Biology and Control of Weeds in Organic Vegetable Production

- Richard Smith, Vegetable Crop and Weed Science Farm Advisor, Monterey County

Weed Biology

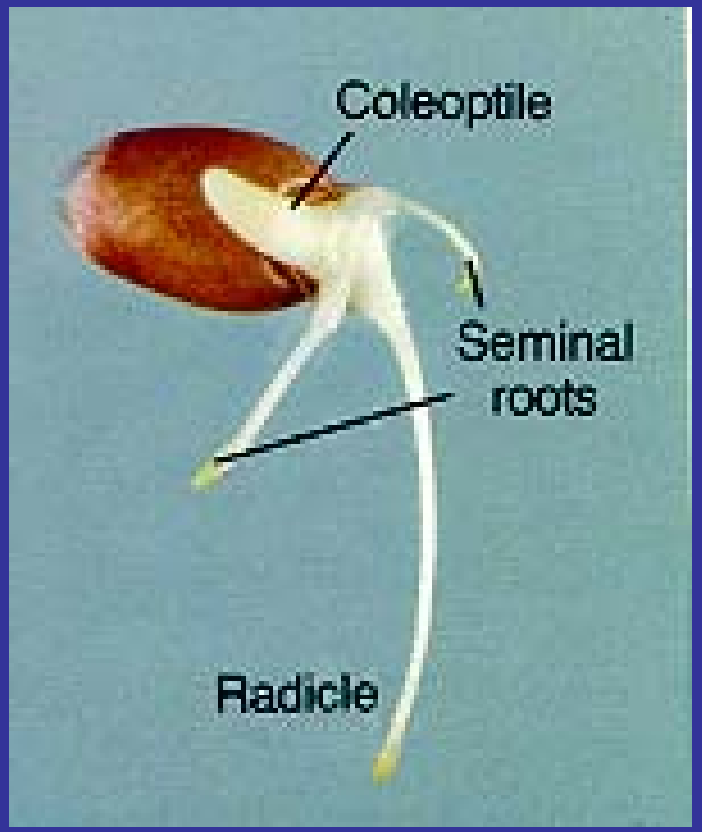
Dicots – also known as broadleaves

- **Have two cotyledons or seed leaves**
- **Generally have net venation**
- **Flowers are usually in patterns of four, five or more parts**

Weed Biology

Monocots

- Have single seed leaf (cotyledon)
- Most have leaves with parallel venation
- Flowers arranged in patterns of three
- Grasses, sedges, lilies and rushes



Weed Classification

- Annuals
  - Complete lifecycle in less than one year (from seed to seed)
    - Winter – germinate in fall and mature in early spring
    - Summer – May germinate in the fall or spring, but mature in the summer

Winter annuals

Summer Annuals


Purslane


Nightshades

Nettleleaf Goosefoot

Weed Classification

- **Biennial**
  - **Live longer than one year but less than two. Often overwinter as a rosette and resume growth in the spring**
- **Perennial**
  - **Live more than one year. Can be woody or fleshy. May have survive as tubers, roots, nutlets, etc.**
    - **Winter – active in the winter**
    - **Summer – active in the summer**

Soil Seed Bank

Non-dormant

Dormant
Weed seed

Germination
& Emergence

Tillage
& other
controls

Microbial
Physical
Physiological
Seed degradation

Seed Death

Castroville-Marina Area Coolest Part of the Valley – Coolest Loving Weeds active all year

156
Castroville
Salinas
Chualar
Gonzales
Soledad
Greenfield
King City
101
San Lucas
San Ardo
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36°23'03.28" N 121°16'25.98" W
elev 207 ft
Eye alt 77.29 mi
Google

Salinas – Gonzales Cool season weeds dominate even in the summer

156
Castroville
Salinas
Chualar
Gonzales
Soledad
Greenfield
King City
101
San Lucas
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36°23'03.28" N 121°16'25.98" W
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Gonzales - Greenfield
Transition Zone
Mix of Cool and
Warm Season
Weeds, but Warm
Season Weeds
Becoming
Dominant
156
Castroville
Salinas
Chualar
Gonzales
Soledad
Greenfield
King City
101
San Lucas
San Ardo
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King City south strong weed seasonality. Few winter weeds in the summer
Purslane
Hairy Nightshade
Pigweeds
Black Nightshade
Lamb's quarter
156
Castroville
Salinas
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elev 207 ft
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Other Weeds of Vegetables

Burr Clover

Malva

Pineapple Weed

Yellow Nutsedge

Knotweed

Henbit

Annual Bluegrass

Why Care about Weeds

- Weeds are not microscopic or small like fungi and insects
- They can always be pulled out
- The issue is their impact on plant growth and on the economics of farming

Hours/Acre to Weed Carrots

Comparison of Organic vs Conventional Broccoli Production Costs

System	Weed Costs $/A	Percent of Growing Costs
Organic[1]	270	9
Conv.[2]	161	8

1 – Tourte and Smith, 2004; 2 – Smith et al. 2004

Comparison of Organic vs Conventional Leaf Lettuce Production Costs

System	Costs $/A	Percent of Growing Costs
Organic[1]	257	8
Conv.[2]	132	5

1 – Tourte and Smith, 2004; 2 – Tourte and Smith, 2001

Weed Strategies – Crop Areas

- Set Seed Quickly
  - Groundsel, Burning Nettle
- Long lived seed
  - Malva, Burr Clover
- Large Numbers of Seed
  - Purslane & many others
- Set seed in surrounding areas and invade from the edges
  - Groundsel, Sow thistle

Weed Control Strategies

- Cultural
  - To be discussed
- Biological
  - Few effective other than seed viability declining in the soil over time
- Chemical
  - To be discussed

Cultural Practices for Managing Weeds

- Aggressively controlling weeds in all prior rotations and during the fallow period over the winter
- Zero tolerance of weeds going to seed

Cultural Practices to Reduce Weed Pressure

- Field selection
- Avoidance:
  - Avoiding weedy fields
  - Avoiding weediest time of the growing season (i.e. purslane during June to Sept.)
- Pre-germination of weeds
- Use of “stale” seedbeds
- Planting vigorous varieties on weediest area

Effects of Preirrigation

No Preirrigation

With Preirrigation

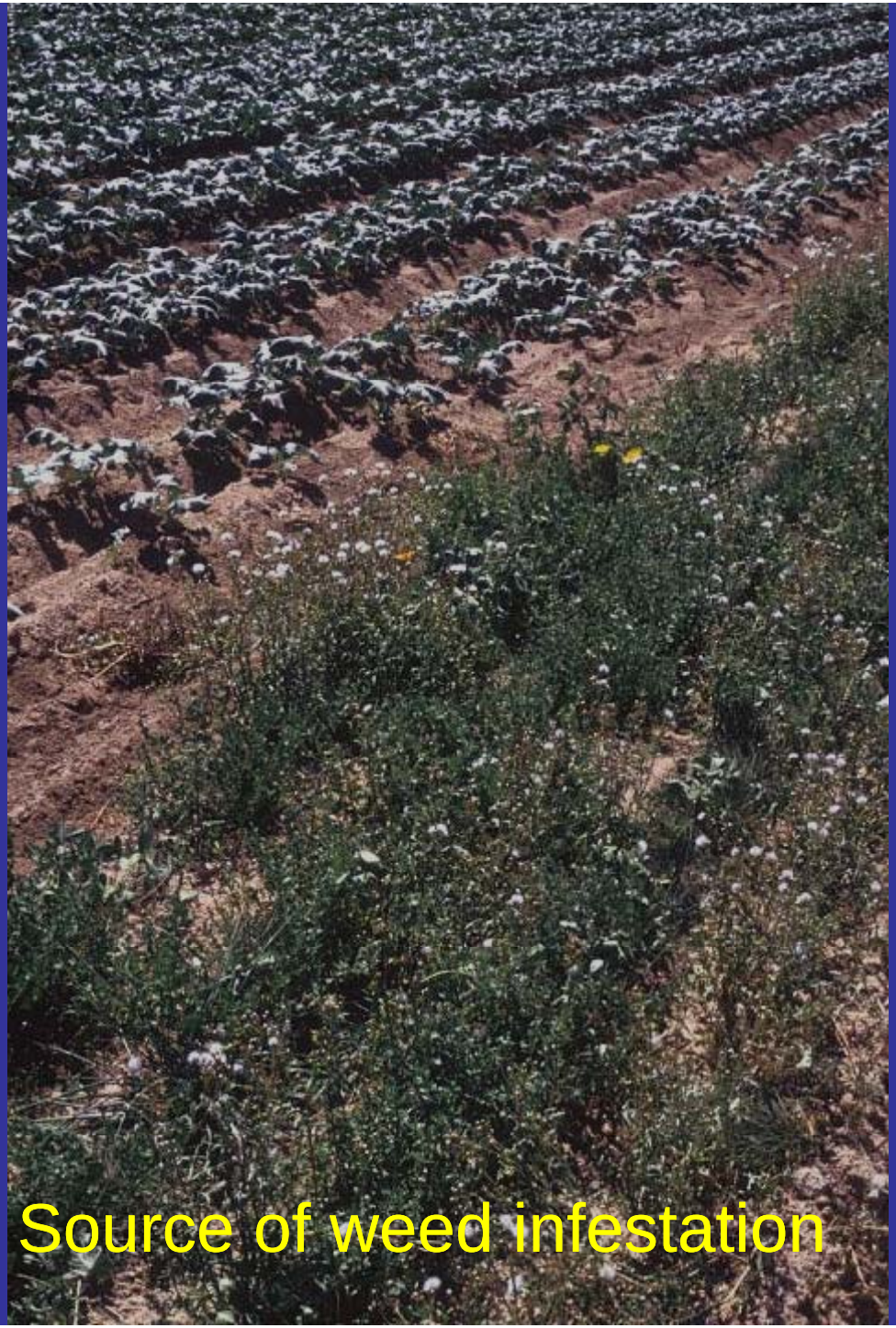
- Reduces the number of weed seed that are ready to germinate in the top layer of the soil
- Can reduce weed emergence in subsequent crop by up to 50% (Shem Tov and Fennimore)

Stale Bed Technique: Pre-germinate and kill flush of weeds on shaped beds, prior to planting cash crop

Cultural Practices to Reduce Weed Pressure

- Control weeds that aerial disperse from surrounding areas
- Not letting weeds go to seed
- Carrying weeds from the field for disposal elsewhere

- Crop rotations
- Deep plowing
- Planting to moisture
- Use of buried drip irrigation
- Solarization
- Mulches
- Transplants
- Cover crops



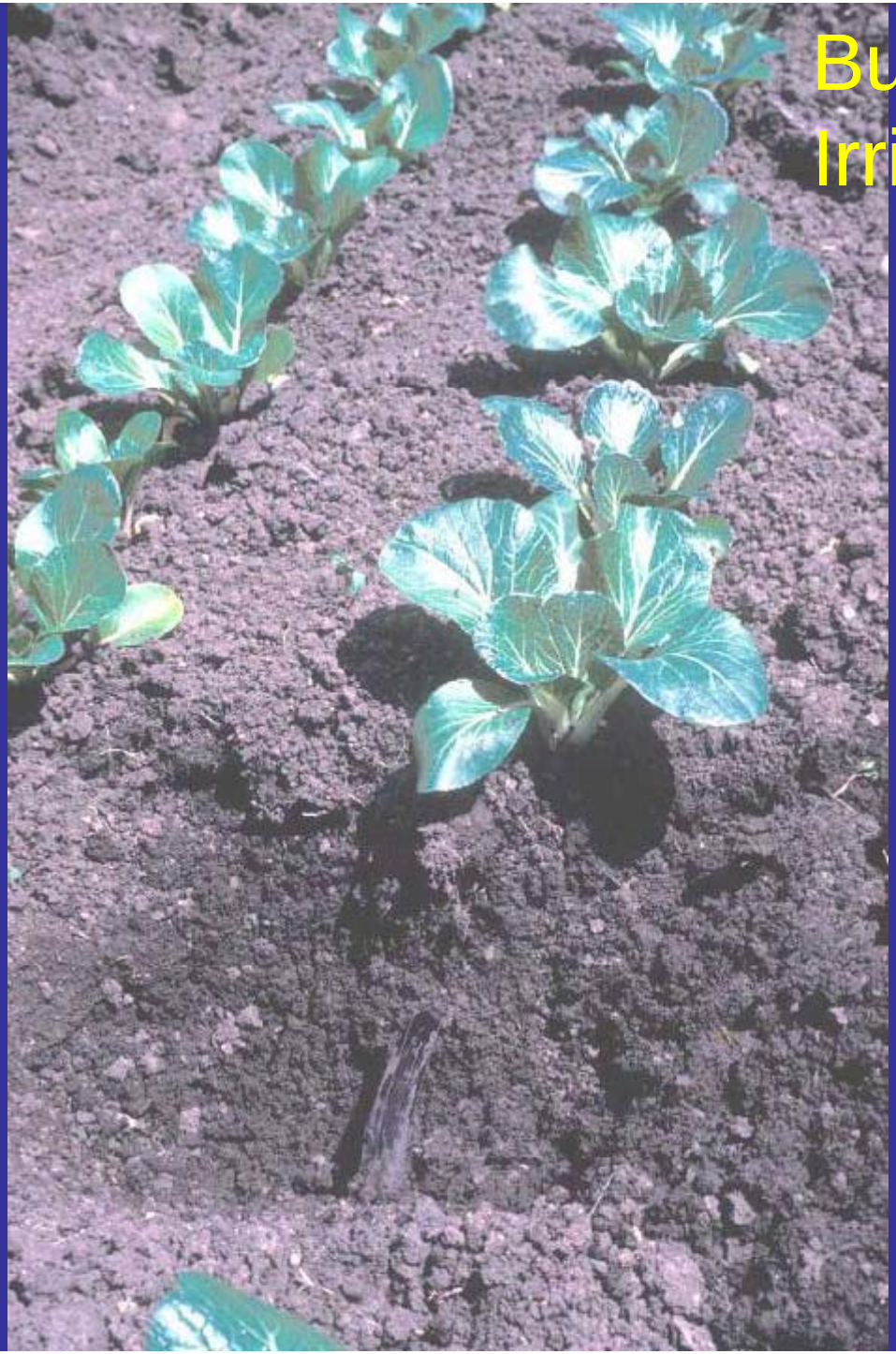
Weeds Around Edge of Field

Carry Weeds Out of Field

Purslane in bags carried to edge of field

Planting to Moisture

Buried Drip Irrigation



Solarization

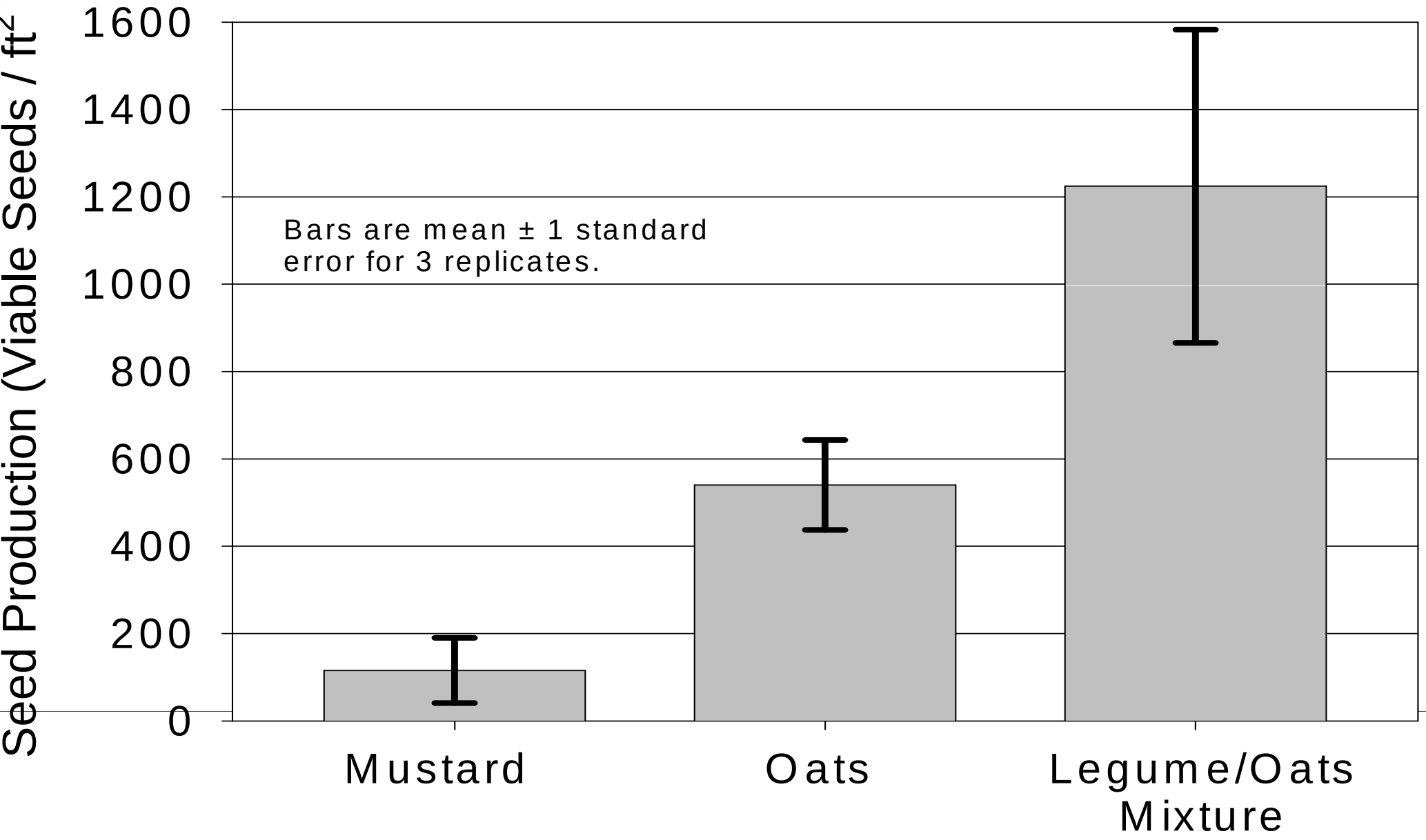
Colored mulches

Impact of Cover Crops on Weeds

Largest Chickweed Under 3 Cover Crops at 2 Seeding Rates (64 Days After Planting)

	Legume/Rye	Mustard	Rye
1x Seeding Rate	 125 lb/acre	 10 lb/acre	 80 lb/acre
3x Seeding Rate			

Burning Nettle Seed Production Under the Cover Crop by January 9, 2002.



Use of Transplants

- Transplants open opportunities for mechanical weed control
- Transplants give the crop a head start on the weeds
- Transplants are more resistant to physical manipulation
- Transplants are easier for high tech mechanical weeders to recognize (distinguish from the weeds)

Mechanical Controls

- Cultivation

Standard cultivation with Knives and sweeps

Typically 80+% of a 40-inch wide bed can be effectively cultivated. The fight with weeds occurs in the uncultivated seedline

Precision Guidance of Cultivators

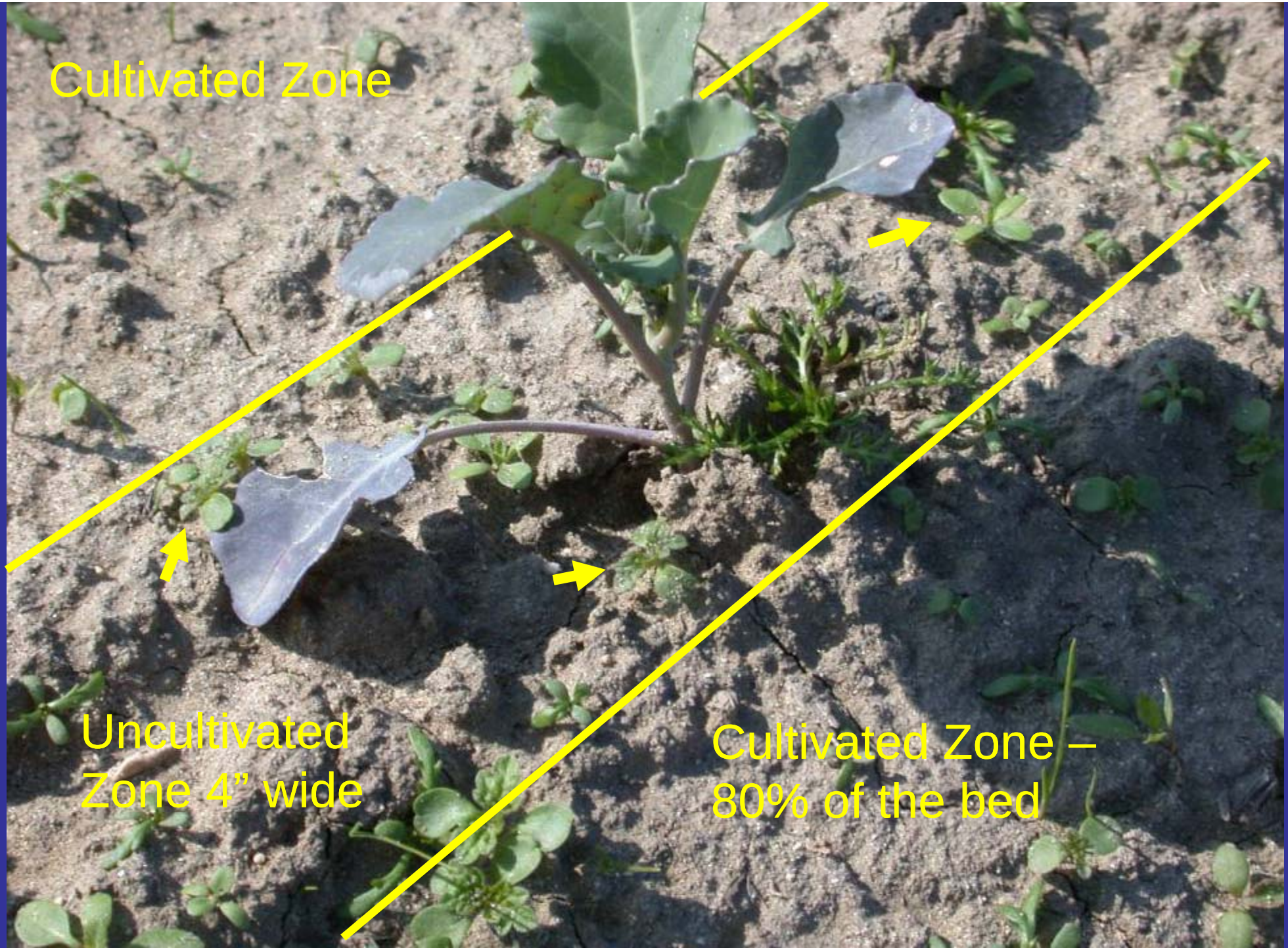
Guided by the Operator

Effective but Slow

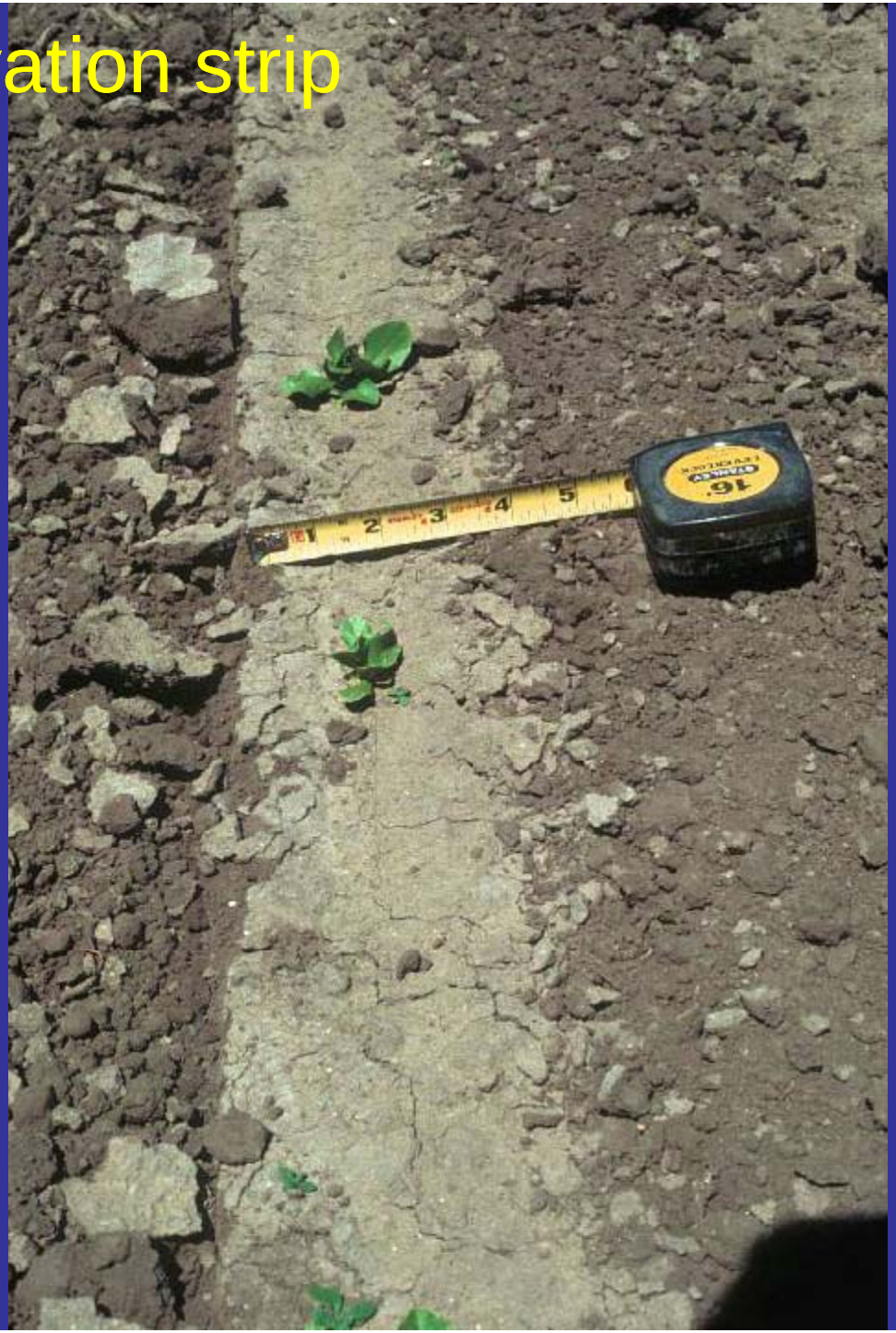
Old Technology

Modern Version

Camera Guidance Systems for Cultivators

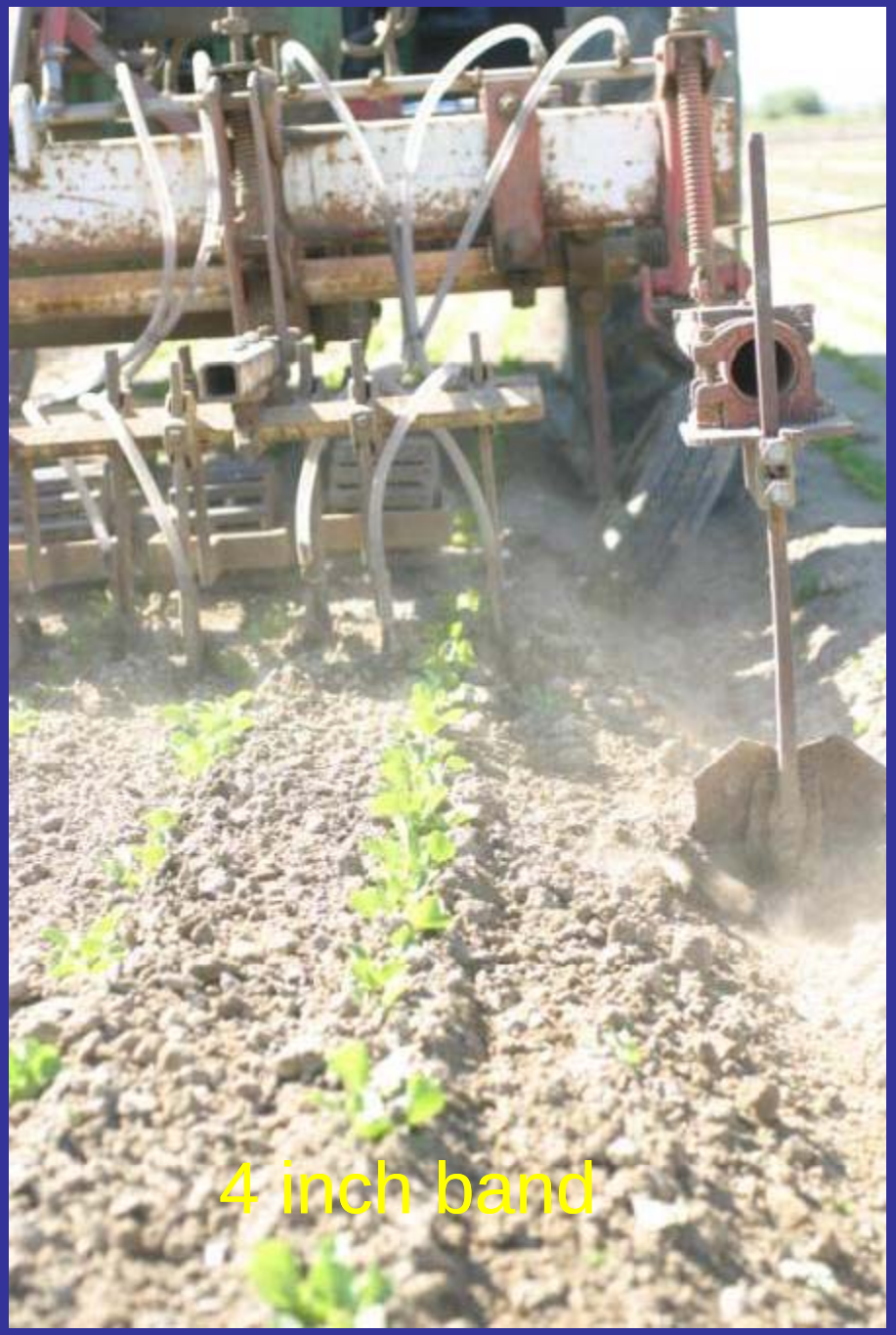

Cultivated Zone
Uncultivated Zone 4” wide
Cultivated Zone – 80% of the bed

4” wide cultivation strip



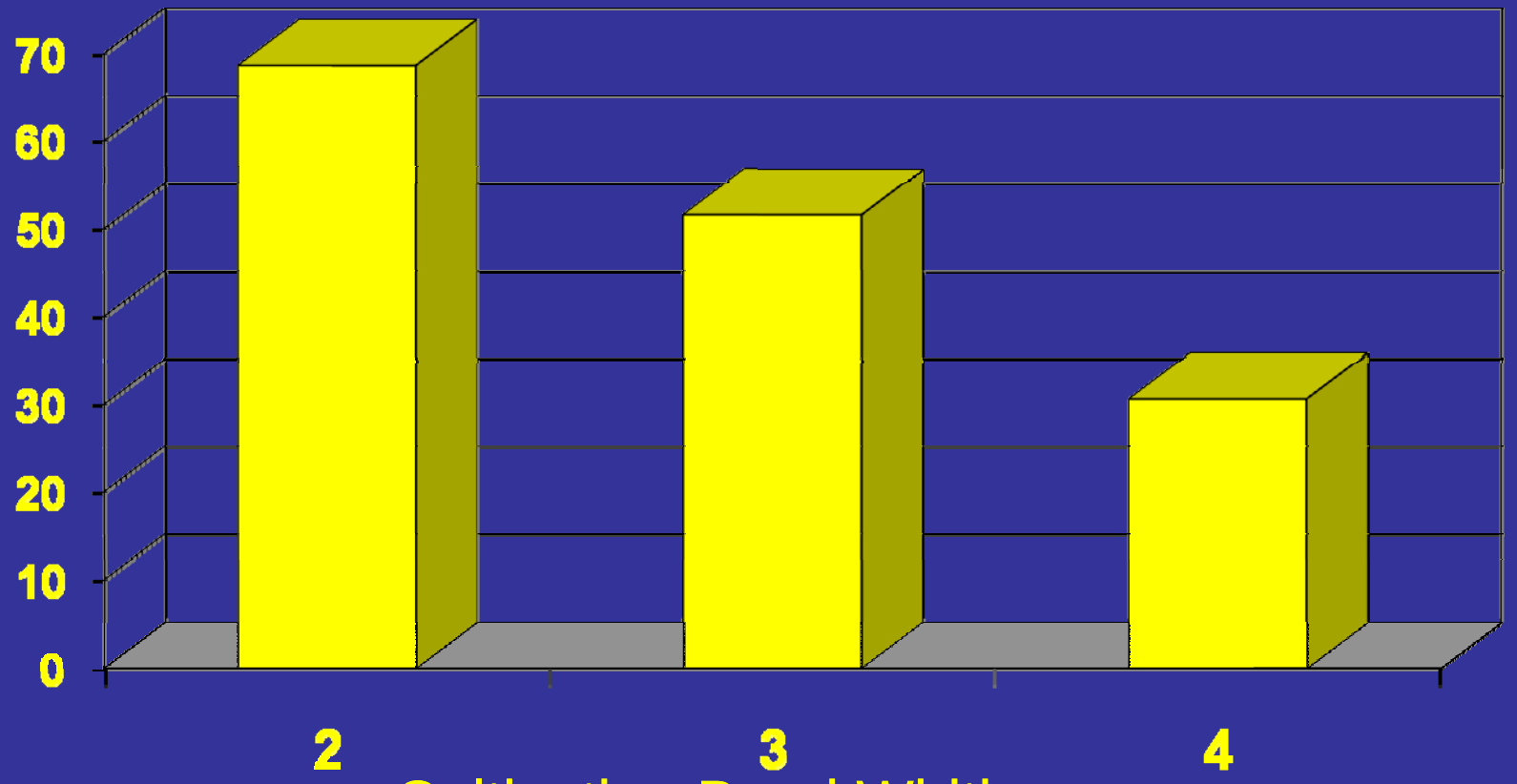
3” wide cultivation strip


2 inch band


4 inch band

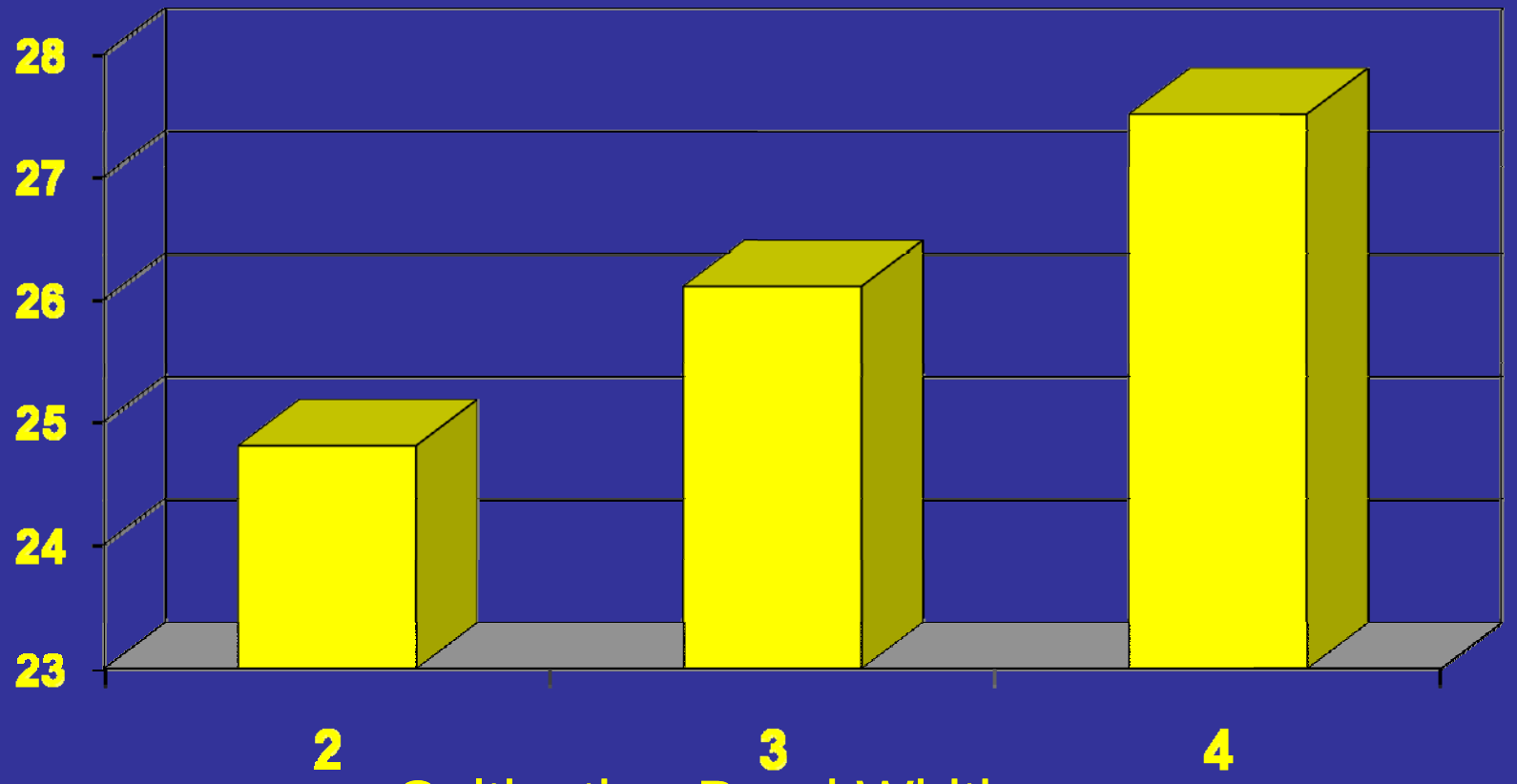
Percent of Weeds Controlled at Different Cultivation Band Widths

2005 Lettuce Trial No. 1

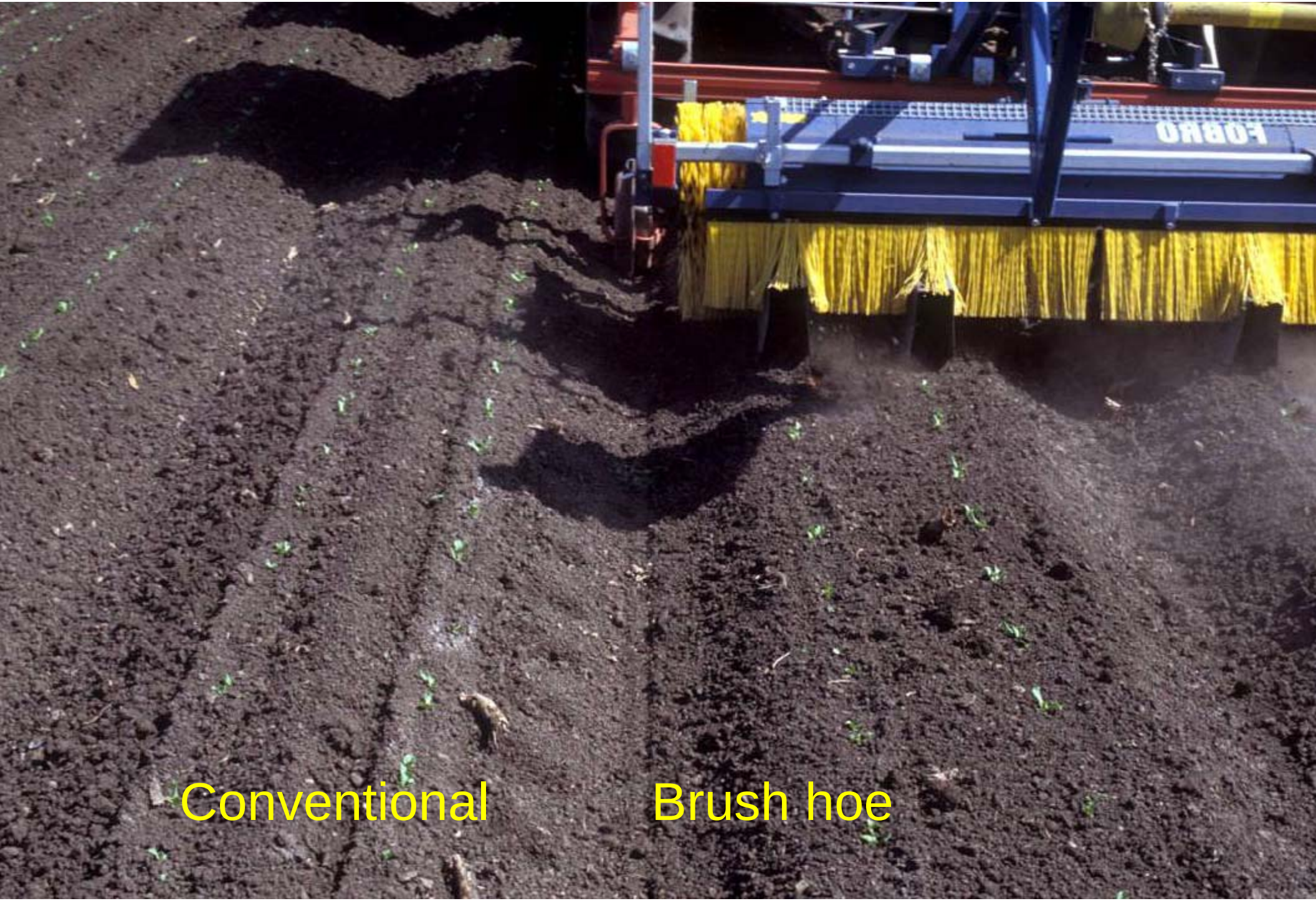


Hours Per Acre to Weed Different Cultivation Band Widths

2005 Lettuce Trial No. 1



Brush Hoe

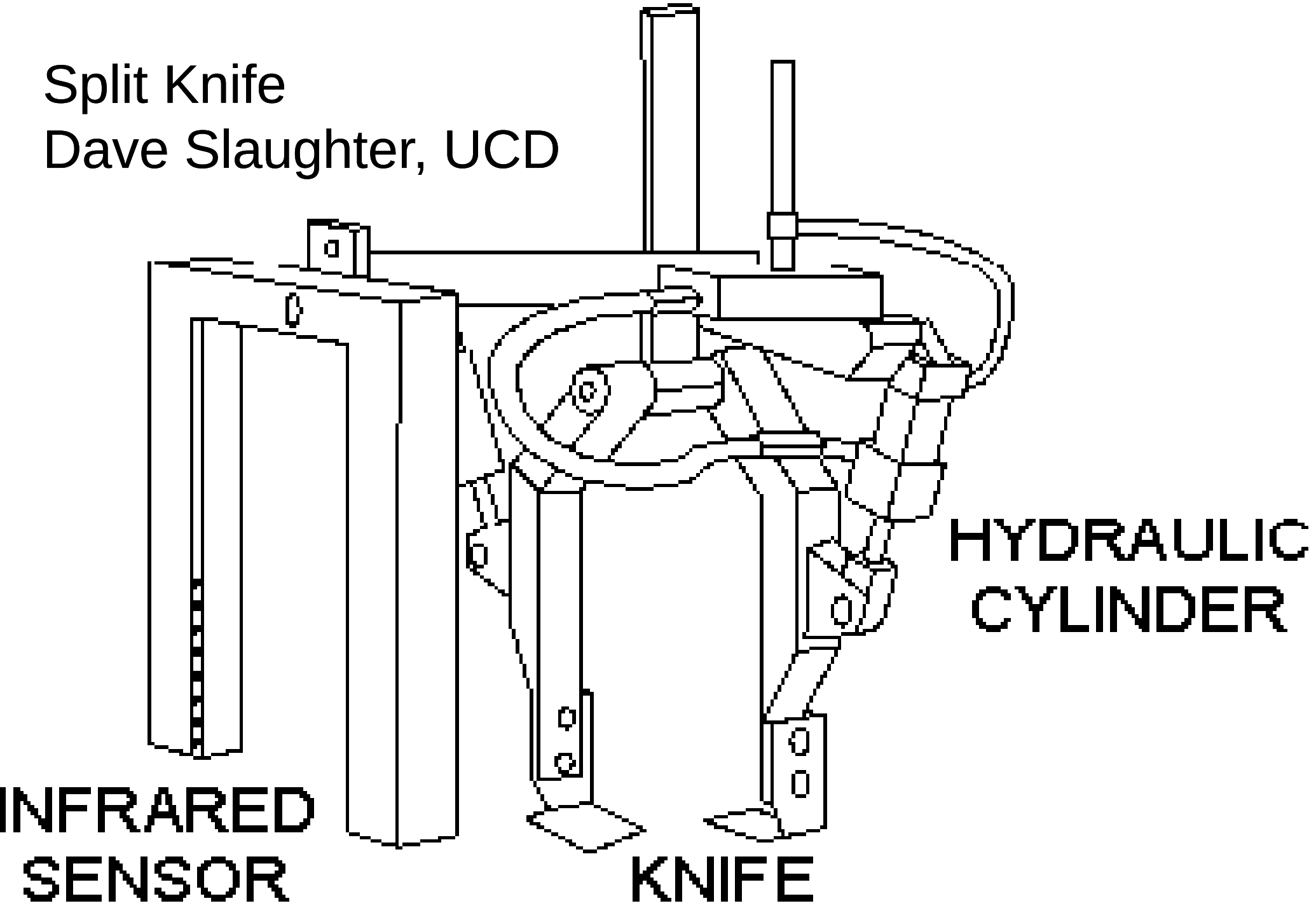

Conventional
Brush hoe

Brush hoe 2.9 inch strips

Removal of Weeds from the Seedline

- High Tech Ideas

Split Knife
Dave Slaughter, UCD



Tillett and Hague Technology Ltd

Lower Tech Ideas for Removing Weeds from the Seedline

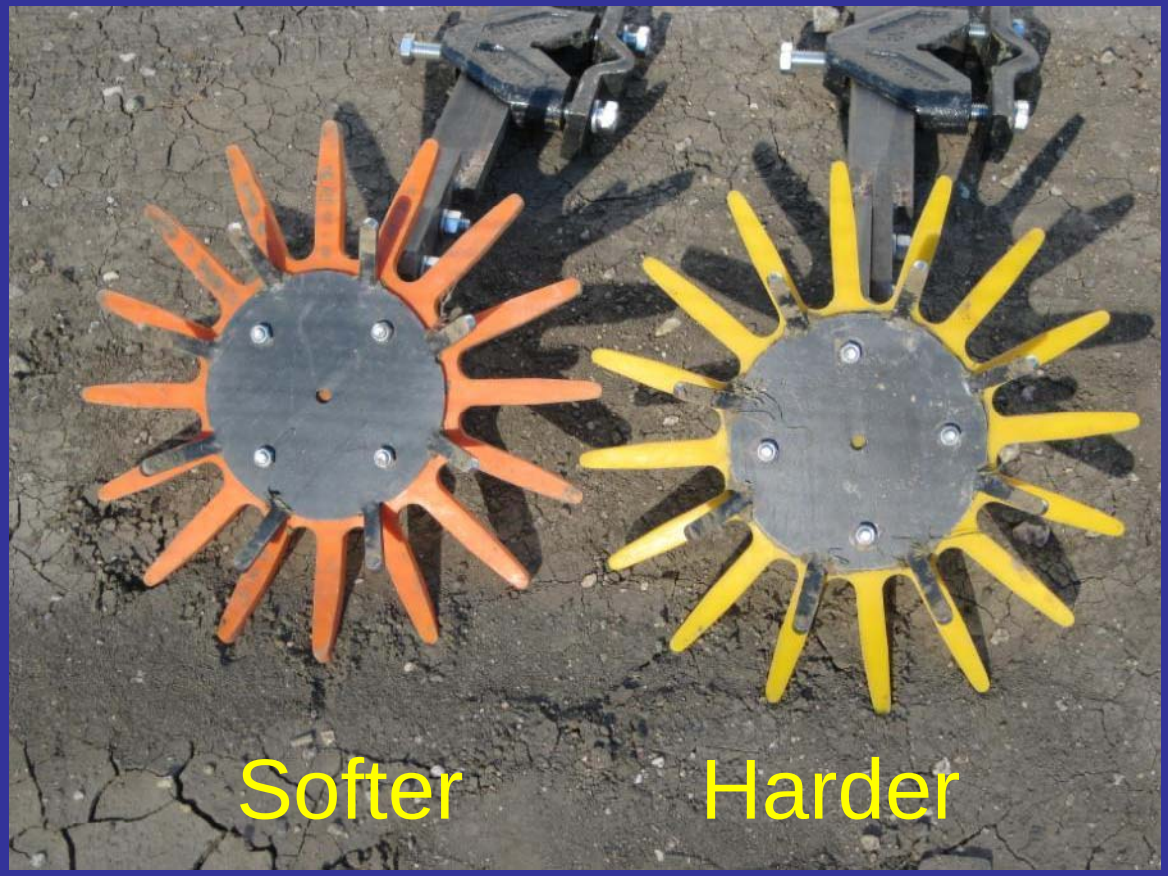
- **In Europe where transplanting of vegetables is commonly used, there is wider use of implements that are capable of removing weeds from the seedline**
- **We tested two of these implements:**
  - **Finger Weeder**
  - **Torsion Weeder**

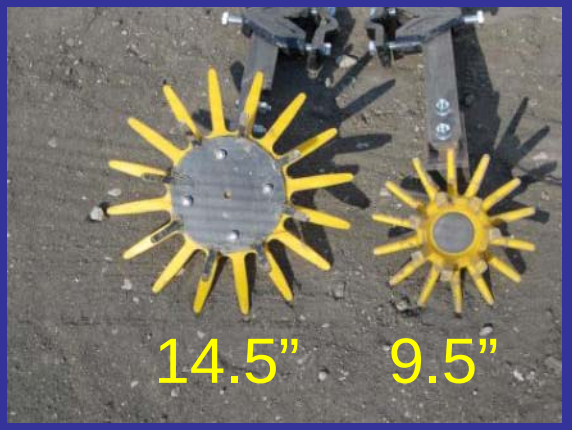
Finger Weeder Background

- This idea originally came from the US – was invented by the Buddingh Company, Michigan
- The idea was taken to Europe and further developed and refined (now produced by three companies)
- The Europeans claim their designs can operate at higher speed

Finger Weeders

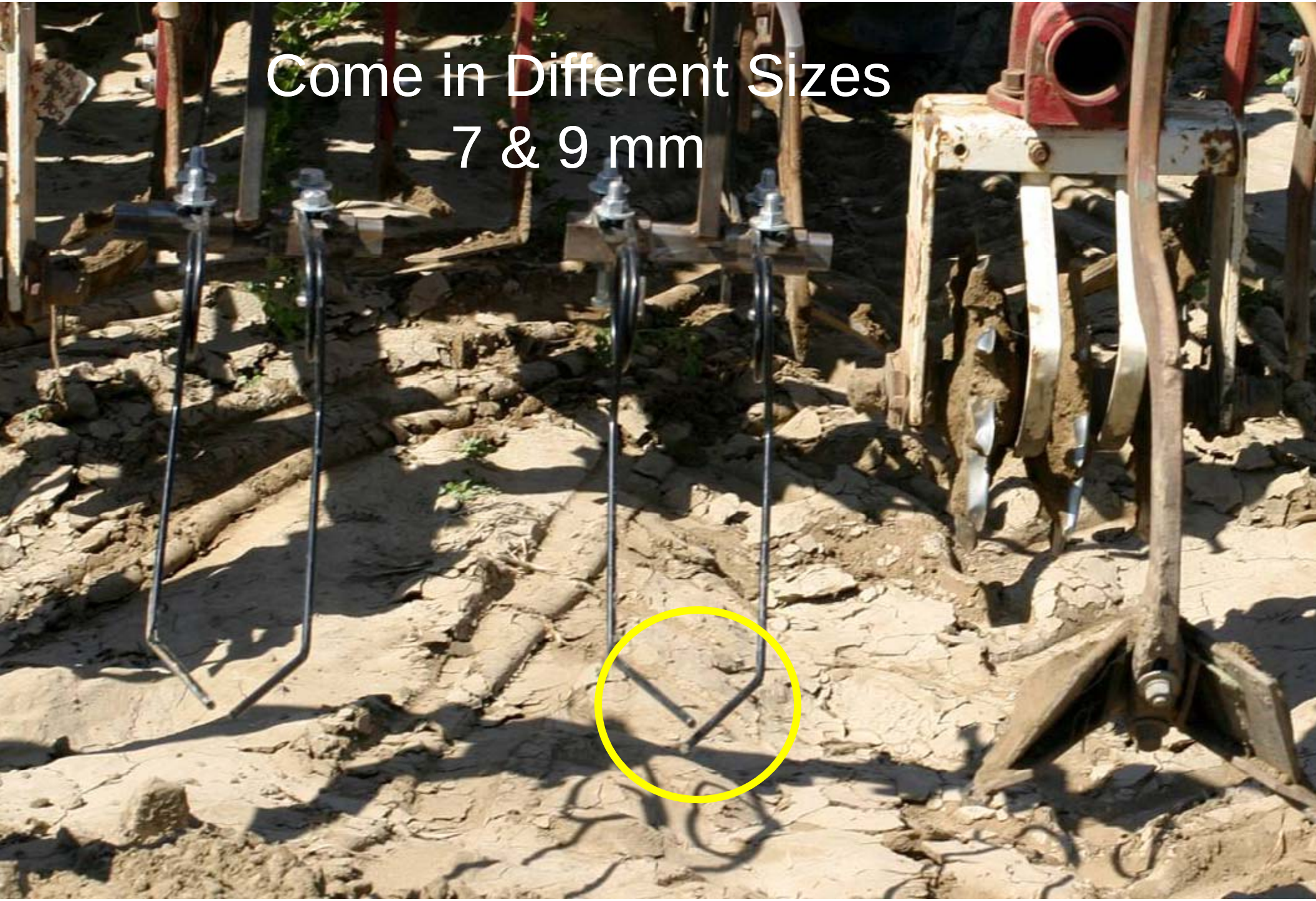
Two sizes and two levels of hardness

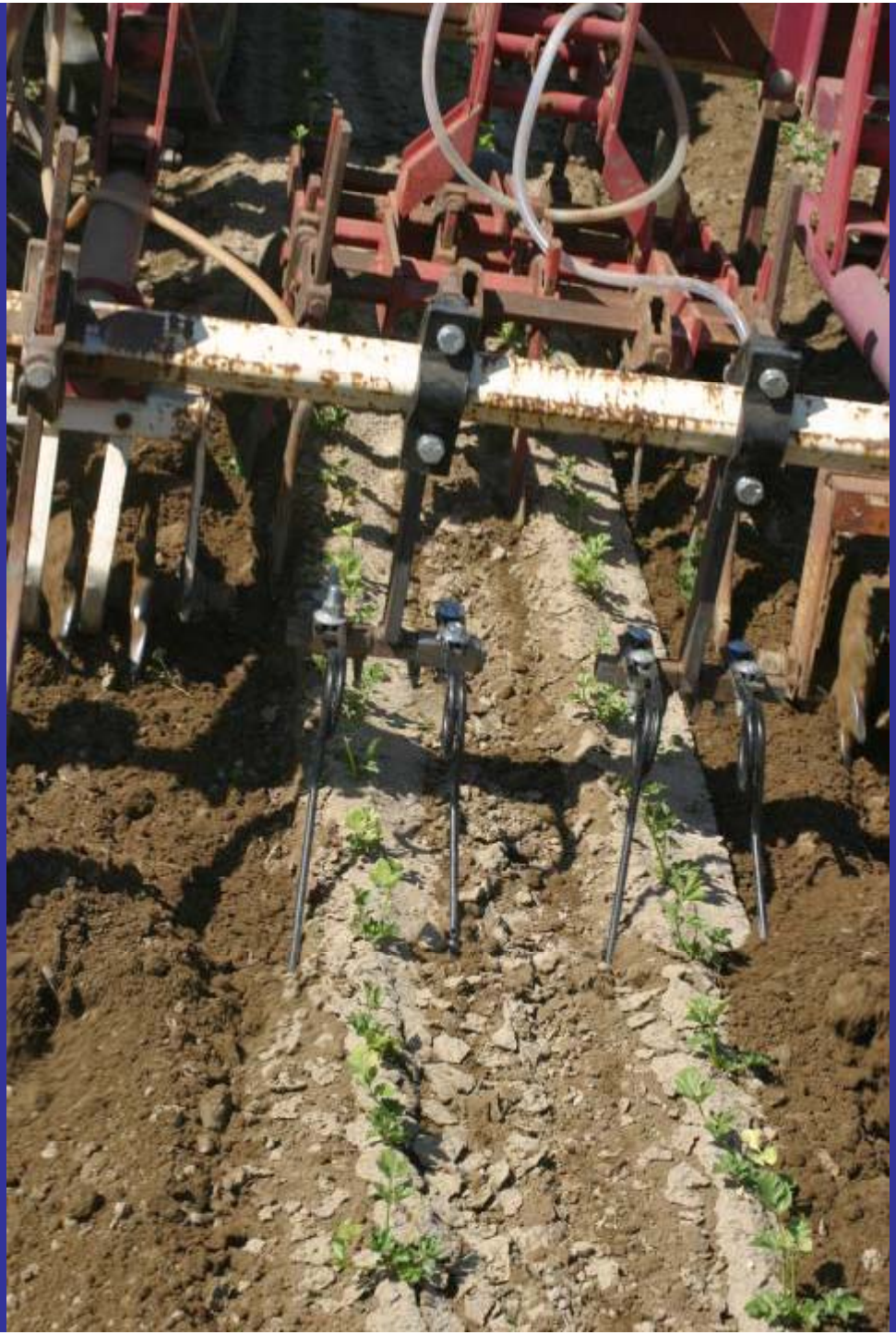




Kress Co, Germany


Torsion Weeder
Erato Corp, Netherlands

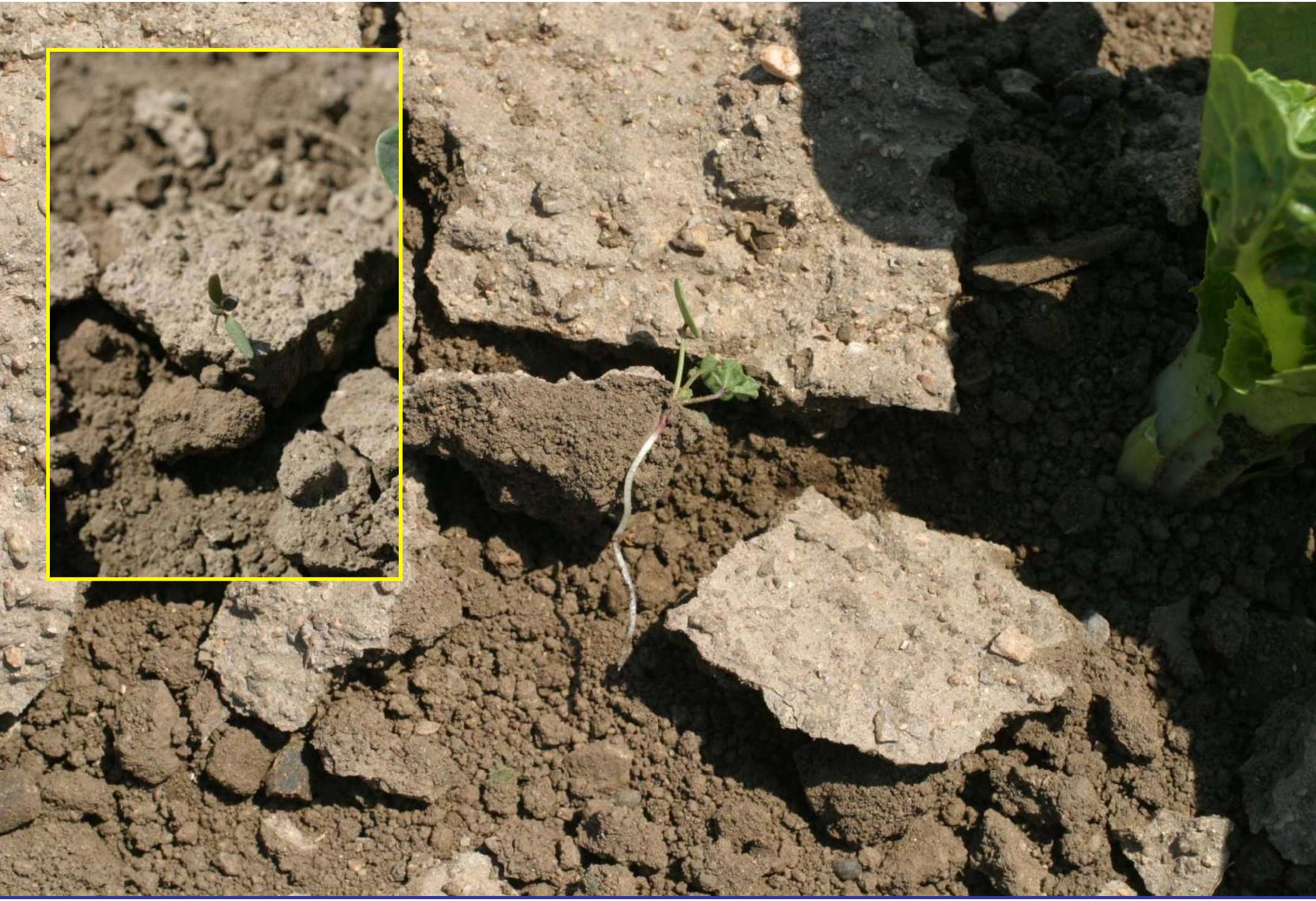

Come in Different Sizes
7 & 9 mm



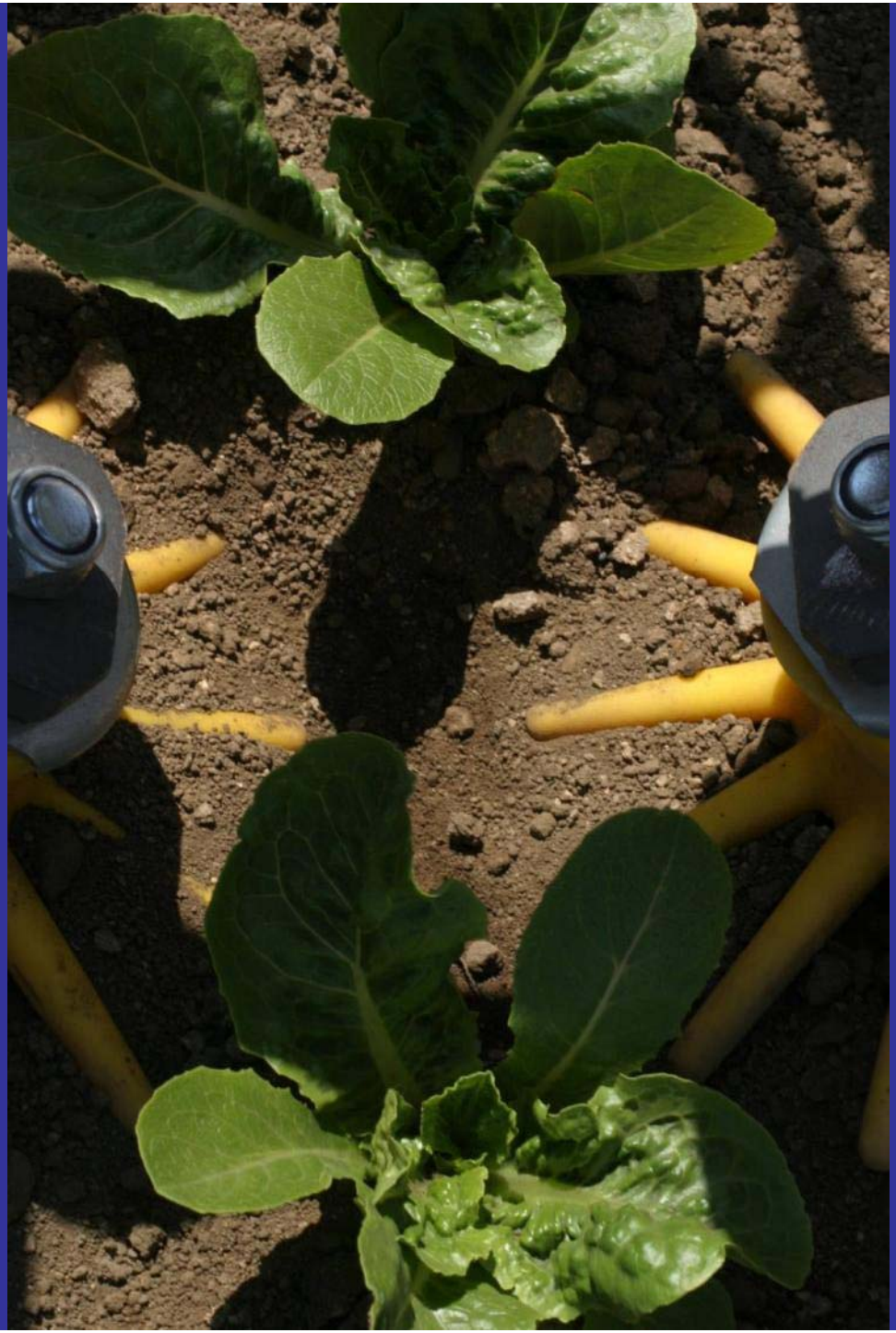

2008 On-Farm Trials

Standard Cultivation

Finger Weeder



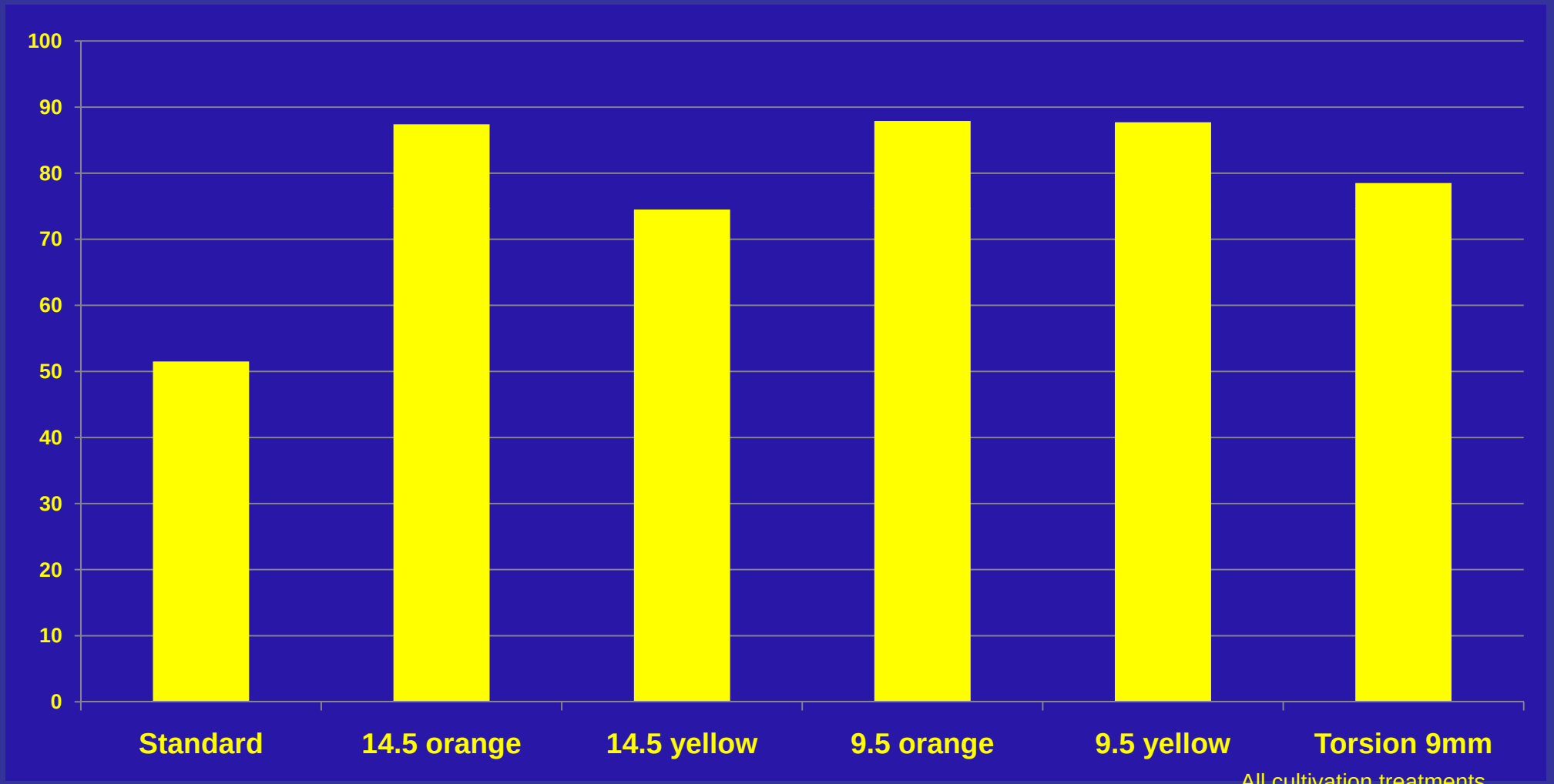

Adjustment of the units
is critical for crop safety



Transplanted Lettuce Trial No. 1

Percent Removal of Weeds

Small Nettle Dominant Weed

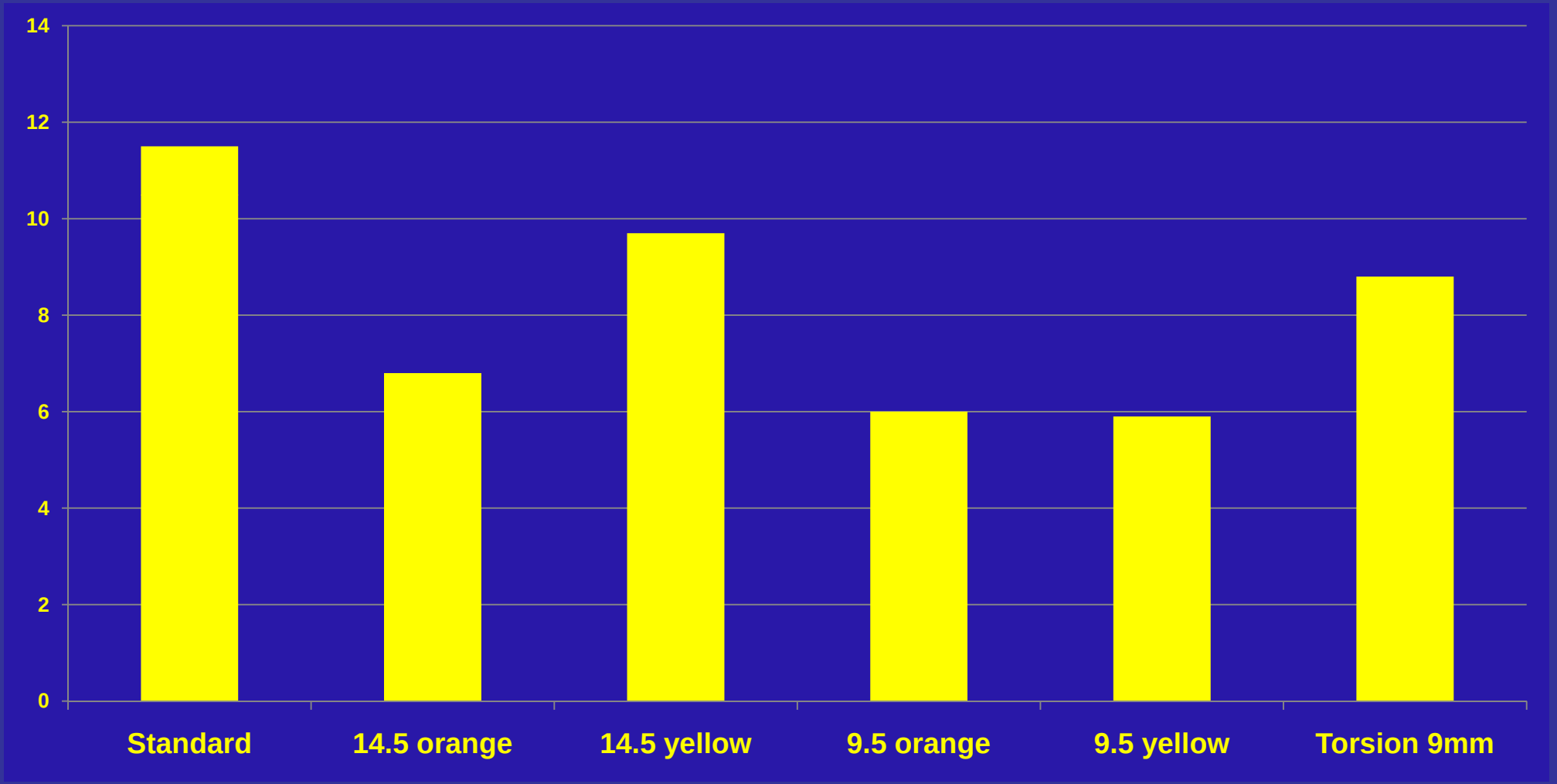


All cultivation treatments

Improved percent removal

Transplanted Lettuce Trial No. 1

Weeding Time hrs/A




2008 Leek Cultivation Trial
1
2
3
4


Standard
9.5” yellow

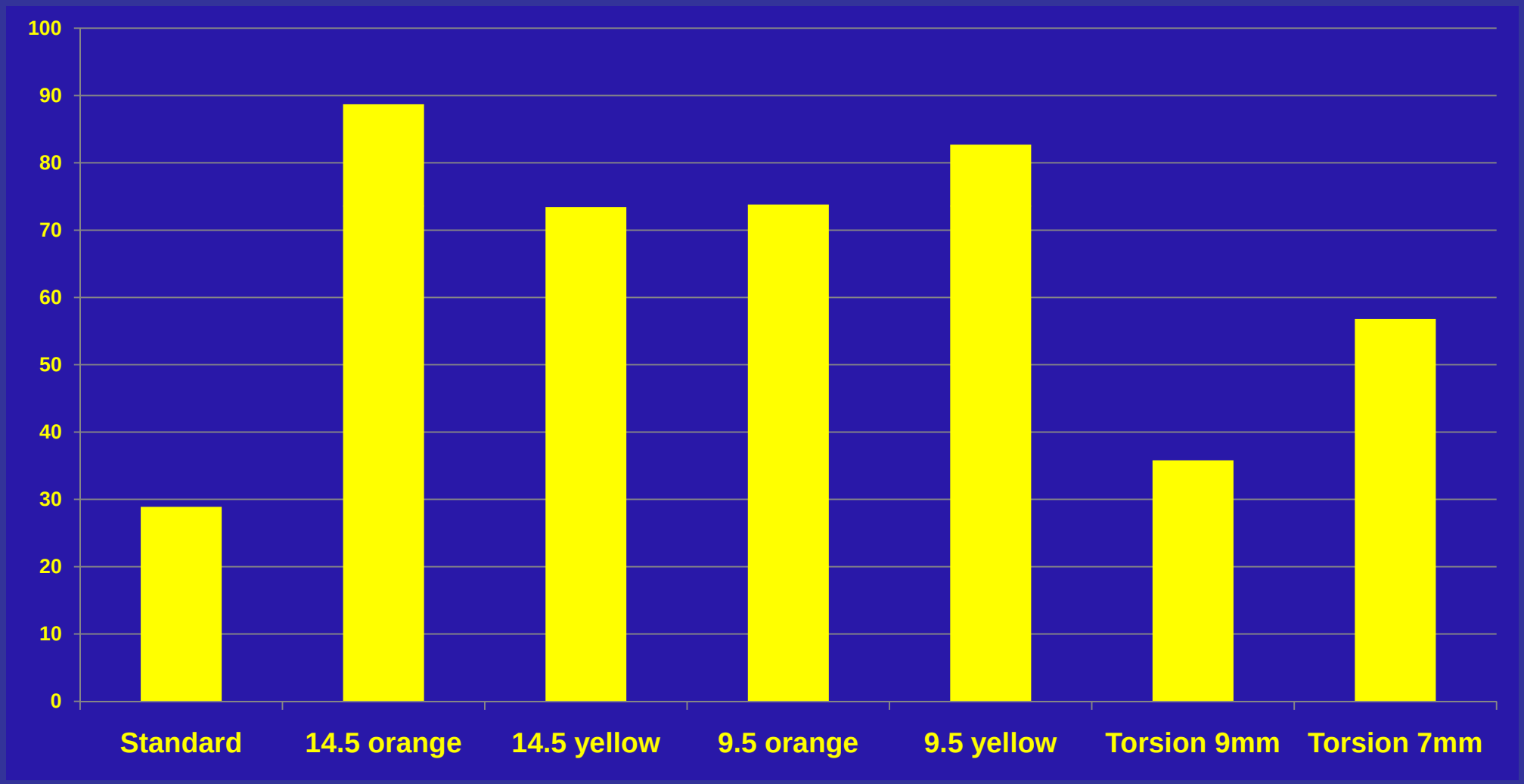

3


4

Transplanted Leek Trial

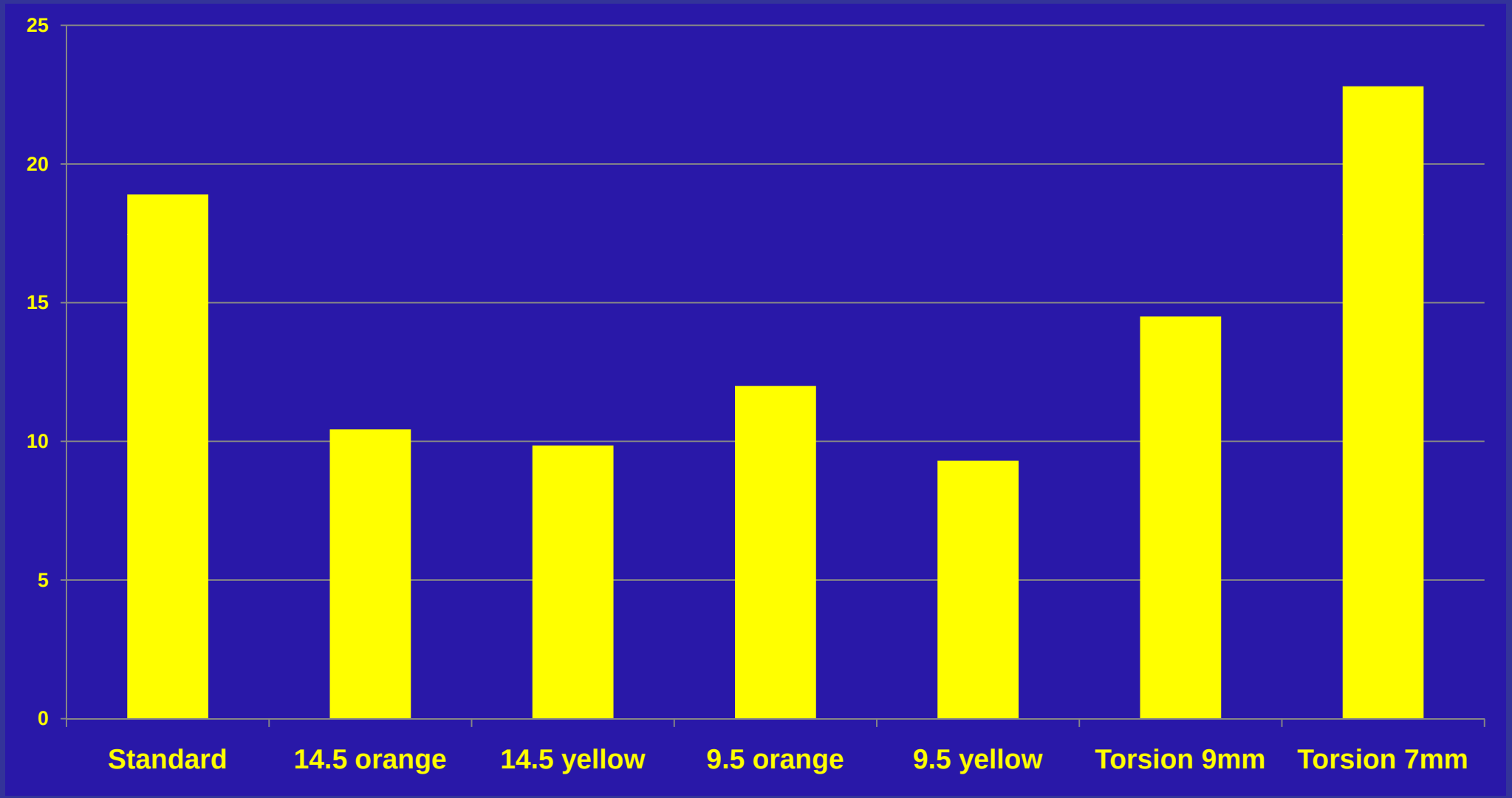
Percent Removal of Weeds

Nettle, Pig Weed and Malva Dominant Weeds



Transplanted Leek Trial

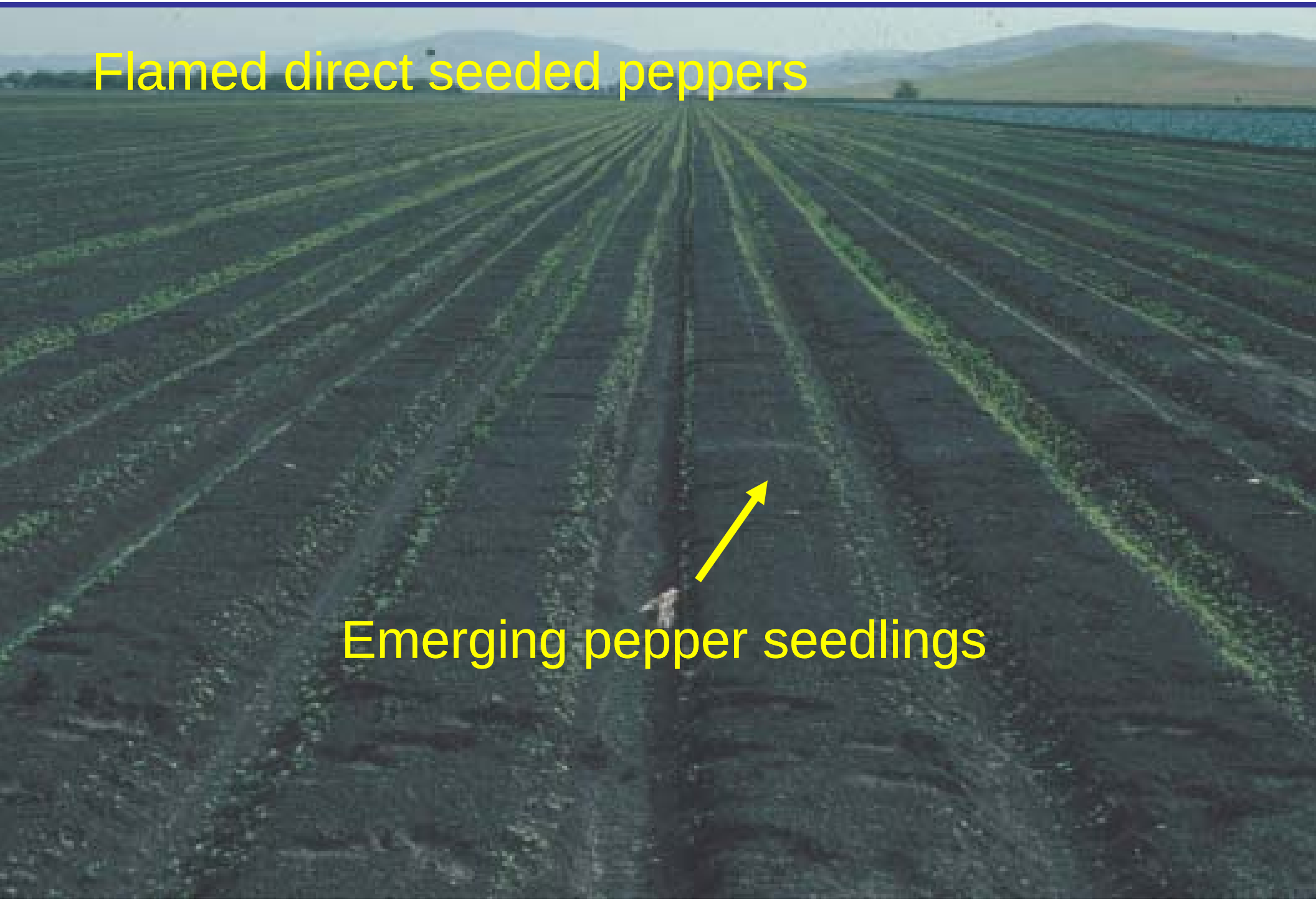
Weeding Time hrs/A




Flex Tined Cultivator
More effective on tough
stemmed crops

Flaming

- **Flaming**
  - **Used to kill weeds following preirrigation**
  - **Can be used preemergence on slow germinating crop such as pepper and others**
  - **Works better on small broadleaf seedlings**


Flamed direct seeded peppers
Emerging pepper seedlings