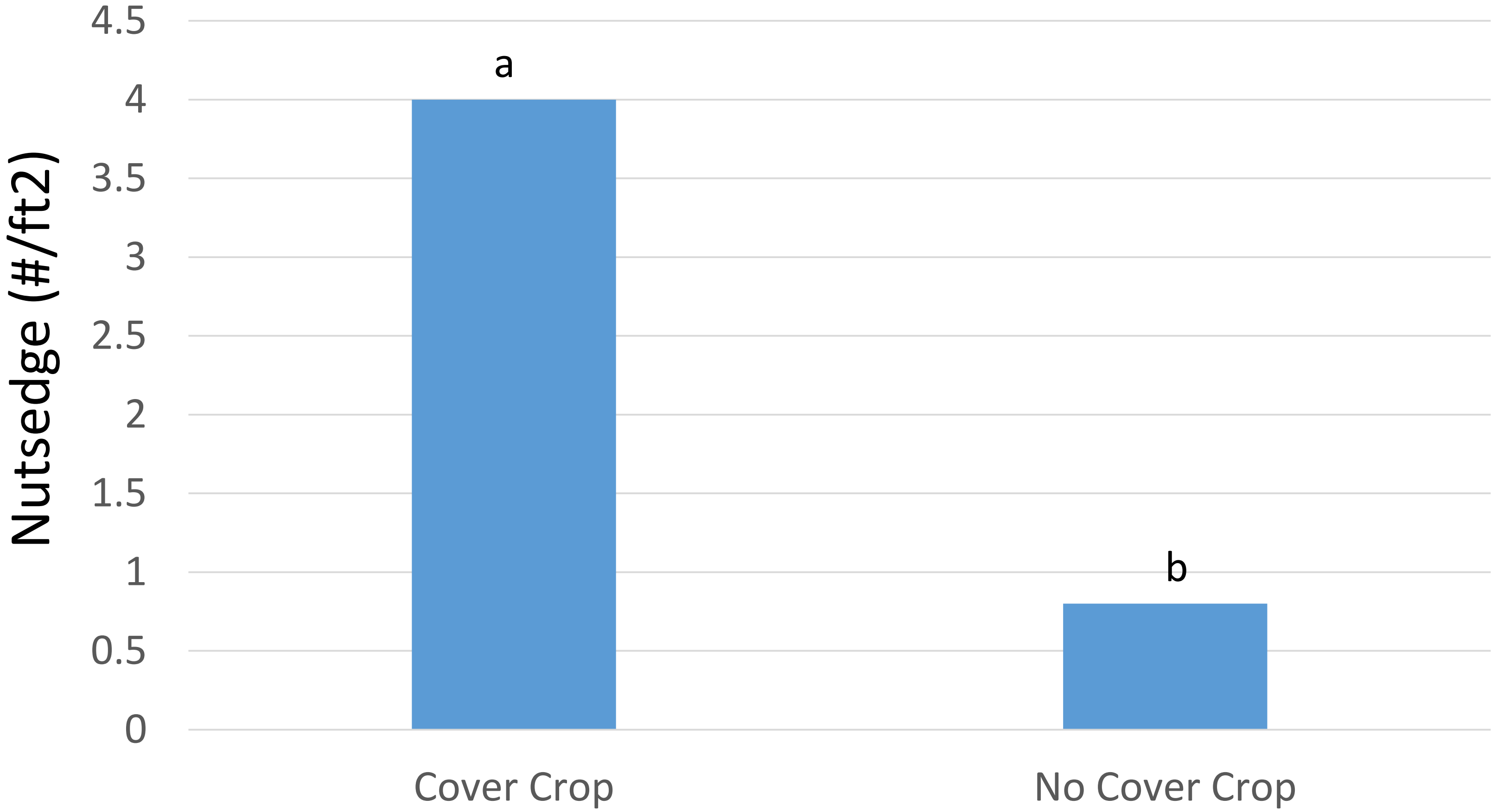
Nontreated

Pic-Clor 60

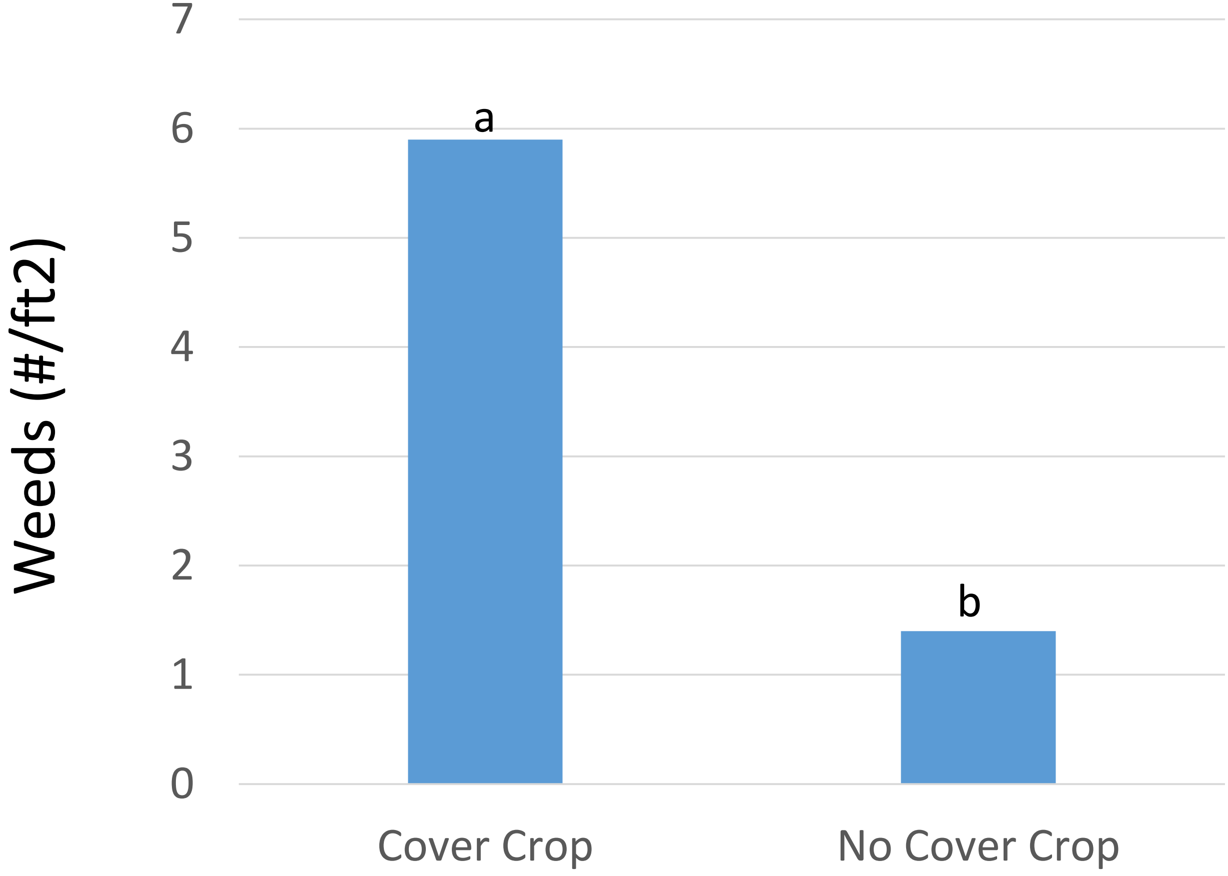
Paladin Pic-21

Cover Crops and Fumigants

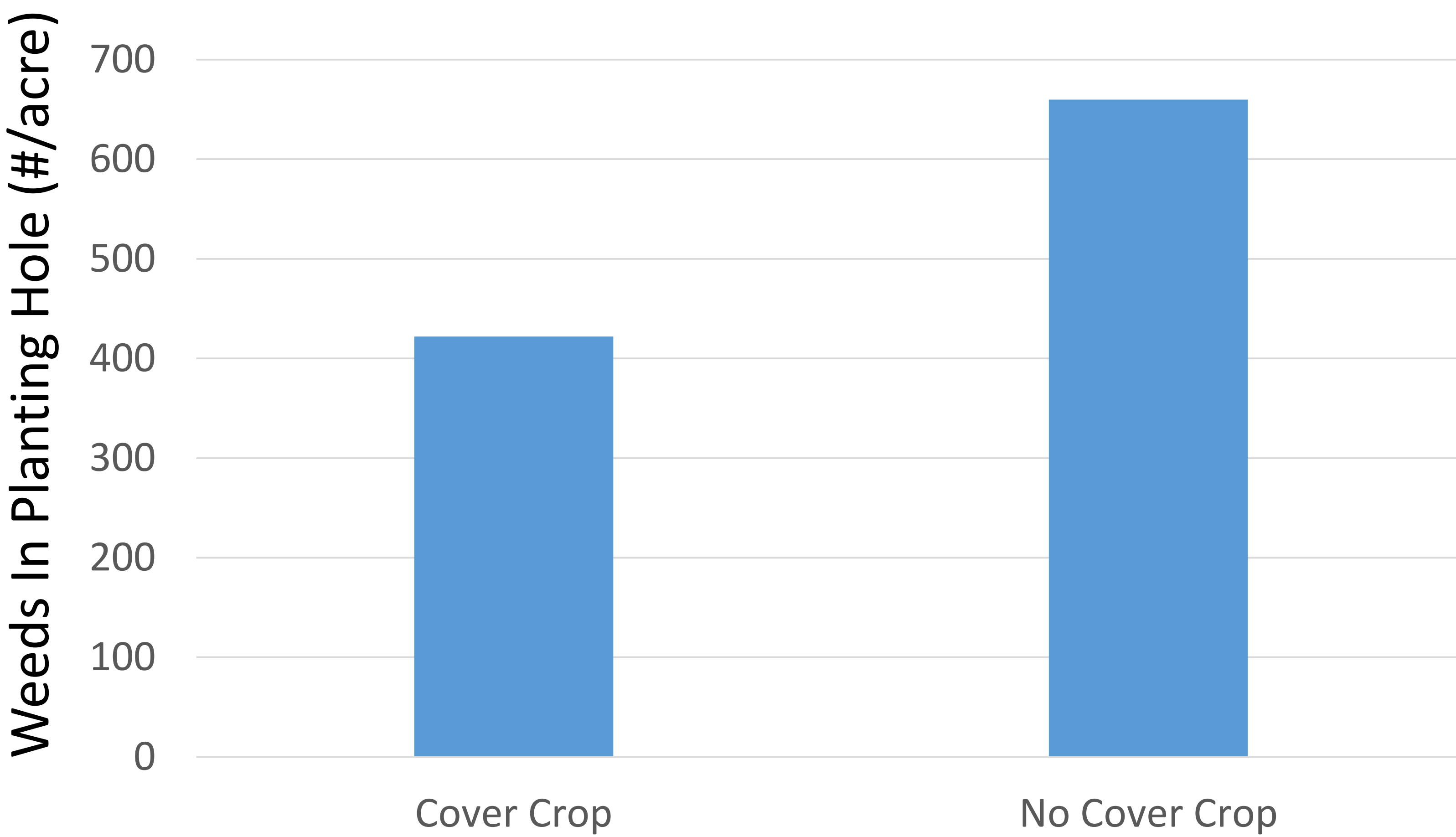
Nutsedge density during the fallow period in the presence and absence of a cover crop in 2017



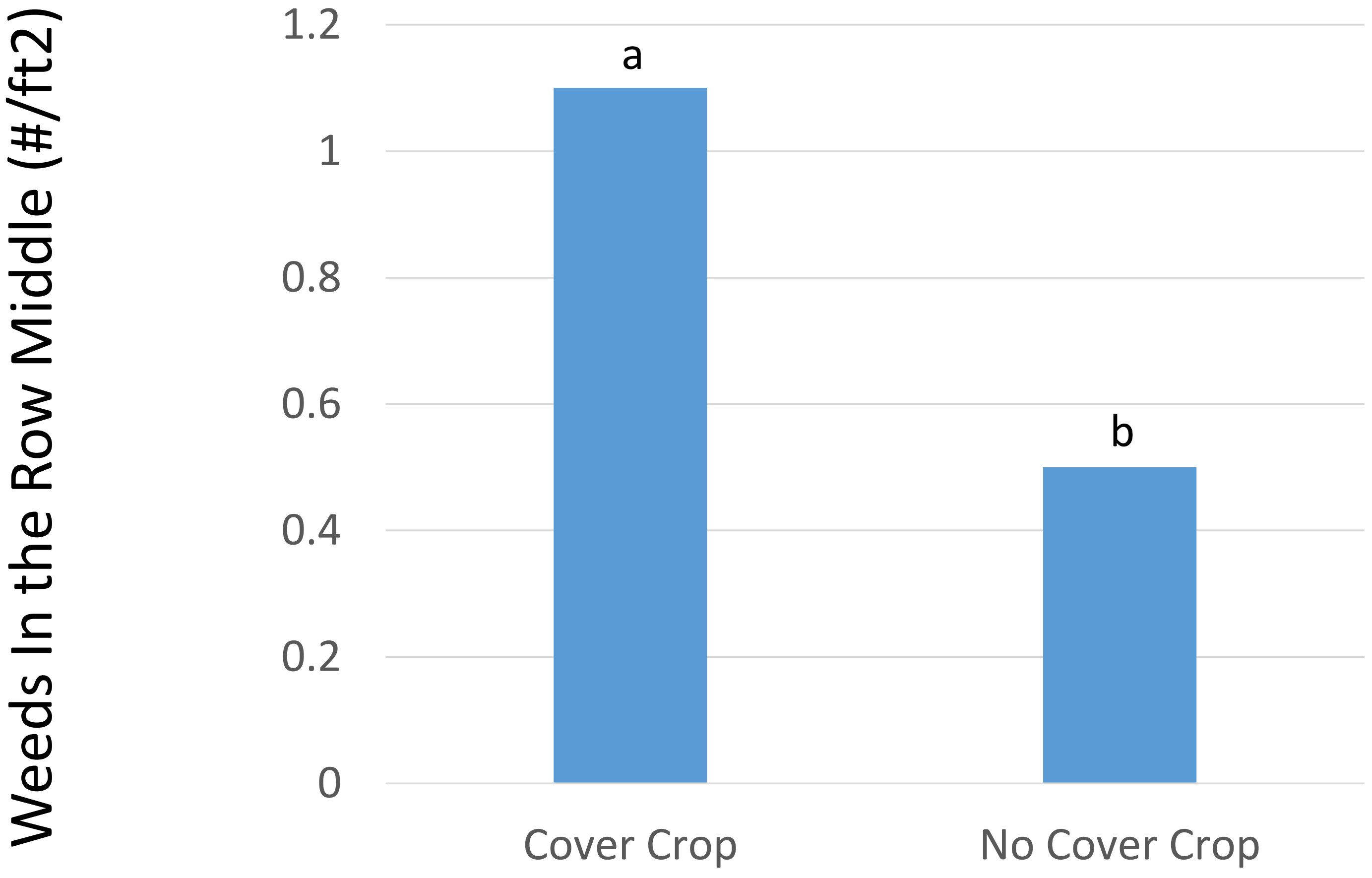
Broadleaf weeds in the cover crop in 2017



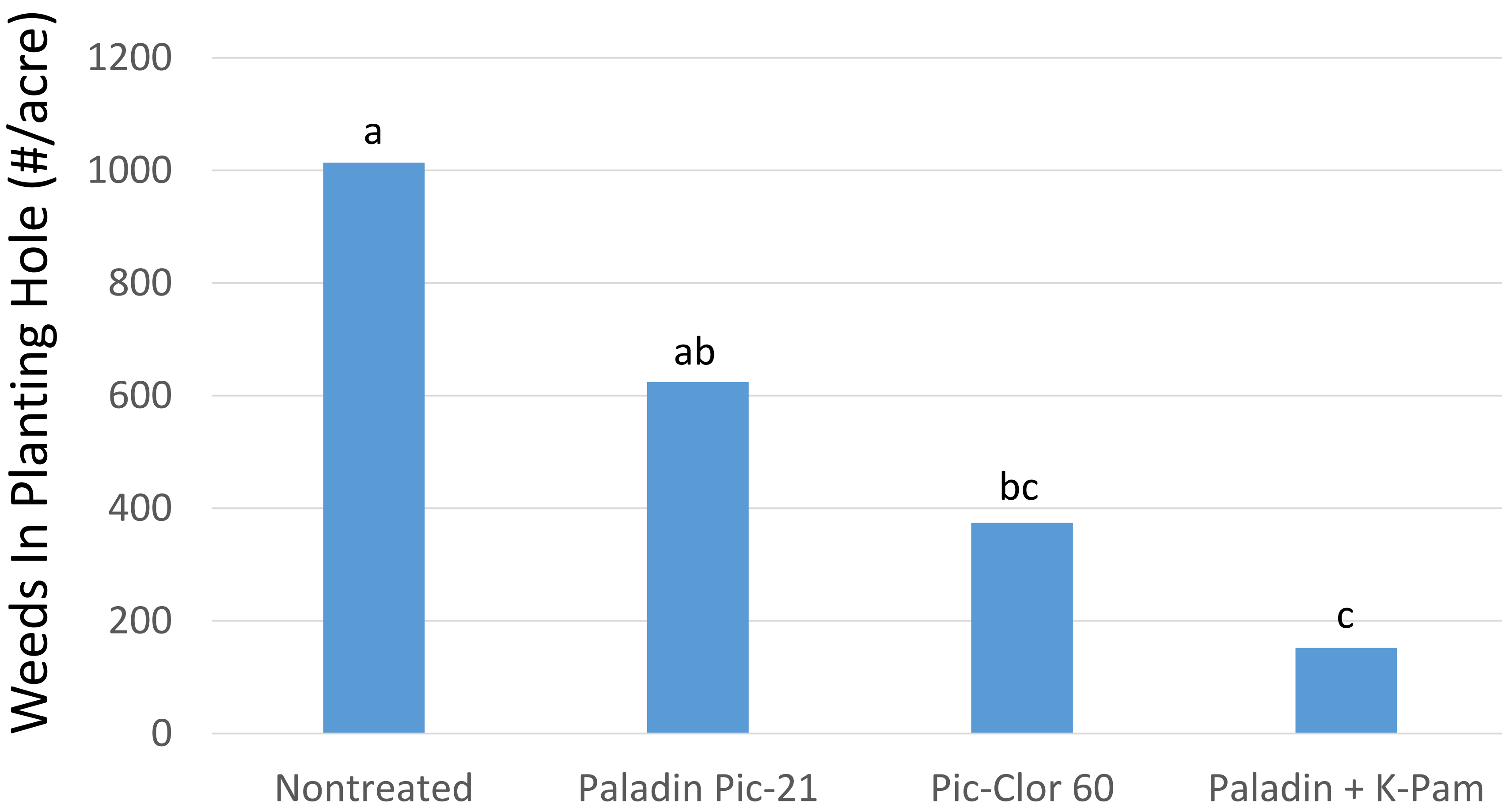
Broadleaf weeds in the planting hole at harvest with and without a cover crop in 2017



Broadleaf weeds in the row middle at harvest with and without a cover crop



Broadleaf weeds in the planting holes at harvest averaged across sites in 2017



Nontreated

Paladin Pic-21

Pic-Clor 60

Paladin + K-Pam

Summary

- Fumigant placement can enhance weed control.
- Supplemental metam potassium or similar products can enhance weed control
- Fumigants on their own may not adequately control broadleaf weeds
- Fumigants can adequately control nutsedge if applied at the correct rate or ratio

Purple Nutsedge (*Cyperus rotundus*) Control in Tomato

Nathan Boyd and Jialin Yu

Introduction

- Low Density Polyethylene Films (LDPE)
  - Mono-layer polyethylene
- Virtually Impermeable Films (VIF)

- Totally Impermeable Films (TIF)

EXPERIMENT 1: RESULTS

Plastic mulch	Site 3
	3 WAT
	------# m^{-2}------
LDPE	68 a
LDPE + halosulfuron	9 b
VIF	21 b
VIF + halosulfuron	1 b
VIF releasing halosulfuron	0 b
TIF	1 b
P value	0.0037

EXPERIMENT 2: RESULTS

	Fall 2014	Spring 2015
	------------------# m^{-2}------------------	
LDPE	15 a	15 a
Blockade VIF	7 b	10 b
Blockade VIF – No fumigant	1 d	1 d
Total Blockade VIF	2 c	7 b
VaporSafe TIF	1 d	6 bc
VaporSafe TIF – No fumigant	1 d	2 cd
P value	0.0001	<0.0001

LDPE versus Blockade VIF: 33-53% reduction
LDPE versus Blockade TIF: 53-87% reduction
Blockade VIF versus Blockade TIF: 30-71% reduction

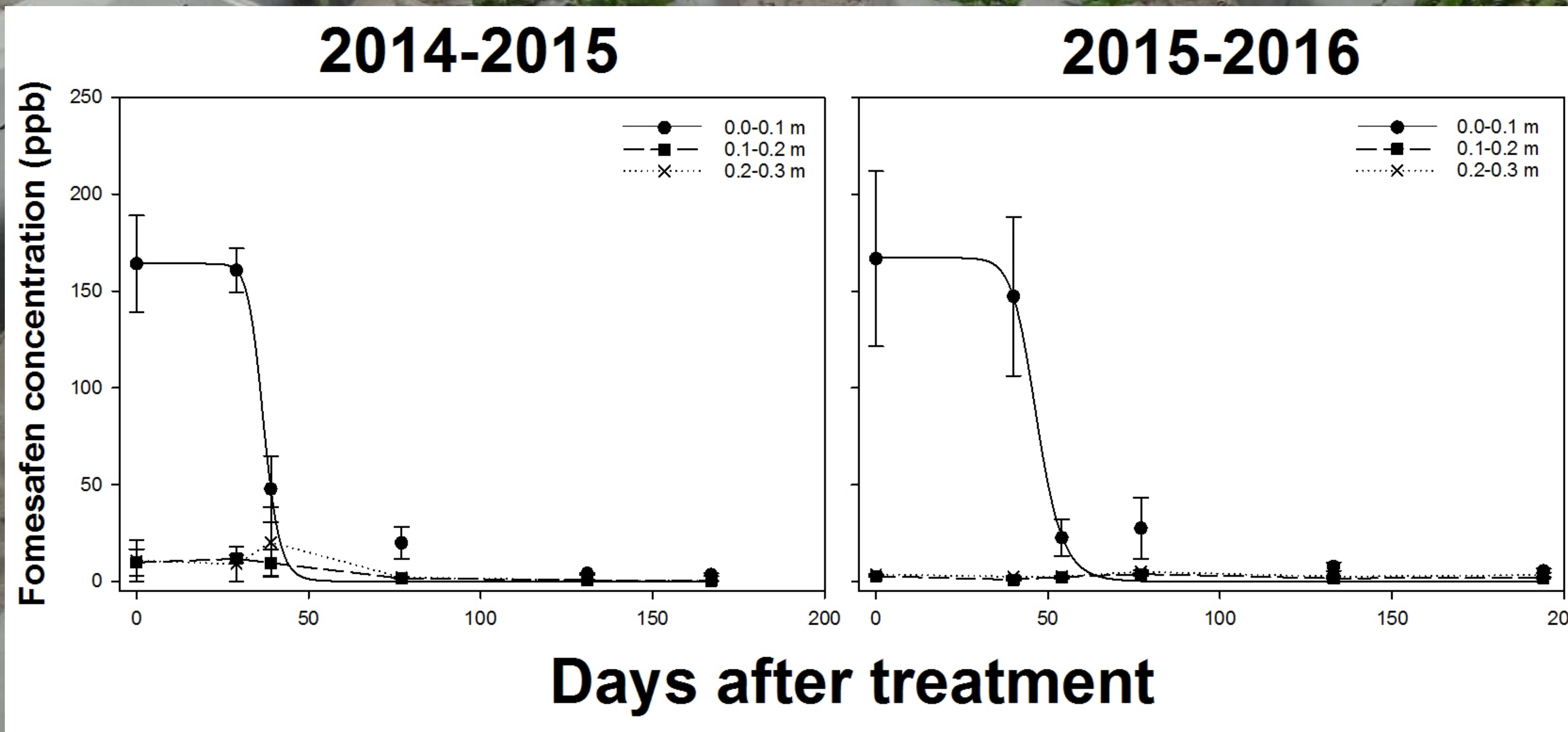
HERBICIDES

Herbicides Under Plastic Mulch

Fomesafen persistence under plastic in vegetable fields

	Fomesafen concentration (DAT[a])		
Plastic mulch[b]	0[c]	19	103
	------------------------	ppb	----------------------
None	150 (A[e])	59 a[f] (B)	7 a (C)
Clear	176 (A)	67 a (B)	36 a (B)
LDPE	139	138 b	101 b
VIF	176	177 b	117 b
TIF	184	142 b	99 b
p-value	0.9372	0.0005	0.0086

Fomesafen persistence under plastic in strawberry fields




Effects of application technique on weed density and crop yield

Application Technique	Weed density		Crop yield	
	Pepper	Tomato	Pepper	Tomato
	--------# m^{-2}--------		-----kg $plant^{-1}$----	
Broadcast	0.4	1.1	0.29	1.86
Precision application	0.4	1.1	0.31	2.20
P value	0.7301	0.6150	0.4925	0.0891

	Spray coverage	Excess coverage	Use Reduction
Treatment	---cm^2---	--cm^{-2}--	--%--
Napropamide	746 b[a]	714 b	91 a
S-metolachlor	849 a	817 a	90 b
P value	0.0053	0.0050	0.0053

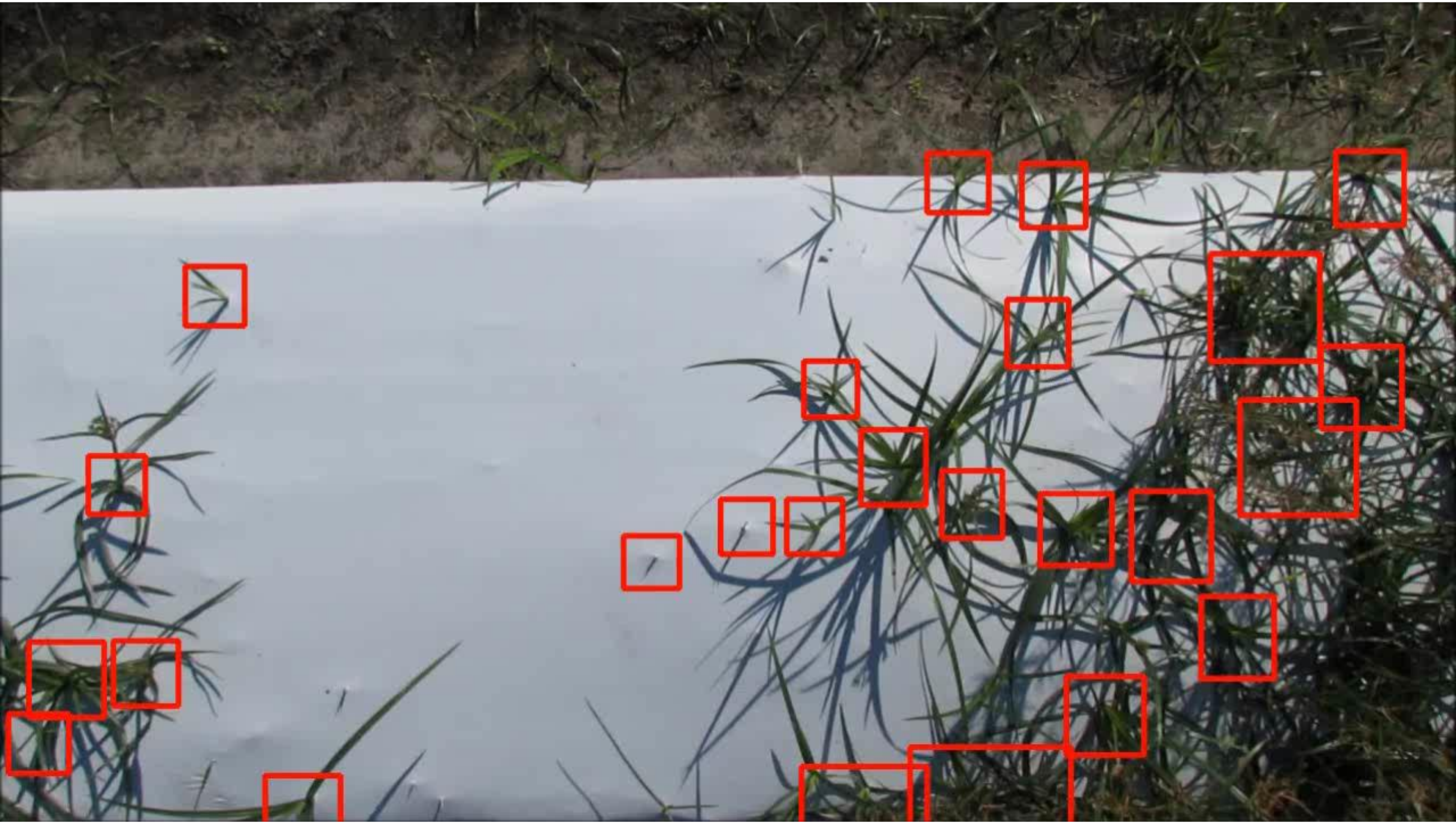
Summary

- Precision herbicide applications had no effect on crop growth or yield
- Herbicide reductions achieved using the precision applicator versus broadcast bed top applications ranged from 88-91%
- Accuracy with current version is near 100%

Potential Benefits

- A reduction in off-target applications
- Reduced herbicide usage
- Reduced crop damage
- Herbicide applications closer to transplant

Automated object detection: nutsedge weed detection



Schumann & Boyd, 2017

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RESULTS

Accuracy of spray decisions based on independent validation:

- incorrect OFF: 5% ***(unsprayed nutsedge)***
- incorrect ON: 1% ***(unnecessary herbicide use)***
- correct ON or OFF: 94%

TOTAL: 100%

Overall accuracy for correct decisions:

- correct ON (100-1): 99%
- correct OFF (100-5): 95%

Potential herbicide saving based on % OFF decisions: 44%

Summary

- Fumigants can control nutsedge but are weak on broadleaves and grasses
- Preemergence herbicides are weak on nutsedges but can work on broadleaf weeds and grasses
- Machine vision and artificial neural networks are likely to modify horticulture dramatically.