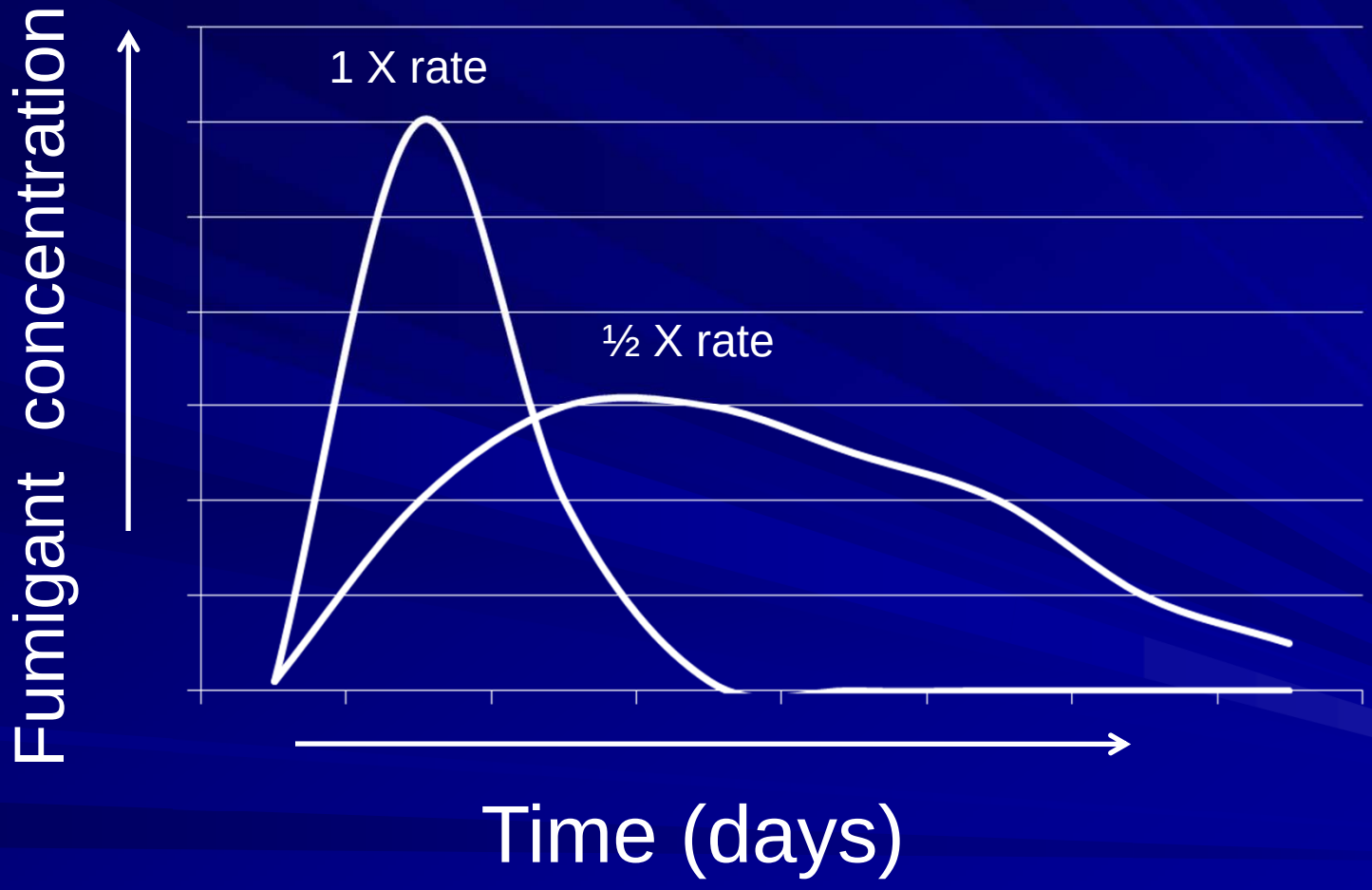
New Developments in Flat Fumigation

Dan Chellemi, USDA, ARS


Control
BLK II
Clear
½ MB

Fumigant effectiveness in soil determined by the *CT* value
i.e., the time weighted exposure concentration



Advantages of increasing exposure time to achieve required *CT* value

- Economics – cutting application rates by 50% or greater will reduce costs significantly
- Regulatory – eliminating fumigant emissions will reduce required buffer zones, PPE restrictions and township caps

Disadvantages of increasing exposure time

- Management: requires additional supervision and maintenance of treated area
- Time: must wait 10 – 21 days to complete the fumigation process

Fumigant properties

Fumigant	Boiling point	Vapor pressure	Water/air
Methyl bromide	38 F	1600	4
Methyl iodide	108 F	398	
Chloropicrin	236 F	18	11
1,3-D	219 F	34	24
MITC	246 F	19	92


10/2/2007 11:25am


NON POTABLE WATER
4/3/2007 9:09

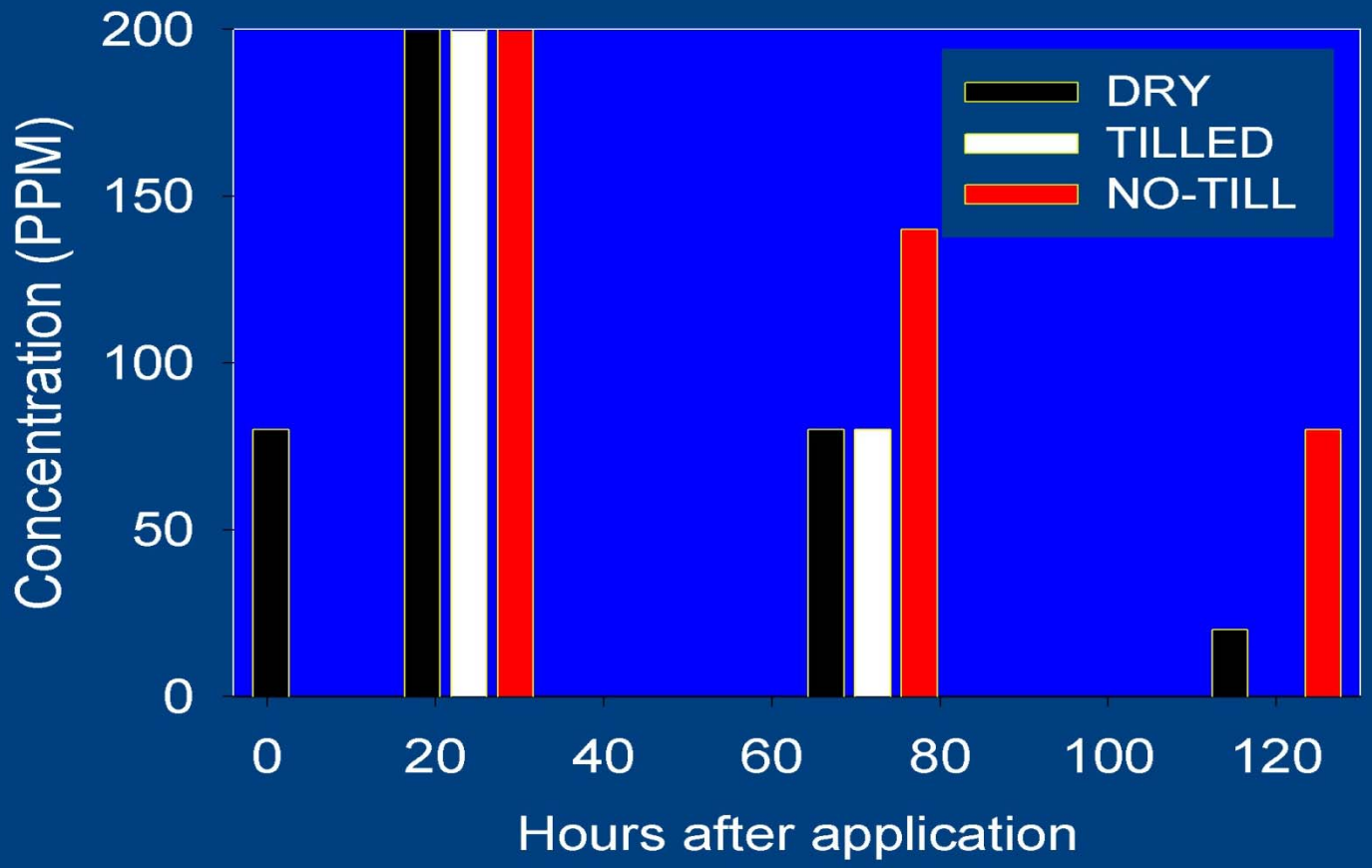
Management practices directly impacting fumigant retention in soil

- Soil tillage prior to application


4/3/2007 11:03

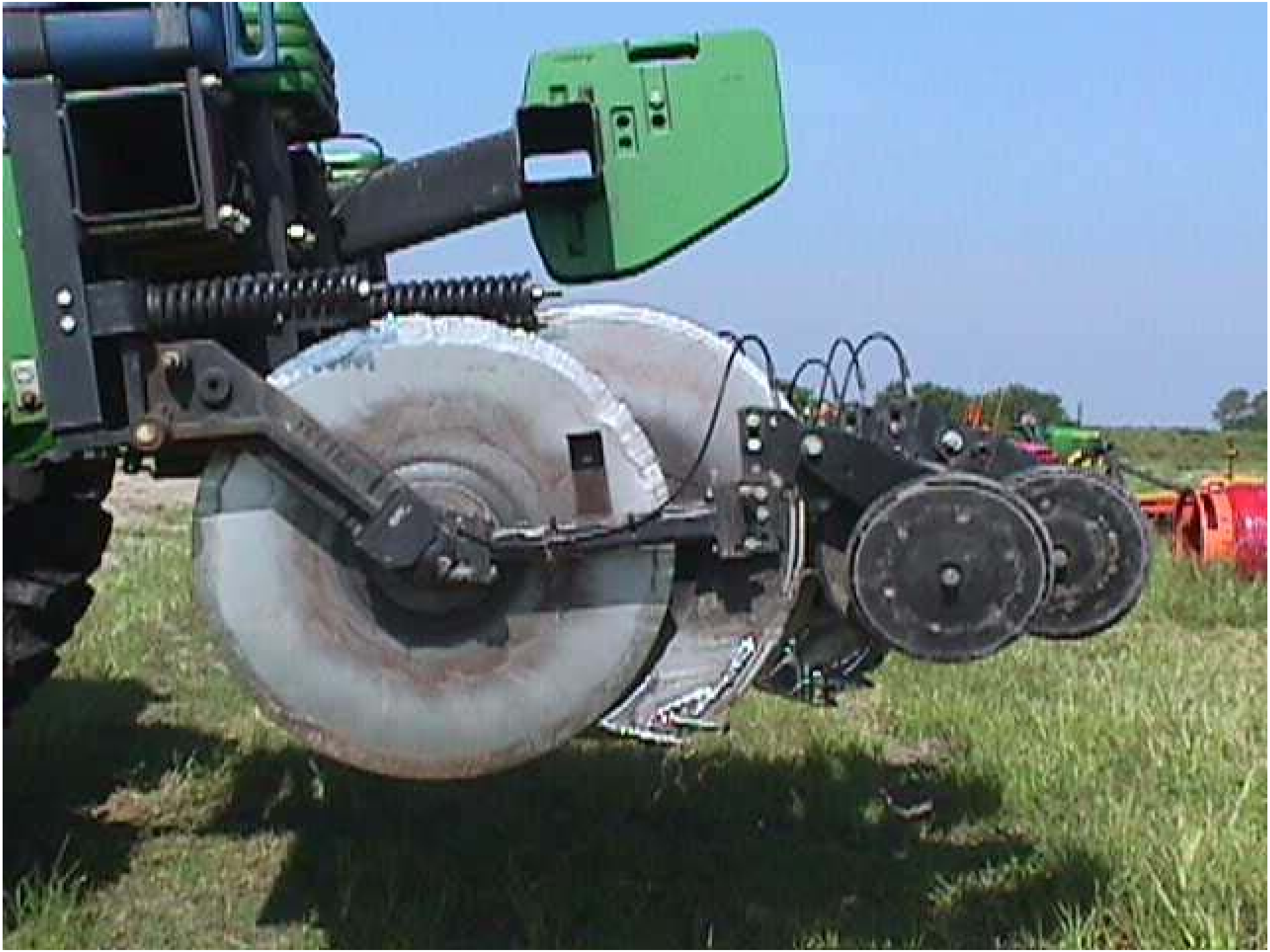
Telone concentration in upper 5 inches of soil

Dry = 4.6% moisture
Tilled and No-till = 8%



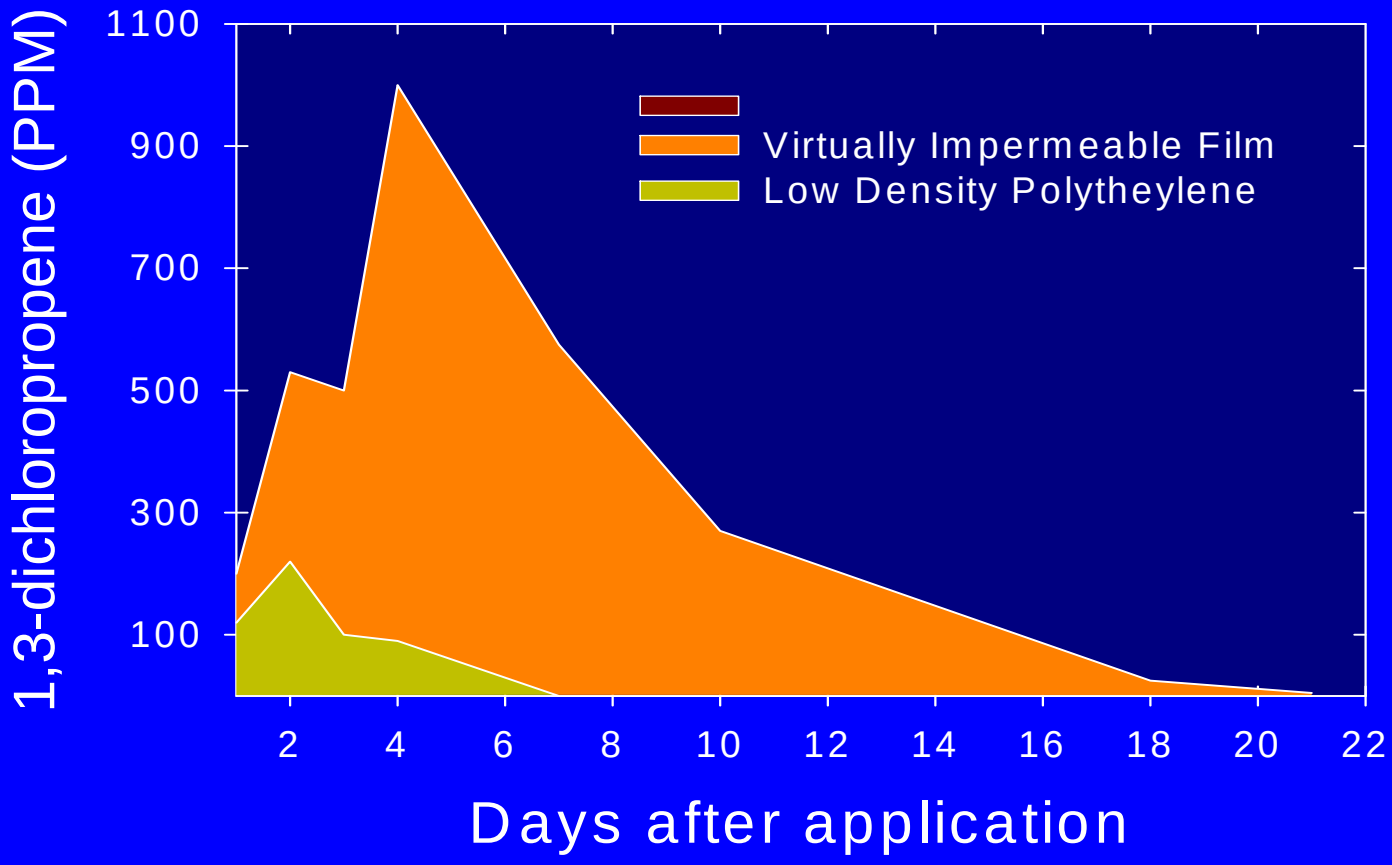
Management practices directly impacting fumigant retention in soil

- Application equipment



Management practices directly impacting fumigant retention in soil

- The type of plastic film used to cover fumigated soil


1,3-dichloropropene (PPM)
1100
900
700
500
300
100
2
4
6
8
10
12
14
16
18
20
22
Days after application
Virtually Impermeable Film
Low Density Polytheylene


4/3/2007 11:03

Demonstration of the individual and combined benefits of:

1) sealing the soil surface prior to fumigation
2) Applying fumigants using low disturbance application technology
3) VIF

on the retention of fumigants in the soil


3/2


6430

Permeability of plastic to fumigants

mass diffusion coefficient *h* (cm / hr)

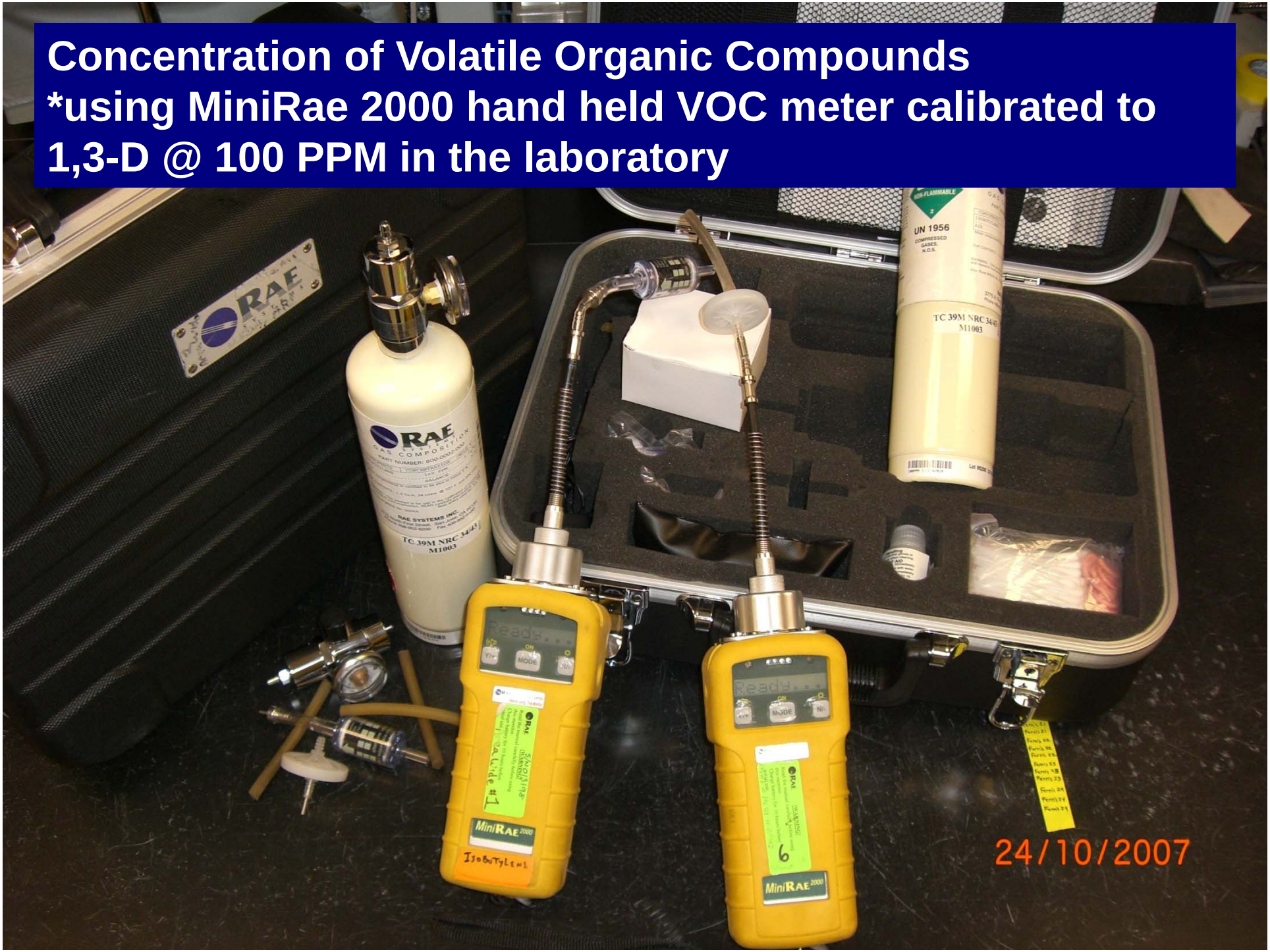
Plastic	MeBr	MeI	1,3-D (cis)	1,3-D (trans)	Pic
LDPE	0.82	1.42	5.1	8.83	1.56
VIF	0.002	0.0013	0.0019	0.0048	0.002

Relative barrier index

1 / mass diffusion coefficient (*h*)

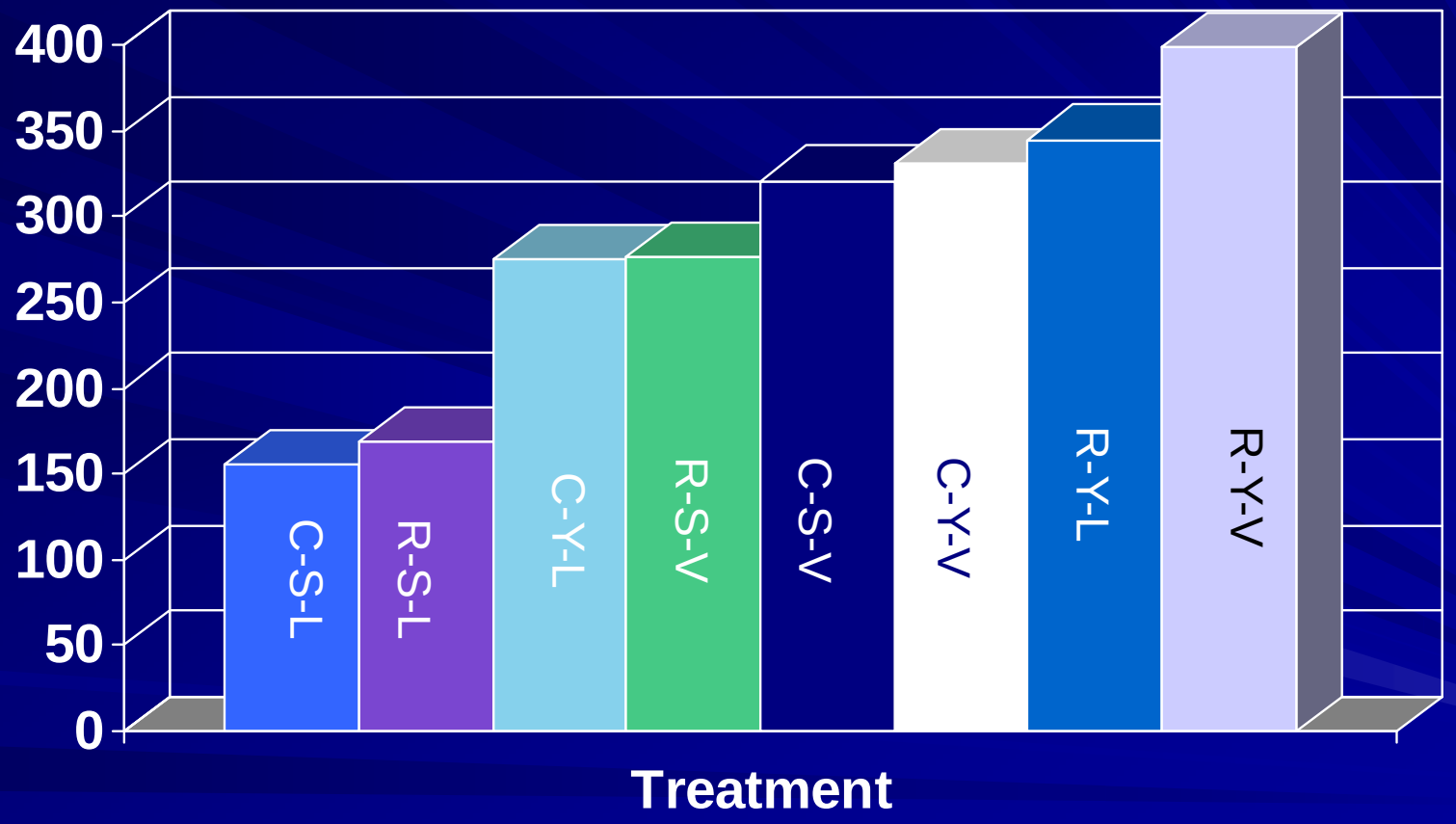
Plastic	MeBr	MeI	1,3-D (cis)	1,3-D (trans)	Pic
Cadillac	1.2	0.7	0.2	0.1	0.6
Bromostop	500	769	526	208	500

Concentration of Volatile Organic Compounds *using MiniRae 2000 hand held VOC meter calibrated to 1,3-D @ 100 PPM in the laboratory



Quantitative determination of fumigant concentration in soil and soil atmosphere
***Based upon EPA methods 5035 and 8260B for soils and NIOSH Method Issue 2 for fumigants in air**

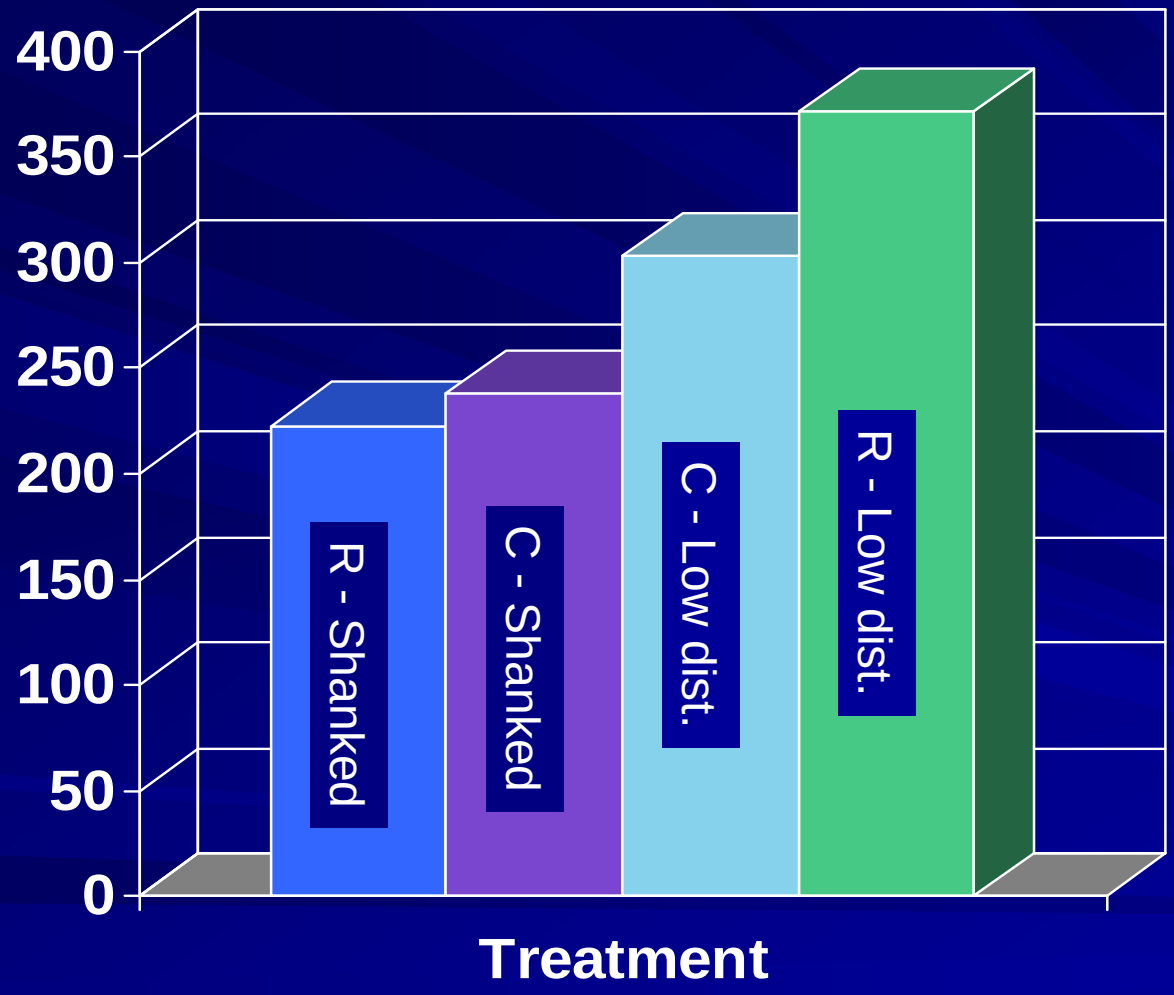
VOC detected 5-days after application (ppm)



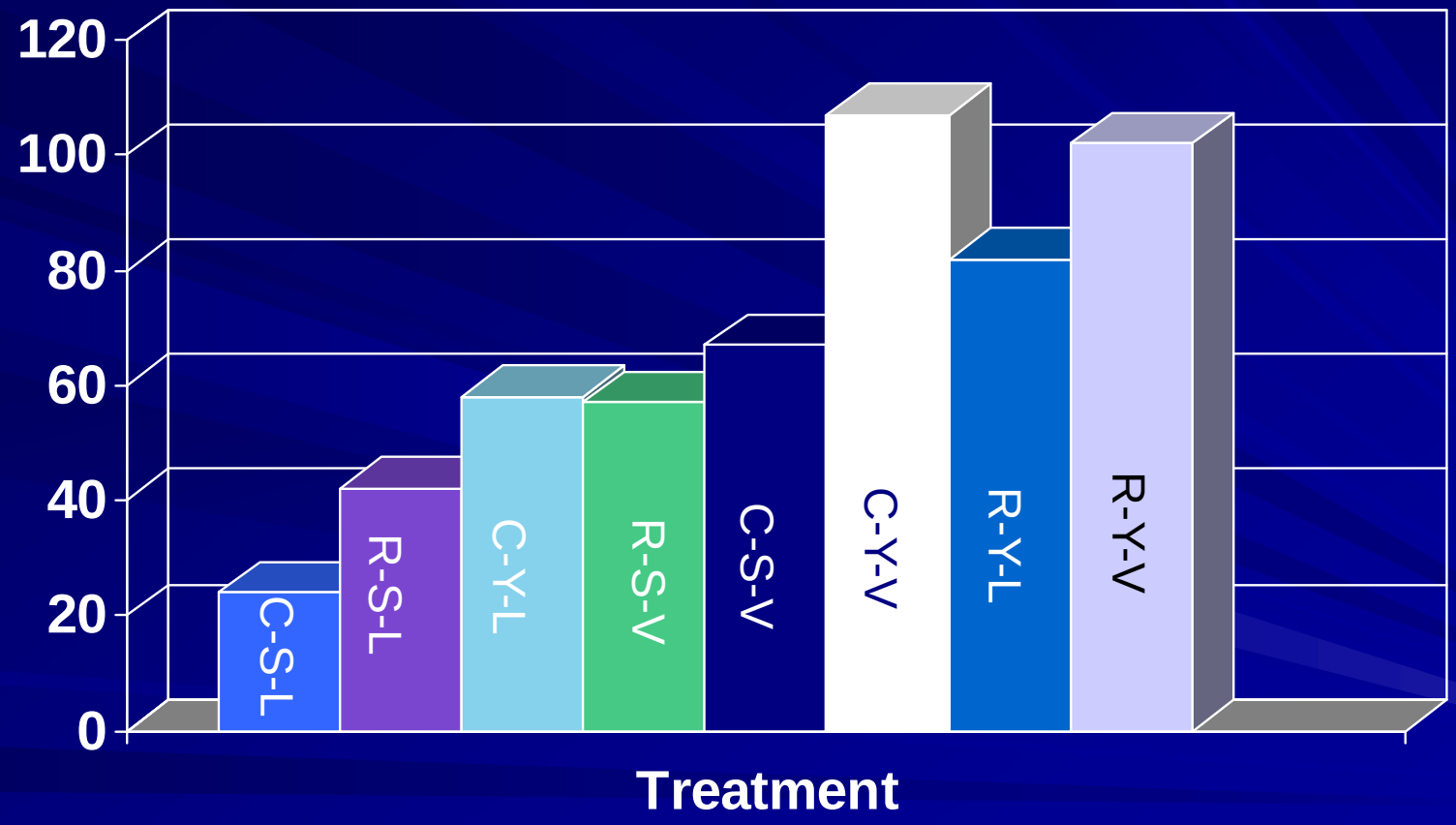
ANOVA for VOC at 5 days

Soil preparation	0.14
Application equipment	**< 0.01**
Plastic	**<0.01**
Soil vs Application	**0.03**
Application vs Plastic	**0.03**
Soil vs Plastic	0.40
3-way-interaction	0.43

Interaction of soil preparation and application equipment



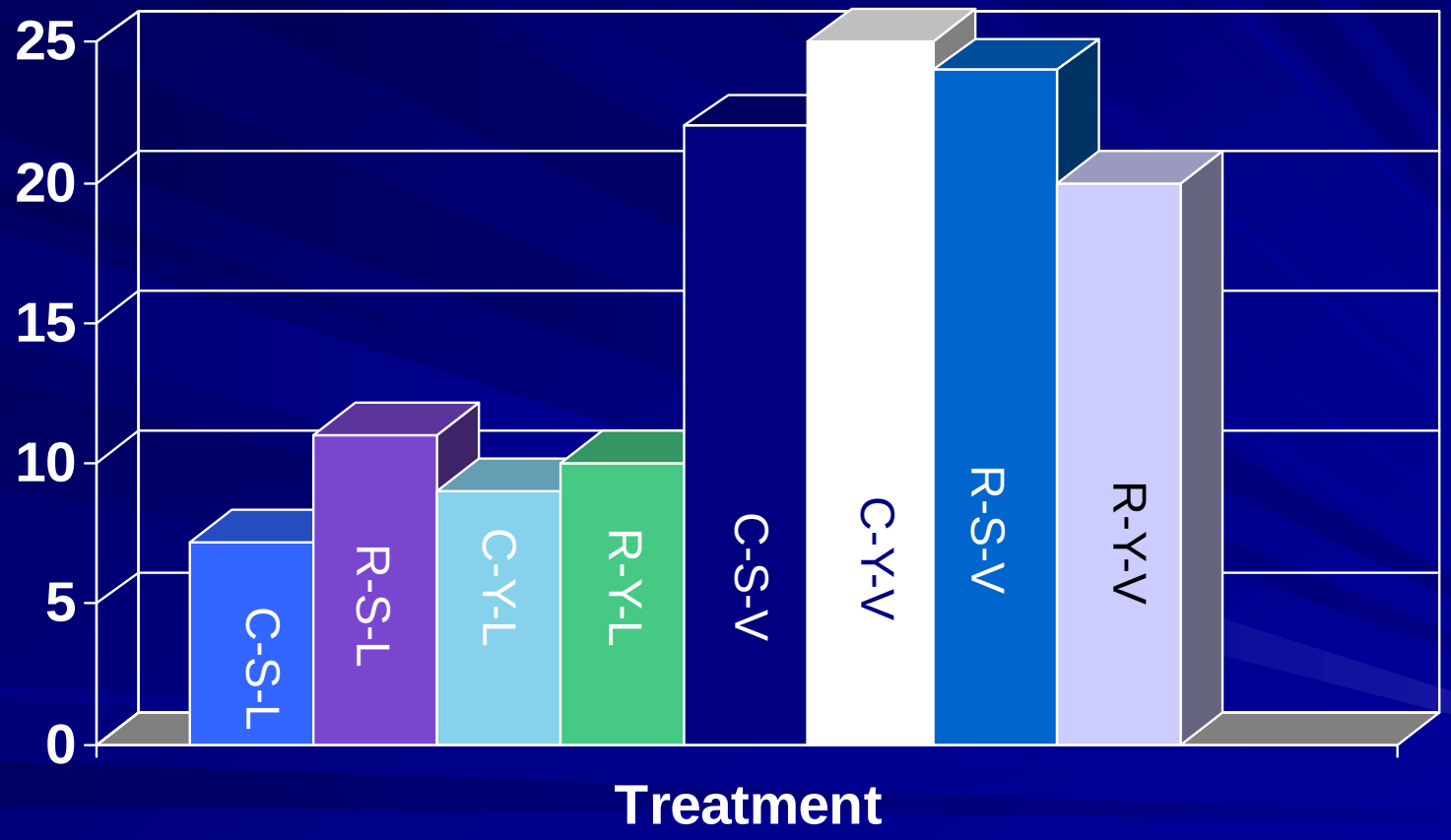
VOC detected 10-days after application (ppm)



ANOVA for VOC at 10 days

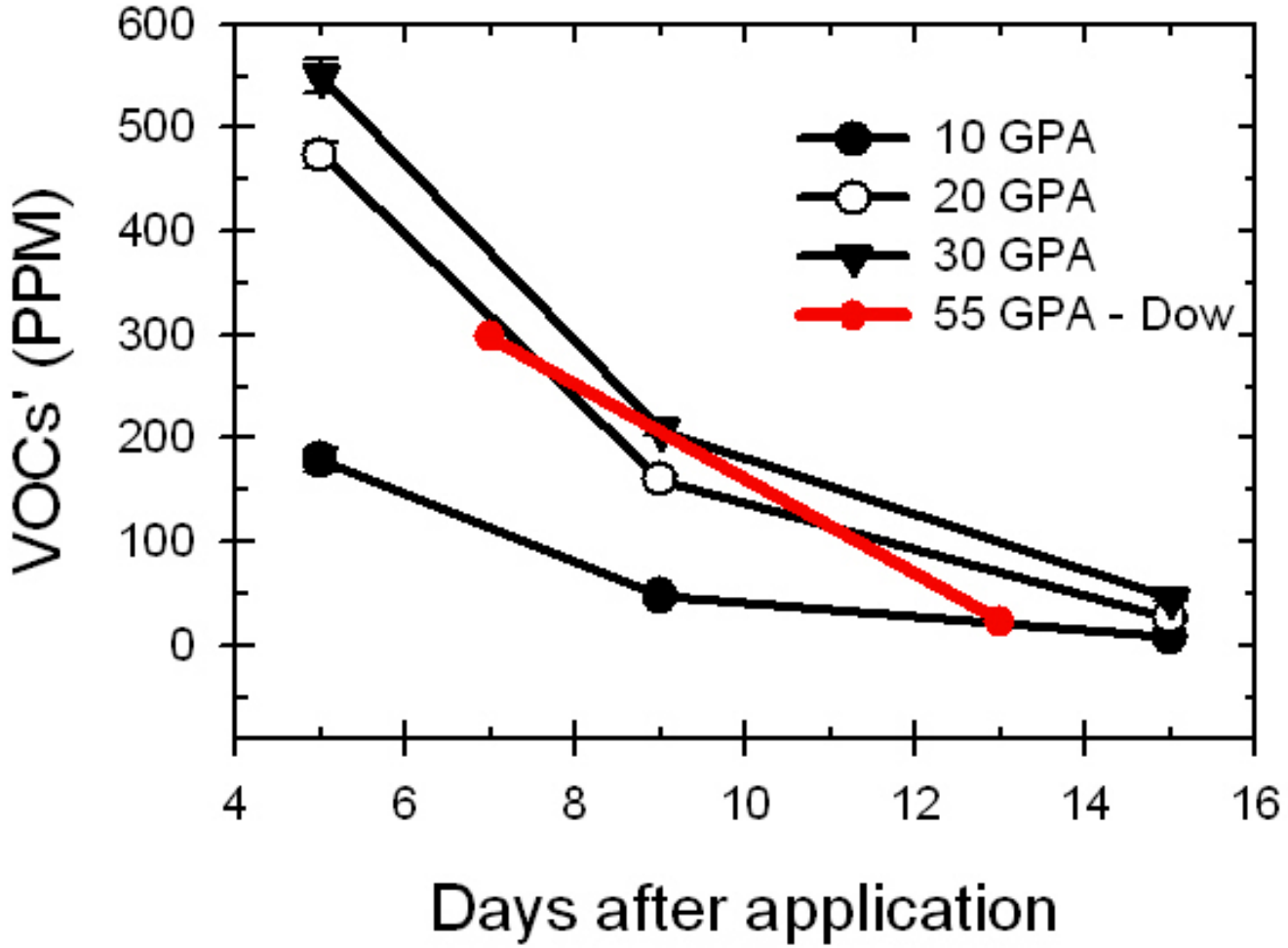
Soil preparation	0.57
Application equipment	**< 0.01**
Plastic	**<0.01**
Soil vs Application	**0.38**
Application vs Plastic	**0.90**
Soil vs Plastic	0.11
3-way-interaction	0.63

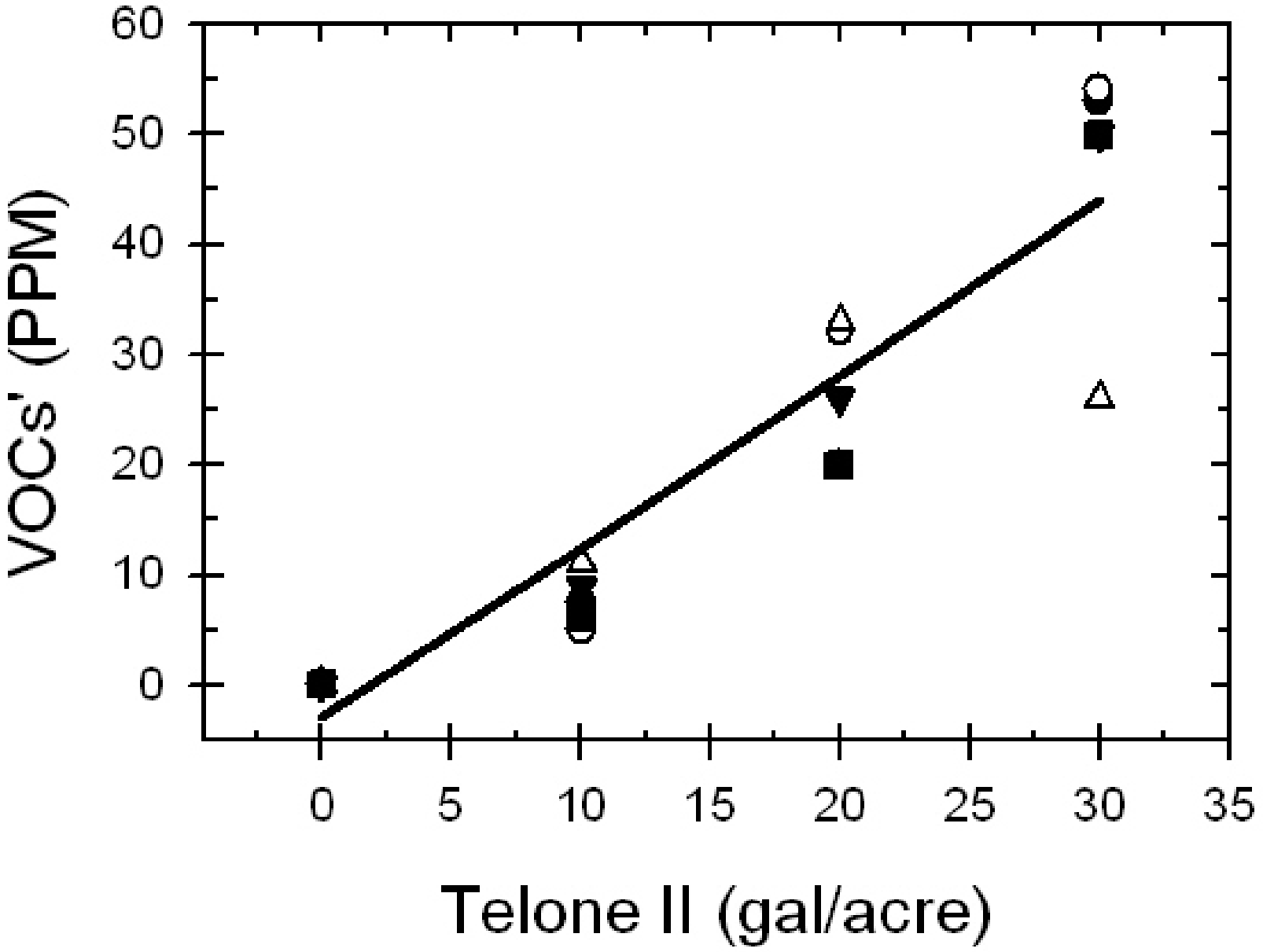
VOC detected 15-days after application (ppm)

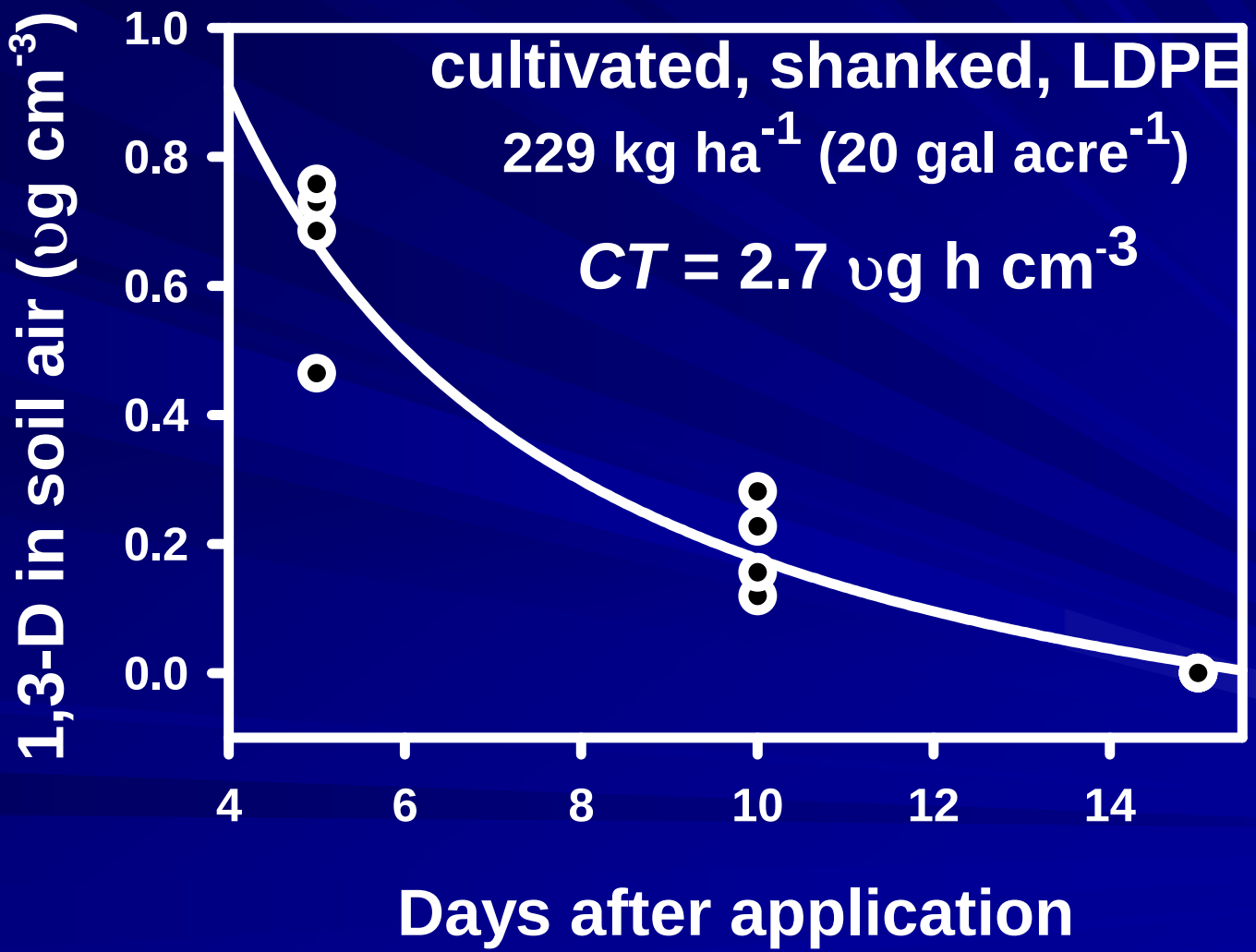


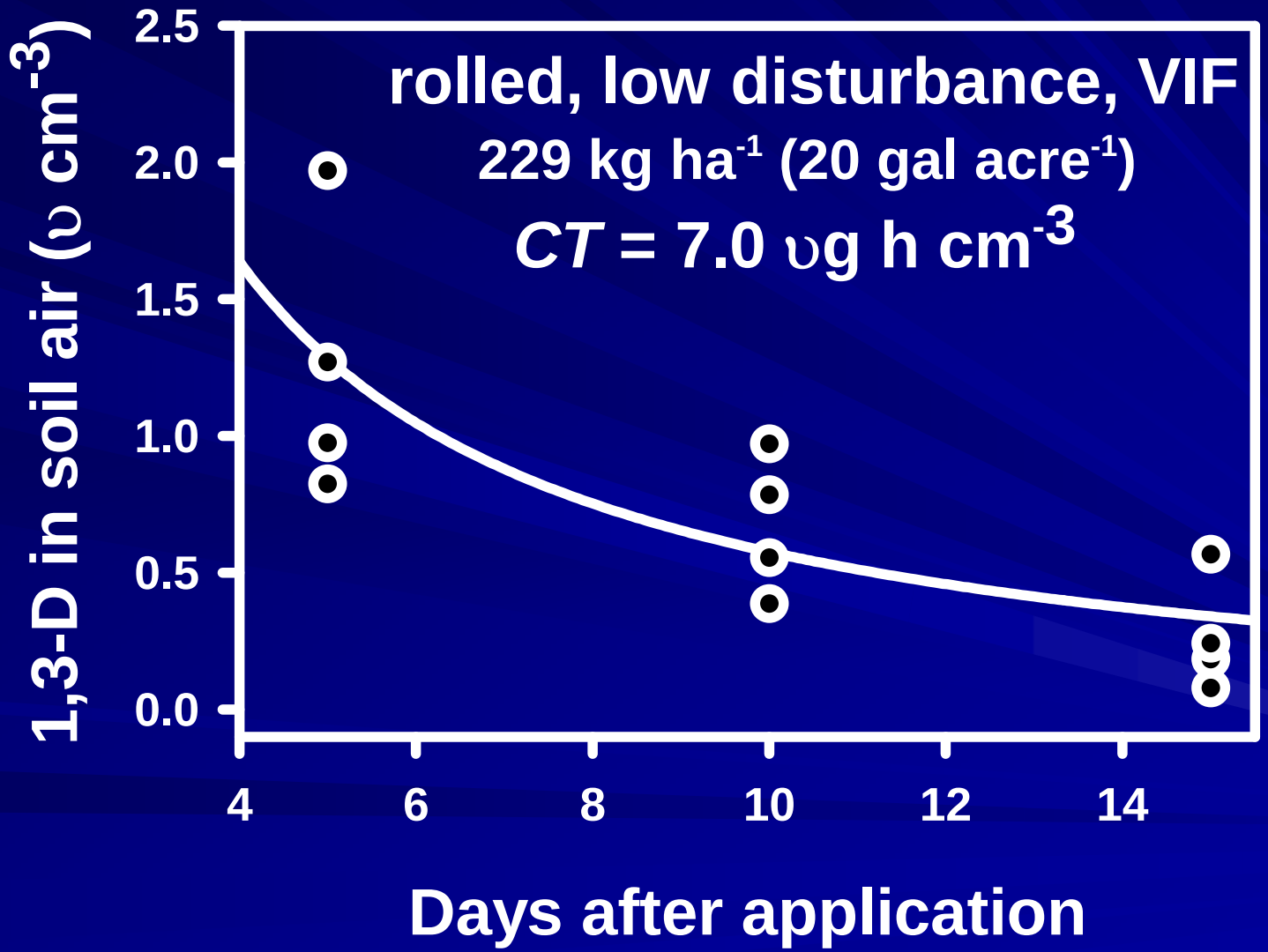
ANOVA for VOC at 14 days

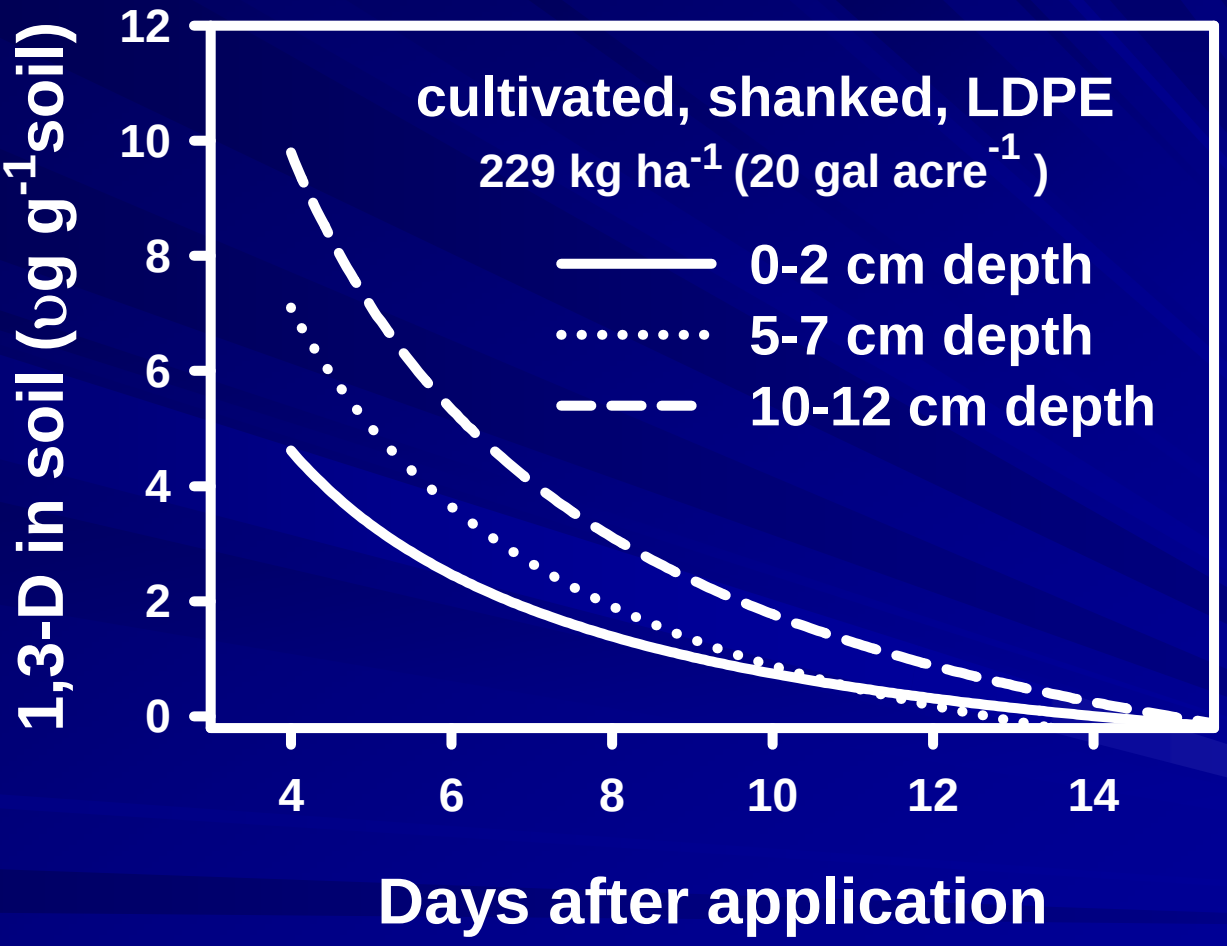
Soil preparation	0.89
Application equipment	**0.91**
Plastic	**<0.01**
Soil vs Application	**0.49**
Application vs Plastic	**0.84**
Soil vs Plastic	0.48
3-way-interaction	0.69

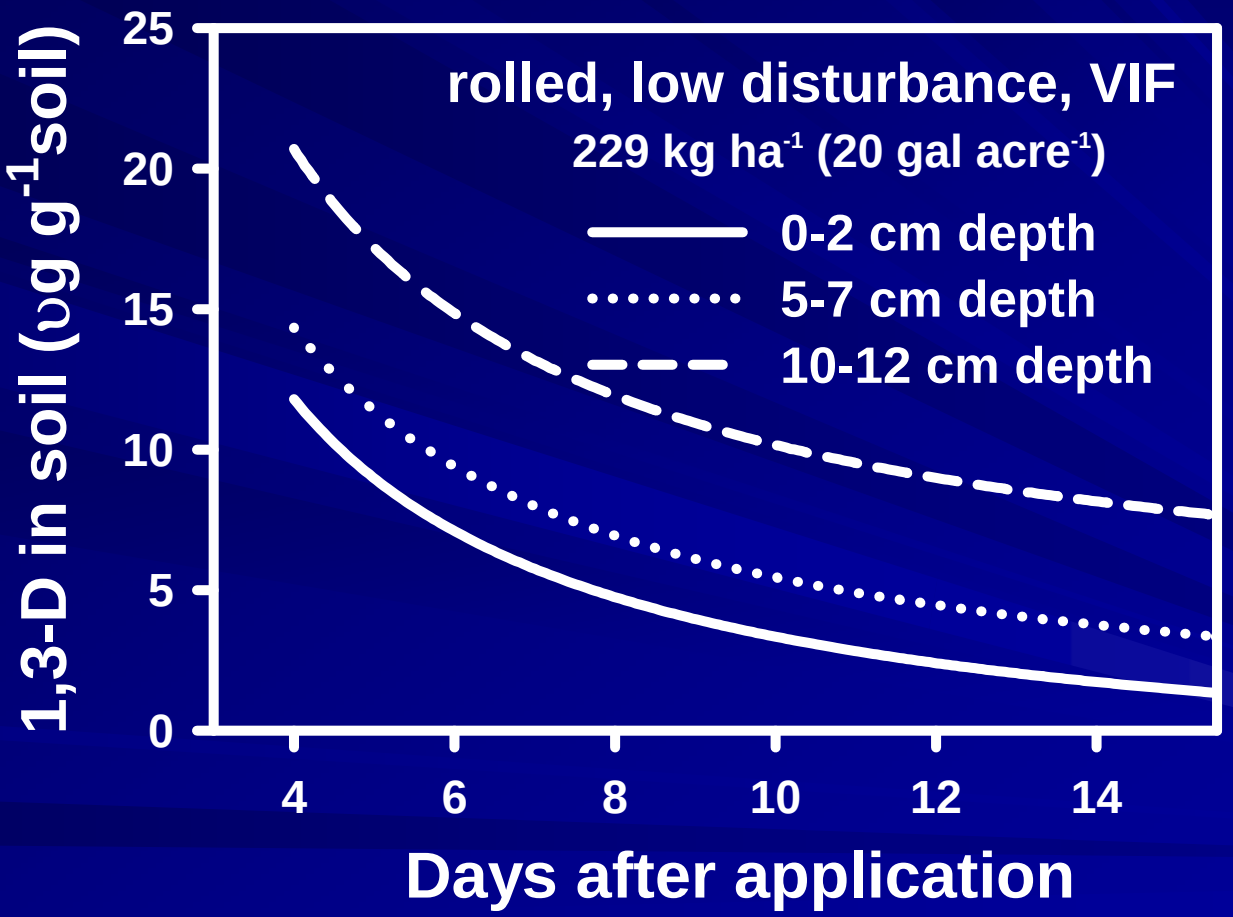

600
500
400
300
200
100
0
VOCs' (PPM)
10 GPA
20 GPA
30 GPA
55 GPA - Dow
4
6
8
10
12
14
16
Days after application


VOCs' (PPM)
60
50
40
30
20
10
0
0
5
10
15
20
25
30
35
Telone II (gal/acre)


cultivated, shanked, LDPE
229 kg ha-1 (20 gal acre-1)
CT = 2.7 υg h cm-3
1,3-D in soil air (υg cm-3)
1.0
0.8
0.6
0.4
0.2
0.0
4
6
8
10
12
14
Days after application


rolled, low disturbance, VIF
229 kg ha-1 (20 gal acre-1)
CT = 7.0 µg h cm-3
1,3-D in soil air (µ cm-3)
2.5
2.0
1.5
1.0
0.5
0.0
4
6
8
10
12
14
Days after application


cultivated, shanked, LDPE
229 kg ha-1 (20 gal acre-1)
0-2 cm depth
5-7 cm depth
10-12 cm depth
1,3-D in soil (µg g-1soil)
0
2
4
6
8
10
12
4
6
8
10
12
14
Days after application


rolled, low disturbance, VIF
229 kg ha-1 (20 gal acre-1)
0-2 cm depth
5-7 cm depth
10-12 cm depth
1,3-D in soil (υg g-1soil)
25
20
15
10
5
0
4
6
8
10
12
14
Days after application

ADJUSTMENT CRITICAL - SEE OWNERS MANUAL
PAT. PEND.


KING
7700 SERIES FLOWMETER
King Instrument Company
Garden Grove, CA
www.kinginstrumentco.com

Enhanced efficacy and reduced emissions of alternative fumigants through improvements in application technology for broadcast fumigation