Fertilizer:
What Happened to My Middle Number ?

OR

Where Did All the P Go?

Let’s talk about Fertilizer

But first –

- What do you call an innovative gardener?
  - An entre-manure
- What did the audience member say to the political candidate?
  - With all the crap being spewed in here, there must be a donkey or elephant somewhere nearby.

Amendments vs Fertilizer

- **Amendments** change/improve soil structure
  - Helps nutrient and water penetration/availability
  - Root growth speed
  - Some amendments for soil also can act as fertilizers
    - Compost is prime example
    - Others are straw, peat moss, leaves
      - Decomposing amendments require energy/food
      - Typically need additional nitrogen
  - Some amendments only change soil structure
    - Sand, vermiculite, perlite, pea gravel

Amendments vs Fertilizer

Fertilizers change/improve soil nutrients

- Concentrated amounts of primary nutrients

Most common are one of two types:

- **Inorganic** –
  - Sold in granular or water-soluble form with varying amounts of
  - **N** Nitrogen
  - **P** Phosphorous
  - **K** Potassium

(Single letters are from the Periodic Table of Elements)

Amendments vs Fertilizer

Fertilizer – second form is:

- **Organic** –
  - Modify soil structure as they decompose
    - Peat moss, leaves, grass clippings, sawdust, wood ash
    - Bone meal, blood meal, worm castings
    - Compost, sometimes with manure added
  - Also contain N, P, K but usually lower concentrations

NUTRIENTS

MACRO NUTRIENTS		MICRO NUTRIENTS
PRIMARY	**SECONDARY**	
N - NITROGEN	SULFUR	IRON
P - PHOSPHORUS	CALCIUM	MOLYBDENUM
K - POTASSIUM	MAGNESIUM	ZINC
		CHLORINE
		BORON
		COPPER

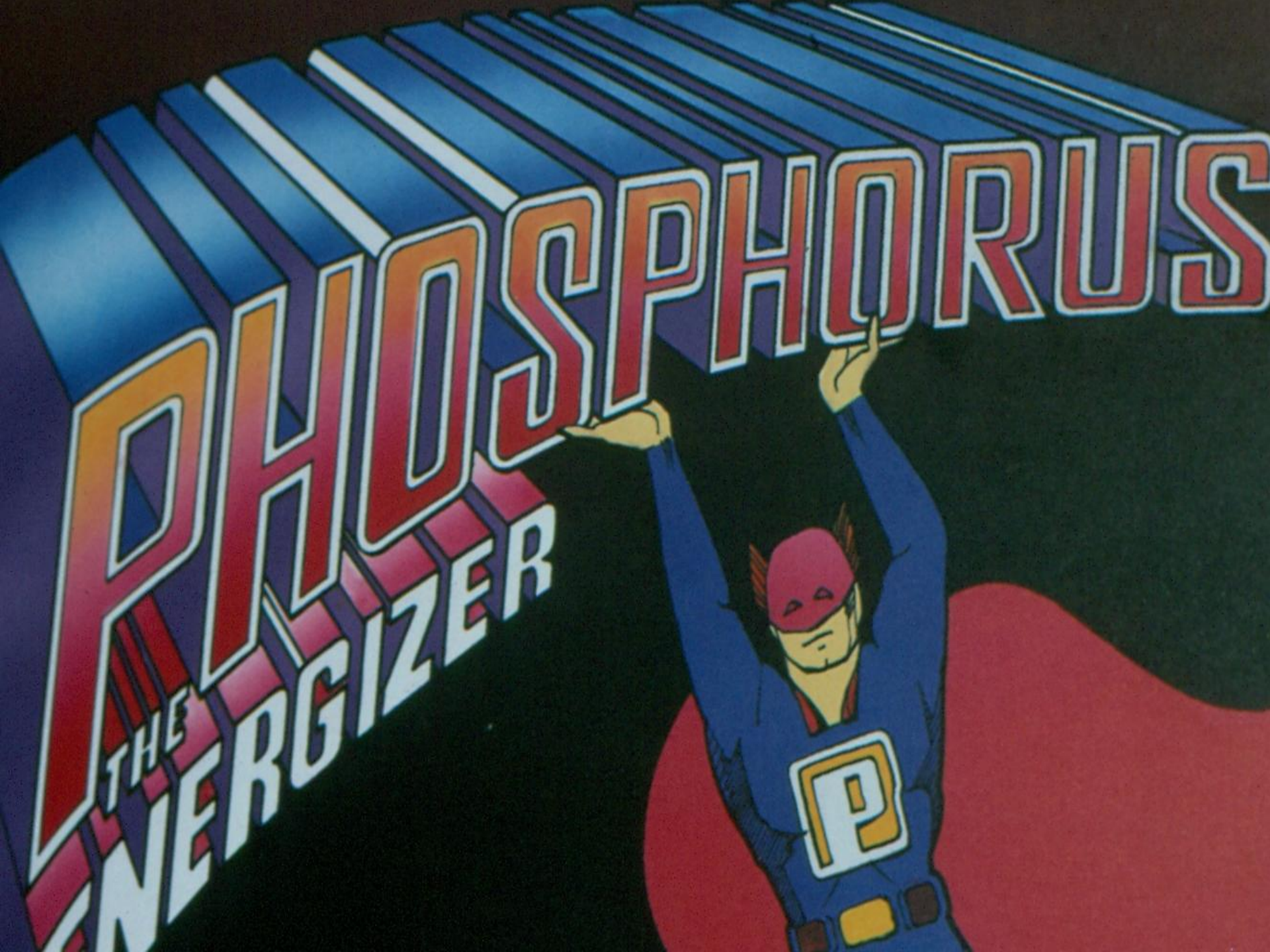
N,P,K What do They Mean ?

- **N** Nitrogen - total nitrogen by per cent in the fertilizer
- **P** Phosphorus - present in fertilizer by per cent as P_2O_5. Total **P** as a percent of P_2O_5 is 44%
- **K** Potassium - total potassium in the fertilizer as K_2O. Total **K** as a percent of K_2O is 83%
- This information must be on every fertilizer package


NITROGEN
THE SUPERSTAR

Nitrogen

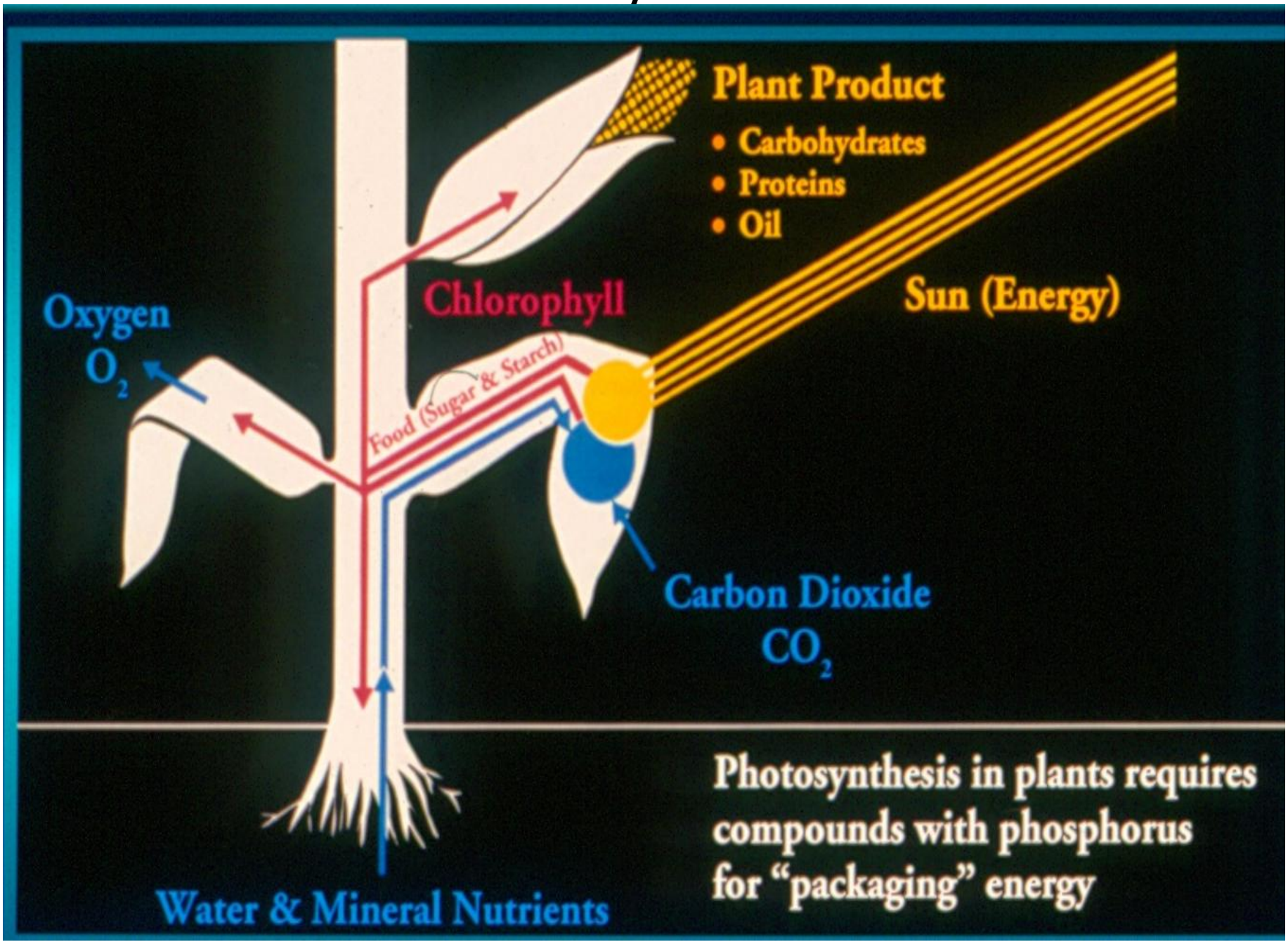
- Essential for growth of leaves and stems
- Increases plant size
- Part of chlorophyll
- Essential for plant food production process
- Plants cannot survive without nitrogen


PHOSPHORUS
THE
ENERGIZER
P

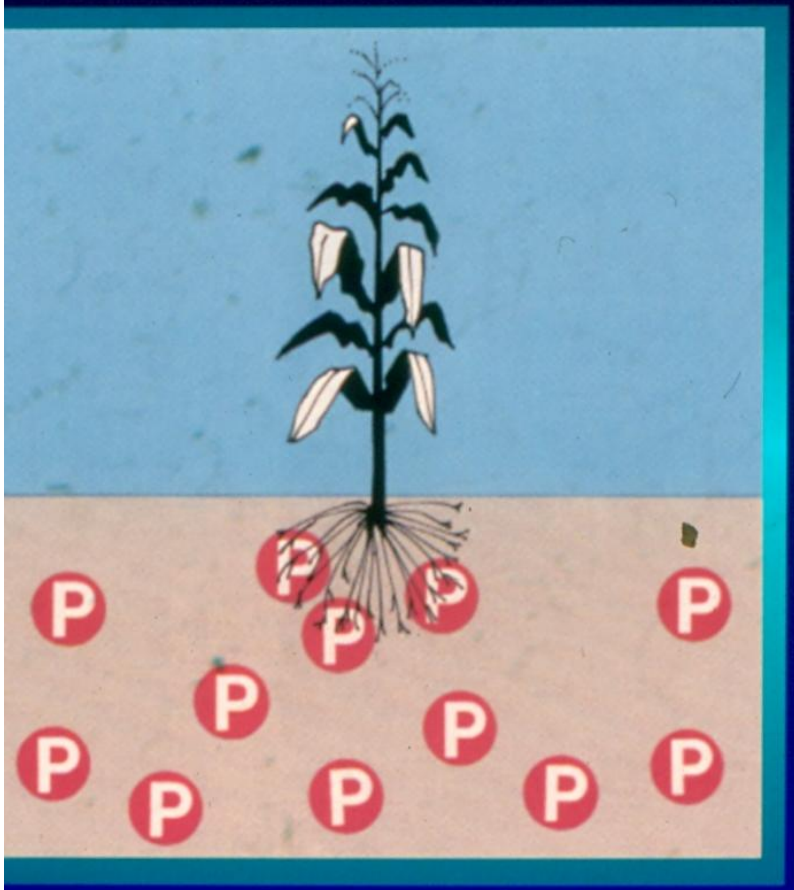
Phosphorus

- Needed for growth of roots and stems
- Speeds up flowering
- Helps plant mature; forms flower, fruit, seeds
- Improves disease resistance
- Required for energy transfer in photosynthesis

Photosynthesis

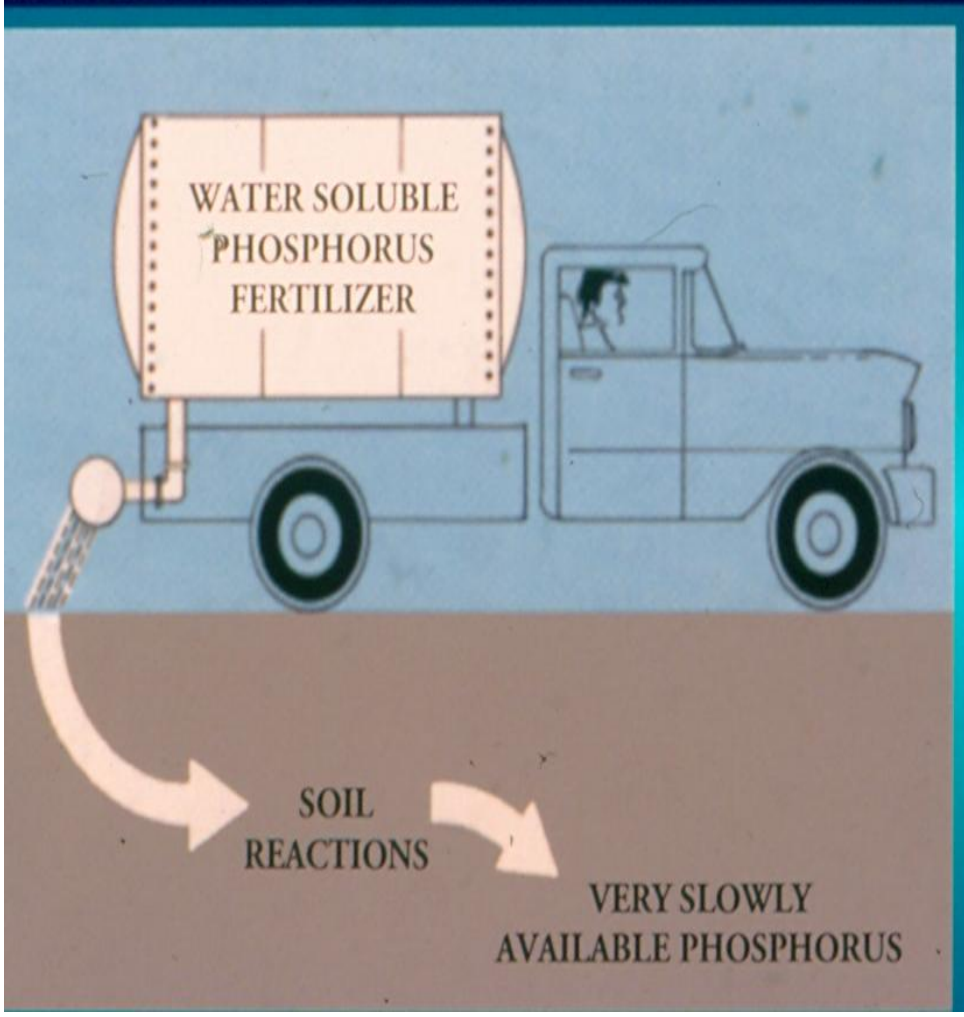


Crop Demands for Phosphorus



The crop root system reache only about one percent of the soil. High soil P fertility in the root zone is essential for optimum crop growth because the nutrient moves very little in the soil

Phosphorus Fertilizers



Phosphorus fertilizers are quite soluble when applied to the soil. However, reactions within the soil quickly convert the P into a form only slowly available for crop growth


POTASSIUM
THE REGULATOR
K

Potassium

- Stimulates production of top-quality blooms
- Improves disease and drought resistance
- Makes plants vigorous
- Regulates enzymes, water, nutrient and sugar transport, protein and starch formation

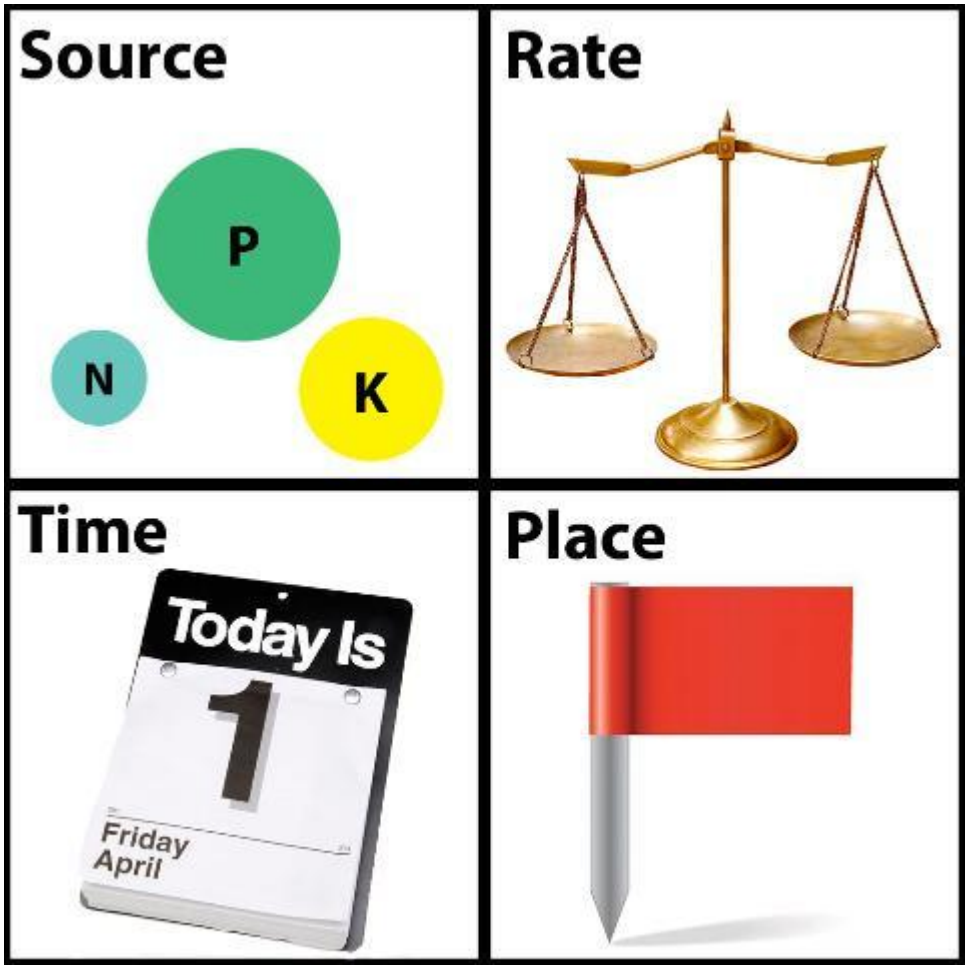
How Potassium Works to Increase Yields

This illustration of a corn plant shows the various functions of K at work

- Helps retard crop diseases
- Maintains turgor; reduces water loss and wilting
- Increases protein content of plants
- Produces grain rich in starch
- Helps translocation of sugars and starch
- Aids in photosynthesis and food formation
- Reduces perspiration, preventing energy losses
- Assists many enzyme actions
- Builds cellulose and reduces "lodging" caused by weak stalks
- Increases root growth and improves

Four Rs of Fertilizer

- Right nutrient
  - Test soil
- Right rate
  - Too much burns
- Right time
  - Watch plant growth
- Right place
  - Top vs root zone



Regular and Slow-Release Fertilizer

- **Regular release** – nutrients immediately available
  - Less expensive
  - Often used for new plants that need immediate boost
  - Will need to use more often
  - Careful to not over-fertilize; can burn
  - Can be granular/solid or water soluble

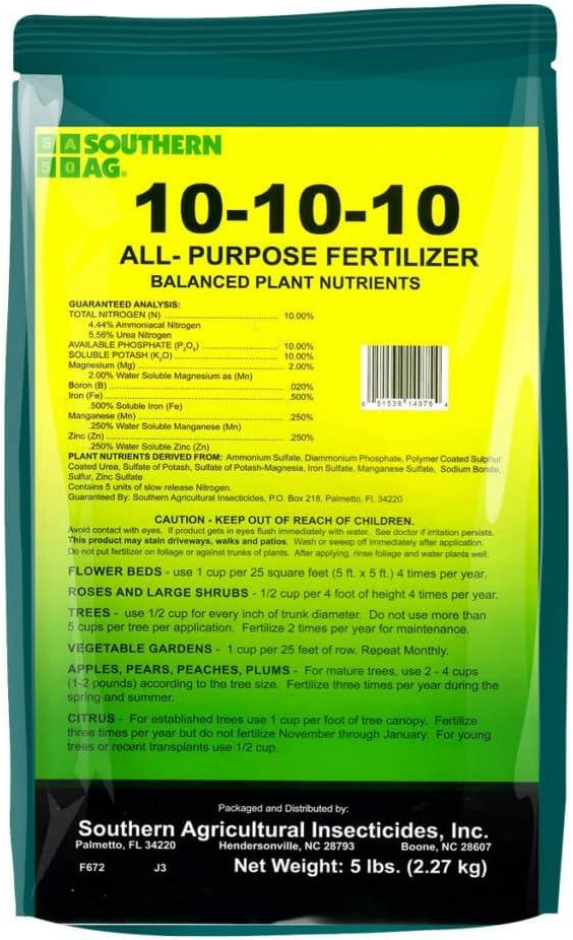
Regular and Slow-Release Fertilizer

- **Slow release** – longer term strategy
  - Often uses pellet structure, to keep on top of soil or in same position in soil
    - Releases small amount each watering
  - Introduces micronutrients and microbes to soil
  - For established plants that need maintenance
  - For slow-growing plants like desert plants
  - Less likely to have burn

- Blended Regular and Slow Release are available

Regular and Slow-Release Fertilizer

Regular-Release Fertilizer

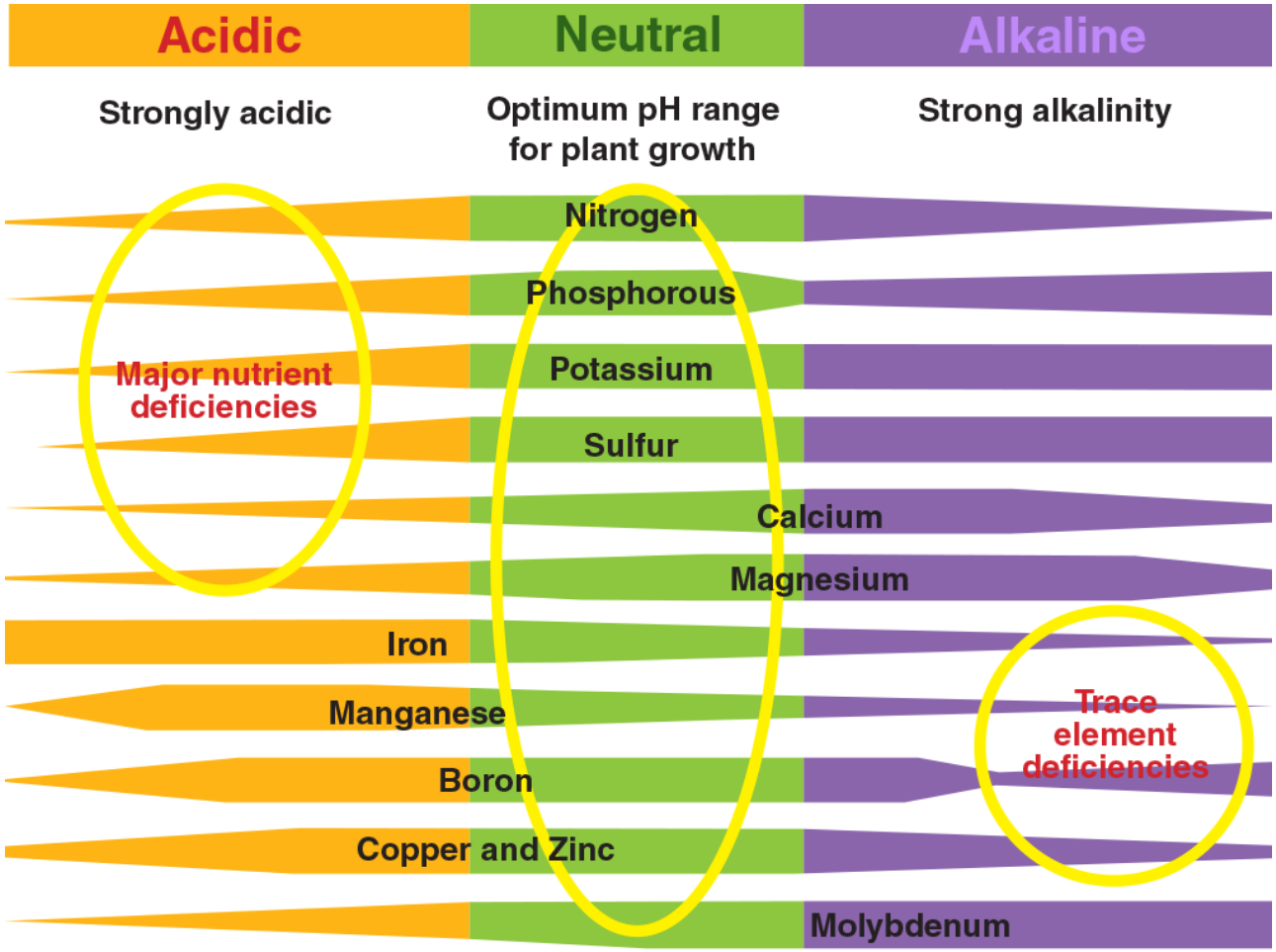


Slow-Release Fertilizer

Soil pH and Nutrient Availability

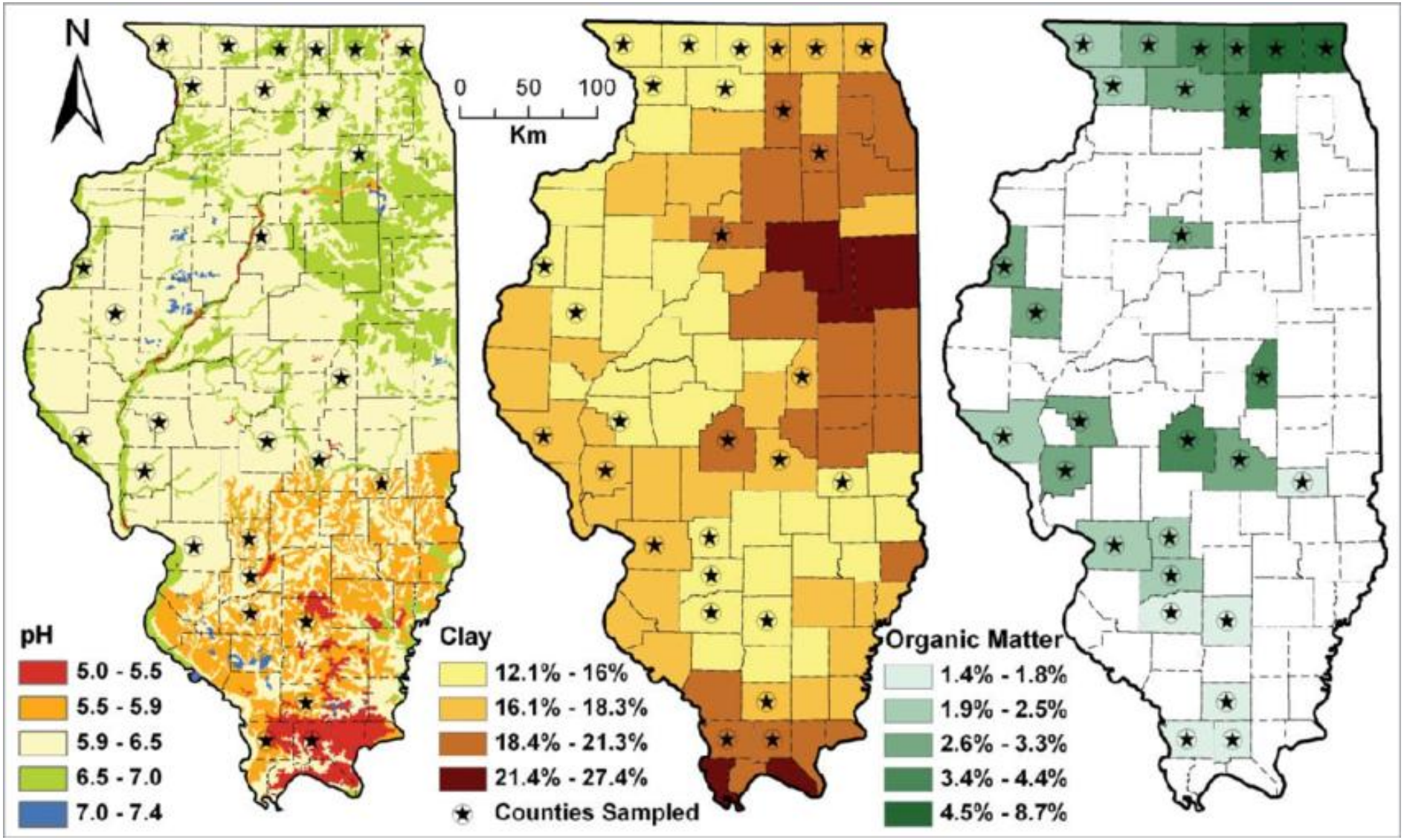
- pH is a measure of alkalinity or acidity of soil
  - pH indicates concentration of Hydrogen in solution
- 0 (extremely acid) to 14 (extremely alkaline)
  - Less than 7 is acidic
  - More than 7 is alkaline
- Nutrient availability is best in 6.0-7.2 range
- Chemical reactions in the soil bind or tie-up certain nutrients above or below this range

Soil pH and Nutrient Availability



Soil pH and Nutrient Availability
(Source: Bluedale - http://www.bluedale.com.au)

Soil pH and Nutrient Availability



Soil pH and Nutrient Availability

Soil pH	Plant Growth
> 8.3	Too alkaline for most plants
7.5	Iron availability becomes a problem on alkaline soils
7.2	6.8 to 7.2 – near neutral 6.0 to 7.5 – acceptable for most plants
7.0	
6.8	
6.0	
5.5	Reduced soil microbial activity
< 4.6	Too acid for most plants

(Source: Colorado State University – CMG Garden Notes #222)

Soil pH and Nutrient Availability

Acidic ← → Alkaline

pH 4.0-6.0	pH 5.0-6.5	pH 6.0-7.5	pH 5.0-7.5	pH 6.0-8.0
Potato	Apple	Apricot	Banana	Avocado
	Blackberry	Cherry	Rhubarb	Asparagus
	Cranberry	Grapevine	Strawberry	Ginger
	Gooseberyy	Grapefruit	Rasberry	Leek
	Mango	Hazelnut	Carrot	Mint
	Melon	Hop	Cauliflower	Paprika
	Pineapple	Lemon	Sweet corn	Watercress
	Pomegranate	Lychee	Cucumber	
	Watermelon	Mulberry	Garlic	
	Basil	Nectarine	Lentil	
	Chicory	Peach	Parsley	
	Fennel	Plum	Pepper	
	Olive	Quince	Pumpkin	
	Peanut	Artichoke	Shallot	
	Sweet potato	Bean	Spearmint	
	Rice	Beetroot	Thyme	
	Rosemary	Broccoli	Tomato	
	Sage	Brussels sprouts	Turnip	
	Soybean	Cabbage		
		Calabrese		
		Celery		
		Chinese cabbage		
		Chives		
		Lettuce		
		Millet		
		Mushroom		
		Mustard		
		Onion		
		Pea		
		Peppermint		
		Radish		
		Spinach		

(Source: Gurumaganize.org)

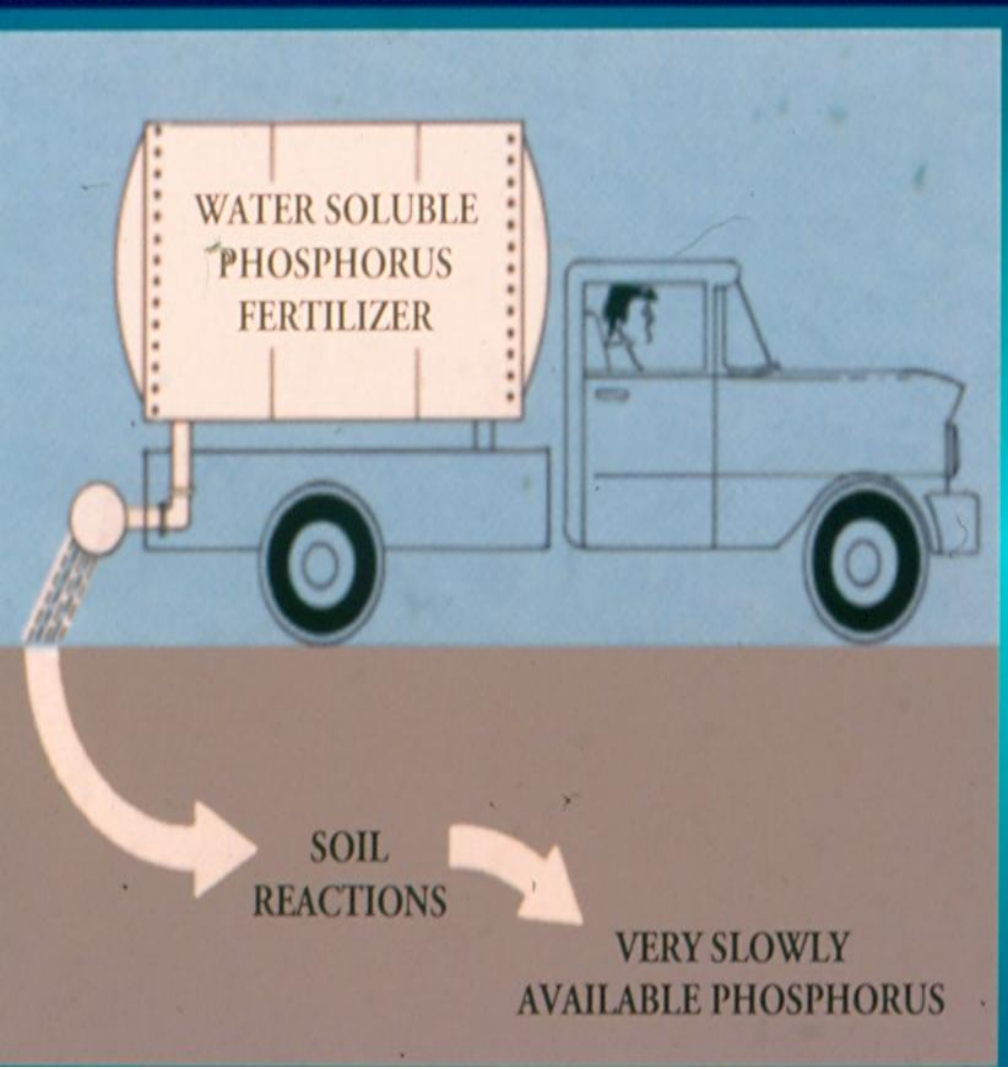
Soil pH and Nutrient Availability

- Test soil to determine pH
- Farm Bureau has soil test service, $35-$50
- Raise pH by adding lime or calcium
  - Dolomite or agricultural limestone
  - Crushed eggshells
  - Wood ashes
- Lower pH by adding sulfur
  - Elemental sulfur
  - Aluminum sulfate

Concerns with Fertilizers

- There are water pollution problems linked to phosphorous (P)
- P was added in powdered detergents to soften hard water, help clean clothes better
  - Same in many dishwashing solutions
- Not fully removed by water treatment facilities
  - Is expensive to remove completely
- Are agricultural application issues as well

Phosphorus Fertilizers



Phosphorus fertilizers are quite soluble when applied to the soil. However, reactions within the soil quickly convert the P into a form only slowly available for crop growth

Conundrum

Q. If **P** only moves slowly through the soil, why is there a problem?

OR

How do our water resources get saturated with **P**?

A. Soil Erosion

- Wind Erosion
- Water Erosion
- Runoff

B. Incomplete wastewater treatment

Sources of Phosphorus in Municipal Wastewater

Source	%
Clothing - Dishwashing detergents	9-34
Lawn fertilizer from storms runoff	50

Runoff goes directly into our waterways

Consequences of Phosphorus in Lakes, Streams and Rivers

- Turn green with algae
- Degrades quality of drinking water
- Promotes growth of weeds
- Blocks sunlight to grass beds, homes to crabs and fish – termed eutrophication
- Creates oxygen-starved dead zones where fish cannot survive – termed hypoxia

Greater Consequences of Excess Fertilizer in Larger Water Systems

- Gulf of Mexico has a growing Eutrophication problem
- Chemicals from Mississippi-Missouri Watershed deliver excess chemicals
- 3-minute video from NOAA (National Oceanic and Atmospheric Association) - https://oceantoday.noaa.gov/deadzonegulf-2021/

How Does Fertilizer Get into Our Waterways?

- Big storms wash it off
- Floods
- From impervious surfaces i.e. sidewalks and driveways
- Applied to frozen ground
- Soil erosion, both wind and water
- Over fertilization (Any gardeners that might do this?)

States Banning Phosphates

All 50 States have banned phosphorus from laundry detergent. The following states have also banned it from dishwasher detergent:

- Illinois
- Indiana
- Maryland
- Massachusetts
- Michigan
- Minnesota
- Montana
- New Hampshire
- New York
- Ohio
- Oregon
- Pennsylvania
- Utah
- Vermont
- Virginia
- Washington
- Washington, DC
- Wisconsin

RICH IN NATURAL ORGANICS

for all seasons

PHOSPHATE FREE

- Environmentally Friendly. Won't Burn Your Lawn
- Long Lasting, Slow Release Nitrogen
- Apply Anytime of the Year for a Thi Green Lawn

NET WEIGHT 20 LBS. (9.07 kg)

Does Banning **P** Do Any Good?

- Numerous states have banned **P** in detergents and dishwasher soaps
  - Not banned in lawn fertilizers or for agriculture uses
- Minnesota Banned **P** in 2005
- **P** decreased in lawn fertilizers sold from 292 tons in 2005 to 151 tons in 2006
- Ann Arbor, Michigan banned **P** in 2006
- **P** levels in waterways dropped 28% in 2 years
- Illinois banned **P** in 2010

How Do I Get more **P** in My Garden?

- Banana peels
- Bone meal (bone ash), Calcium Phosphate Tribasic
- Compost
- Balanced fertilizers used carefully, i.e. feed only a few times a year with 10-10-10
- Or perhaps use 24-0-10 in May and 10-10-10 during other time

WHAT CAN YOU DO?

- Gardeners are the stewards of our land and environment
- Set an example, do not use P on lawn
- Ask for, buy P-containing fertilizers only where needed, if allowed
- Reduce wind and soil erosion in addition to runoff
- Do not over-fertilize
- Apply all fertilizer properly

Look for the middle number: The three numbers on a fertilizer container lists its percent nitrogen, phosphorus and potassium content, in that order. A zero in the middle means a phosphorus-free fertilizer.

Apply All Fertilizers Properly

- Never apply fertilizer before a big rainstorm
- Keep fertilizer off hard surfaces i.e. cement
- Sweep up any that falls on hard surfaces and reapply to lawn
- For rose beds scratch it in and water it in.
- Do not apply within 10 feet of a lake or stream

Fertilizers with Other Ingredients

- Preen
  - Weed killer is trifluralin
  - Harmful to fish, aquatic life, gardeners
- Is widely available and widely used
- Is a pre-emergent

Fertilizers with Other Ingredients

- Weed and Feed
  - Weed killer is 2, 4-D
  - Possibly harmful to kids, pets, gardeners
- Is widely available and widely used
- Is a post-emergent

Fertilizer Recommendations

- Organic is best but can take a lot of work
  - Home-grown compost is best, sustainable
    - Know what has been sprayed, applied to plant materials
  - Can also use other organic supplements
    - Composted manure – low levels of NPK
    - Blood meal – high in nitrogen
    - Bone meal – high in phosphorous

Fertilizer Recommendations

- Inorganic is fine but use thoughtfully
  - Is susceptible to wind, water erosion
  - Can burn plants if applied too heavily
- Regular-release is relatively inexpensive
- Slow-release costs more, provides longer coverage, “stays put” better

- All plants need to be fed

Fertilizer-related Issues

Applying fertilizer – check label instructions

Lawns –

- Mow 1-2 days ahead to allow penetration
- Broadcast, by hand or spreader

Plants –

- Spread around base, work into soil or
- Place at bottom of hole before inserting plant
- Can be solid or water-based

Fertilizer-related Issues

Storing fertilizer – keep from moisture

- Keep in original bag, container
- Cool, dry, dark and secure (away from children, pets) spot; well ventilated
- Keep separate from other garden materials, like pesticides
- Make sure it is clearly labeled

LYNN ARTHUR PUBLIC ROSE GARDEN

- Located in downtown Libertyville Illinois
- Founded in 1952
- Maintained by the Gardeners of Central Lake County since inception
- Dedicated and named after our long-time curator Lynn Arthur in 1989
- We moved to Libertyville in 1992 and have been a rose garden volunteer ever since
- Curator since 2001

Lynn Arthur Rose Garden Nitrogen Fertilization Changes Since 1992

May Fertilizer Applications

- 1992 - Ammonium Nitrate 34%
- 2006 - Urea nitrogen 46 %
- 2009 - Lawn Fertilizer 29-3-12
- 2011 - Lawn Fertilizer 24-0-10
- 2012-2013 – 28-0-12
- 2014-2025 – 22-0-11

June and July Fertilizer Applications

- 1992-2025 - 12-12-12 or similar

Lynn Arthur Rose Garden Phosphorous Fertilization Changes Since 1992

- 1992-2006 ½ Cup superphosphate put in bottom of planting hole when a new bush planted
- 1992-2009 - 8-32-13 used for the last fertilization each year, August 7-15
- 2010 Lawn fertilizer - 12-12-12
- 2011-2025 - 6-24-24

June and July Fertilizer Applications

- 1992-2025 - 12-12-12 or similar

Rose Garden gives us blooms like this

A Few Other Issues

UREAFORM Nitrogen

- A polymer formed from urea and formaldehyde
- A slow-release form of nitrogen, 38-0-0
- 70% of the total nitrogen is water insoluble
- The WIN nitrogen is released by microbial action
- Great material as it never burned foliage
- Disappeared from home gardener’s market in the late 90’s

Production of Nitrogen in the USA Over the Years

Year	Ammonia	Ammonium Nitrate	Urea
1983	13,361	3232	4112
1985	16,594	3178	3975
1990	14,167	2579	4231
1995	14,509	2648	4808
2000	13,438	2873	4742
2004	9,164	2165	3095
2005	8,945	2473	3086
2006	7,209	2045	2284
2007	7,888	2180	2603
2008	8,226	2105	2463
2009	7,609	1959	2340
2010	8,600	1841	2320
2011	8,814	1947	2260
2012	9,131	2003	2475

Thousands of tons, From Tables in Chemical and Engineering News

Production of Phosphorus in the USA Over the Years

Year	DAP	MAP	Super Phos	Phos Rock	P_2O_5
1983	10,264	1423	2684	40,664	9,182
1985	10,800	1641	2570	49,348	9,837
1990	13,860	2252	1998	44,311	11,349
1995	14,010	2541	1528	38,303	11,263
2000	12,670	4106	991	32,327	10,253
2004	10,404	5328	790	35,338	10,530
2005	9,988	5213		35,183	10,533
2006	9,474	4170		33,127	9,802
2007	8,202	4838		29,370	9,379
2008	8,018	5004		29,673	8,912
2009	6,745	3307		26,332	6,775
2010	7,419	4300		26,118	7,895
2011	6,845	4732		25,196	8,309
2012	6,482	4672		26,908	8,200

Thousands of tons, From Tables in Chemical and Engineering News

How Superphosphate is Used

- Put the 0-46-0 superphosphate directly in the hole at ½ cup /bush when planting a rose bush
- Recommended for trees, shrubs and bulbs also
- Superphosphate is a major component of many balanced fertilizers such as 10-10-10

THANK YOU FOR COMING

- We will be here to answer additional questions
- This presentation will be uploaded onto our website