

## WHAT NEMATICIDES ARE AVAILABLE?

No longer available or in danger of going away soon **Non-fumigants**

### HISTORICAL DEVELOPMENT OF NEMATICIDES

	YEAR	TYPE
CARBON DISULFIDE (CS <sub>2</sub> )	1869	FUMIGANT
*CHLOROPICRIN	1936	FUMIGANT
METHYL BROMIDE	1940'S	FUMIGANT
EDB (ETHYLENE DIBROMIDE)	"	FUMIGANT
DD (1,3-D+1,2-D) (1,2-DICHLOROPROPANE)	"	FUMIGANT
DBCP (DIBROMOCHLOROPROPANE)	"	FUMIGANT
*TELONE II (1,3-D) (1,3-DICHLOROPROPENE)	"	FUMIGANT
FORMALDEHYDE	"	FUMIGANT
*MIT>>METAM-SODIUM	1950'S	FUMIGANT
*BASAMID	"	FUMIGANT
NEMACUR (FENAMIPHOS)	LATE	ORGANOPHOSPHATE
*FURADAN (CARBOFURAN)	50'S &	CARBAMATE
*MOCAP (ETHOPROP)	1960'S	ORGANOPHOSPHATE
DASANIT	"	ORGANOPHOSPHATE
*TEMIK (ALDICARB)	"	CARBAMATE
*VYDATE (OXAMYL)	1970'S	CARB (SYSTEMIC)
ENZONE (GY-81) SODIUM	1990'S	FUMIGANT
TETRATHIOCARBONATE>>CS <sub>2</sub>	"	"
*DITERA ( <i>MYROTHECIUM VERRUCARIA</i> TOXIN)	"	NATURAL
*TELONE EC, INLINE	"	FUMIGANT
*ADMIRE PRO (IMIDACLOPRID)	2000'S	NEONICITYNOID
*NEEM (AZADIRACTIN)	"	"
*NEMA-Q (QUILLAJA, SOAPBARK TREE)	"	NATURAL
*ABAMECTIN SEED TREATMENTS	"	NATURAL
MIDAS (IODOMETHANE)	"	FUMIGANT
*MELOCON ( <i>PAECILOMYCES LILACINUS</i> )	"	NATURAL
*NIMITZ	"	FLUENSULFONE

\*Currently available for use on some crops in California

## FUMIGANTS:

	YEAR
CARBON DISULFIDE (CS <sub>2</sub> ) (WITHDRAWN)	1869
*CHLOROPICRIN (TEAR GAS)	1936
*METHYL BROMIDE (OZONE DEPLETER)	1940'S
EDB (ETHYLENE DIBROMIDE) (CARC / GW)	"
DD (1,3-D+1,2-D) (1,2-DICHLOROPROPANE) (CARC / GW)	"
DBCP (DIBROMOCHLOROPROPANE) (CARC / GW)	"
*TELONE II (1,3-D) (1,3-DICHLOROPROPENE) (PROP65 / AIR)	"
FORMALDEHYDE (CARCINOGEN)	"
*MIT>>METAM-SODIUM (ISOTHIOCYANATE)	1950'S
*BASAMID (GRANULE, ISOTHIOCYANATE)	"
*ENZONE (GY-81) SODIUM	1990'S
TETRATHIOCARBONATE>>CS <sub>2</sub>	"
*INLINE (TELONE + CHLOROPICRIN) (PROP65 / AIR)	"
MIDAS (Iodomethane) (WITHDRAWN)	2012
*DOMINUS (ALLYL ISOTHIOCANATE, AITC)	In Progress

**NO LONGER AVAILABLE  
ON ITS WAY OUT**

CARC = CARCINOGEN  
PROP65 = CARCINOGEN AS DEFINED BY PROPOSITION 65  
GW = FOUND IN GROUNDWATER IN CA

\*CURRENTLY AVAILABLE FOR USE ON SOME CROPS IN CALIFORNIA

## NONFUMIGANTS

	YEAR	TYPE
NEMACUR (FENAMIPHOS) (WITHDRAWN)	LATE	OP
FURADAN (CARBOFURAN)	50'S &	CARB
*MOCAP (ETHOPROP)	1960'S	OP
DASANIT (WITHDRAWN)	"	OP
*THIMET (PHORATE)	"	OP
*TEMIK (ALDICARB)	"	CARB
*VYDATE (OXAMYL)	1970'S	CARB (SYSTEMIC)
*DITERA ( <i>MYROTHECIUM VERRUCARIA</i> TOXIN)	1990'S	NATURAL
*NEEM (AZADIRACTIN)	"	NATURAL
*ADMIRE PRO (IMIDACLOPRID)	2000'S	NEONICITYNOID
*NEMA-Q (QUILLAJA, SOAPBARK TREE)	"	NATURAL
*ABAMECTIN SEED TREATMENTS	"	NATURAL
*MELOCON ( <i>PAECILOMYCES LILACINUS</i> )	"	NATURAL
*MOVENTO (SPIROTETRAMAT)	"	TETRAMIC ACID
*NIMITZ (FLUENSULFONE, MCW-2)	"	FLUENSULFONE

OP=ORGANOPHOSPHATE,  
CARB=CARBAMATE

**NO LONGER AVAILABLE**

\*CURRENTLY AVAILABLE FOR USE ON SOME CROPS IN CALIFORNIA

## DITERA

VALENT (ABBOTT LABORATORIES)

KILLED MICROBIAL

TOXIN PRODUCED BY A FUNGUS

VERY WATER SOLUBLE

ISOLATED FROM FIELD WITH

SOYBEAN CYST NEMATODE

CA REGISTRATION ON SEVERAL CROPS





**BIOPESTICIDE FOR AGRICULTURAL SOIL TREATMENT USE**

A Broad Spectrum Pre-Plant Soil Biofumigant For The Control Of  
Certain Soil Borne Fungi, Nematodes, Weeds And Insects

**ACTIVE INGREDIENT:**

Allyl isothiocyanate ..... 96.3%

**OTHER INGREDIENTS:** ..... 3.7%

**TOTAL:** ..... 100.0%

Contains 8.19 lbs. active ingredient (allyl isothiocyanate)  
per gallon. This product weighs 8.5 lbs. per gallon.



Manufactured for:  
Isagro USA, Inc.  
430 Davis Drive, Suite 240  
Morrisville, NC 27560

**KEEP OUT OF REACH OF CHILDREN**

**DANGER**

**DOMINUS**  
**Allyl isothiocyanate**

**IRF135**



April 2013

- *Product Performance Update*
- *Region: USA*

**ISAGRO USA**

**Mike Allan**

**A synthetically produced biopesticide**

**Active ingredient is Allyl isothiocyanate (AITC)**

**Isothiocyanate is the active ingredient in Metam products**

**Husein Ajwa (UC Davis)**

**GENERALIZATIONS FOR CHOOSING A NEMATOCIDE:**

**REGISTRATION STATUS**

**FUMIGANTS**

**TYPICALLY REGISTERED ON MANY CROPS**

**LOW POTENTIAL FOR RESIDUES**

**ORGANOPHOSPHATES AND CARBAMATES**

**TYPICALLY REGISTERED ON A FEW CROPS**

**POTENTIAL FOR RESIDUES LIMITS**

**NUMBER OF CROPS**

**NEWER CATEGORIES - PRODUCT DEPENDENT**

**GENERALIZATIONS FOR CHOOSING A NEMATOCIDE:**

**ANNUAL CROPS**

**PREPLANT - CONTROL NEEDED TO A 2 TO 3  
FOOT DEPTH**

**POSTPLANT - COST EFFECTIVENESS IS  
QUESTIONABLE**

**PERENNIAL CROPS**

**PREPLANT - CONTROL NEEDED TO 5 FOOT  
DEPTH**

**POSTPLANT - 50% NEMATODE REDUCTION  
TYPICALLY IMPROVES YIELDS WITH 2  
YEARS OF USE**

**CALIFORNIA LEGISLATION AFFECTING NEMATOCIDES:**

**PROPOSITION 65 - SAFE DRINKING WATER AND TOXIC ENFORCEMENT ACT OF 1986**

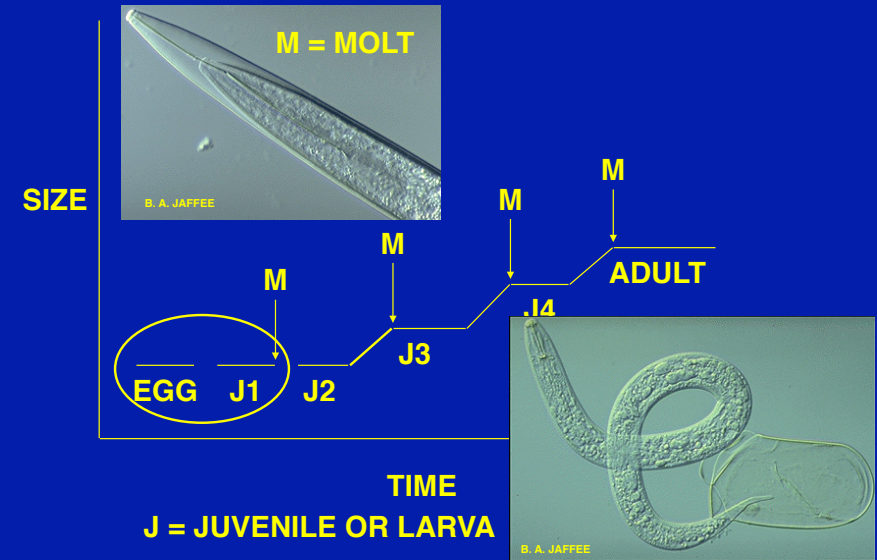
**AB 2021 - PESTICIDE CONTAMINATION PREVENTION ACT (1985 - GROUNDWATER PROTECTION)**

**SB 950 - THE BIRTH DEFECT PREVENTION ACT OF 1984**

**AB 1807 - AIR TOXICS (1983 - THE TOXIC AIR CONTAMINANT IDENTIFICATION AND CONTROL ACT)**

**EFFECTIVENESS MAY DEPEND ON LIFE CYCLE STAGE**

**LIFE CYCLE OF A TYPICAL PLANT PARASITIC NEMATODE:**



**EFFECTIVENESS MAY VARY DEPENDING ON THE TARGET**

**COMMON PLANT PARASITIC NEMATODES IN CALIFORNIA:**

**ECTOPARASITES**

- Trichodorus* - Stubby Root\*
- Xiphinema* - Dagger\*
- Longidorus* - Needle\*
- Helicotylenchus* - Spiral
- Criconebella* - Ring
- Paratylenchus* - Pin
- Hemicycliophora* - Sheath

**MIGRATORY ENDOPARASITES**

- Pratylenchus* - Lesion
- Ditylenchus* - Stem & Bulb
- Aphelenchoides* - Foliar

**SEDENTARY ENDOPARASITES**

- Meloidogyne* - Root Knot
- Anguina* - Seed & Leaf Gall
- Tylenchulus* - Citrus
- Heterodera* - Cyst

**SOME GENERA CONTAIN SEVERAL IMPORTANT SPECIES**

\*Vectors of plant viruses

**THE MORE VOLATILE THE PRODUCT THE BETTER IT MOVES THROUGH SOIL:**

<u>COMPOUND</u>	<u>VOLATILITY</u> HIGH
<b>FUMIGANTS</b>	
Methyl Bromide - Tarped	5
- Nontarped	5
Chloropicrin	7
1,3-Dichloropropene(1,3-D.Telonell)	30
<hr/>	
Methyl isothiocyanate (Metam Sodium, Vapam, Basamid)	500
<b>ORGANOPHOSPHATES &amp; CARBAMATES</b>	
Ethoprop(Mocap)	100,000
Carbofuran(Furadan)	1,000,000
Aldicarb(Temik)	1,500,000
Fenamiphos(Nemacur)	10,000,000
Oxamyl(Vydate)	100,000,000
	LOW

**GENERALIZATIONS ABOUT SOIL TYPE:**

**NEMATOCIDES MOVE FURTHER THROUGH COARSER THAN THROUGH FINER TEXTURED SOILS**



**GENERALIZATIONS ABOUT WATER SOLUBILITY:**

**THE MORE WATER SOLUBLE A PRODUCT IS THE FURTHER IT WILL MOVE THROUGH SOIL**

**AND THE GREATER THE CHANCE IT WILL REACH GROUNDWATER**

**INCREASING  
WATER  
SOLUBILITY**



**THIMET (PHORATE)  
MOCAP (ETHOPROP)  
NEMACUR (FENAMIPHOS)  
TEMIK (ALDICARB)  
VYDATE (OXAMYL)**

**NON-FUMIGANT PRODUCTS MAY NOT ALWAYS KILL NEMATODES:**

**NEMATISTAT VS NEMATICIDE**

**PRODUCTS MAY PROMOTE PLANT GROWTH BUT NOT REDUCE NEMATODE NUMBERS OR THEY MAY RESULT IN AN INCREASES IN NEMATODES BECAUSE A HEALTHIER ROOT SYSTEM CAN SUPPORT MORE NEMATODES**

**EFFECTS OF NEMACUR ON MOBILITY OF PRATYLENCHUS PENETRANS & DITYLENCHUS DIPSACI TIME FOR PARALYSIS TO OCCUR (HOURS):**

CONCENTRATION (PPM)	<i>P. PENETRANS</i>	<i>D. DIPSACI</i>
100	1	1
10	1	5
1	5	1
0.1	48	504

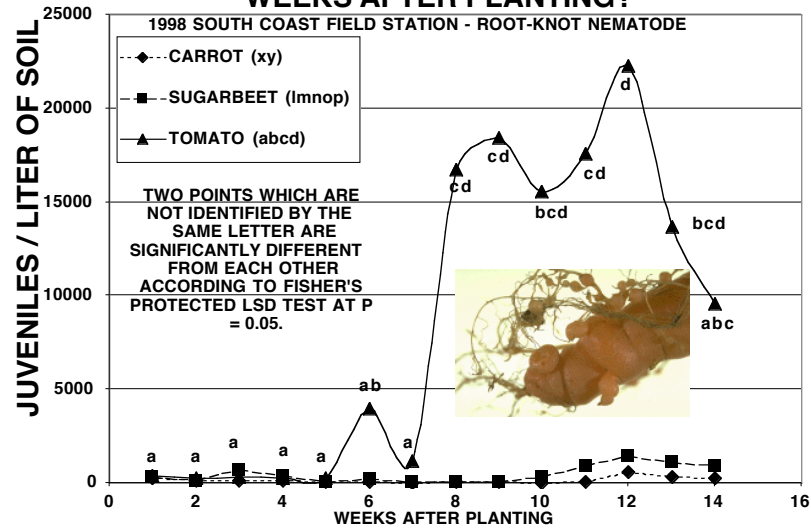
**INHIBITION OF MOBILITY IS REVERSIBLE IF NEMATODES ARE TRANSFERRED TO WATER**

**TIME FOR MORTALITY TO OCCUR (DAYS):**

CONCENTRATION (PPM)	<i>P. PENETRANS</i>	<i>D. DIPSACI</i>
100	5	21
10	12	41
1	27	65
0.1	57	105

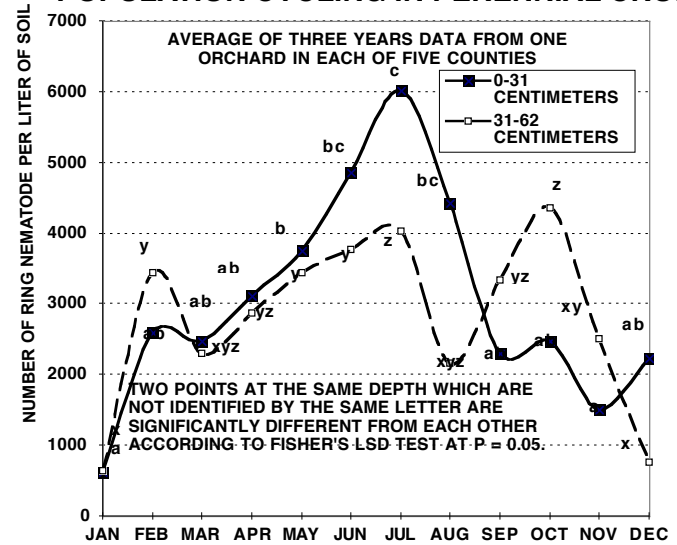


## ANNUAL CROPS ONLY NEED PROTECTION FOR SIX WEEKS AFTER PLANTING?



YES, BUT ONLY IF YOU CONTROL THEM PREPLANT

## POPULATION CYCLING IN PERENNIAL CROPS



WHEN IS THE BEST TIME TO APPLY A NEMATICIDE?

**GENERALIZATIONS ABOUT CROPS MOST IN NEED OF PROTECTION**

**PERENNIALS TREATED AT REPLANT EVERY 10 TO 50 YEARS**

**ROOT-KNOT NEMATODE ON TOMATO**



**ANNUAL CROPS: MILLIONS OF DOLLARS LOST IN 1992 FOLLOWING SUSPENSION OF USE OF TELONE II IN 1991**

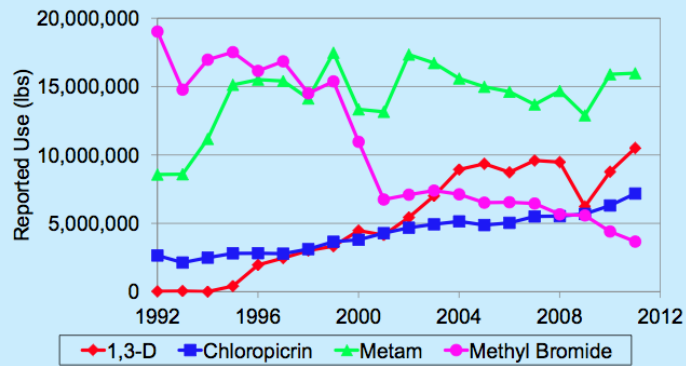
**ROOT-KNOT NEMATODE (RKN)**

Tomatoes	13.4
Cotton	9.8
Sweet potatoes	7.5
Potatoes	0.4
Carrots	15.1
<b>SUGARBEET CYST(SBCN)&amp; (RKN)</b>	
Broccoli	15.7
Cauliflower	7.9
Sugar beets	6.1
Brussel sprouts	0.7

## Fumigant Costs

Product	\$/lb. AI	Per acre, applied
Methyl Bromide	\$3.50	\$2100 (350 lb/ac, broadcast shank, tarped)
Chloropicrin	\$2.40	\$1200 (200 lb/ac, broadcast shank, tarped)
Telone (1,3-D)	\$1.40	\$550 (35 gal/ac, broadcast shank)
InLine	\$2.00	\$640 (25 gal/ac, drip application)
Metam Sodium (MITC)	\$1.00	\$400 (75 gal/ac, shanked, water seal)

## Fumigant use in California by chemical, 1992-2011



Randy Segawa (CDPR)<sup>2</sup>



### Significant Regulatory Pressure:

- Buffer zones
- VOCs regulations
- Application rates

### Resulted in development of new film (tarp) technology:

- "Virtually impermeable (VIF)"
- "Totally impermeable (TIF)"

## Conventional Fumigation (Acres, California 2007):

Methyl Bromide/Chloropicrin:	40,000
Telone/Chloropicrin:	17,000
Telone II:	37,000
Chloropicrin alone:	6,000
Metam sodium:	77,000

**TOTAL: ~ 180,000 acres annually**



Husein Ajwa (UC Davis)

## Need for Emission Reduction Research

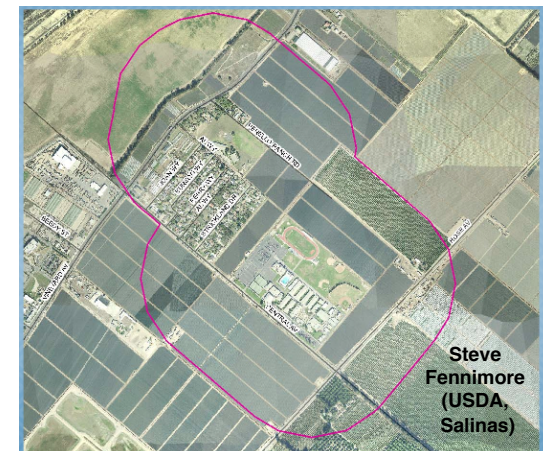
- Recent US-EPA regulations imposed larger buffer zones and lower application rates of fumigants.
- In California, many townships exceeded the "Township Cap" of 90,250 lbs of Telone per township (36 square miles).
- In California, volatile organic compounds regulations limit fumigants use in certain areas in California due to high emissions.

Husein Ajwa (UC Davis)



David Sullivan (Consultant)

Emissions from field applications are monitored and models are developed to establish buffer zones for sensitive areas.



# Types of Mulch Film

PE	PE	PE + Adhesive	PE	PE	PE
LDPE	HDPE	Nylon	Adhesive Nylon	Adhesive EVAL™	Adhesive EVAL™
PE	PE	PE + Adhesive	PE	PE	PE
<b>STD</b>	<b>SIF</b>	<b>VIF</b>	<b>VIF</b>	<b>TIF</b>	<b>TIF</b>
Poor		FUMIGANT BARRIER Medium		High	High
Excellent		MECHANICAL PROPERTY Poor		Good	Excellent

STD = Standard PE film  
 SIF = semi-impermeable film  
 VIF = virtually impermeable film  
 TIF = "totally" impermeable film



# Benefit to the Grower

Buffer Zone Distances in Feet  
 Assuming 350 lbs/A of MB/PIC 67:33 on 10 acres

Block size in Acres	USEPA Table: Broadcast Equivalent Application Rate (lbs ai/acre)														
	43	75	108	134	161	188	215	242	269	296	323	350	377	403	430
1	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25
5	25	25	25	60	90	120	150	210	265	320	375	450	525	600	675
10	25	25	25	95	165	235	300	385	465	545	625	700	775	850	925
20	25	25	25	145	265	385	500	625	750	875	1000	1115	1225	1340	1450
30	25	38	50	210	365	520	675	835	980	1145	1300	1440	1575	1715	1850
40	25	75	125	310	490	770	850	1035	1215	1395	1575	1760	1940	2120	2300
60	25	115	200	425	650	875	1100	1350	1595	1840	2085	2330	2570	2810	3050
80	25	165	300	565	825	1090	1350	1660	1965	2270	2575	2885	3150	3440	3725
100	25	200	375	690	1000	1315	1625	1985	2340	2695	3050	3375	3700	4025	4350

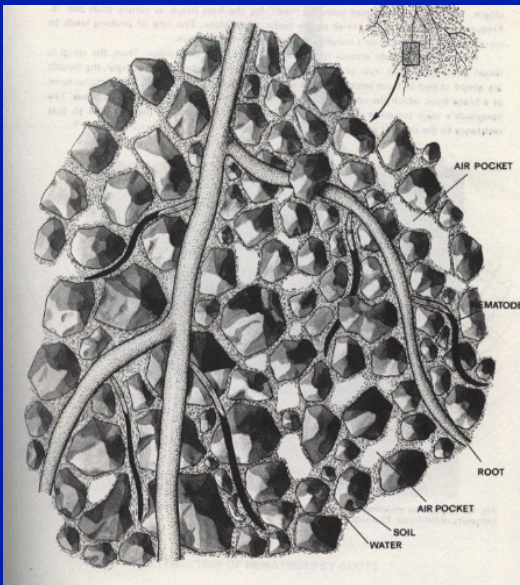
TIF  
 50% Dose  
 60% BZC  
 34 ft BZ

TIF  
 60% BZC

USEPA  
 STD film  
 350 lb/a dose



# NEMATODES ARE AQUATIC ORGANISMS



FUMIGANTS MOVE THEMSELVES THROUGH AIR IN SOIL PORES AND THEN DISSOLVE IN WATER TO KILL NEMATODES

WHAT MAKES A FUMIGANT WORK, ALSO MAKES IT A VOC

NON-FUMIGANTS NEED TO BE MOVED WITH WATER OR TILLAGE

Schedule D, Chart V. Protection for a 14-month crop. Telone II™, not flipped, followed by 1 pound active ingredient NemaCur (Fenamiphos) or Vydate (Oxamyl) monthly through emitter tubing with 12 inch or less emitter spacings (drip irrigation). Do not use Chart V if pencil-sized or larger viable roots are present in the top 12 inches of soil. CHECK WITH COUNTY PESTICIDE USE ENFORCEMENT OFFICIALS PRIOR TO TREATMENT TO ENSURE COMPLIANCE WITH CURRENT STATE / COUNTY PESTICIDE USE RESTRICTIONS.

Temperature	5 to 25°C		10 TO 25°C		15 to 20°C	
	Sand	Loamy Sand	Sandy Loam	Loam	Clay Loam	Clay
2 to 6%	190 lbs. a.i					
3 to 8%		190 lbs. a.i				
4 to 9%			190 lbs. a.i			
9 to 12%			285 lbs. a.i			
6 to 9%				190 lbs. a.i		
9 to 14%				285 lbs. a.i		
14 to 18%						
8 to 12%					285 lbs. a.i	
12 to 18%						
18 to 22%						
15 to 35%						

TOO DRY

TOO WET

➤ Numbers indicate the pounds of actual ingredient of Telone II™ (94% or 97.5% 1,3-dichloropropene) to apply per acre at a minimum depth of 16 inches and a chisel spacing of 30 inches (76 cm) or less. Treatment followed by ring roller or compaction device. Highest soil moisture percent in the top five feet of soil shall be considered. It is not necessary to apply monthly applications of NemaCur and Vydate until the crop is planted and the soil temperature exceeds 14°C at a depth of 12 inches.



### SOIL TEXTURE:

#### Coarse Texture (high % sand)

- has large pore spaces
- dries out more quickly.

#### Fine Texture (high % silt & clay)

- small pore size
- dries out more slowly

The finer the soil texture, the higher the rate of fumigant needed.

### SOIL TEMPERATURE:

If temperatures are too high, fumigant will volatilize and degrade too quickly.

If temperatures are too low, fumigant will volatilize but not move through pore space as rapidly or as far.

### SOIL MOISTURE:

Too low - fumigant becomes adsorbed to soil particles.  
Too high - water in soil pore spaces hinders movement.



WHAT IS THE TARP FOR?

REMOVE ROOTS



### MATERIAL SAFETY DATA SHEET -HEALTH HAZARD INFORMATION (METHYL BROMIDE):

Inhalation - Early symptoms of overexposure are dizziness, headache, nausea and vomiting, weakness and collapse. Lung edema may develop in 2 to 48 hours after exposure, accompanied by cardiac irregularities. Repeated overexposure can result in blurred vision, staggering gait, and mental imbalance, with probable recovery; after a period of no exposure. In extreme cases of overexposure, unconsciousness and death can occur. Liquid can cause severe burns to eyes and skin.



## **GASOLINE:**

Inhalation causes intense burning of the mucous membranes, throat and respiratory tract; overexposure to vapors can lead to bronchopneumonia. Inhalation of high concentration can cause fatal pulmonary edema. Repeated or prolonged skin exposure causes dermatitis. Can cause blistering of skin due to its defatting properties. Exposure to eyes can cause hyperemia of the conjunctiva. Ingestion or excessive vapors can cause inebriation, drowsiness, blurred vision, vertigo, confusion, vomiting and cyanosis. Aspiration after ingestion causes bronchitis, pneumonia, or edema which can be fatal.

## **BLEACH:**

Ingestion can cause corrosion of mucous membranes, perforation of esophagus and stomach, and laryngeal edema; may lead to convulsion, coma, death. Inhalation of mist or fumes can cause bronchial irritation, cough, difficult breathing, stomatitis, nausea, and pulmonary edema. Additional effects have included circulatory collapse and delirium. Liquid contact can produce irritation of the eyes or skin with blistering and eczema.

## **IS IT ORGANIC?**

**ALTERNATIVE AGRICULTURE (1989) - NATIONAL RESEARCH COUNCIL**

**CASE STUDY 8 - Fresh Grapes in California and Arizona: Stephen Pavich & Sons**

"Nematodes are controlled by fumigation and a 2- to 3-year fallow period." (page 351)

"The bare field is then fumigated with chloropicrin and methyl bromide..." (page 360)

## **PRODUCT X Soil Conditioner - COMPANY X**

"PRODUCT X contains a micro-organism capable of combating most of the known soil fungi that can be harmful to crops. PRODUCT X is the best tool to combat nematodes and fungi that prey on cotton fields."  
(PRODUCT X BULLETIN)

"There was an outbreak of nematodes in the spring of 1981... whereupon we added 200 pounds quickly. We found nematodes at crop pullout, but nevertheless did not sterilize.

At crop pullout on July 1, 1982, we found no nematodes."  
(Letter from GROWER X)

GROWER X gave his nematodes something else to chew on - PRODUCT X

We have been especially concerned about the high cost of nematicides and the problems handling them. COMPANY X introduced a product to us about three years ago called PRODUCT X.

They suggested that we use it in place of nematicides, as a natural solution to the nematode problem.

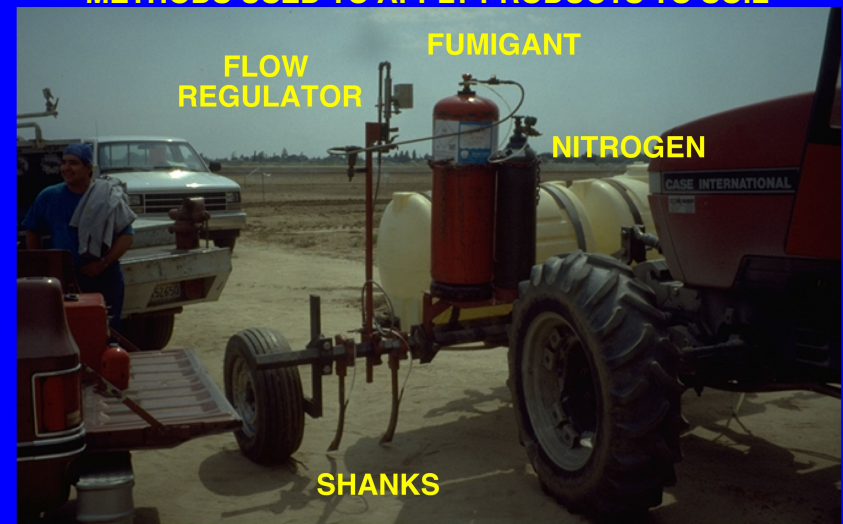
We have been using PRODUCT X for the past three years on carrots and melons and are very pleased with the results.

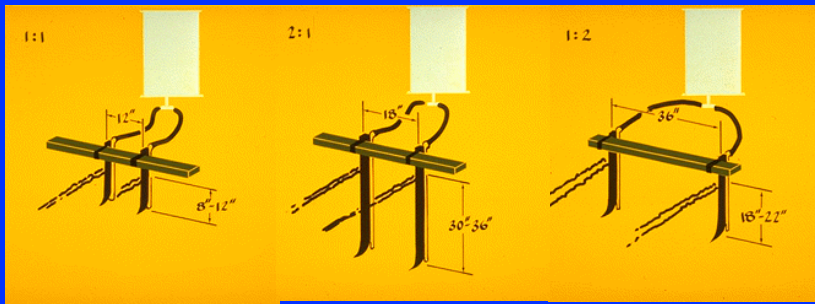
We had as good or better crops without using any chemical nematicide. " (Source: PRODUCT X AD)

"It has no toxic materials, it is not a nematocide, and it does not kill nematodes. ... encourage and enhance those natural processes already present in the soil which could control non-beneficial nematodes. Practical field experience is showing that when used as a part of the integrated Company X system, Product X is a highly cost-effective tool in the management of nematode infestations in agricultural situations."

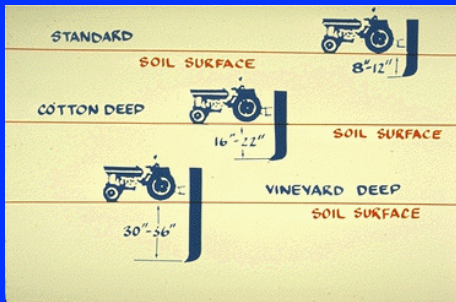
(source: Agricultural Trade Journal, Summer 1990)

#### METHODS USED TO APPLY PRODUCTS TO SOIL





**SHANK SPACING AND DEPTH OF INJECTION**



**SOIL SEALING AFTER INJECTION**



**RING ROLLER**

**PUMP DRIVEN APPLICATOR**





**PUMP DRIVEN APPLICATOR**



**NITROGEN PRESSURIZED APPLICATOR**



**WINGED SHANKS WITH SPRAY NOZZLES**



**SHANKS WITH SPRAY NOZZLES**





**SPRAY NOZZLES FOR MULTIPLE DEPTHS OF INJECTION**



**TURF GRASS INJECTION WITH COULTER CUTTERS**





## FLOOD APPLICATIONS OF ENZONE



**ENZONE**

**SODIUM  
TETRATHIOCARBONATE**

**RELEASES CS<sub>2</sub> IN SOIL  
NEEDS TO BE APPLIED  
IN IRRIGATION WATER**

**CA REGISTRATION ON  
CITRUS, GRAPES,  
ALMONDS, PRUNES,  
PEACHES, PLUMS**

**REGISTRATION  
WITHDRAWN**

## EQUIPMENT USED FOR INCORPORATION OF NONFUMIGANTS CAN EFFECT EFFICACY

LILLISTON ROLLING CULTIVATOR



ROTERA CULTIVATOR



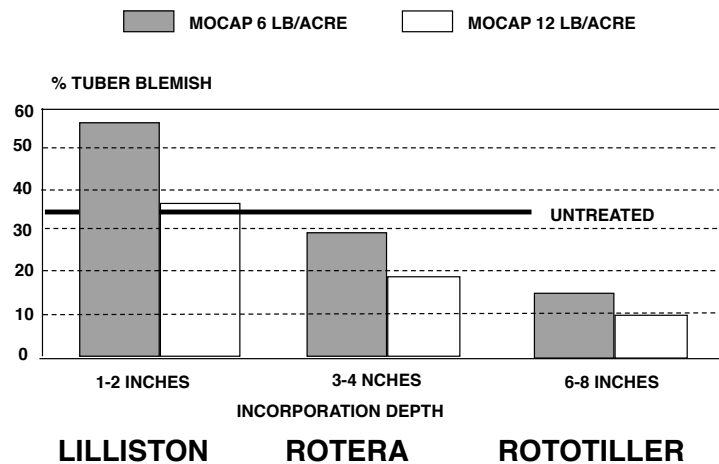
ROTOTILLER



POTATO



## EFFECT OF DEPTH OF INCORPORATION ON EFFICACY BLEMISH CONTROL WITH PREPLANT SOIL INCORPORATED MOCAP



GRANULAR APPLICATOR



SPRINKLER APPLICATION OF METAM SODIUM



TRACTOR MOUNTED SPRAYER



DRIP IRRIGATION





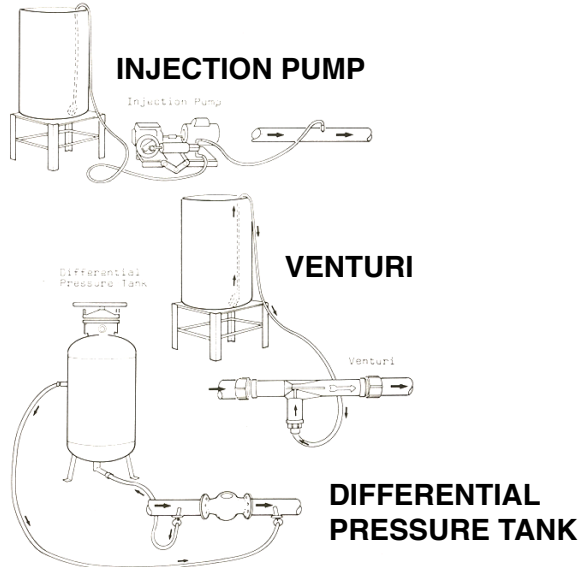
**GANDY GRANULAR APPLICATOR**



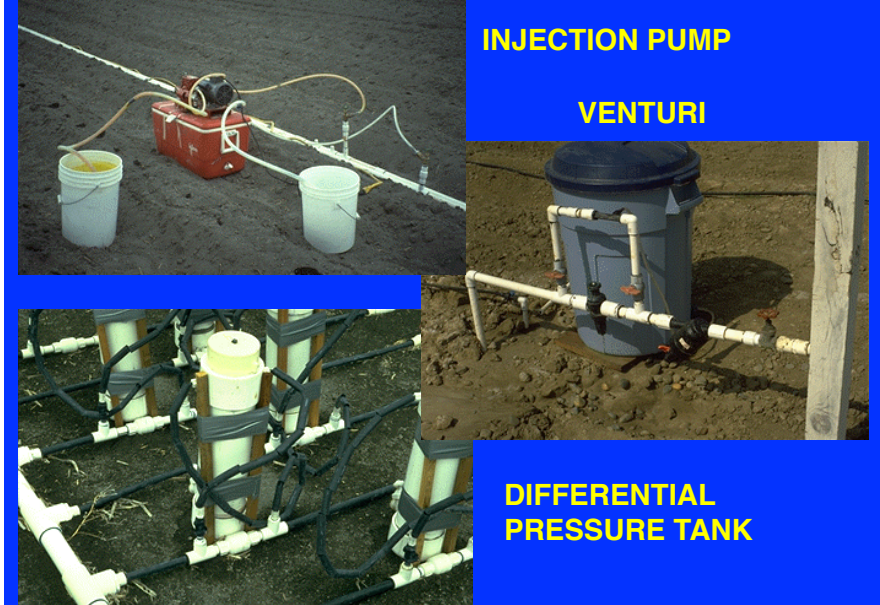
**TRACTOR MOUNTED SPRAYER**



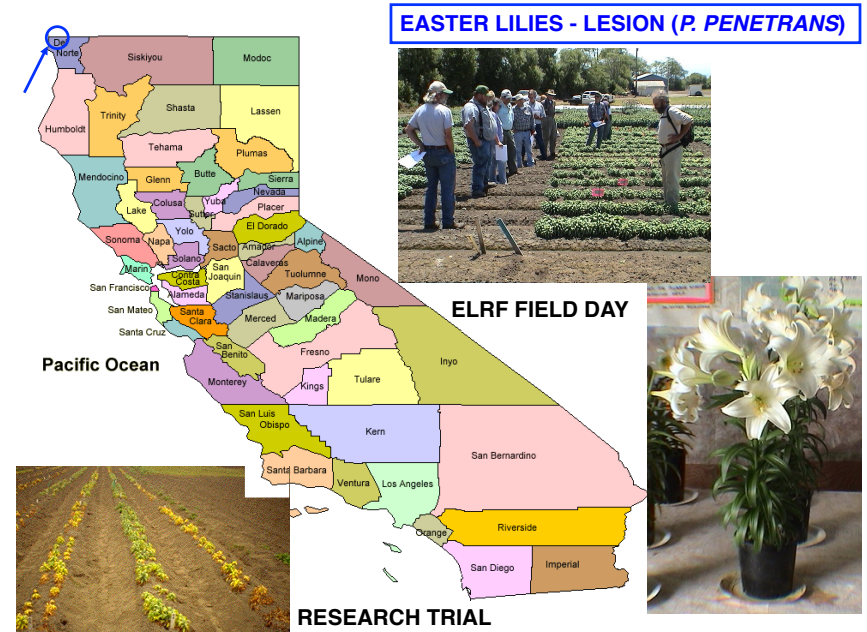
**TYPES OF APPLICATORS USED FOR DRIP IRRIGATION**



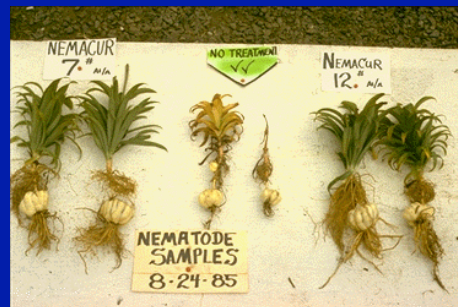
**TYPES OF APPLICATORS USED FOR DRIP IRRIGATION**







**EASTER LILY BULB PRODUCTION:**  
 ORIGINAL PLANTING STOCK FROM JAPAN  
 GROWN IN HUMBOLDT COUNTY SINCE 1940'S  
 600 ACRES ROTATED WITH PASTURE  
 65,000 BOXES OF BULBS/YEAR  
 6.5 MILLION YEARLY FARM GATE VALUE  
 AREAS LARGEST EMPLOYER



**NEMATODE MANAGEMENT:**  
**LESION NEMATODE (*PRATYLENCHUS PENETRANS*)**  
 STANDARD TREATMENT -  
 DD PLUS TEMIK (ALDICARB)  
 (1,3-DICHLOROPROPENE+1,2-DICHLOROPROPANE)  
 1982 1,2-D AND TEMIK FOUND IN GROUNDWATER  
 SWITCHED TO TELONE II AND NEMACUR  
 (FENAMIPHOS)  
 1986 REGISTRATION FOR NEMACUR WITHDRAWN  
 SWITCHED TO THIMET (PHORATE)  
 1990 REGISTRATION FOR TELONE II SUSPENDED  
 SWITCHED TO VAPAM OR METHYL BROMIDE  
 1996 USE OF TELONE II REINSTATED (TOWNSHIP CAP)  
 RIGHT NOW: DANGER OF LOSING THIMET  
 AND METHYL BROMIDE



**CURRENTLY, THE COST OF CHEMICAL CONTROL IS  
FREQUENTLY LESS THAN THE COST OF  
ALTERNATIVES.**

**WHY?**

**COST FIGURES EASILY AVAILABLE:**

**FOR CHEMICAL PRODUCT PLUS APPLICATION  
(PAID BY GROWER)**

**COST FIGURES NOT AVAILABLE:**

**FOR ACTUAL OR PERCEIVED ENVIRONMENTAL  
DAMAGE**

**(COST IS CURRENTLY SUBSIDIZED BY SOCIETY)**

**WHAT'S MISSING FROM COST FIGURES?:**

**OZONE DEPLETION**

**CARCINOGENICITY**

**MUTAGENICITY**

**GROUND WATER POLLUTION**

**AIR POLLUTION**

**ACUTE TOXICITY (WORKERS,**

**ENDANGERED SPECIES)**