

# Improving Fertilizer Use Efficiency for Horticultural Crops

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# How to reduce fertilizer costs?

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## □ BMPs

- Florida **Container Nursery** BMP Guide
  - Water Quality/Quality BMPs for Florida **Vegetable** and agronomic crops
  - Water Quality/Quality BMPs for Florida **Specialty Fruit** and Nut crops
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# How to reduce fertilizer costs?

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- Use less fertilizer with improving fertilizer use efficiency
  - Use alternatives for inorganic fertilizers
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# Alternative to inorganic fertilizer

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- ❑ **Animal Manure**
- ❑ **Compost and biosolids**
- ❑ **Cover crop/crop residue**



# Increase fertilizer use efficiency:

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- Low P fertilizer formula
  - Soluble vs. Controlled-release fertilizers
  - Fertigation
  - Foliar fertilization
  - “Snake oils”
  - Other practices
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Low P fertilizer formula

# Phosphorus deficiency

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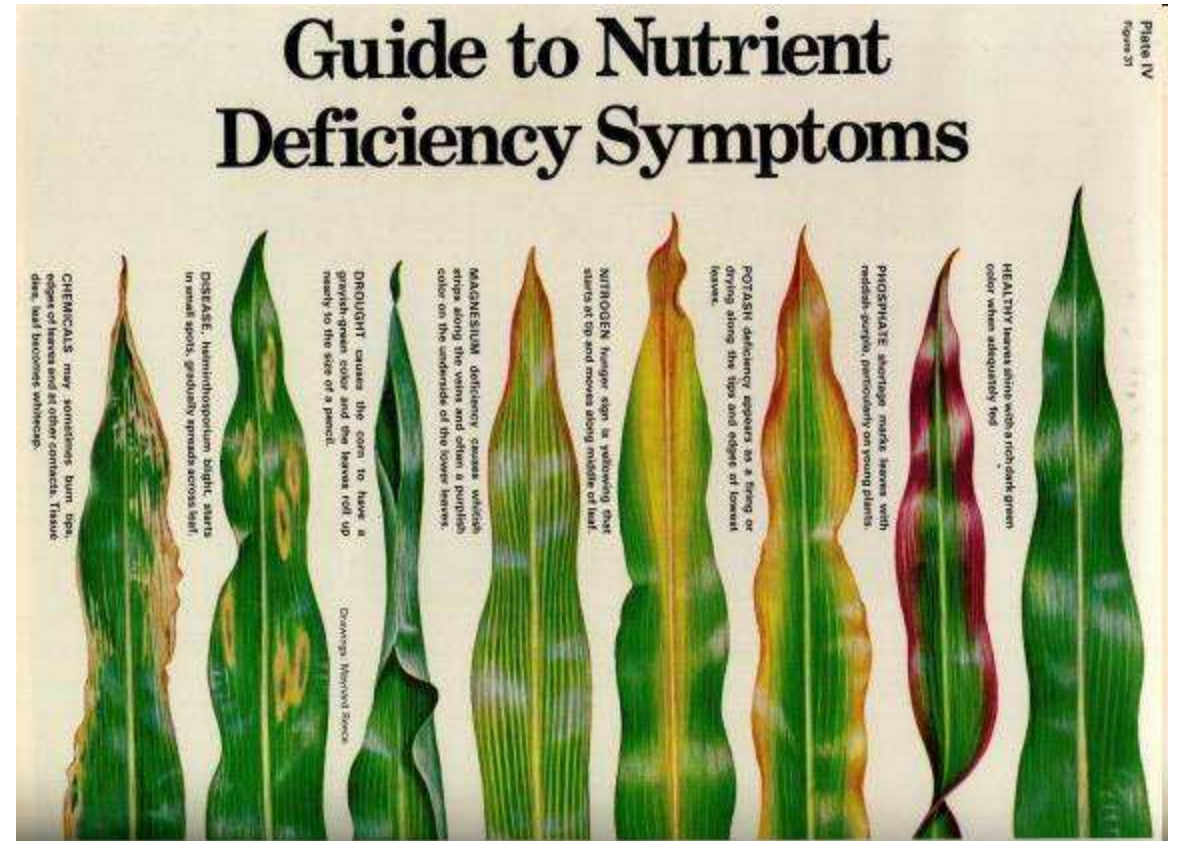


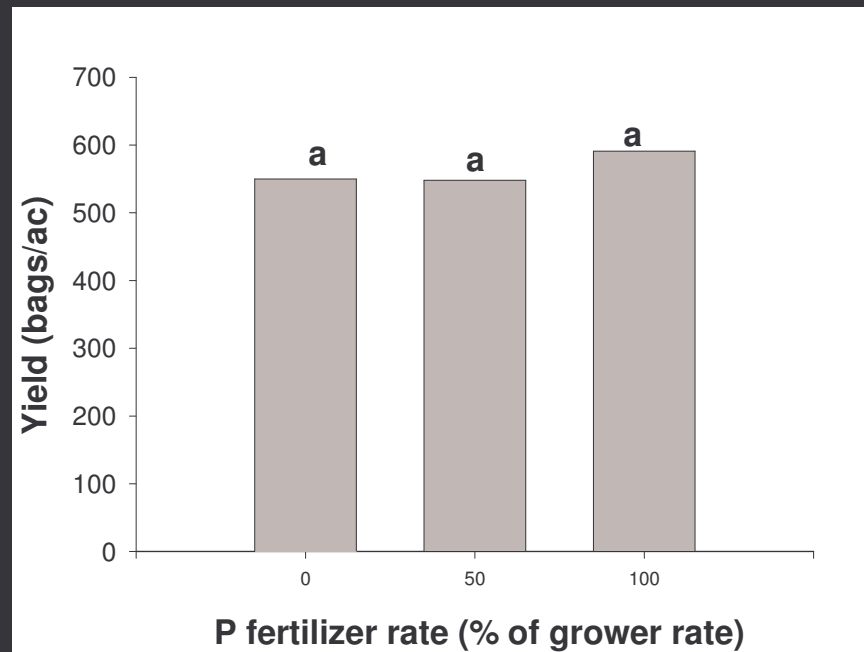
Pear

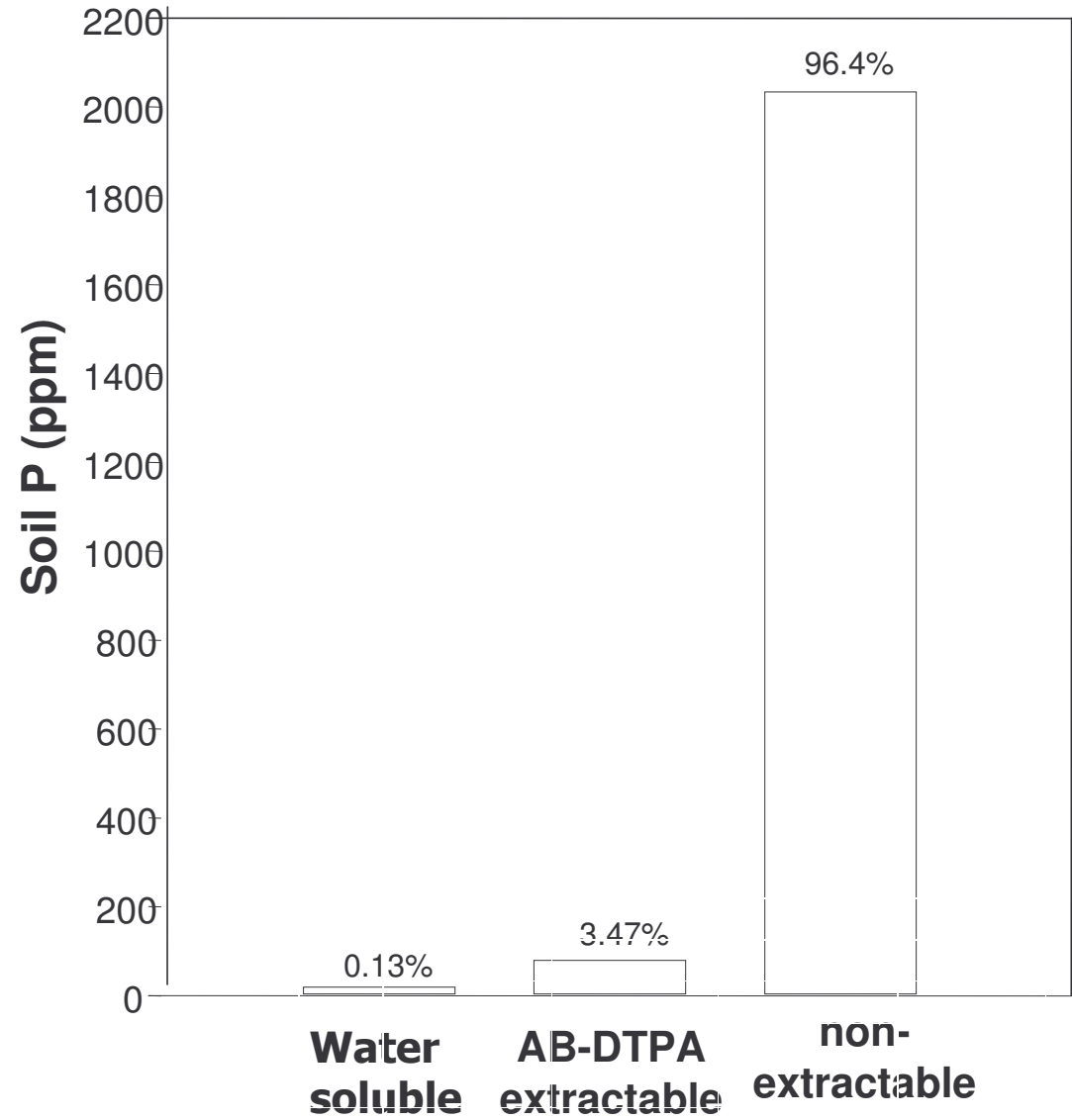
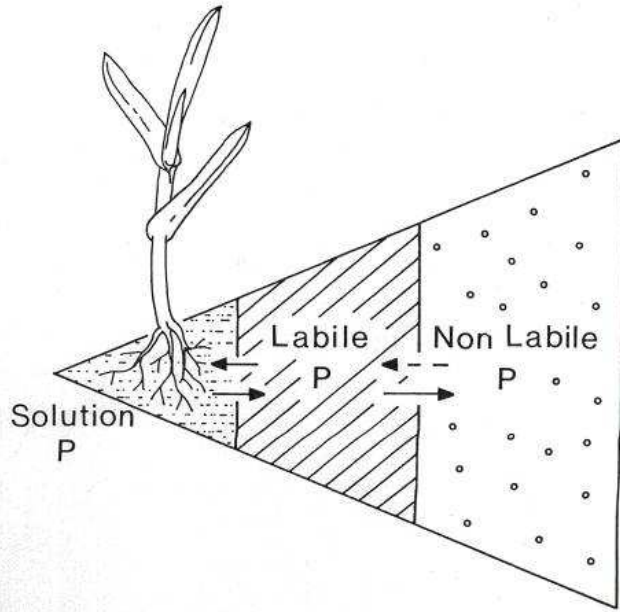


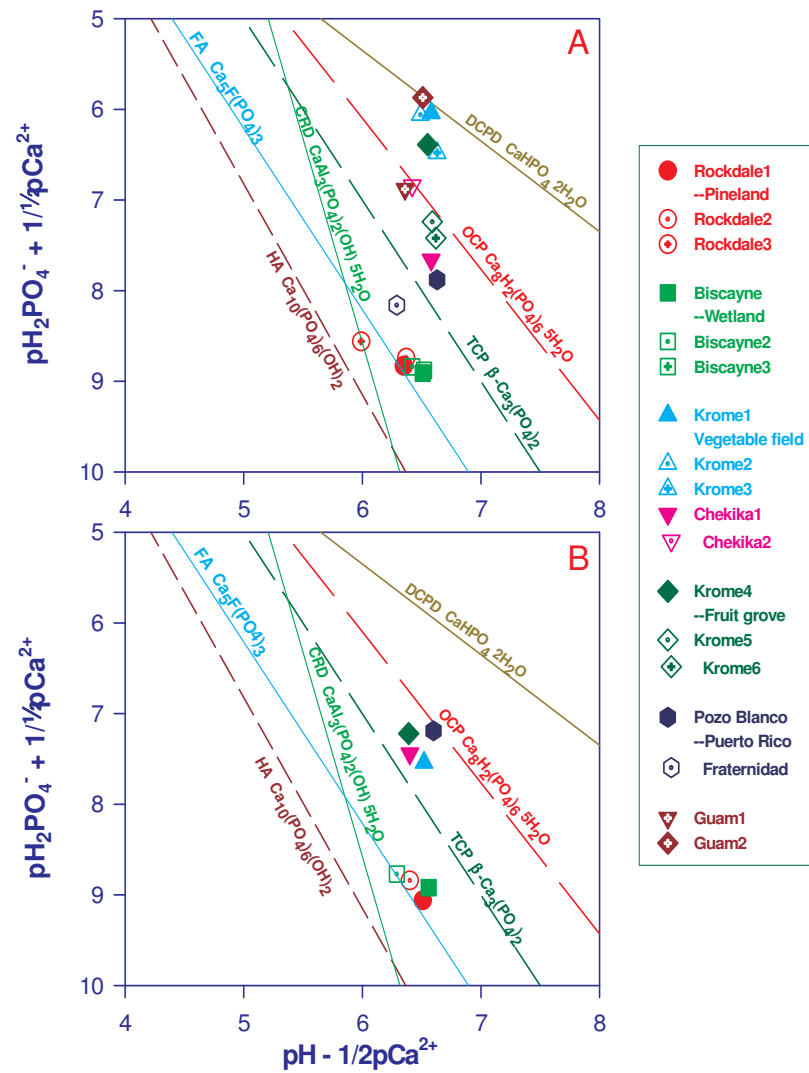
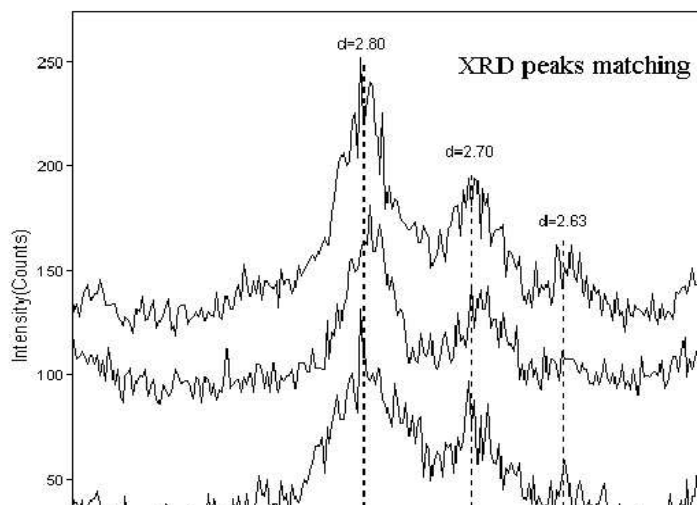
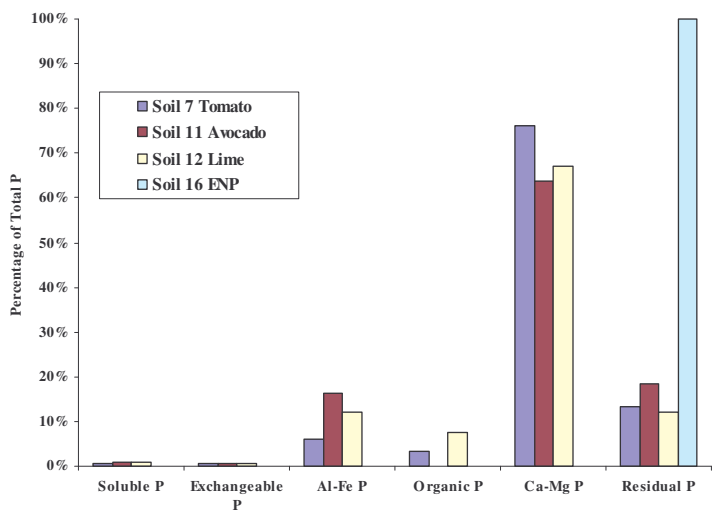
Avocado

# Phosphorus deficiency





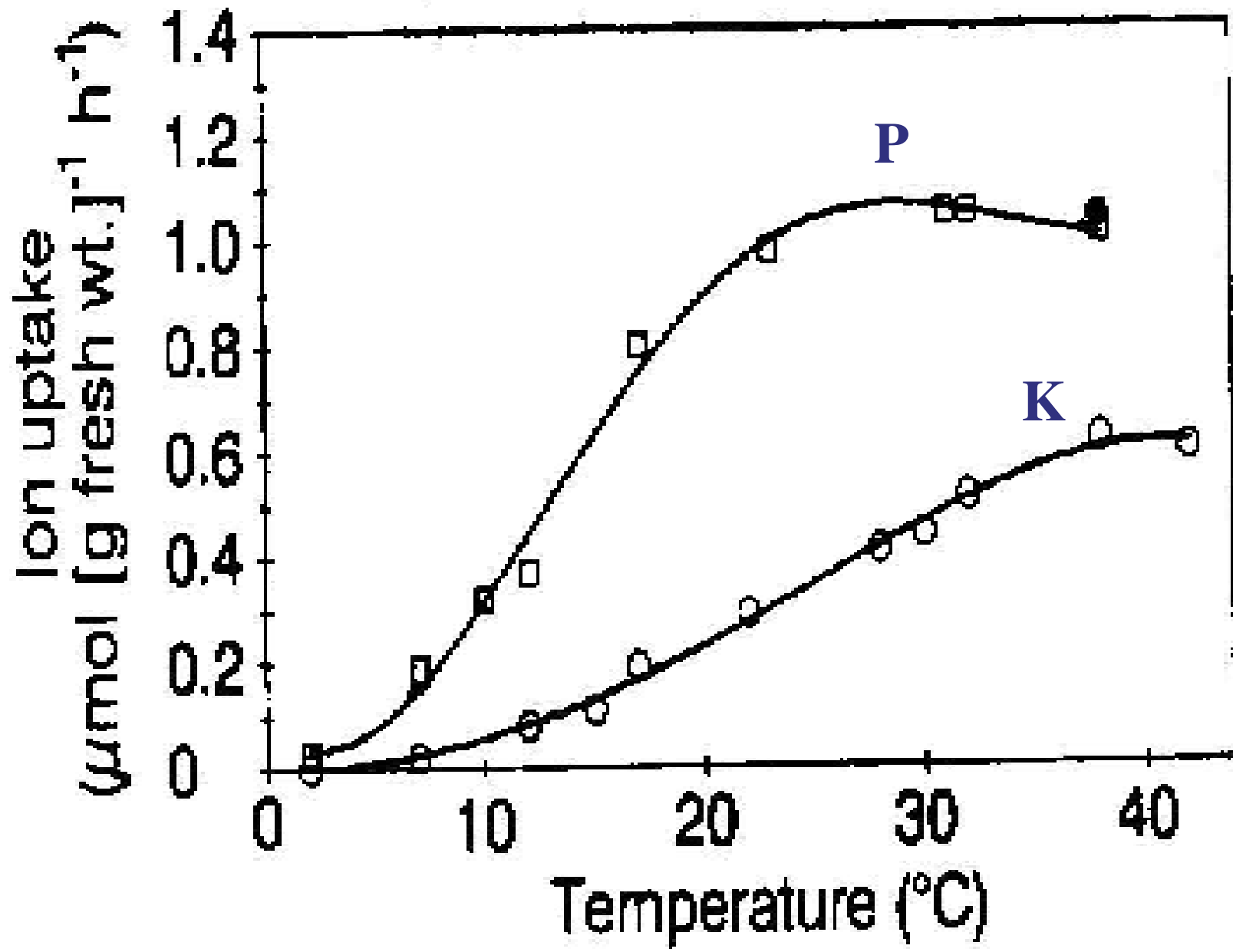




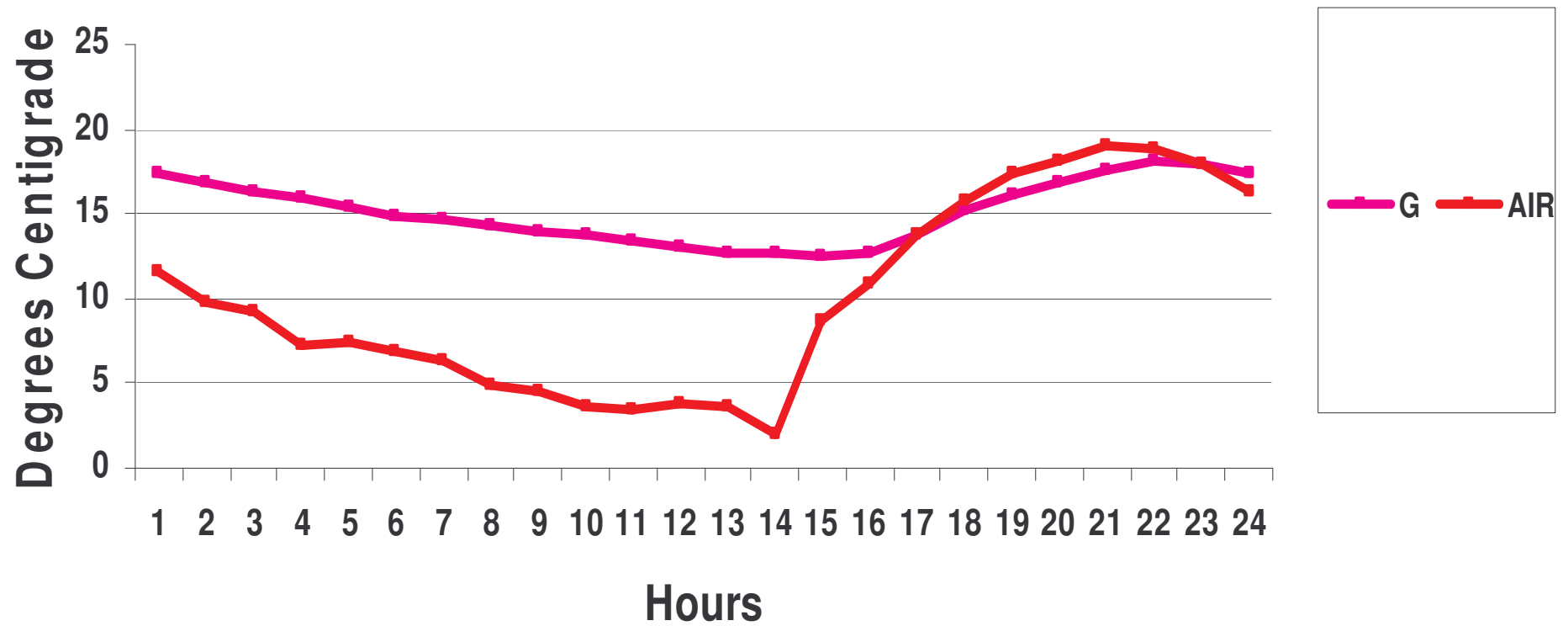
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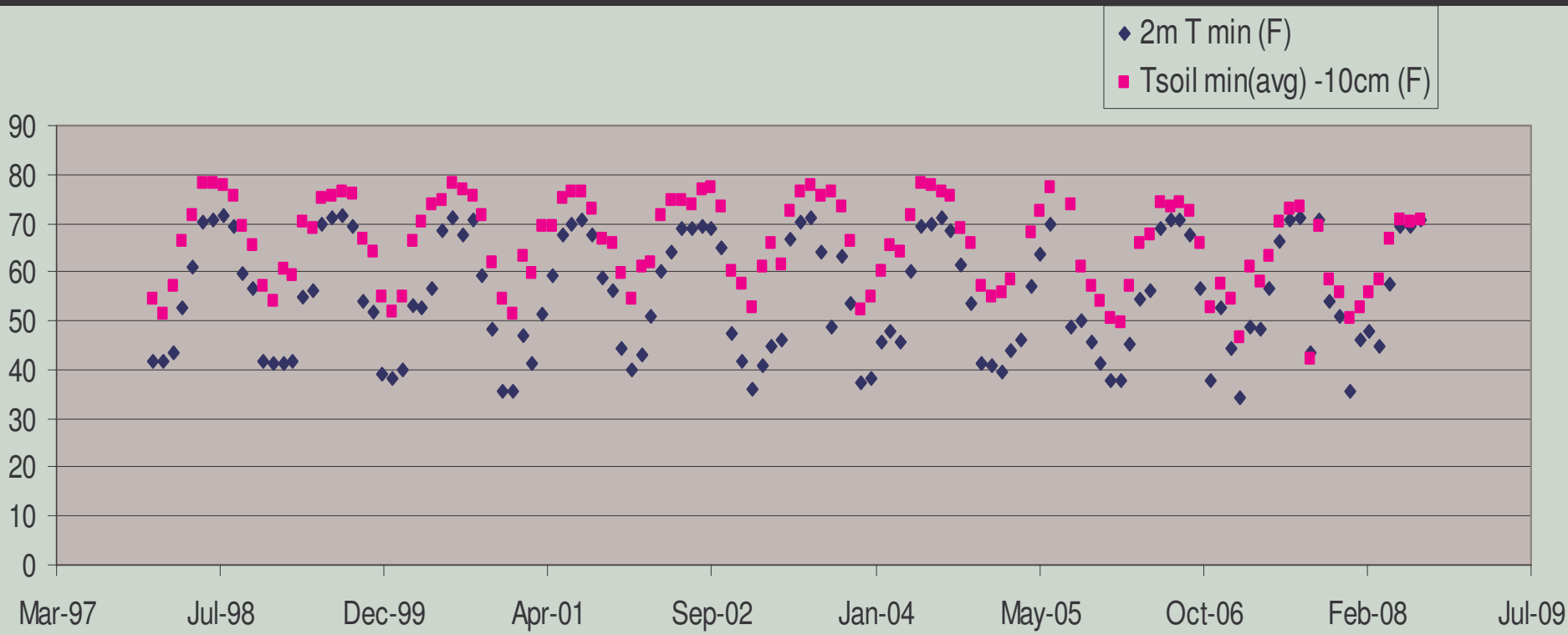
# **Available P and Temperature**

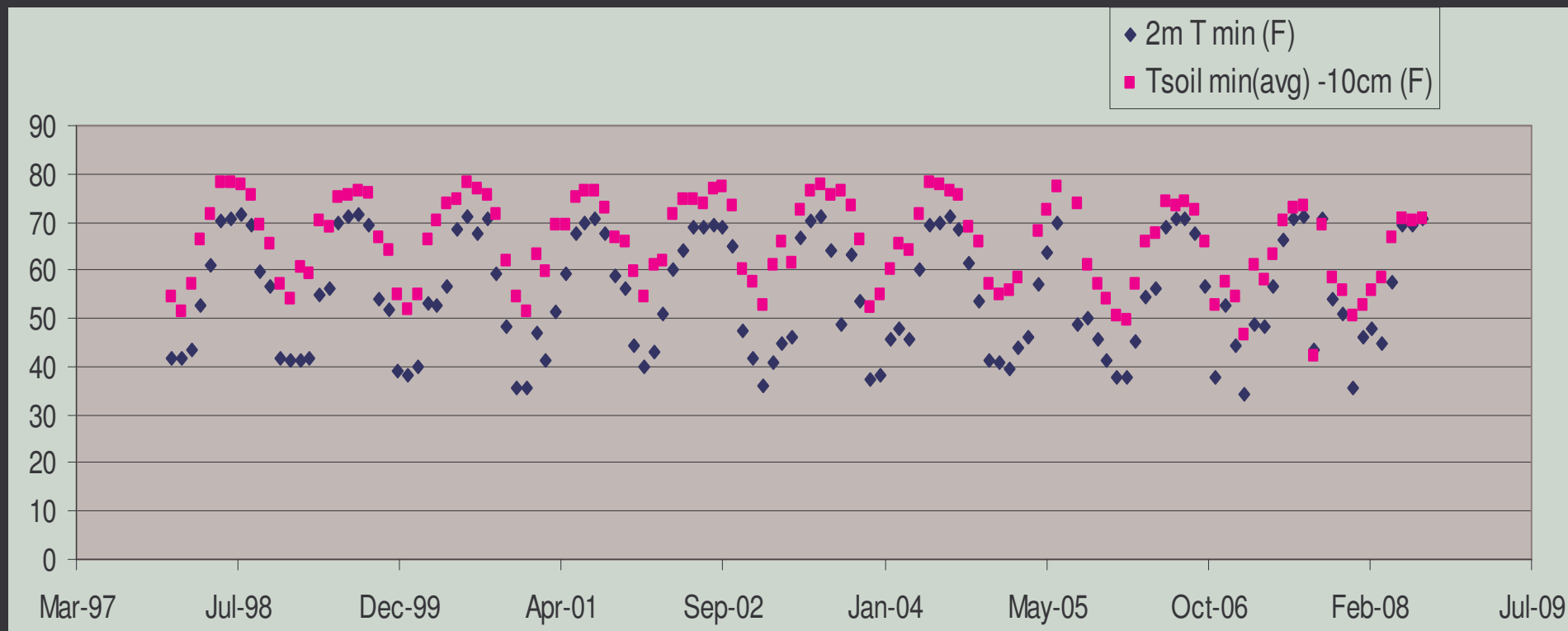
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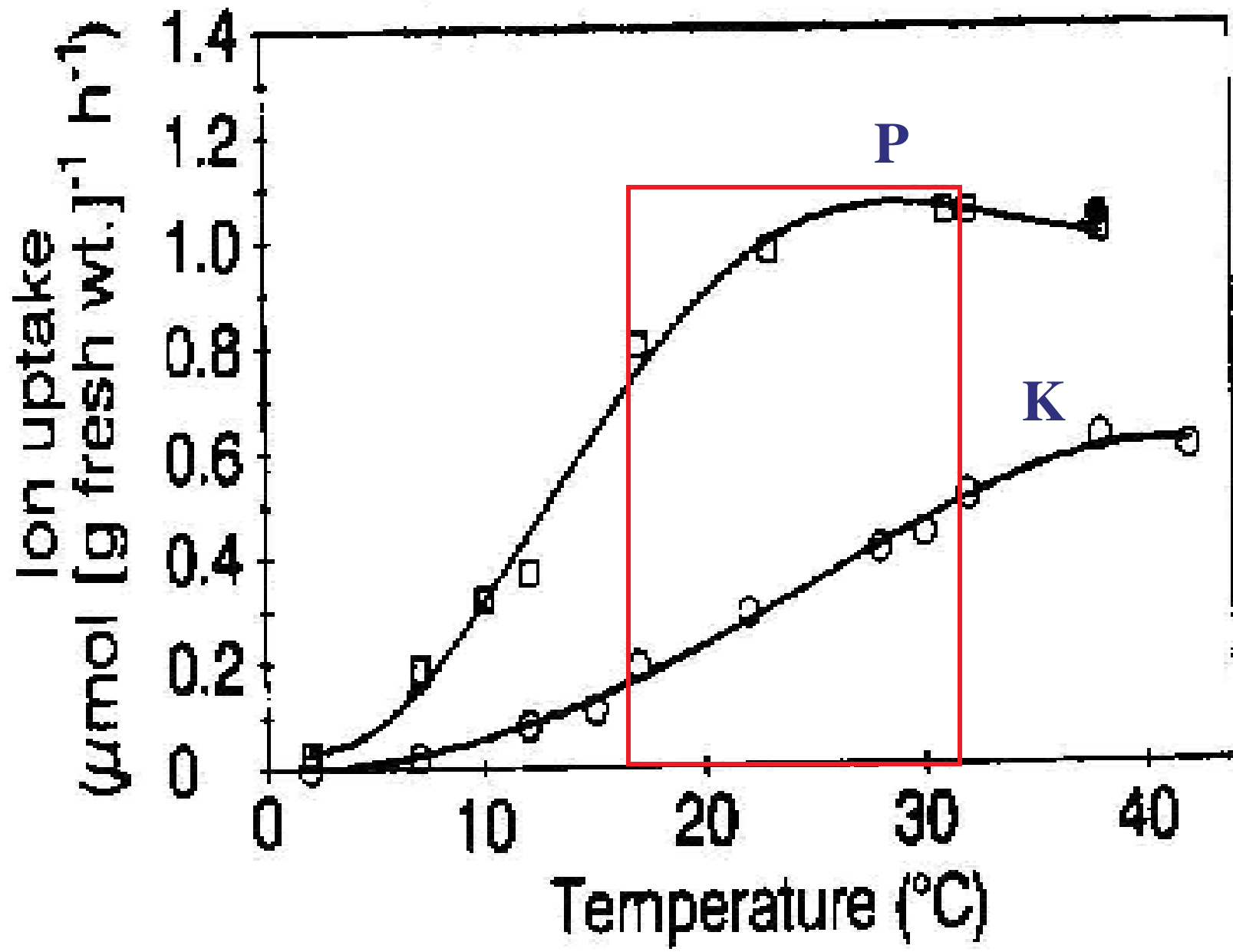
### Soil and Air Temperatures:24 hr. Jan. 26 to 27.(6 pm -5 pm)







Last ten years:	Average	Min	Max
Air (2m)	74	54	89
Soil (10cm)	76	65	87



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# **Low P fertilizer formula**

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## N-P-K fertilizer formula for tropical fruits

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- ◆ Current high P formula used by growers:

10-10-10, 1-10-20, 8-8-9, 4-16-8,  
6-6-6, 8-6-9

- ◆ Recommendation: **8-3-9**  
(2.7-1-3)
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## N-P-K fertilizer formula for palm trees

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- ◆ Current high P formula used by growers:

12-6-8, 12-4-12, 8-4-12, 8-4-12

- ◆ Recommendation: **8-2-12**  
(4-1-6)
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## N-P-K fertilizer formula for vegetables

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- ◆ Current high P formula used by growers:

6-12-12, 7-11-14, 8-8-16, 8-6.6-6.6

- ◆ Recommendation: **8-3-12**  
(2.7-1-4)
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# Do soil P testing before applying fertilizer:

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- Plant available P (AB-DTPA):
    - No P effect if  $>70\text{ppm}$
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**Water soluble fertilizers**  
**vs.**  
**Controlled-release fertilizers**

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Water-soluble fertilizer

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# “Standard” N and P fertilizers are...

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- ...water-soluble.
- ...plentiful.
- ...lowest cost materials.
- ...leachable.



# Typical water-soluble N and P fertilizers used in horticultural production

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## Nitrogen




- Ammonium sulfate
- Ammonium nitrate
- Urea
- Potassium nitrate
- Calcium nitrate

## Phosphorus

- Concentrated superphosphate
  - Mono-ammonium phosphate
  - Di-ammonium phosphate
  - Ammonium polyphosphate
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# Nutrient release from CRF depends on temperature and moisture

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Water-soluble	Slow/controlled-Release	
 <p data-bbox="310 1065 701 1109">Ammonium nitrate</p>	<p data-bbox="915 643 1188 686">Non-coated</p>  <p data-bbox="852 1065 1251 1109">Urea formaldehyde</p>	<p data-bbox="1514 643 1682 686">Coated</p>  <p data-bbox="1472 1065 1713 1109">Osmocote®</p>
<p data-bbox="359 1174 659 1284">Dissolves all at once</p>	<p data-bbox="810 1174 1335 1284">Slowly decomposes to soluble N</p>	<p data-bbox="1440 1174 1797 1284">Nutrients “leak” through coating</p>

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# Examples of slow and controlled-release fertilizers

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## Non-coated

- Nitroform ®
- Nutralene ®
- Nitamin ®
- IBDU

**(N sources only)**

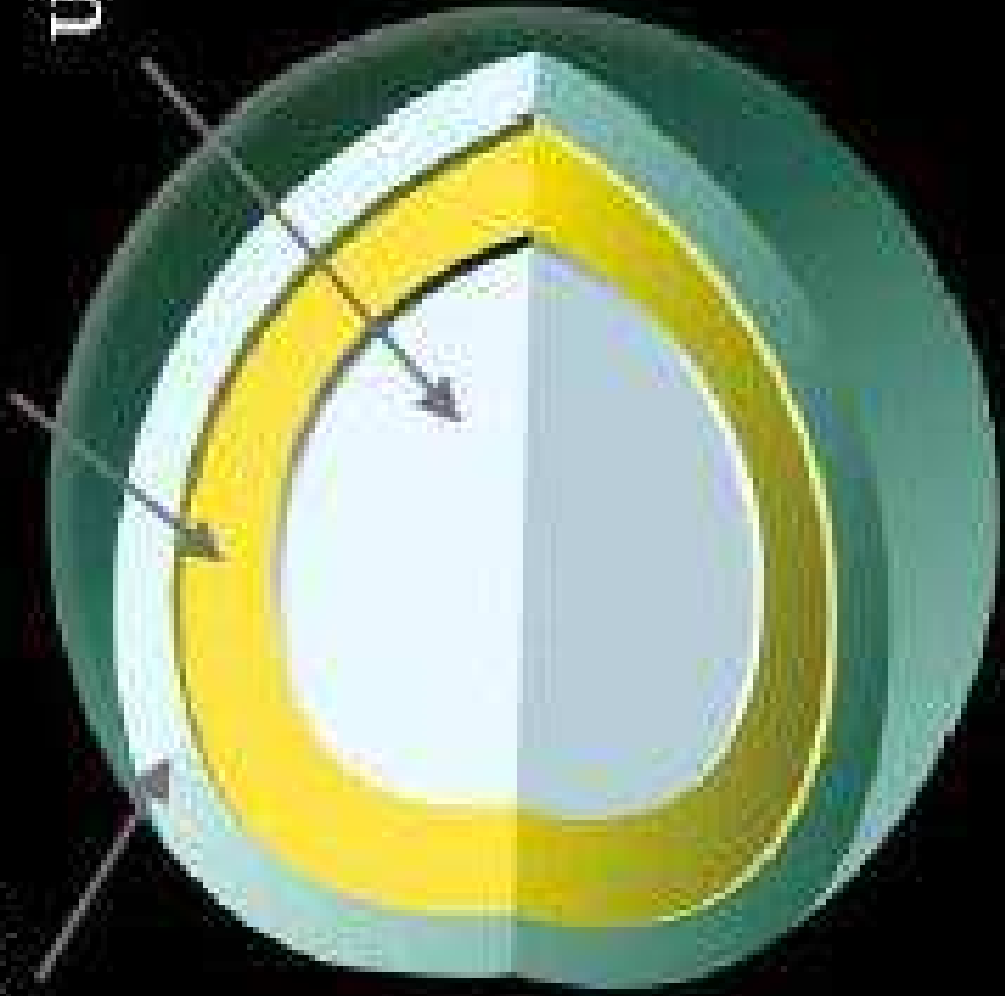
## Coated

- Osmocote ®
- Polyon ®
- Nutricote ®
- Syncote ®
- Polymer/Sulfur-coated fertilizers

**(N, P, K + others)**

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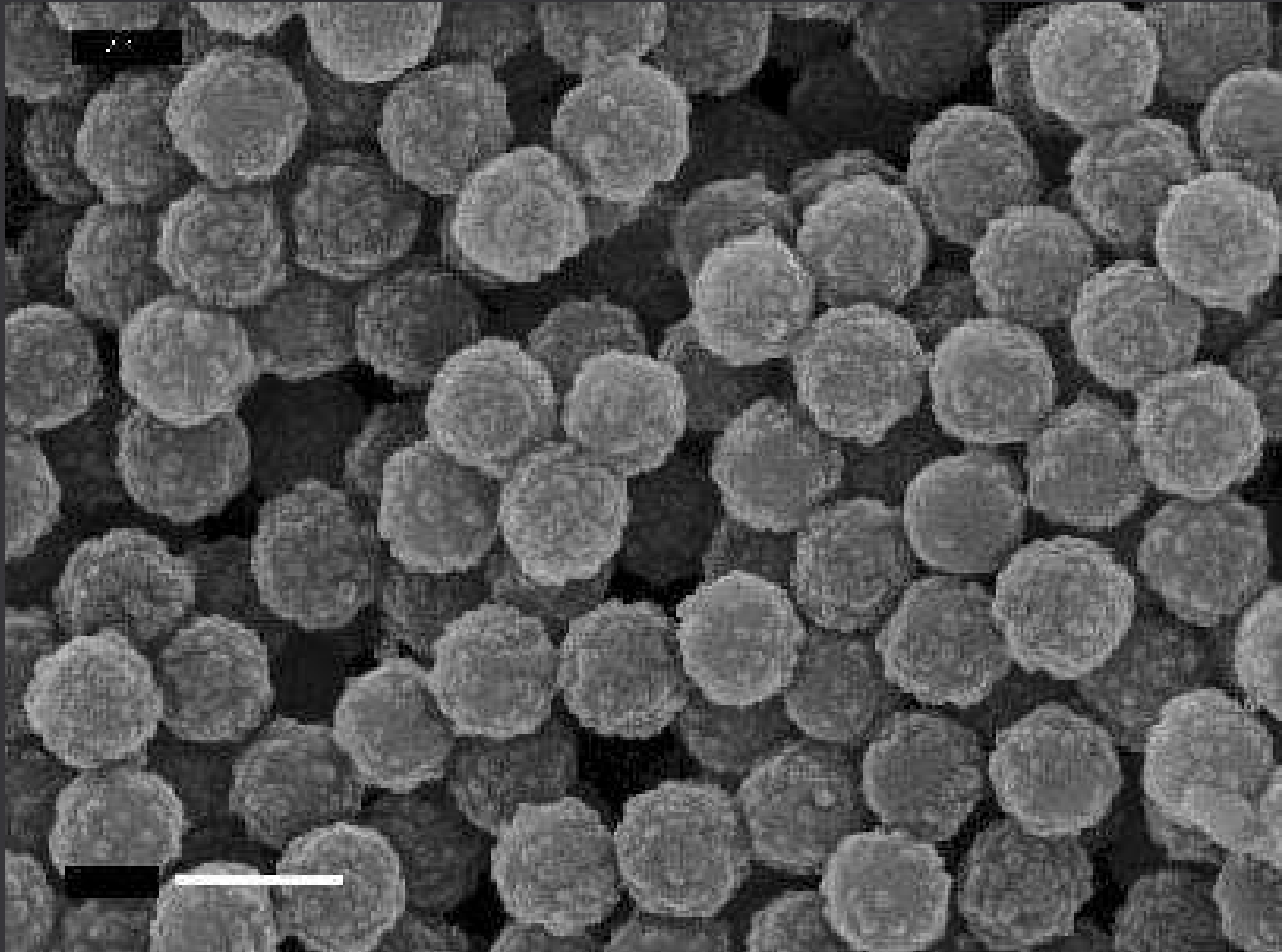
Sealant  
Sulfur  
Urea



# Coating Technology of CRFs

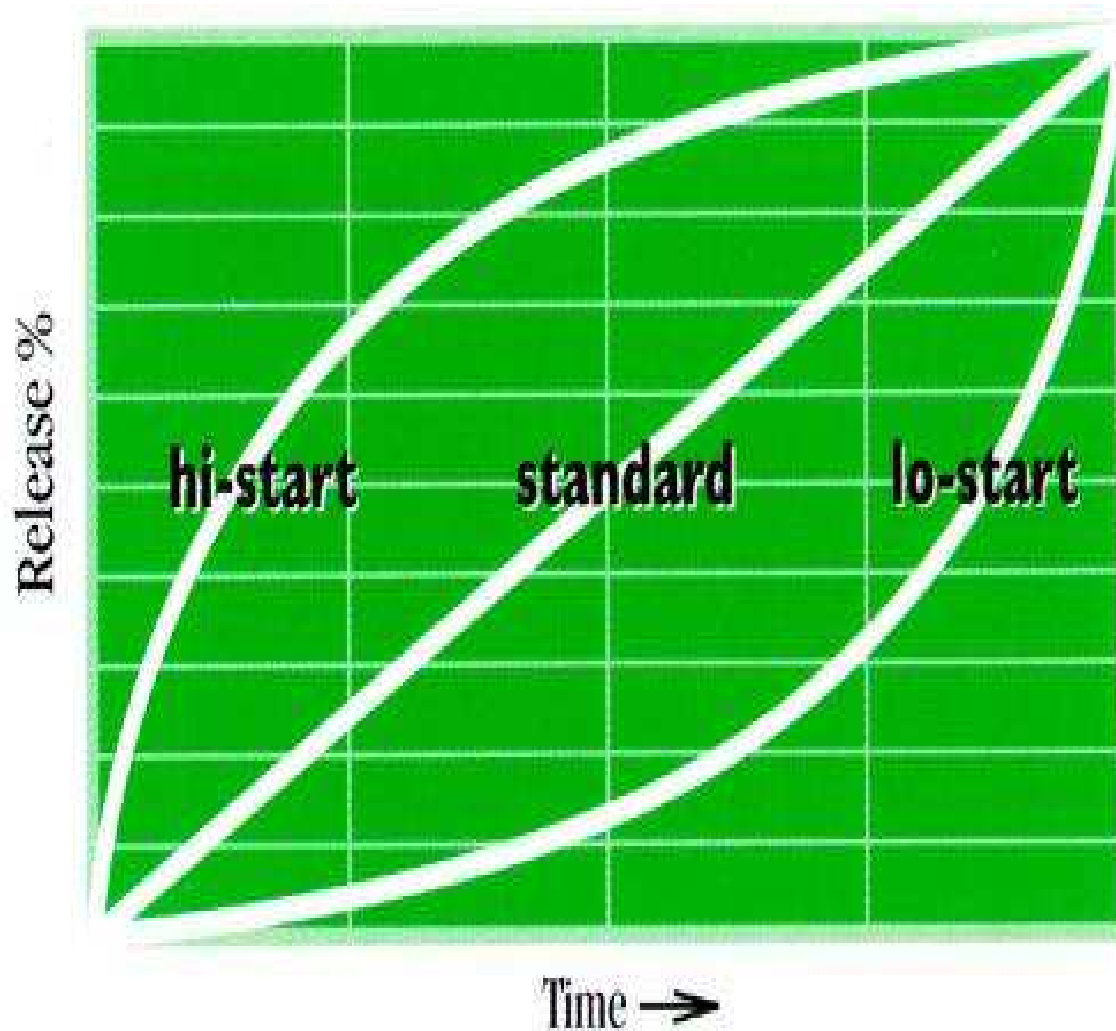
- **Polymer (polyethylene, polyesters)**
- **Sulfur**
- **Sulfur plus polymer**

# Polymer coating layer



**PLANT RESPONSE** to CRF depends on how well the release curve matches plant need.

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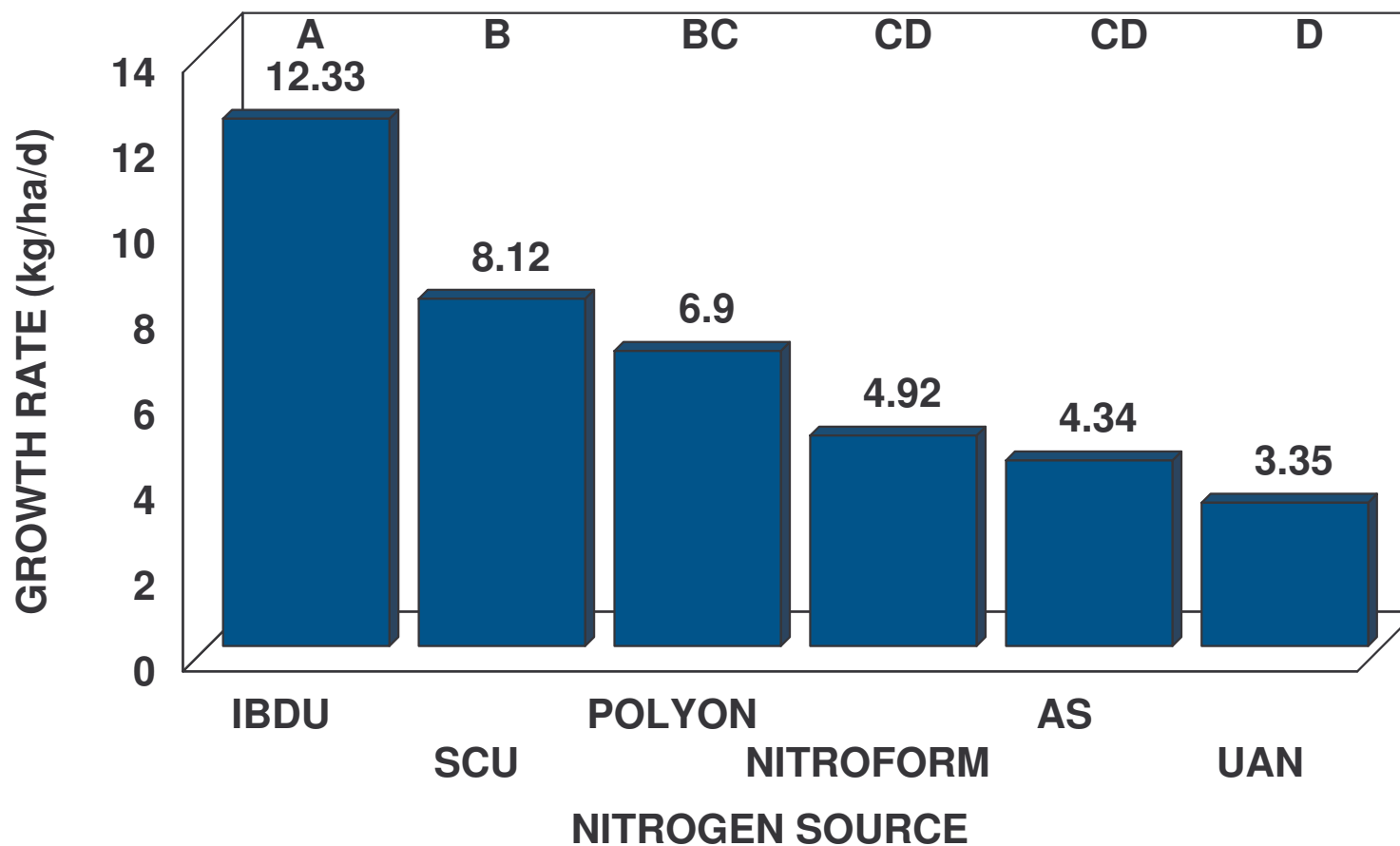
# Advantages of CRF/SRF

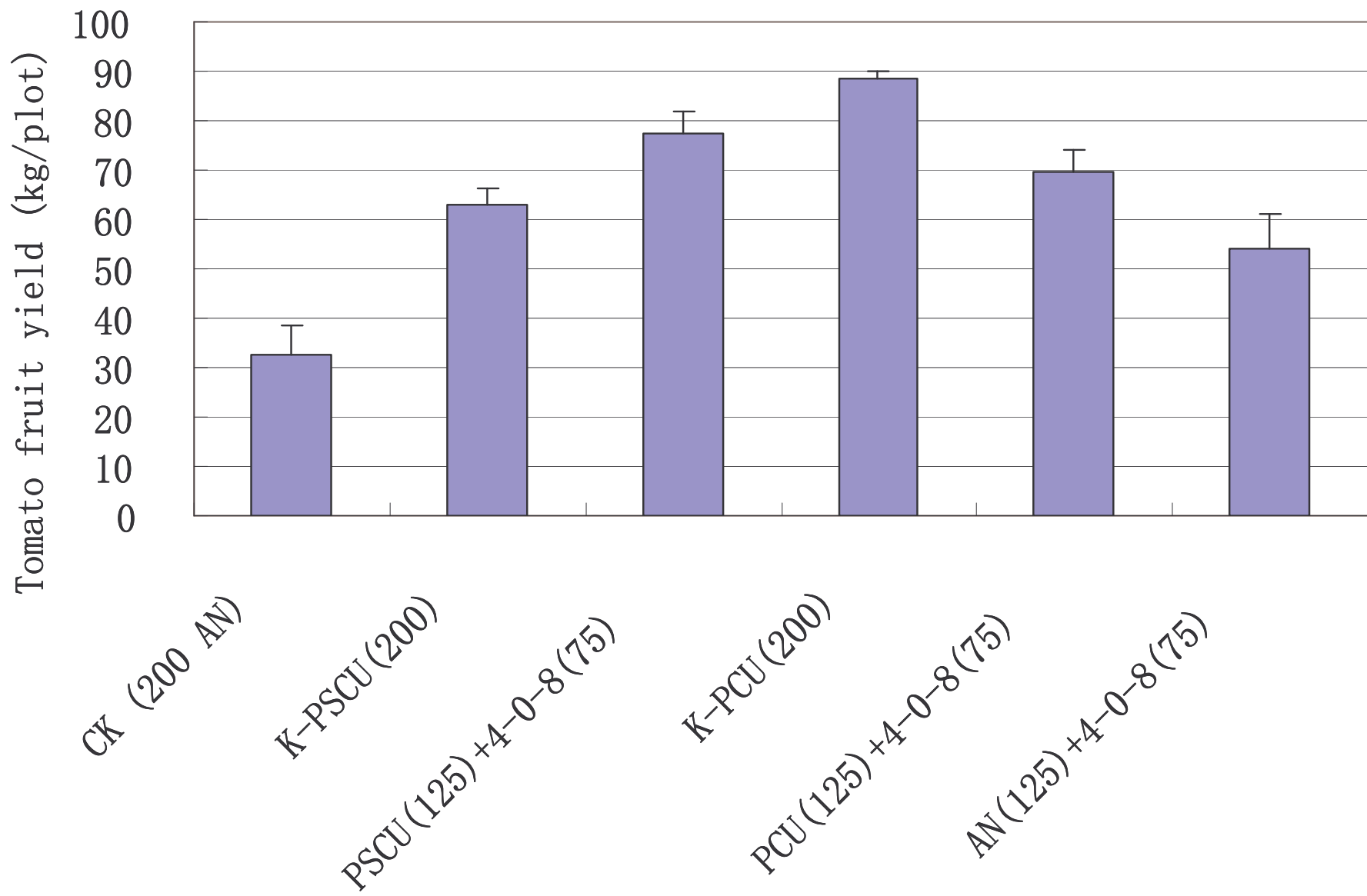
# 1

Improved nitrogen use efficiency by  
10 – 50%

# Growth rate of overseeded ryegrass as affected by N source

(180 days after application, 2 lbs N/1000 sq. ft/90 days)



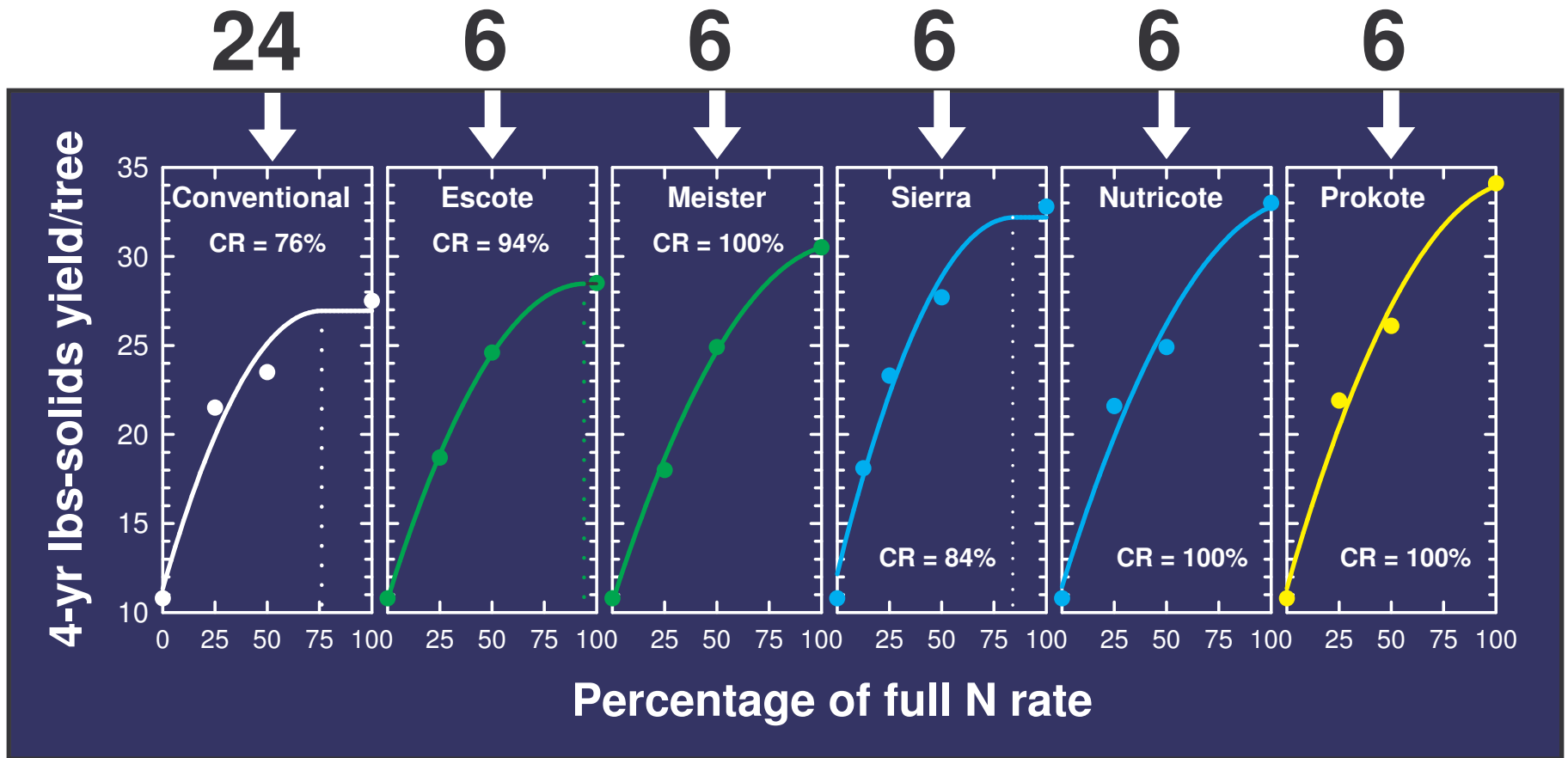


# Advantages of CRF/SRF

#2

Fewer applications needed.  
(Decreased application cost.)

# Total no. of applications in a 6-year-old citrus grove



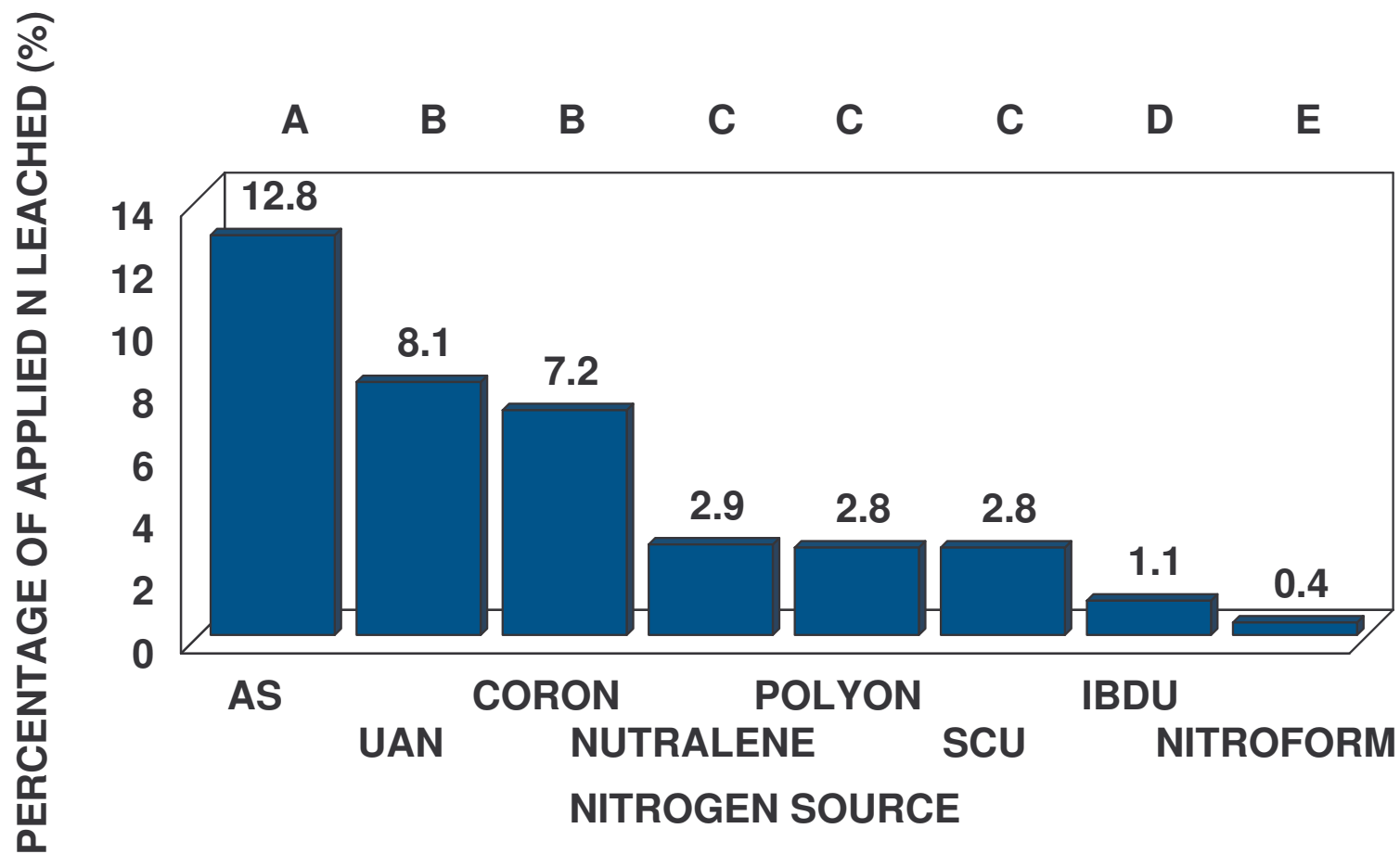
# Advantages of CRF

# 3

Environmentally advantageous;  
less fertilizer loss.

(Decreased nitrate leaching  
below root zone.)

# Percentage of applied N leached from ryegrass (2 lbs N/1000 sq. ft./125 days)



# Advantages of CRF

## #4 Decrease salt damage

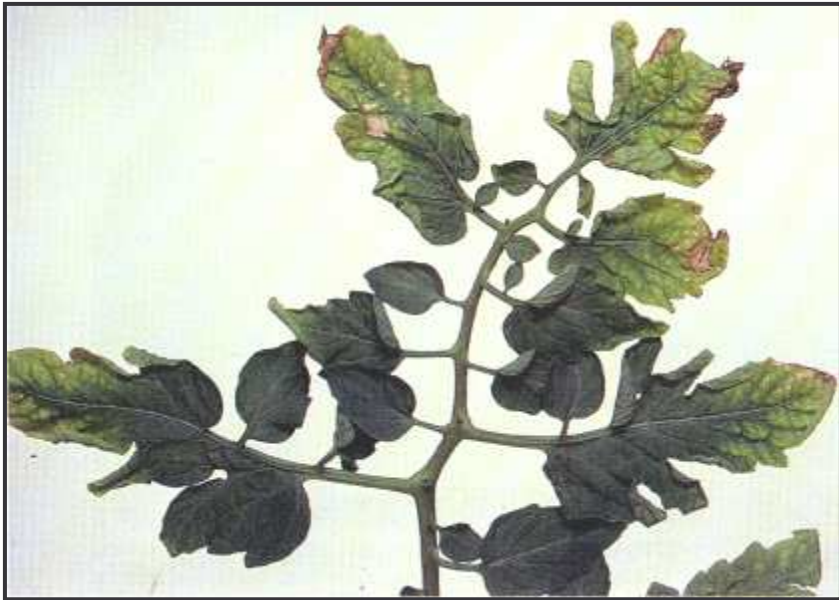




Plate 9

# High-volume use of controlled-release fertilizer is limited to...

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- ...turfgrass
- ...greenhouse
- ...nursery
- ...landscape



## Cost of materials for citrus (3 yrs ago)

Fertilizer	6-yr fert cost (\$/tree)	Cumulative lbs sol/tree	Gross return (\$/tree)
Nutricote	19.85	26.5	27.47
Meister	15.81	25.8	26.41
Escote	14.90	24.9	25.98
Water-soluble	5.06	24.2	25.40
None	0.00	10.8	11.23

# How does the relative **COST OF FERTILIZER MATERIALS AND APPLICATION METHODS** affect fertilizer selection by producers?

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## *Vegetables (3 yrs ago)*

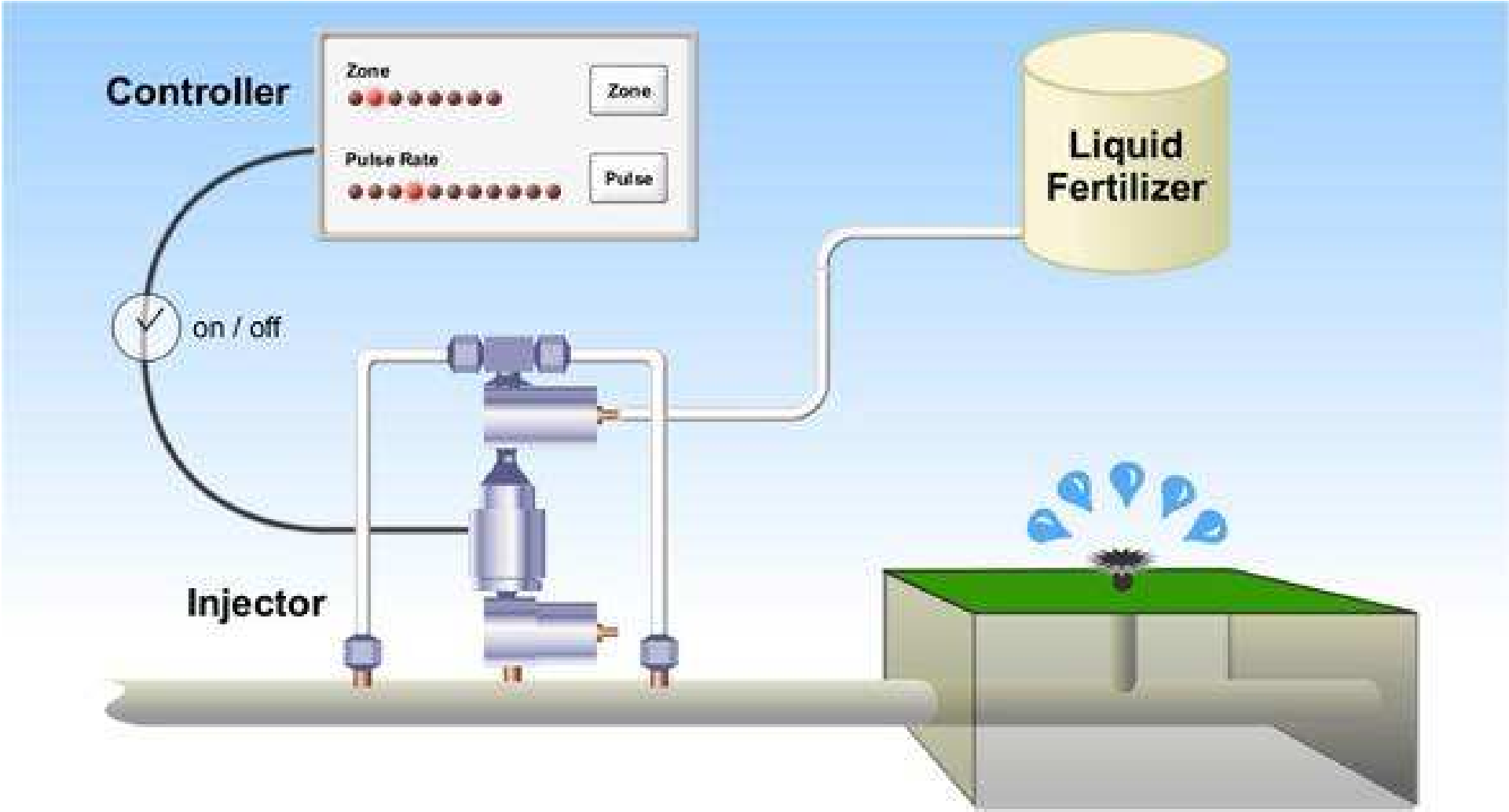
- Potato study: Cost of a water-soluble N fertilization program – \$38 to \$63 per acre.
  - Extra cost to use a CRF program cost – \$8 to \$79 more than the most expensive soluble N cost.
  - Extra cost could be offset by reduced application rate and/or providing cost-share to use CRF.
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# What do we know about CRF...

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- ...rates?
  - ...timing?
  - ...placement?
  - ...plant response?
  - ...leaching?
  - ...release rates as affected by temperature and moisture?
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# Fertigation





# Fertigation:

What do we know about...

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- ...nutrient use-efficiency?
  - ...application frequency?
  - ...plant response?
  - ...leaching potential?
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# Fertigation improved **N USE EFFICIENCY** in bell pepper production.

Yield at four pre-plant/fertigation N fertilizer combinations.

Fert. application method		Total fancy pepper yield	Total marketable pepper yield
Percent N applied pre-plant	Percent N applied by fertigation		
		----- tons/acre -----	
0	100	4.2	9.1
<b>30</b>	<b>70</b>	<b>4.4</b>	<b>9.5</b>
70	30	3.8	8.3
<b>100</b>	<b>0</b>	<b>2.9</b>	<b>6.6</b>
P-value		0.0531	0.0006

With good water management, fertigation  
**APPLICATION FREQUENCY** doesn't matter much.

6-year-old orange trees growing in lysimeters.

Year	Fertigation treatment	Fertigations per year	Relative amount of applied N that leached	N uptake efficiency <sup>z</sup>
			%	%
1999	Every irrigation	76	51	30
	Weekly	36	58	27
	Monthly	11	56	24
2000	Every irrigation	81	46	42
	Weekly	38	62	28
	Monthly	14	53	35

<sup>z</sup> Amount of N taken up by the citrus trees divided by the amount of N applied.

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Horticultural **PLANT RESPONSE** to fertigation is as good or better than the response observed with well-managed dry soluble fertilization.

In both cases, irrigation (and sometimes drainage) water management is critical for success.

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## Why was there more leaching with fertigation compared with dry soluble fertilizer application?

Estimated N leached below a ridge citrus grove root zone.

<b>N rate</b>	<b>Dry soluble fertilizer</b>	<b>Fertigation</b>	<b>CRF</b>
lbs/acre	-----	lbs N/acre/year	-----
50	---	---	0.8
100	11.1	16.3	2.9
150	11.8	21.5	7.1
200	12.2	27.1	---
250	19.0	31.3	---

Study authors: This occurred “purely because of unexpected prolonged irrigation or unexpected high rainfall following certain fertigation events in both years.”

# Foliar fertilization



# Can FOLIAR FERTILIZER APPLICATION improve nutrient use efficiency?

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## □ Tree crops: Possibly

- Foliar uptake of urea can be 50% efficient; it has enhanced flowering and yield.
- Phosphite is recognized as a P source; it has increased flowering, fruiting, and lbs solids.

## □ Vegetables: No?

- Leaves cannot absorb enough N/P to correct a deficiency.
  - Leaf burn is likely.
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# Magical/mysterious products

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- Biostimulants**
  - Soil supplements**
  - Soil conditioners**
  - Natural fertilizers**
  - Soil additives**
  - Growth activators**
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## **Magical/mysterious products:**

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- So far, few of them have demonstrated significant impact on crop production. Some of them have either no effects or negative effects on crop growth. Others are said to reveal their beneficial effects only under certain conditions of plant stress.
  - However, I hope someday some products from this group will make significant contributions to crop nutrient management.
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# Improve fertilizer use efficiency by:

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- Develop a nutrient management plan
  - Do a fertilizer trial by yourself
  - Use appropriate application equipment.
  - Use appropriate fertilizer sources and formulations
  - Add organic matter to the soil whenever possible.
  - Split fertilizer applications.
  - Try to wet only the root zone when irrigating.
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THANK YOU!



Questions?